भारतीय दिवाला और शोधन अक्षमता बोर्ड

Insolvency and Bankruptcy Board of India

# STUDY MATERIAL
# FOR THE EXAMINATION
# IN THE DISCIPLINE OF

# PLANT AND MACHINERY


**PREPARED BY:**

CENTRE FOR VALUATION STUDIES,
RESEARCH AND TRAINING ASSOCIATION
(CVSRTA)

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## Preface

19th November, 2018

Institutions are the foundations of a well-functioning market economy. Professions constitute a key element of the institutional framework. The nature and extent of professionalisation, to a large extent, determines the competitive edge of nations and sustainability of prosperity.

2. In a market economy, market discovers price, which usually reflects the worth of an asset (or a liability). It discovers different prices for the same asset in different contexts. Thus, price is not absolute; it is context specific. Often it is neither feasible nor desirable to go through the market to discover the worth of an asset. In such cases, worth of an asset is estimated by a professional outside the market. The worth so estimated is 'value', which is what the price ought to be in the same context. If value of an asset is equal to its price, the valuation or value estimated is considered perfect. It requires specialised knowledge, considerable dexterity and the highest integrity on the part of a professional to take the asset through a simulated market in the given context to estimate its value, which is very close, if not equal, to the price. A market economy needs a cadre of such professionals for valuations of for a variety of purposes.

3. The valuation profession has a long history in India. Different statutes and authorities require valuation for different purposes and often prescribe the manner of such valuation. There have been several attempts in the past to develop holistically an institutional arrangement that develops and regulates the profession of valuers who can estimate the value of any asset with full responsibility. It took a concrete shape with enactment of the Companies Act, 2013. Section 247 of the Act provides that where valuation is required to be done under the provisions of the Act, it shall be valued by a person who, having the necessary qualifications and experience, and being a valuer member of a registered valuer organisation (RVO), is registered as a valuer.

4. The Central Government notified the commencement of section 247 of the Companies Act, 2013 with effect from 18th October, 2017. It also notified the Companies (Registered Valuers and Valuation) Rules, 2017 (Rules), which provide for a complete framework for development and regulation of the profession of valuers and the manner of valuation, including valuation standards and Code of Conduct for registered valuers. The Central Government delegated its powers and functions under section 247 of the Act to the Insolvency and Bankruptcy Board of India (IBBI) and specified the IBBI as the Authority under the said Rules.

5. Subject to meeting other requirements, an individual is eligible to be a registered valuer, if he (i) is a fit and proper person, (ii) has the necessary qualification and experience, (iii) is a valuer member of an RVO, (iv) has completed a recognised educational course as member of an RVO, (v) has passed the valuation examination conducted by the IBBI, and (vi) is recommended by the RVO for registration as a valuer. A partnership entity or a company is also eligible for registration subject to meeting the requirements. The Rules prescribe that with effect from 1st February, 2019, every valuation required under the Companies Act, 2013

and the Insolvency and Bankruptcy Code, 2016 needs to be conducted by valuers registered with the IBBI.

6. The IBBI performs the functions of the Authority under the Companies (Registered Valuers and Valuation) Rules, 2017. It recognises RVOs and registers valuers and exercises oversight over them. It has published the syllabus, format and frequency of the valuation examination for all three Asset Classes, namely, (a) Land and Building, (b) Plant and Machinery, and (c) Securities or Financial Assets, in consultation with the stakeholders. It conducts computer-based online valuation examinations every day from several locations across the country for all three Asset Classes. It has specified the details of educational course for the three Asset Classes, which a member of an RVO is required to complete before taking the valuation examination.

7. The international market is offering a large variety of books and training programmes for individuals wishing to become valuation professionals or provide any service in the valuation chain. However, there is a dearth of quality study material and faculty in Indian context. It is necessary to supplement the efforts of RVOs and the registered valuers - existing and prospective - by making available quality study material relevant to Indian context.

8. The Centre for Valuation Studies, Research and Training Association (CVSRTA) has developed this study material as per syllabus of the valuation examinations for two Asset Classes, namely, Land and Building and Plant and Machinery. I compliment the CVSRTA, and the Authors, Subject Editors and Language Editors for putting in very hard work to prepare such comprehensive study material for the benefit of valuation profession. I thank the CVSRTA for its offer to place this study material on the website of the IBBI for free download by users. I am sure, this study material will greatly support development of the fledgling valuation profession in the country and will be useful to those who wish to learn the subject, practise as a professional valuer or provide any other service in the valuation chain. It will motivate more inquisitive minds to delve deeper into various aspects from an interdisciplinary perspective, enriching the Indian literature on valuation in the days ahead.

9. The IBBI, however, does not recommend any reader to use this study material for any purpose, including preparation for valuation examinations, or any person to take any action or decision, commercial or otherwise, by using this study material. It urges the reader to do her own research and / or seek professional guidance as she may consider necessary for her purpose, while using this study material.

M. S. Sahoo

**(Dr. M. S. Sahoo)**

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Centre for Valuation Studies, Research and Training Association (CVSRTA) considers itself privileged to prepare the study material for the examinations in the disciplines of Land and Building as well as Plant and Machinery conducted by the Insolvency and Bankruptcy Board of India (IBBI) which will be beneficial to professionals in India.

CVSRTA is thankful to IBBI for giving an opportunity to prepare the material.

Kirit P. Budhbhatti
Chairman - CVSRTA

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# PLANT AND MACHINERY

## SUBJECTS PRESCRIBED

- PRINCIPLES OF ECONOMICS
- BOOK KEEPING AND ACCOUNTANCY
- LAW – GENERAL
- INTRODUCTION TO STATISTICS
- ENVIRONMENTAL ISSUES IN VALUATION
- PROFESSIONAL ETHICS AND STANDARDS
- VALUATION OF PLANT AND MACHINERY
- LAW – PLANT AND MACHINERY
- PRINCIPLES OF INSURANCE AND LOSS ASSESSMENT
- INDUSTRIAL PROCESSES
- REPORT WRITING
- CASE STUDIES

Efforts to make the study material of Plant and Machinery is concentrated for those subjects which are generally not easily available in public domain. For common subjects like Valuation of Plant and Machinery, Various Approaches for Plant and Machinery Valuation, General Process needs to be adopted for Valuation, Leasing of Plant and Machinery, Case Laws, Report Writing, etc. are to be referred from following books:

- *Valuation on Plant & Machinery (Theory & Practice) by Kirit P. Budhbhatti*
- *Real Estate Valuation in Practice by Kirit P. Budhbhatti*
- *Writing a Report by P. T. Hardikar*
- *Valuing of Machinery and equipment, The fundamentals of apprising machinery and technical assets - 3rd edition by ASA*

# PRINCIPLES OF ECONOMICS

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Chairman, CVSRTA

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# UNIT – I

## DEFINITIONS AND CONNOTATIONS

### 1.1 INTRODUCTION

Economics can be divided into three parts, namely, descriptive economics, economic theory, and applied economics. In descriptive economics one collects together all the relevant facts about a particular phenomenon. While economic theory or analysis gives a simplified version of the way in which an economic system functions. Applied economics takes the framework of analysis provided by economic theory.

There are three broad assumptions namely assumptions regarding behaviour of individual. Economists are concerned with people as consumers and as businessmen. When economists discuss the actions of consumers, they assume that they behave rationally. It means that they try to maximize their satisfaction with minimum possible expenditure. In the same manner, economic theories assume that the businessmen try to maximize their profits. It is their economic rationality.

The second group of assumptions is about the physical structure of the world i.e. natural conditions. They always remain to be given. It is these conditions give rise to economic problem because resources are limited in relation to their demand. Therefore, goods and services are scarce in supply. The scarcity of resources leads to economic system and economic problem. What is worse is that the scarce resources have alternative uses. This makes all the more difficult for human being to solve economic problems.

The third group of assumptions relates to social and economic institutions. Under this group of assumptions, comes political stability. Without which neither consumers nor producers attain their goals. For economic prosperity, political stability is a must. Applied economists are often concerned with 'test' theory studying statistical and other evidence to discover if it appears to support particular economic theory. Hence, economics is concerned with a study of one of the aspects of human beings. It enquires into how a human being gets his income to satisfy his unlimited wants with limited means. It deals with day-to-day activities of human being relating to his efforts of maximizing his satisfaction. Therefore scope of economics centers around wants – efforts – satisfaction.

Economic problem begins with human wants and ends with satisfaction of those wants. Economics is concerned with every human being poor as well as rich. In nutshell it could be deduced that science of economics enquires into how a consumer attains his income and spends it in order to achieve maximum satisfaction with minimum efforts or expenses.

## 1.2 DEFINITION OF ECONOMICS

A good number of definitions of economics have been numerated but we shall be dealing with three main definitions given by Adam Smith who is considered to be the father of economics, Dr. Alfred Marshall and Prof. L. Robbins.

Adam Smith called economics as "Science of Wealth". He emphasized wealth because in days of Adam Smith monarchy was in existence. The kings were interested in amassing wealth for their military operations. Hence, Adam Smith emphasized wealth. He paid attention exclusively to wealth. He totally neglected role played by man. Wealth has no significance if there is no man to make use of it. Wealth attains importance if it is considered in relation to man because wealth is not be all and end all of human life. It is simply a means to end and the end being the maximum welfare of the society.

According to Dr. Alfred Marshall "Economic is a study of man's actions in the ordinary business of life; it enquires how he gets his income and how he uses it – Thus it is on one side a study of wealth and on the other, and more important side a part of the study of man."

Dr. Marshall in his definition of economics makes it clear that in economics how human being earns his living by earning income and spending it for maximization of his welfare. Marshall shifted emphasis from wealth to man. Production of wealth and using it for his welfare is stressed by Marshall. Thus Marshall's definition covers consumption, production, exchange and distribution. Marshall pays more attention to material welfare of man which is obtained by using economic resources rationally. Thus, Marshall accords secondary position to wealth. Economics concerns with ordinary men and women who are motivated by maximum advantages that is welfare. He holds that it is a social science which studies individual behaviour also. It is therefore economics ignores non-material aspects.

However, Marshall's definition is criticized by Prof. Lionel Robbins on the following grounds:

1. It is classificatory.
2. It is concerned with material welfare alone narrowing the scope of economics.
3. Marshall's definition totally neglects the non-material services.
4. No clear-cut distinction is made between ordinary business of life and extraordinary life.

Wealth and welfare cannot go together. Wealth like poison does not increase the welfare. Non-material things like love and affection also raises the human welfare, which Marshall totally neglected. Moreover concept of welfare is subjective. It varies from person to person, time to time and place to place. The term welfare may land us in the domain of ethics. Prof. Lionel Robbin held that economics is neutral between wants. Economics is not concerned with the causes of material welfare as such. It is for this reason Robbins held that Marshall's definition is narrow, classificatory and unscientific.

### 1.2.1 LIONEL ROBBIN'S DEFINITION

"Economics is a science that studies human behaviour as a relationship between ends and scarce means which have alternative uses."

The following are the four pillars of Robbin's definition:

1. Economic is a science that studies economic aspect of man's life. From the social point of view, it is a normative science but from individual point of view, it is positive science.

2. **Wants unlimited**
   Human wants are unlimited. It is not possible to satisfy them all because means are limited. If one want is satisfied another crops up. Man is such an animal that he is never satisfied. He tries for variety and plenty. This applies to his all wants. Besides his basic wants, he wants to have a number of things such as comforts and luxuries. Since human wants are countless, as a rational being he or she has to be selective ones. He chooses to satisfy most urgent wants first postponing the satisfaction of less urgent wants. Hence, human wants are be all and end of all of economic activities.

3. **Limited means**

Though wants are unlimited, means to satisfy them are limited. Moreover they have alternative uses. That is why economic problem arises, because all goods are not free goods. That is why goods are paid to obtain them. Scarcity of resources gives rise to economic problem because these resources have alternative uses either for this or that. But one must know that it is not the absolute scarcity. It is in light of demand for it, is to be considered. For example rotten egg may be scarce in supply but since nobody demands it, it is plentiful in supply. Hence scarcity be considered in relation to demand only.

4. **Alternative uses of resources**

Means or resources are not only limited but they have alternative uses also. It means that they can be put to number of uses. Had they possessed fixed and specified use, economic problems would not have arisen. But multiplicity of uses of scarce means makes things all the more difficult. Hence, scale of preference of uses is to be made. Most urgent wants are to be satisfied first. In case of less urgent wants, satisfaction is postponed. This means that a rational choice is to be made between wants. Hence multiplicity of wants, scarcity of means and their alternative uses give rise to economic problem. Thus, L. Robbins held that economics tells us how a man makes use of his scarce resources having alternative uses for the satisfaction of his countless ends. Hence it involves choice making it all the more difficult that is why economics is called as a science of choice.

### 1.2.2 Superiority of Robbin's Definitions

Prof. L. Robbins definition of economic preferred to all other definitions. It is called as scarcity definition. It is considered to be scientific definition because it is independent of any classification. Secondly, all types of wants social as well as individual fall within the domain of economics. Thirdly, it has a widened the scope. Marshall had restricted it only to wealth and activities related to the material welfare of man. Fourthly, Robbins held that economics is only science and not arts. Lastly it is also held that economics is neutral between wants. It does not consider moral – immoral consideration. It is for the consumer to make rational choice between wants. This makes economics is a positive science.

**Limitations**

Robbins definition though it is widely accepted and more scientific yet it is considered to be colourless, impersonal and neutral between wants. However, from the social point of view, economics cannot keep aside its normative appearance. The job of economics is also to advocate and condemn.

It also appears that L. Robbins has reduced economics only to valuation theory. Economics not only touches upon resource allocation or price determination but also study how the national income and employment are determined. Thirdly, Robbins definition does not cover theory of economic growth or development which has become an important branch of economics. The theory of economic growth deals with growth of economy but according to Robbins resources are given. He only discusses their allocation. Further more, Robbins definition does not deal with problem of plenty and also of unemployment. According to Robbins economics studies only the problem of scarcity. It also lacks human touch. L. Robbins made economics more abstract and complex making it more difficult. Hence it goes away from its utility for the common man because it must be concrete and realistic study.

### 1.2.3 Modern Views

Of late economic thinking has gone a long way. Lionel Robbins held that economics is concerned with multiplicity of wants and scarcity of resources having alternative uses. But in modern times, it is held that economics is much more than merely a theory of value and allocation of resources. It was Lord J.M. Keynes who brought about a change in economic thinking by advocating government participation in economic development of the country. Now economics is looked upon as the study of the administration of limited resources and of the determinant of employment and income. Thus, besides, theory of value, it studies how the levels of income and employment are determined. It means that modern economics studies the causes of economic fluctuations in order to achieve economic stability. In other words economics studies the factors affecting the size, distribution and stability of country's national income.

Second half of the twentieth century, saw growth theories occupying important place in the study of economics particularly with reference to poor countries. Therefore, one can conclude that a satisfactory definition of economics is one which includes in it theory of income, employment and growth in addition to theory of value or resource allocation.

## 1.3 Scope of Economics

Scope of economics as stated earlier is wants, efforts and satisfaction. Economics begins with human wants and ends with satisfaction of those wants. Man undertakes efforts to satisfy his innumerable wants. It studies only one aspect of man's life. All activities of man are centred around the satisfaction of his wants. Economics is concerned with satisfaction of wants. It is a social science and therefore tries to find out solutions to social problems like unemployment of natural resources, raising national income through planned economic development. Acceleration of economic growth has become main thrust of economic development in these days.

Economic is a science. Science is defined as a systematized body of knowledge. Economics, too, has its rules, regulations and laws in which it binds itself. Now, the question is whether economics is a positive or normative science. Positive science is one which deals with the facts as they are while normative science is one which deals with the facts as they should be or ought to be. Positive economics attempts to describe and analyze the existing situation rather than suggesting how to change it. But many times economists do often make normative statements. Instead of explaining how the economy actually operates, they suggest, how it should operate. Especially, where problems of the economy are concerned, economists abandon the objectivity of positive economics and make normative statements. It is in this context, that we suggest what the government's economic policy ought to be. How government should act to raise the level of employment etc. Physics, chemistry, geology and biology are the positive sciences as they deal with the facts as they are while social sciences like economics, psychology, sociology, political science etc. deal with the facts as they should be. Thus, economics is both positive as well as normative science. While dealing with individual economic problems, it is a positive science and while dealing with social problem it becomes normative science.

The study of economics incorporates it in its scope, consumption, production, exchange and distribution of natural resources. It concerns with economic growth leading to raising national income and its equitable distribution along with balanced economic development. Now-a-days economics' scope is widened so much that maximization of economic welfare has become the main goal of the economic activities.

The knowledge of economics has gone so far that it reached a stage when its facts have been collected and carefully analyzed and laws or general principles explaining to facts have been laid down. This makes economics a positive science.

It is also considered an Art because it lays down and formulates to guide people who want to achieve a certain aim. The aim may be removal of poverty or raising production of goods and services in the country. Economics does help us in solving many day-to-day practical problems. It is not mere a theory. It has great practical use. Therefore, one can conclude that economics is both a science and an art also.

## 1.4 Micro-Economics

British Economist named Adam Smith is the founder of micro-economics which deals with individual behaviour such as markets, firms and households. According to Smith, economic benefit comes from the self-interested actions of individuals. K.E. Boulding holds, "Micro-economics is the study of particular firms, households, prices, wages, incomes, industries and commodities, etc.". In micro-economic, we study how the various cells of economics organism namely individual consumers and producers reach their equilibrium positions. In other words, in micro-economics, we make microscopic study of the entire economy. However, it must be noted that the micro-economics does not study the economy in its entirety, instead under this branch of economics, we study equilibria of thousands of units of the economy. Prof. Lerner rightly observes, "Micro-economics consists of looking at the economy through a microscope as it were to see how millions of cells in the body of economics viz. individuals or the firms as producers play their part in the working of the whole economic organization.

- Micro Economics
  - ProductPricing
    - Theory of demand
    - Theory of supply
  - Factor Pricing
    - Rent
    - Wages
    - Interest
    - Profit
  - Economic Welfare

The scope of micro-economics includes in it production, consumption and distribution or any other activity tends to be carried out with the highest efficiency so as to maximize social welfare. It also studies every constituents of the circular flow of income. In other words micro-economics is the application of partial equilibrium analysis to economic problems. Micro-analysis are useful for price determination and allocation of resources, determination of economic policies, international trade, linear programming and optimum utilization of resources.

Limitations of micro-economics – it does not throw any light on the collective activity. The analysis is based on unrealistic assumptions which may result into doubtful conclusions.

### 1.5 Macro-Economics

It deals with aggregates. It is concerned with total demand, supply, output, income and so on. Hence macro-economics is a study of aggregates and averages. It is the study of economic system as a whole. It directly concerns with relations among large aggregate such as national income, general price level, total output, consumption, employment, savings, investment, demand and supply. These relations indicate the behaviour of economic system as a whole. J.M. Keynes holds that macro-economics concerns itself with those aggregates which relate to the whole economy.
Prof. Paul Samuelson rightly remarks, "There is really no opposition between micro and macro economics. Both are absolutely vital; and you are only half educated if you understand one while being ignorant of the other."

The scope of macro-economics is very wide and it assumed added importance since the publication of J.M. Keynes, General Theory of Employment, Interest and Money in 1936. It is considered to be policy making economics. The study of macro-economics includes, the theory of income, employment, general price level, theory of factor pricing, economic growth and inflation and deflation.

Macro-Economics

- The theory of Income and Employment
- The theory of General Price Level and Inflation
- Theory of Factor Pricing
- The Theory Economic Growth

**Importance of Macro-Economics**

1. The study of macro-economics enables the government to frame the correct and effective economic policy.
2. It proves to be more helpful in economic planning.
3. It helps developing micro-economic theories.
4. It also enables one to have international comparison.
5. Lastly it is absolutely essential to have knowledge of macro-economics to make correct decisions.

**Limitations**

Use of macro-economics analysis complicates the process of the study of prices, savings, investment, factor pricing etc. Secondly all aggregates are not identical and therefore macro-study will become rather difficult. Thirdly, statistical data and techniques are the soul of the study of macro-variables. Therefore, if reliable data is not available decisions based on such data proved to be wrong. In the fourth place, it cannot be said that only one variable is affected from the changes leaving all other variables unaffected.

According to Prof. K.E. Boulding, "Micro-economics follows the method of slicing whereas macro-economics uses the method of humping."

## 1.6 Connotations

If we probe a little deeper, however, we find that economics is really not so much about money as about some things which are implied in the use of money. Three of these – exchange, scarcity, and choice are of special importance. Let us take them in turn.

### 1.6.1 Exchange

Money implies exchange. It is in fact the medium of exchange. In a primitive community, where exchanges are rare, we can dispense with money and resort to direct barter. Money is unnecessary so long as we are at the stage of trying to satisfy all our wants by our own efforts, growing our own wheat, milling our own flour, baking our own bread, and only now and again exchanging, say, wheat for a ploughshare or a calf for a millstone. But immediately we begin to specialize, and cease to produce goods for our own use, money becomes indispensable if exchanges are to take place smoothly. Exchange becomes triangular – we convert goods into money and money into other goods, instead of simply bartering goods for goods. If exchanges did not take place in this apparently circuitous way, no one who specialized in making bricks or bowler hats would relish a morning's shopping. The grocer might have no use for bricks, and match-sellers would hesitate to accept the hundredth part of a bowler hat. A walletful of money goes so much further than other walletfuls!

Nowadays, therefore, exchange rarely takes the form of direct barter. Instead, we do business with money. We buy what we want with money, sell for money, fix prices in terms of money, are paid our wages, salaries, or dividends in money, save money, and measure our wealth in money. But the problems which present themselves to us in terms of money are exactly similar to the problems raised by direct barter. There is a surface difference between money-exchange and barter-exchange, but no difference in principle. Economics, therefore, does not limit itself only to money-problems but studies exchange-problems of all kinds. It is, in fact, about exchange rather than about money, for exchange underlies the use of money.

**Exchange Implies Interdependence**

When one exchange, we have stopped being self-sufficing and have become dependent in those from whom we buy and to whom we sell. Our fortunes are linked with theirs. If they are poor or unemployed then we are likely to be in danger of poverty and unemployment ourselves. Famine and flood in one part of the world can create scarcity and distress thousands of miles away by cutting off supplies of foodstuffs and raw materials. We are all within the circle of exchange. Yet this interdependence rarely occurs to us : it is so easy to overlook the implications of exchange.

Consider, for example, some everyday event like the purchase of a packet of cigarettes. I take from my pocket a small piece of metal – probably Mexican silver alloyed with Canadian nickel – and offer it to a total stranger who accepts it with alacrity. In exchange, I receive a cardboard packet whose contents are the product of workers from all over the globe – Norwegian lumbermen, Turkish peasants, Malayan tin-miners, American inventors. I draw also on the services of British workers scattered over the country. The packing of the cigarettes has been done in Bristol; the cellophane wrapper and silver paper come from London; the paper round the cigarettes from Swindon; the stiffener, or cigarette card, from Glasgow. But about all these workers, through whose efforts I am able to smoke my cigarettes, I am amazingly ignorant. I do not trouble to inquiry whether they include cannibals, racketeers, Jew-baiters; whether they are mean, grasping, or dissolute; or whether their daily earnings are less than 1d or over £100. Their creed, their way of living, their income, the colour of their skin, do not interest me. I can drive my bargain with them without even knowing that they exist. The cash-nexus that binds us is the loosest of bonds. It leaves me free to pursue my own interest, undeterred by any sense of moral obligation to other workers as fellow-citizens. They satisfy my wants and earn the means of satisfying theirs. And that, to most of us, might seem to be the end of the matter.

But not to the economist. It is precisely these exchange-bargains which he sets out to investigate. Why, he asks, do people exchange at all? What advantages does society reap from leaving people free to satisfy their wants by exchange? When exchange is fair and when unfair? Is it in the social interest that exchanges dictated by mutual self-interest should be left unregulated by the State? Or, if regulation is desirable, on what principles should the State intervene?

### 1.6.2 Scarcity

The use of money implies scarcity. Money itself must be scarce or it will cease to be used. If the supply of money is increased without limit it will soon lose value and in the end no one will accept it. Whatever passes as money, therefore, must necessarily be scarce. So also – and this is the important point – must be the things that money will buy. We only exchange one scarce thing for another. We do not pay for air and earth and water unless somehow they are stinted just as the supply of money is stinted.

The fact of scarcity makes it necessary for us to economise, i.e., to make the most of what we have. We have constantly to be counting the cost, weighing up alternatives, and going without one thing so as to be able to buy more of another. Nominally it is money that we economise, for what we have to decide is whether to spend money on this or on that. What we are really doing, however, is to economise the things that money will buy. We try to buy, with our limited income, the collection of goods and services which gives us most satisfaction. We are faced with the fact that these goods and services are scarce, and we have to accommodate this scarcity as best we can to our wants and needs. Similarly, in earning money we have to husband our scarce time and energy in order to obtain as large a return as possible (in money or in amenities and personal satisfaction) for our efforts. On some men, of course, the pressure of scarcity and want bears harder than on others. On the millionaire, for example, the pressure is negligible; he can almost always neglect considerations of cost. But for others the necessity of making ends meet enforces constant self-denial.

### 1.6.3 The Economic Problem

What is true of each of us is true also of society as a whole. There is an economic problem of making the ***social*** income go as far as possible. The goods produced and services rendered in any country in the course, say, of a year, are limited in amount and insufficient to maintain a standard of more than moderate comfort if equally distributed amongst the inhabitants of the country. The goods and services at the disposal of the country in other words, are scarce in relation to the demand for them. There are very few things that can be provided free of charge, even in a rich country. We can make as much use as we like of public libraries and parks and roads. But we cannot help ourselves to books and motor-cars, much less to food and clothing. The more of one thing is offered to us, the less can we have of other things. We cannot have more of all simultaneously. If A is free, B will be all the dearer. The provision of free motor-cars, - for example, would lead to an expansion of the automobile industry and the transference to it of engineers, materials, and machinery from a host of other industries. Motor-cars would be more abundant; but other things would be scarcer. Only if we set a very high value on motor-cars (like the value which we set on good roads, or schooling, or health services) will we be prepared to face the cost of offering them free.

This balance between value and cost is forced on us wherever we are faced with a shortage of supplies relatively to our wants. The things which we value highly and which cost little to produce will be provided first and in large quantities. What costs a great deal and is of comparatively little value will not be produced at all. We have to decide what commodities, and how much of each, to produce; and our decision will rest upon our estimates of cost and value. The decision is one that must be taken in every society, whether it be Russia or the United States, Italy or Malaysia. The way in which the decision is taken, and the kind of people who take it, are, of course, very different in different countries. The responsibility may rest with a bureaucracy or with the mass of "consumers." One country may have a State Planning Commission; another may rely on the laws of supply and demand. Whatever the economic system, the decision is one that cannot be avoided. There is an economic problem which has to be solved by dictatorships and democracies, "planned" and "unplanned" societies alike. Want and scarcity are universal, and so, too, is the problem of a accommodating the one to the other.

In some countries the problem may be solved more satisfactorily than in others. But there is no question of one social system bringing plenty and another condemning us to scarcity. Man's wants are insatiable, and there would continue to be scarcity under any social system. If, for example, we all had twice as large an income as at present – an advance which could not be brought about immediately by any conceivable change in our social system – the annual income of the average British worker would still be under £600, and from this sum a large slice would be taken in taxation, and a further slice would have to be put aside as savings. Such an income would probably fall short of the aspirations of most people and could be reached only by exertions which would be decidedly irksome. The conflict between scarcity and want would continue to be felt.

Scarcity, like exchange, raises problems for the economist. He tries to formulate the principles on which our limited productive resources can be used to the fullest advantage. He studies how unemployment, for example – an obvious waste of labour power – can be reduced or eliminated; how the community's savings can be made to find their way into productive investments, how the land can be cultivated in the best interests of society. He studies; too, on what principles we should allocate resources between different industries so as to produce a maximum of all commodities in the right proportion of each; and how the output of commodities should be distributed between those who help to make them.

These are problems which cannot be confined within the narrow bounds of pure economics. They extend into politics, ethics, and even religion. But we can get a better view of them from the heights of economic theory than from any other standpoint. Since this better view will still be coloured by our personal convictions, it will not of itself remove differences in outlook. But it will give us a wider perspective and open our eyes to the more remote implications of our problems.

### 1.6.4 Choice

The use of money also implies choice. We have to choose between the many claims on our purse when we spend money, and between the many uses to which we might put our time and energy in earning it. We cannot spend the same evening in the cinema and in the theatre. We must choose one form of entertainment or the other. We may have to choose, also, between spending an extra shilling or so on a seat and spending the same shilling later on cigarettes.

Our choice, of course, is not always made rationally. That is, we do not always weigh up carefully the possible ways in which we might spend our money. We are much more lighthearted and irrational in buying sweets, for example, than we are in renting a house. We buy, very, often, impulsively or through habit or force of example. Or we may buy because our "sales resistance" has crumpled at the sounding of some advertiser's trumpet. It is irrational to pay more than is necessary for a thing; and yet hardly a day passes but we buy goods without asking their price, or cannot be bothered to look for cheaper brands. We do not take the trouble to find out where prices are lowest; or we take excessive trouble to save a trifling sum, like the wealthy man who walks to save a penny fare. We do not budget for so much on clothes, so much on amusements, so much on food, so much on our savings account, and so on, but spend haphazard so long as the money lasts. Or at least that is what large numbers of us do.

Perhaps, however, the careful housewife – and the tradition amongst economists are to think of housewives, as the persons who hold the purse-strings – is more rational in her buying. The economic woman may be less of an abstraction than the economic man!

The way in which we make a choice is of great importance to the economist. For he cannot tell how much weight to place on the preferences expressed in the spending and earning of money until he knows how far these preferences are ***rational*** (i.e., based on full knowledge and formed after reflection). If for instance, people persist in buying an expensive brand of cigarette it is important to know whether they buy it out of a liking for that particular brand or because they are ignorant of cheaper brands with the same flavour or because of snob-appeal in the advertisements. Until the psychology of cigarette-smokers is explained to us, we cannot say whether the production and the sale of these high-priced cigarettes involve a social waste. If smokers are rational there ***may*** still be a waste (for instance the price may be kept high by a monopoly). But if they are irrational, there is certainly a waste; they are paying more than they would if they were in possession of all the facts.

In economics we begin by assuming that choice is rational. The so-called "economic man" is simply one who is completely "rational" in satisfying his wants, and pays no regard to the interests of others. It is, of course, an abstraction from the facts to assume that men are self-interested and rational. But to make this kind of abstraction is the only satisfactory procedure open to us. If we assume that people are self-interested and rational, we can predict how they will behave given a certain monetary inducement, and we can work out an analysis of action and reaction.
For instance, if similar goods are on sale at different prices, or similar jobs advertised at different rates of pay, we know that men will, other things being equal, purchase the cheaper goods, and apply for the better-paid job. If we could not make such generalizations, if men were quite irrational, then we should never "get anywhere" in economics. So we begin by assuming that choice is deliberate and rational, without, however, overlooking the part played by impulse, custom, and inertia. Later, we may study the psychology of choice more closely; analyzing what shapes our expectations and desires, and sifting what is basic in our wants from what is superficial or conventional. But to begin with, we ignore these difficulties, take people's desires for granted, and assume that choice is rational.

In the economic system as we know it, choice rests largely with the individual. His preferences go to determine what is to be produced and what is not. Every penny spent on A is a vote in favour of the production of A; every refusal to buy B is a vote against the production of B. It is the free choice of individual consumers between the goods, competing on the market that determines what industries can carry on at a profit. The industries that cannot show a profit are not carried on at all. Those that show excessive profits attract competition and expand until people's wants – as indicated by the price which they are prepared to pay – are more adequately met.
That is, if competition is possible and effective. But if some commodity is monopolized, consumers may be powerless to get what they want (and will pay for) in the proper quantity. They show their readiness to cast votes for more of the commodity by offering high prices for it. But the election is disregarded. No one is willing to stand against the monopolist. So he is able to preserve an excessive scarcity by keeping people out of his line of business. He makes things scarcer than people want them to be and earns high profits by doing so.

Thus a country like ours does not deliberately decide what industries fit best with its advantages and needs and on what scale they should be carried on. The decisions that might otherwise rest with a central planning authority take shape instead in the market. One industry expands and another contracts as consumers alter their preferences and purchases. The scarce productive resources of the community are not always rationed between the different industries by some Planning Commission. They flow into the channels lubricated by the expenditure consumers.

But is it desirable that the individual should retain so much freedom of choice? What if consumers are irrational or incapable of judging between competing goods? Would it be better to appoint a State Planning Commission with power to decide what kind of goods should be produced and what kind of jobs workers should be encouraged to take up? Should each man's daily rations be assigned to him as the average man's daily work is at present? With whom should choice rest, and through what agencies is it best exercised? Here is another batch of problems for the economist.

Now it is clear that scarcity is more fundamental than exchange. It is, in fact, as a result of our efforts to deal with scarcity (i.e. to economise) that exchange arises. We try to ration our limited means among the innumerable wants that compete for satisfaction and find that we can make our limited means go farther by striking bargains with our neighbours. We give what we have in relative abundance – muscle or brain, professional knowledge or organizing ability – for what is comparatively scarce, what we could not do, or could not afford to do, ourselves. We sell our time and energies and spend our earnings on what others have laboured to produce.
In doing so, we are offering goods or services in which our talents show to greatest advantage (or least disadvantage) for the goods or services which others are specially fitted to produce. We are supplementing our deficiencies – our imperfect versatility, for instance – our of the proficiencies of others.

Not only are we able to draw on the skill of others – skill which we may not possess at all – but we are also able to give our whole energises to a single task – one to which, either through practice or natural bent, we are far more fitted than those who engage in it only intermittently. By exchanging, we are making our efforts go further towards meting our wants. We are reducing the pressure of scarcity and achieving economy.

## 1.7 SOCIETY'S TECHNOLOGICAL POSSIBILITIES

Each economy has a stock of limited resources – labour, technical knowledge, factories and tools, land, energy. In deciding *what* and *how* things be produced, the economy is in reality deciding how to allocate its resources among the thousands of different possible commodities and services. How much land will go into growing wheat? Or into housing the population? How many factories will produce computers? How many will make pizzas? How many children will grow up to play professional sports or to be professional economists or to program computers?

Faced with the undeniable fact that goods are scarce relative to wants, an economy must decide how to cope with limited resources. It must choose among different potential bundles of goods (the *what*), select from different techniques of production (the *how*), and decide in the end who will consume the goods (the *for whom*).

### 1.7.1 Inputs and Outputs

The answer these thee questions, every society must make choices about the economy's inputs and outputs. **Inputs** are commodities or services that are used to produce goods and services. An economy uses its existing *technology* to combine inputs to produce outputs. **Outputs** are the various useful goods or services that result from the production process and are either consumed or employed in further production. Consider the "production" of pizza. We say that the eggs, flour, heat, pizza oven, and chef's skilled labour are the inputs. The tasty pizza is the output. In education, the inputs are the time of the faculty, the laboratories and classrooms, the textbooks, and so on, while the outputs are educated and informed citizens.

Another term for inputs is **factors of production**. These can be classified into three broad categories: land, labour, and capital.

- ***Land*** – or, more generally, natural resources – represents the gift of nature to our productive processes. It consists of the land used for farming or for underpinning houses, factories, and roads; the energy resources that fuel our cars and heat our homes; and the non-energy resources like copper and iron ore and sand. In today's congested world, we must broaden the scope of natural resources to include our environmental resources, such as clean air and drinkable water.

- ***Labour*** – consists of the human time spent in production – working in automobile factories, tilling the land, teaching school, or baking pizzas. Thousands of occupation and tasks, at all skill levels, are performed by labour. It is at once the most familiar and the most crucial input for an advanced industrial economy.

- ***Capital* resources** form the durable goods of an economy, produced in order to produce yet other goods. Capital goods include machines, roads, computers, hammers, trucks, steel mills, automobiles, washing machines, and buildings. As we will later see, the accumulation of specialized capital goods is essential to the task of economic development.

Restating the three economic problems in terms of inputs and outputs, a society must decide –

(1) *what* outputs to produce, and in what quantity;

(2) *how* to produce them – that is, by what techniques inputs should be combined to produce the desired outputs; and

(3) *for whom* the outputs should be produced and distributed.

### 1.8 The Production-Possibility Frontier

Societies cannot have everything they want. They are limited by the resources and the technology available to them. Take defense spending as an example.

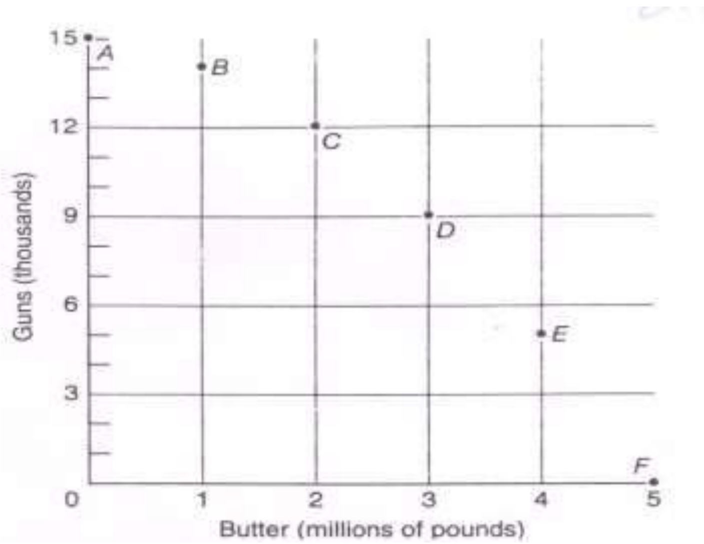


**Figure 1 : The Production Possibilities in a Graph**

This figure displays the alternative combinations of production pairs from **Table 1.**

**Alternative Production Possibilities**

| Possibilities | **Butter** (millions of pounds) | **Guns** (Thousands) |
|---|---|---|
| A | 0 | 15 |
| B | 1 | 14 |
| C | 2 | 12 |
| D | 3 | 9 |
| E | 4 | 5 |
| F | 5 | 0 |

**Table 1 : Limitation of Scarce Resources Implies the Guns-Butter Tradeoff**

*Scarce inputs and technology imply that the production of guns and butter is limited. As we go from A to B … to F, we are transferring labour, machines, and land from the gun industry to butter and can thereby increase butter production.*

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Countries are always being forced to decide how much of their limited resources go to their military and how much goes into other activities (such as new factories or education). Some countries, like Japan allocate about 1% of their national output to their military. The United States spends 5% of its national output on defense, while a fortress economy like North Korea spends up to 20% of its national output on the military. The more output that goes for defense, the less there is available for consumption and investment.

Let us dramatize this choice by considering an economy which produces only to economic goods, guns and butter. The guns, of course, represent military spending, and the butter stands for civilian spending. Suppose that our economy decides to throw all its energy into producing the civilian good, butter. There is a maximum amount of butter that can be produced per year. The maximal amount of butter depends on the quantity and quality of the economy's resources and the productive efficiency with which they are used. Suppose 5 million pounds of butter is the maximum amount that can be produced with the existing technology and resources.

At the other extreme, imagine that all resources are instead devoted to the production of guns. Again, because of resource limitations, the economy can produce only a limited quantity of guns. For this example, assume that the economy can produce 15,000 guns of a certain kind if no buster is produced.

There are two extreme possibilities. In between are many others. If we are willing to give up some butter, we can have some guns. If we are willing to give up still more butter, we can have still more guns.

A schedule of possibilities is given in **Table 1.** Combination F shows the extreme where all butter and no guns are produced, while A depicts the opposite extreme where all resources go into guns. In between – at E, D, C, and B – increasing amounts of butter are given up in return for more guns.

How, you might well ask, can a nation turn butter into guns? Butter is transformed into guns not physically but by the alchemy of diverting the economy's resources from one use to the other.

We can represent our economy's production possibilities more vividly in the diagram shown in **Figure 1.** This diagram measures butter along the horizontal axis and guns along the vertical one. We plot point *F* in **Figure 1** from the data in **Table 1** by counting over 5 butter units to the right on the horizontal axis and going up 0 gun units on the vertical axis; similarly, *E* is obtained by going 4 butter units to the right and going up 5 gun units; and finally, we get *A* by going over *0* butter units and up 15 gun units.

If we fill in all intermediate positions with new rust-colored points representing all the different combinations of guns and butter, we have the continuous rust curve shown as the *production-possibility frontier, or PPF, in* **Figure 2.**

The **production-possibility frontier** (or *PPF*) shows the maximum amounts of production that can be obtained by an economy, given its technological knowledge and quantity of inputs available. The *PPF* represents the menu of goods and services available to society.

**Putting the *PPF* to Work**

The *PPF* in **Figure 2** was drawn for guns and butter, but the same analysis applies to any choice of goods. Thus, the more resources the government uses to build public goods like highways, the less will be left to produce private goods like houses; the more we choose to consume of food, the less we can consume of clothing; the more society decides to consume today, the less can be its production of capital goods to turn out more consumption goods in the future.

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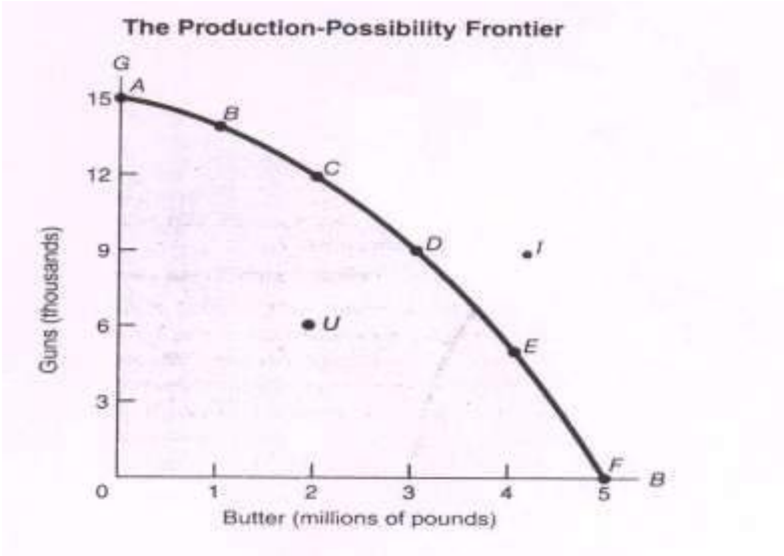
**Figure 2 : A Smooth Curve Connects the Plotted Points of the Numerical Production Possibilities**

This frontier shows the schedule along which society can choose to substitute guns for butter. It assumes a given state of technology and a given quantity of inputs. Points outside the frontier (such as point I) are infeasible or unattainable. Any point inside the curve, such as U, indicates that the economy has not attained productive efficiency, as occurs when unemployment is high during severe business cycles.

**1.9**




**Exercise :**

1. How would you define Economics? How it is related to human wants?
2. How would you differentiate between Micro-economics and Macro-economics?
3. What do you understand by Production Possibility Frontier? Explain with diagram.
4. Explain the role of exchange, scarcity and choice as issues in economics.

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# UNIT – II

## CONSUMPTION

### 2.1 INDIFFERENCE CURVES ANALYSIS

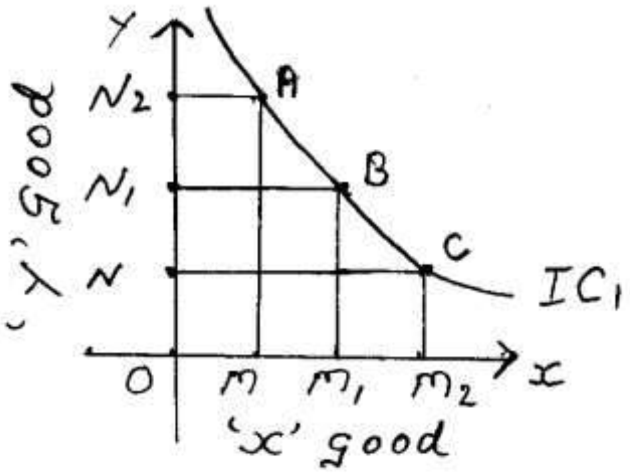
The technique of indifference curves was first used by Prof. Edgeworth, but he used it only to show the possibilities of exchange between the two persons. A decade later Prof. Irvin Fisher of America tried to develop a theory of consumer's equilibrium based on ICs analysis but he did not go beyond substitutes and complementary goods. It is so because they believed in cardinal measurement of utility. Then Prof. Pareto developed his theory of demand based on ordinal measurement of utility. But credit goes to Prof. J.R. Hicks and Dr. R.G.D. Allen of Great Britain of introducing ICs technique in demand analysis. Prof. J.R. Hicks published a book named 'Value and Capital (1939) in which he made use of ICs techniques. This technique is developed to mark an improvement over utility approach. It is based on new assumptions. After having criticized Marshall, J.R. Hicks stated ICs approach based on ordinal measurement of utility. Since, utility is psychic and cannot be measured in cardinal numbers such as 1, 2, 3, 4 etc., Prof. J.R. Hicks and Dr. R.G.D. Allen made use of ordinal numbers like $1^{st}$, $2^{nd}$, $3^{rd}$, $4^{th}$ etc. to measure the level of satisfaction since utility is subjective and state of mind.

### 2.2 What is an IC?

The indifference curve is a conceptual curve at which every point represent the combination of goods at x-axis and y-axis, which would place a consumer at a point of indifference as to which combination to choose. Every combination at each point of the curve gives him the equal satisfaction. That is why he is indifferent to any particular choice and the curve is called indifference curve.

An IC is defined as one which joins all those combinations of two goods such as 'x' and 'y' goods which yield same level of satisfaction to the consumer or which occupy the same position in the consumer's scale of preference. In other words, it is a curve which joins all those combinations of two goods yielding same level or equal level of satisfaction to the consumer. The curve which represents all those points on it which yield equal level of satisfaction is called IC because the consumer is indifferent between the combinations of two goods since they yield him the same level of satisfaction.

The Figure given below depicts the ICs curve yielding equal level of satisfaction from combinations of ‘x’ and ‘y’ goods.




The combinations of ‘x’ and ‘y’ goods A, B, and C lie on IC, yielding the equal level of satisfaction to the consumer. Though they yield same level of satisfaction the quantity of ‘x’ and ‘y’ goods differ at each combinations. As the consumer moves from A to C combination, he consumes more of ‘x’ and less and less of ‘y’. Similarly, when he moves from C to A combination he prefers ‘y’ to ‘x’. It all depends upon his tastes and preferences as to which good is to be consumed more or less.

**2.3 Assumptions of ICs Analysis**

ICs approach is based on following assumptions:

1. Like Marshallian approach the ICs approach also takes the assumption of rationality. Rationality implies that the consumer possesses all the relevant information to make his rational decision of maximization of satisfaction.

2. Ordinal measurement of utility is the second important assumption of ICs. Since utility cannot be measured in objective cardinal numbers like 1, 2, 3, 4 .. 5 etc. because it is psychic, it is to be measured in ordinal numbers such as 1st, 2nd, 3rd, 4th, etc.

3. Assumption of continuity - This assumption falls under the domain of geometry, yet it forms core of ICs analysis. Continuity implies the consumer is capable of ordering or ranking all the possible combinations of two goods in accordance with satisfaction they yield to him. He can move from low level of satisfaction to a high level of satisfaction provided his money income permits him to do so.

4. Assumptions of transitivity - It implies that if the consumer prefers 'A' combination of two goods to B and B to C it means he prefers A to C. Similarly if he is indifferent between A and B. B and C, it means that he is indifferent between A and C. In other words under this approach, the consumer's preference is valid for every successive pairs in the curve.

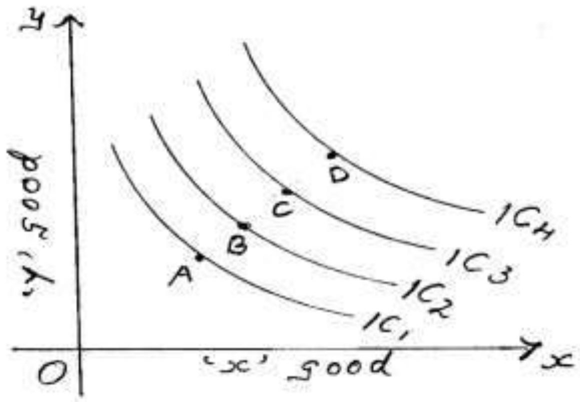
5. The ICs approach is based on weak ordering form of preference hypothesis. Thus, the weak ordering form of hypothesis recognizes the relation of preference as well as indifference. Strong ordering believes in only one relationship and that is preference.

## 2.4 The Scale of Preference

The rational consumer always makes his purchases in the light of his scale of preferences. It refers to valuation of goods and services independent of their market prices. In short it involves choices of buying goods and services. Each consumer develops his own scale of preference independent of others. It differs from person to person based on everybody's level of income and tastes and preferences.

## 2.5 IC's Map

An IC's map is an important tool of this approach. It represents complete description of the consumer's tastes and preferences. As long as consumer's tastes and preferences remain constant, IC's map also remain constant. It refers to a set of ICs or a family of ICs representing different levels of satisfaction. Each IC represents different level of satisfaction. A higher IC represents a higher level of satisfaction and a lower IC represents a lower level of satisfaction, but how much higher or lower is not indicated because ICs approach is based on ordinal measurement of utility. The scale of preference of the ICs analysis replaces the utility schedules of Marshall's approach. The following ICs map is drawn based on hypothetical tastes and preferences.




ICs No.1, 2, 3 and 4 represent different levels of satisfaction. Hence combination 'A' represents the lowest level of satisfaction while 'D' represents the highest level of satisfaction.

### 2.6 Price Line or Budget Line

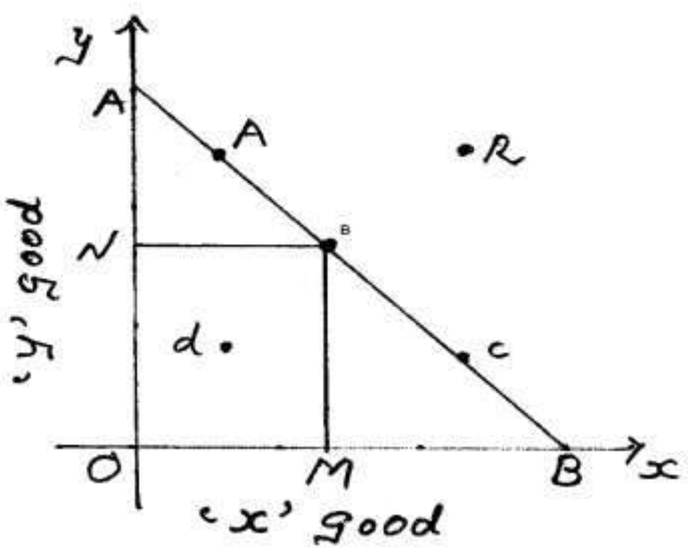
Price line represents the money income of the consumer given the prices of goods and services. Prices of goods and money income are the two constraints of the price line. If the money income changes (rise or fall), prices remaining constant price line shifts upward or downward as the case may be. If the prices change, money income remaining constant, price line still changes. Price line is also called as the budget line because it provides various opportunities to the consumer costing the same money expenditure.

**Assumptions of Budget Line**

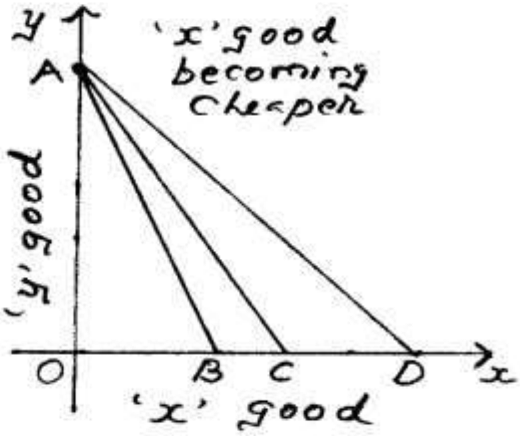
1. Prices of goods and services are given and remain constant through out.
2. The consumer tries to maximize his satisfaction with given money income and set of prices of 'x' and 'y' goods.
3. He has limited income which he spends on 'x' and 'y'.
4. Tastes and preferences of the consumer remain constant.
5. Goods are divisible and their units are homogeneous.

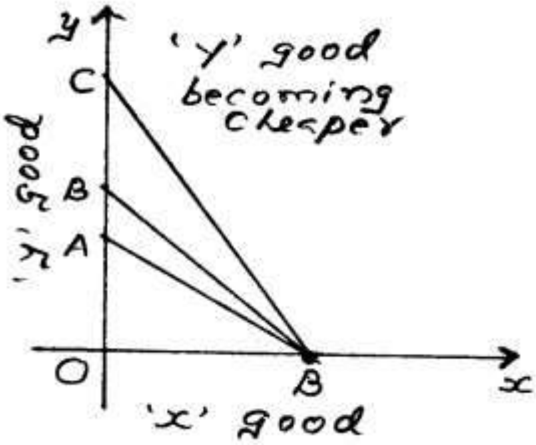
Given the above assumptions, the consumer has to choose that combination of 'x' and 'y' goods which will lie on the given price line. Any combinations lying on the same price line, will cost the consumer the same money expenditure though quantity of 'x' and 'y' goods is different at different combinations.

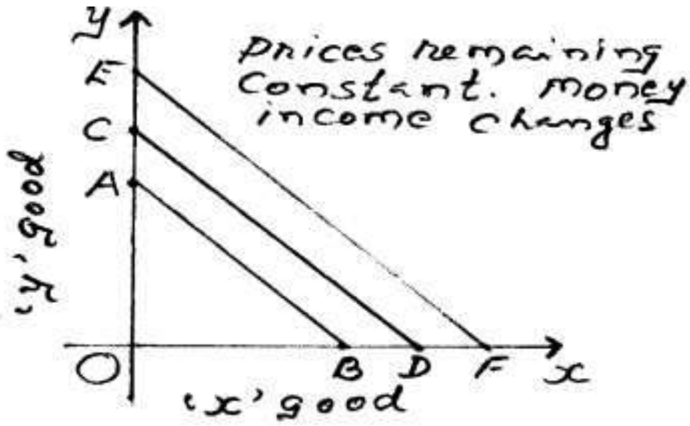
The consumer cannot choose any combination beyond AB price line because his limited money income does not permit him to do so nor he would choose any combinations inside the $\Delta$AOB because in that case he may not be spending his entire money income. Therefore, he would choose that combination which would lie only on price line AB. In the graph, it is shown the consumer chooses B combination which gives him maximum satisfaction with the given money income. He does not choose either A or C combinations because in that case he may not be spending his entire income. At the same time combination R is beyond reach of the consumer. 'd' combination does not allow him to spend his entire income. Hence, it is out of question. That is why he chooses B combination which gives him maximum satisfaction and permits him to spend his entire income on 'x' and 'y' goods.




The price line shifts if prices of goods change or money income changes prices remaining constant. The following three diagrams depicts the position of the price line.




The slope of the price line is measured and always equal to price ratio of both the goods.

The slope of price line AB $= \dfrac{AO}{OB} = \dfrac{Px}{Py}$

## 2.7 Consumer's Equilibrium

A consumer is said to be in equilibrium when he is buying such a combination of two goods as leaves him with no tendency to rearrange his purchases. In other words, he would choose that combination which would give him the maximum satisfaction with the given money income and prices of goods and services.

**Assumptions**

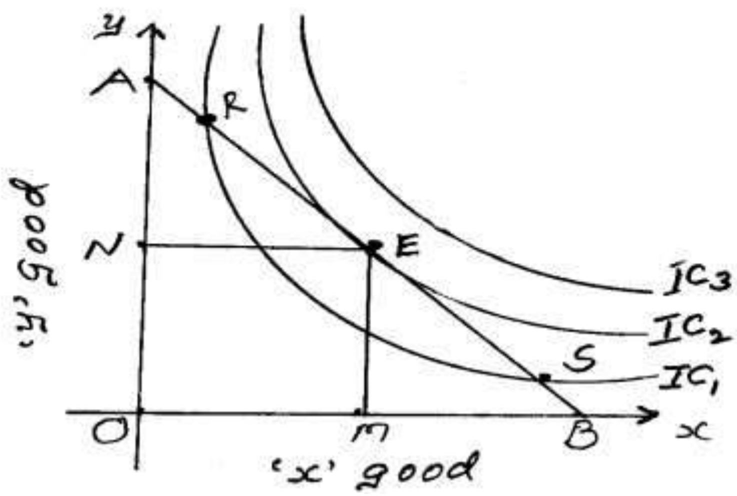
1. The consumer has his IC map exhibiting his scale of preference
2. The consumer has limited money income which he spends on ‘x’ and ‘y’ goods.
3. The consumer is rational. It means that he knows market conditions. He tries to maximize his satisfaction.
4. Goods are divisible and their units are identical.
5. Prices of goods are given and they remain constant.

**Conditions for Equilibrium**

1. The consumer would attain his equilibrium at a point where price line is tangent to the highest possible IC. In other words, the slope of the price line and IC curve must be the same at the point of equilibrium. The slope of the price line is represented by the ratio of prices of goods i.e. $\frac{Px}{Py}$ while slope of the IC is represented by MRSxy.

   Thus at the point of equilibrium = $\frac{Px}{Py}$ = MRSxy or MRSxy = $\frac{Px}{Py}$

2. The second condition is that IC curve must be convex at the point of equilibrium, then only satisfaction of the consumer would be maximum. This is depicted in the following diagram:



## Marginal Rate of Substitution (MRSxy)

MRS between two goods is an important tool of ICs analysis. It refers to the rate at which one good is substituted for another at margin without altering the level of satisfaction. Thus, MRSxy represents the amount of ‘y’ good which the consumer has to give up for the gain of one more unit of ‘x’ good so that his level of satisfaction remains the same. The MRS between two goods always falls as the quantity of one good is increased.

The consumer is in equilibrium at ‘E’ point where $IC_2$ is tangent to the price line AB. The consumer buys ON quantity of ‘y’ good and OM quantity of ‘x’ good maximizes his satisfaction. At ‘E’ point both conditions of equilibrium are fulfilled i.e. MRSxy = $\frac{Px}{Py}$ and also MRSxy is declining or $IC_2$ is convex to the origin. That is why the consumer is in equilibrium at ‘E’ combination. He is not in equilibrium at ‘R’ point because it is here MRSxy > $\frac{Px}{Py}$ and in case of ‘S’ combination MRSxy < $\frac{Px}{Py}$. Combinations ‘R’ and ‘S’ place him on lower IC. Therefore, the consumer is permanently in equilibrium at ‘E’ point where both the conditions of equilibrium are fulfilled.

The equality between MRSxy = $\frac{Px}{Py}$ is essential condition for equilibrium but not sufficient condition. The sufficient condition is that at the point of equilibrium MRSxy must be falling or IC must be convex to the origin. Then only the consumer would be maximizing his satisfaction.

## 2.8 Income Effect

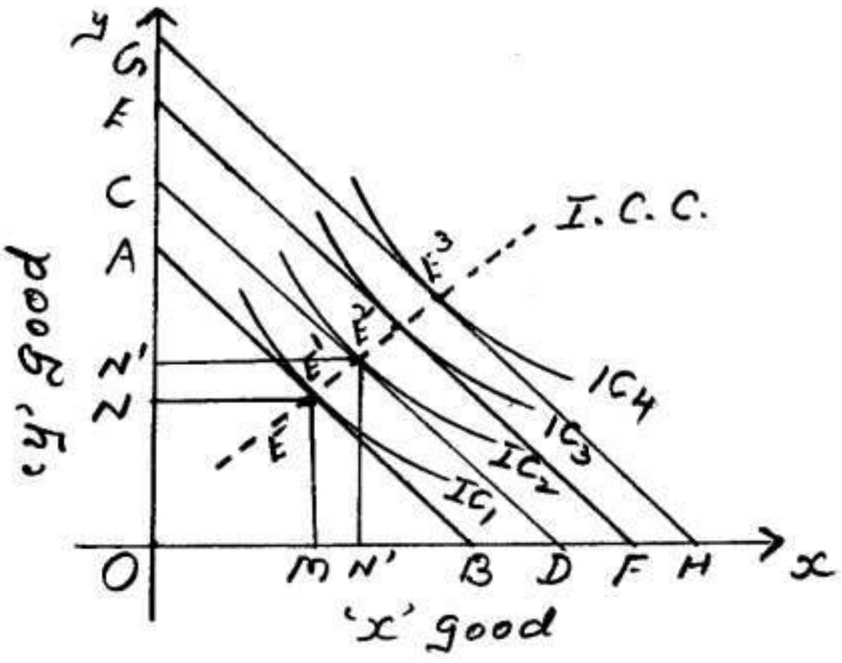
The consumer may become better off or worse off because of a change in his money income. Prices of goods and services remaining constant. His satisfaction will either increase or decrease based on larger or smaller size of money income at his disposal. The result of this type is called as income effect. In other words, it refers to a change in his level of satisfaction on account of a change in his money income. Under income effect consumer is allowed to become either better off or worse off as the case may be. If the income increases he will buy more of both the goods and thus will become better off. In the same manner his income may fall, as result of which he would buy less of both the goods, which would reduce his level of satisfaction making him worse off prices remaining constant. When he becomes better off, he will reach on higher IC and when he becomes worse off he will be placed on lower IC.

Income effect can be negative also if the commodity is interior. Even after increase in income he may buy less quantity of the commodity, which is inferior. However it is difficult to name certain goods to be inferior. What is inferior to one person may not be inferior to other person. Therefore, taste and preferences along with size of money income label certain goods as inferior one.

**Assumption of Income Effect**

1. Money income alone changes; rise or fall.
2. Prices of goods and services remain constant throughout.
3. Consumer is rational and tries to maximize his satisfaction.
4. Tastes and preferences remain constant.
5. The consumer has no control on market conditions.

In the light of the above assumptions let us examine the income effect in case of normal good with a diagram below:




I.C.C. = Income Consumption Curve

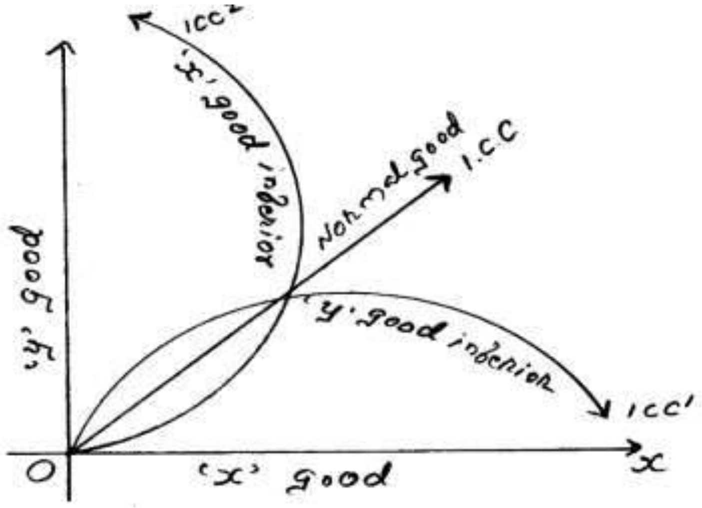
Income effect is to be studied with the help of ICs' map and price line. ICs number one to four represents consumer's ICs map highlighting his tastes and preferences whereas price lines AB, CD, EF and GH present different levels of money income. As the money income of the consumer increases, he moves from $IC_1$ to $IC_4$ consuming more of both the goods and becoming better off. And when his money income falls from GH to AB price line he is shunted to lower and lower ICs, thus making him worse off as he buys less and less of both the goods. The consumer attains equilibrium at E, $E^1$, $E^2$ and $E^3$ tangency points on AB, CD, EF, GH price lines as his money income goes on increasing. He becomes better and better off. When his money income falls he becomes worse off when he becomes better off, he is placed on higher ICs and in case of worse he is placed on lower ICs. Thus under income effect the consumer is allowed to become either better off or worse off.

## 2.9 Income Consumption Curve (I.C.C.)

Since, the price line represents the money income of the consumer or in other words, his purchasing power, the price line in its each point represents the affordability of the limited purchasing power within which the means of income. The combination of goods at E point will give him the maximum satisfaction because, it is at this point it will touch the indifference curve.

The other points of which are beyond his reach with his limited income. The combination pf 'X' and 'Y' goods at point E will be his obvious choice because it satisfies both his affordability as well as preference. Similar points of intersection can be considered at the successive price line.

A line which is drawn through all the equilibrium points such as E, $E^1$, $E^2$ and $E^3$ is called as income consumption curve. It shows how the consumer's purchases react to change in money income when prices remain constant. If the prices were different the ICC would take different shape and position. It is also defined as the locus of equilibrium points at different levels of consumer's money income. It traces out income effect on the quantity of goods purchased. I.C.C. can be positive or negative. It is positive when an increase in money income is accompanied by increase in consumption of goods and services and negative when an increase in money income is accompanied by reduction in consumption of goods. If I.C.C. slopes backwards towards 'y' axis, then 'x' good is inferior good and if it slopes towards 'x' axis, 'y' good is inferior. In case of normal goods it slopes upwards. The following diagram depicts the shapes of I.C.C.




One thing must be noted that IC approach does not tell which goods are inferior. It merely describe the phenomenon.

## 2.10 Substitution Effect

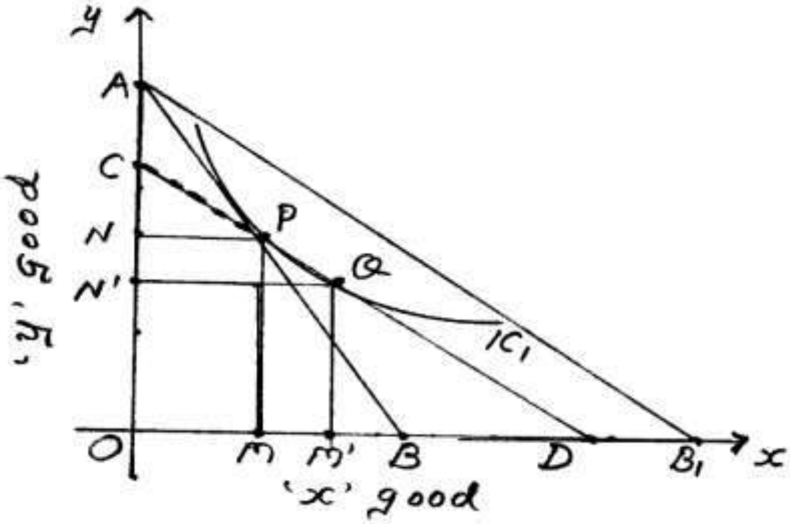
While explaining income effect, we held that prices remain constant but it is not a realistic assumption. Prices always change and therefore consumer's real income undergoes changes. It may rise or fall. When prices rise, real income of the consumer falls, money income remaining constant.

Likewise when prices fall, real income of the consumer rises. But under substitution effect we shall be analyzing the effect of fall in price of one of the goods, real income of the consumer keeping it constant. In other words when prices rise or fall, the consumer's money income is also changed in such a way that he is neither better off nor worse off than before so he will find it worth his while to buy more of that good which has become relatively cheaper.

He will substitute relatively cheaper good for relatively costlier good. The result of this type is known as a substitution effect.

In substitution effect, the consumer's real income remains the same but he rearranges his purchases in such a way that he is neither better off nor worse off than before as a result of change in price of one of the goods. The following diagram illustrates the phenomenon.

In the above figure, AB is the original price line. IC is tangent at 'P' point so the consumer is in equilibrium at 'P' point where both the conditions of equilibrium are fulfilled. The consumer consumes ON quantity of 'y' good and O M quantity of 'x' good. Now we suppose the price of 'x' falls and 'y' remains constant. That is why AB, new price line is drawn to show fall in price of 'x' good. Now 'x' has become relatively cheaper and 'y' good relatively costlier. If his money income kept intact, he will become better off.




But under substitution effect consumer is not allowed to become better off. Therefore, his money income is cut in such a way that his real income remains the same. So that he is neither better off nor worse off. To show cut in money income, a new price line C D is drawn parallel to A B, price line to keep his real income intact. Now he will choose that combination which will lie on C D price line.

Since 'x' has become relatively cheaper he will buy more of 'x' good and less of 'y' good. In other words, he will substitute relatively cheaper good for relatively costlier good by rearranging his purchases in accordance with change in prices. Thus, he substitutes M M' quantity of 'x' good for N N' quantity of 'y' good and attains his new equilibrium at Q point on C D price line and on the same IC curve. He moves from 'P' equilibrium to 'Q' equilibrium in favour of 'x' good.

The amount by which his money income is changed so that he is neither better off nor worse off than before is called as the compensating variation in income. In other words, it is a change in money income of the consumer which is just sufficient to compensate him for a change in the price of ‘x’ good. Hicks Allen substitution effect takes place on the same IC whereas Slusky’s substitution effect takes place on a different IC. Substitution effect is always positive. It is positive because general tendency of the people is that to buy that good more which is relatively cheaper and that good less which is relatively costlier.

**2.11 Price Effect**

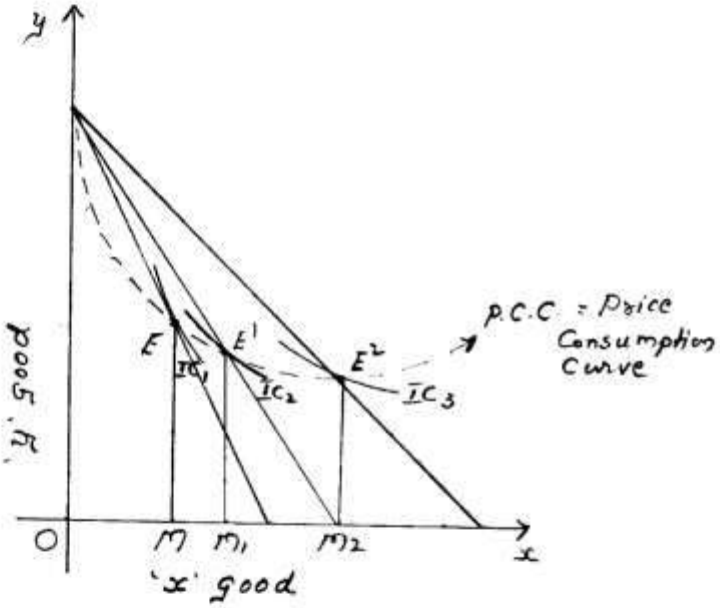
Price effect studies the effect of a change in real income of the consumer on his purchases. A change in real income may be either an increase or a decrease in the real income of the consumer due to fall or rise in prices of goods. Therefore, under price effect the consumer is allowed to become either better off or worse off as the case may be.

**Assumptions**

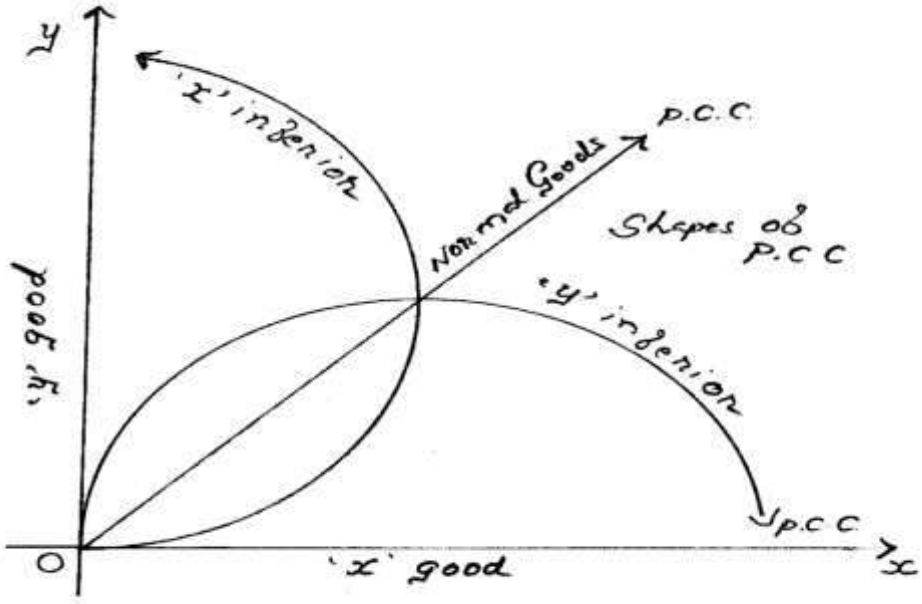
1. Money income remains constant
2. Prices rise or fall; as result of which real income of the consumer rises or falls
3. The consumer spends his entire money income
4. The consumer is rational
5. Price of ‘x’ falls and price of ‘y’ remain

When price of ‘x’ falls, real income of the consumer rises. This means that with the same money income he can buy more of both the goods and becomes better off. An increase in real income produces two effect simultaneously viz. income effect and substitution effect. Thus the price effect is the combination of income effect and substitution effect. Under price effect, the consumer is allowed to become either better off or worse off as the case may be.

We suppose price of ‘x’ falls and price of ‘y’ remains constant. Therefore ‘x’ becomes relatively cheaper in terms of ‘y’ and ‘y’ costlier in terms of ‘x’. Since substitution effect is always positive, the consumer will buy more and more of ‘x’ good as price continues to fall. Price lines AB, $AB_1$, $AB_2$, $AB_3$ show fall in price of ‘x’ good. Therefore, the consumer becomes better and better off and reaches higher and higher ICs. The following diagram illustrates the phenomenon.




The curve which passes through all the equilibrium points such as E, $E^1$ and $E^2$ is called as price consumption curve. If traces out the price effect on the purchase of the consumer. It shows how changes in price of 'x' good will affect the consumer's purchases of 'x', price of 'y', tastes and preferences and money income remaining constant. It is locus of equilibrium points at different levels of prices or real income. The P.C.C. may shift backward towards 'y' axis if 'x' good becomes inferior or it may slope downward towards 'x' axis if 'y' good is inferior and it may slope upward if both the goods are normal goods.

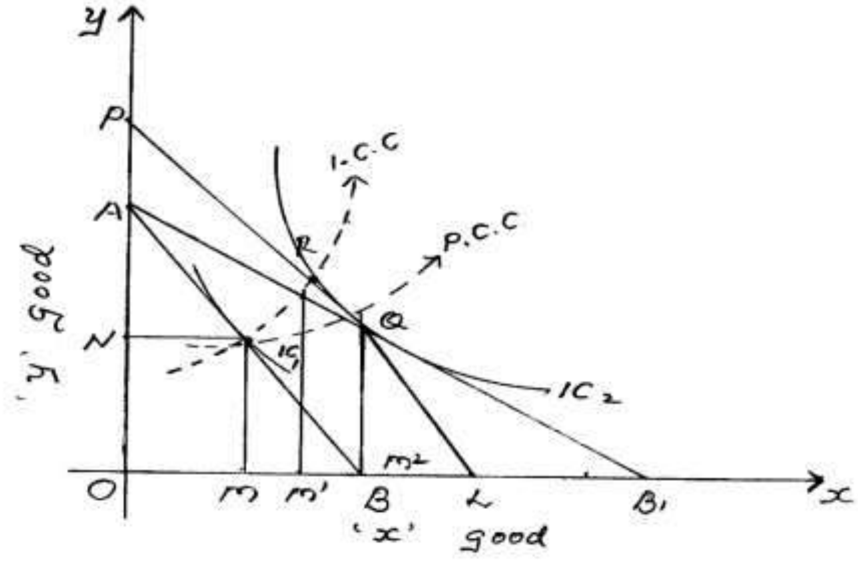



## 2.12 Breaking up Price Effect

Price effect is combination of income effect and substitution effect. Substitution effect is always positive but nothing can be said about income effect. It can be negative also. Therefore, it is necessary to decompose price effect into income effect and substitution effect. When price of 'x' falls, the consumer's real income increase, money income remains constant. Therefore, the consumer either buys more quantity of both the goods or relatively cheaper good and will become better off. When he becomes better off I.C.C. curve takes him on a higher IC. This shows income effect is positive. Now, he buys more of both the goods. He reaches second IC. His movement from IC to $IC_2$ is due to positive income effect. However, he won't be at 'R' point in equilibrium permanently as MRSxy > $\frac{Px}{Py}$ at 'R' equilibrium. Moreover, substitution effect is stronger than income effect. Therefore, he substitutes some units of 'x' good for some units of 'y' good. It is done because 'x' has become relatively cheaper and 'y' relatively constlier as a result of fall in price of 'x' good. It is a general tendency of the consumer to buy that commodity more which is relatively cheaper. That is why he slides down along the $IC_2$ towards right. Now he moves from 'R' equilibrium to 'Q' equilibrium point on $IC_2$. the movement from 'R' to 'Q' is due to positive substitution effect. Thus, price effect is made of income effect and substitution effect.

Price = Income effect + Substitution effect

This phenomenon is illustrated in the following diagram:

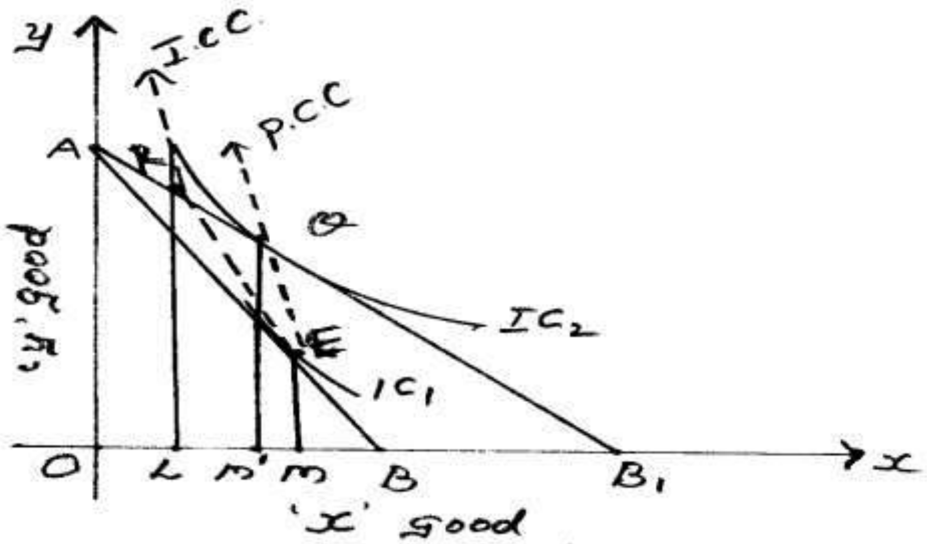



**Price effect = I.E. + S.E.**

$$\mathbf{MM_2 = M M_1 + M' M^2}$$

## 2.13 Giffen's Good

In case of Giffen's good negative income effect is so large that it outweighs completely positive substitution effect as a result of which consumer buys less than before. The following diagram depicts the phenomenon.




**P**

**E = Strong negative I.E. + P.S.E.**

**= – L M + L M'**

**= – M' M**

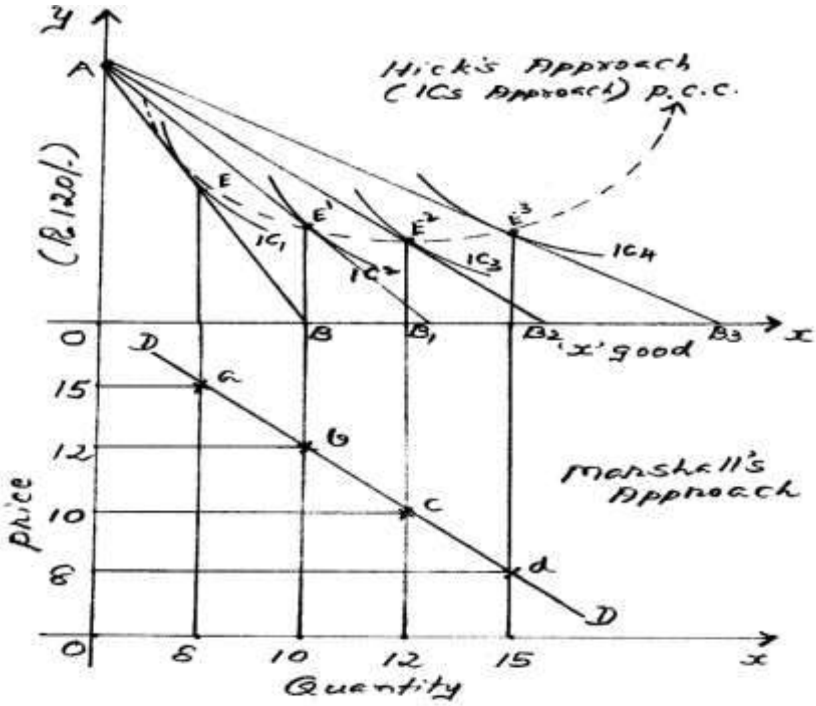
## 2.14 Derivation of Demand Curve from the P.C.C.

The P.C.C. of the indifference curve approach does not directly relate price with quantity demanded. It does not explicitly express price in money terms. It is so because in the IC analysis price is not explicitly shown on 'y' axis. On the other hand Marshall's demand curve explicitly relates price with quantity demanded. Thus, the demand curve showing the relationship between quantity demanded of a good at its various alternative prices can be derived from the P.C.C. of the indifference curves approach. Instead of price of a good being measured in terms of money, it is measured in terms of a good. For example we measure price of 'x' good in terms of 'y' good and price of 'y' in terms of 'x' good.

Thus the P.C.C. also expresses the same relationship i.e. inverse between price and quantity demanded in case of normal good and direct in case of inferior and Giffen's goods. The following diagram depicts the derivation of demand curve from the P.C.C.

**Assumptions**

1. The consumer possesses Rs.120/- as his money income
2. Price lines AB, $AB_1$, $AB_2$, $AB_3$ are different alternative price lines representing Rs.15/-, Rs.12/-, Rs.10/- and Rs.8/- per unit.



The above graph shows that the P.C.C. curve of the IC analysis is the same as Marshall's demand curve. Normally demand curve slopes downward from left to right due to positive income effect. Both the positive effect extend demand for the good.

**Limitations of ICs Analysis**

1. Unrealistic assumptions
2. Combination of two goods may lead to absurdity like shoes and shirts.
3. In case of more than two goods, IC analysis cannot be put to use.
4. The assumption of continuity is also not true.
5. No provision for uncertainty.
6. The approach is highly introspective rather than behaviouristic.
7. Prof. Robertson calls the IC approach as old wine in new bottle!

## *2.15 CONSUMER SURPLUS*

### 2.15.1 Law of diminishing utility:

The concept of consumer surplus is based on theory of diminishing utility. The law of diminishing utility means that total utility increases at the decreasing rate after a point is reached in the consumption level. As we consume glasses of water when we are thirsty, the total utility from consuming second or the third glass of water may reflect in increase in total utility at an increasing rate. But after point, we are less inclined to take more water. The fourth glass of water may, therefore, add o our total utility only at decreased rate. That is what we call the marginal utility is less as we consume fourth one. The fifth glass of water correspondingly may yield a still less marginal utility. If we project the rate of decreasing utility in a geometrical curve, it represents the law of diminishing utility.

The idea of consumer's surplus was developed by French engineer economist A.J. Dupuit in 1844. But it was improved and popularized by English economist Dr. Alfred Marshall in 1879 in his book named "Pure theory of Domestic Values".

### 2.15.2 Meaning and Definition of Consumer's Surplus

We buy goods and services because they give us utility. But at the same time we lose some utility in terms of money. Payment of prices means parting with money in exchange of goods and services. This causes disutility to the consumer. In the beginning utility gained is higher than the utility lost. Since the consumer being rational goes on buying units of the commodity as long as utility gained is higher than utility lost. In terms money paid. Utility goes on falling, as more units of the same commodity are consumed but utility of units of money remains constant. Thus a point will reach when utility gained is equal to utility lost in terms of price. At this point, the consumer stops purchasing additional units of that commodity. Beyond this point utility lost is greater than utility gained. In other words, a rational consumer buys the commodity only if he expects a surplus of utility and this surplus is called consumer's surplus. It is defined as the difference between the satisfaction gained and satisfaction lost. The satisfaction that the consumer obtains from the consumption of a commodity is measured by the price he would pay for it rather than go without it. While satisfaction he loses in procuring that commodity is measured in terms of price he actually pays for it. According to Dr. Alfred Marshall, "the excess of the price which he would be willing to pay rather than go without the thing over that which he actually does pay, is the economic measure of this surplus satisfaction. It may be called consumer's surplus." In other words, it can be called as the difference between the expected price for a commodity in terms of price and the actual price that the consumer pay for it rather than go without it.

### 2.15.3 Measurement of Consumer's Surplus

It is derived from the demand curve or the marginal utility curve. The following diagram and table illustrate the concept. Let us suppose that our consumer has only five rupees to spend on apples. Price of apple is hundred paise per unit which remains constant. As the consumer goes on buying units of apple his utility gained is much more than the utility lost. At the 5$^{th}$ unit of apple, utility lost (100) becomes equals to utility gained (100 units). It is at this point he would stop buying further as beyound 5$^{th}$ unit, the utility lost would be greater than utility gained.

The following table explains the whole thing.

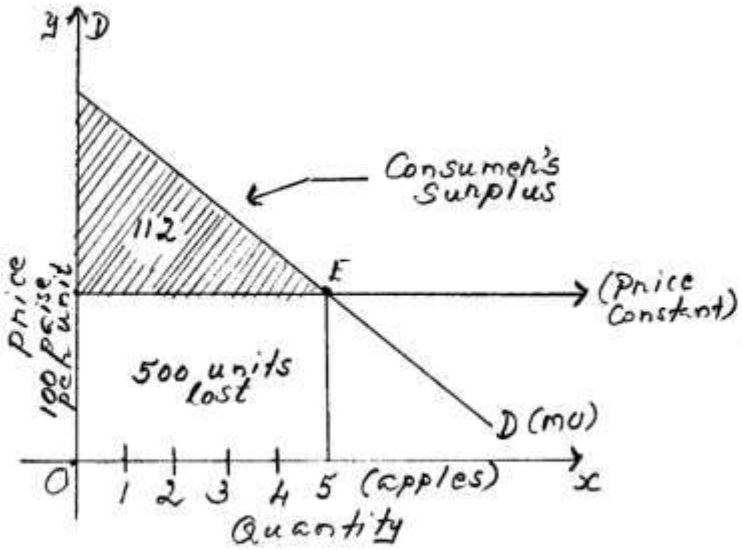
| Units of Apple | No. | Price in Paise | Consumer's Surplus |
|---|---|---|---|
| 1 | 150 | 100 | 50 |
| 2 | 130 | 100 | 30 |
| 3 | 120 | 100 | 20 |
| 4 | 112 | 100 | 12 |
| 5 | 100 | 100 | 0 |

Total - 5 Units - 612 - 500 = 112 Consumer's surplus

The surplus derived by him from five units of apple is 112. The total utility derived is 612 units and utility lost in buying five units is 500. Thus, total consumer's surplus is 612 - 500 = 112 units.

C.S. = Total utility gained - Total utility lost
= 612 - 500
= 112 units

But one must keep in mind the consumer's surplus derived from different commodities is different. Some commodities yield higher surplus than others. For instance, salt, match box, newspapers etc. People enjoy greater surplus on these commodities than luxury goods. The concept of individual consumer's surplus can very well be applied to the society as a whole.



Price is measured along 'ox' axis which is hundred paise per unit that remains constant and quantity demanded along 'ox' axis. Demand curve DD is based on MU schedule. The price of apples assumed to be fixed and remains constant for all units. Therefore, the consumer loses 100 x 5 = 500 units whereas he gains 150 + 130 + 120 + 112 + 100 = 612 units. Hence consumer's surplus = Total satisfaction (u) - Total satisfaction scarified (DO) in buying apples $\therefore$ 612 – 500 = 112 units c.s.

**Assumptions**

1. The fixed relationship between utility and satisfaction, but utility is different from satisfaction.
2. MU of money remains constant through out the process of exchange. No comparison is made in the absence of this assumption and it becomes difficult to measure the consumer's surplus.
3. The concept of consumer's surplus is based on cardinal measurement of utility which is not true.
4. DD schedule and MU schedule are assumed to be the same but they are not.
5. The concept ignores the differences in incomes, fashions, tastes and preferences between consumers.

**Importance**

1. The concept is made use of public finance in the matter of taxation. Taxes are imposed on those commodities on which people enjoy very high consumer's surplus.
2. It helps producers to decide upon pricing policies.
3. It is also helpful to international trade.
4. International comparison of economic welfare can also be possible through consumer is surplus.

**Limitations**

1. It is based on certain assumptions which are not tenable in actual life. Therefore, it is said that the concept is based on unrealistic assumptions.
2. Cardinal measurement of utility is not possible. Utility is psychic and hence cannot be quantified.
3. Marginal utility of money cannot remain constant.
4. It is also said utility is not independent. It is inter-dependent.
5. Differences in income, tastes and preferences cannot be ignored.
6. There is no definite relationship between utility and satisfaction as visualized by Marshall.

# UNIT III

## DEMAND AND SUPPLY

### 3.1 DEMAND

In economics, demand has a distinct meaning. Supposing, you desire to have a car, but you do not have enough money to buy it. Then desire will remain just a wishful thinking; it will not be called demand. If you have enough money, you do not want to spend it on car, demand does not emerge. The desire becomes demand only when you are ready to spend money to buy the car. Thus, Demand for a commodity refers to the desire to buy a commodity backed with sufficient purchasing power and willingness to spend. Hence demand is equal to desire plus purchasing power plus willingness to pay. Demand for a commodity is always refers to price. At higher price quantity demanded will be low, and at lower price quantity demanded will be high.

**Demand schedule:**

It is a numerical tabulation, showing the quantity that is demanded at different prices. It expresses the relation between price and demand of a commodity. A demand schedule can be of two types –

- Individual Demand Schedule
- MarketDemand Schedule

**Individual Demand Schedule:**

Individual demand schedule is defined as the quantity of a given commodity which a consumer will buy at all, possible price, at a particular period of time.

**Table3.1-Individual demand schedule for Apples**

| Price of Apples (Rs.) | Quantity demanded (Kg) |
|---|---|
| 10 | 4 |
| 20 | 3 |
| 30 | 2 |
| 40 | 1 |

In the above table we can see that as the price of apples increases, quantity demanded is decreases.

**Market demand Schedule**

In every market, there are several consumer of a commodity. Market demand schedule is one that shows total demand of all the consumers in the market at different price of the commodity.

**Table 3.2 - Market demand schedule for Apples**

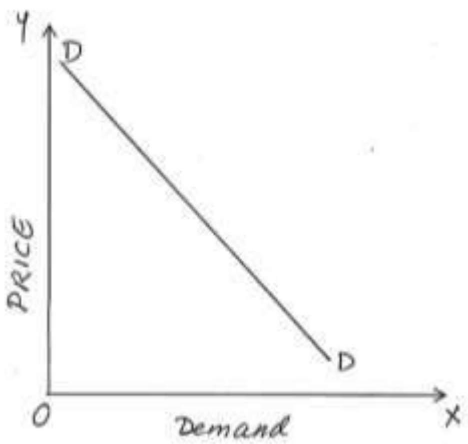
| Price (Rs.) | Ravi's Demand | Sahil's Demand | Market Demand |
|---|---|---|---|
| 10 | 4 | 5 | 4+5=9 |
| 20 | 3 | 4 | 3+4=7 |
| 30 | 2 | 3 | 2+3=5 |
| 40 | 1 | 2 | 1+2=3 |

Table 3.2 shows that with the rise in the price of apples the market demand for apples is decreasing.

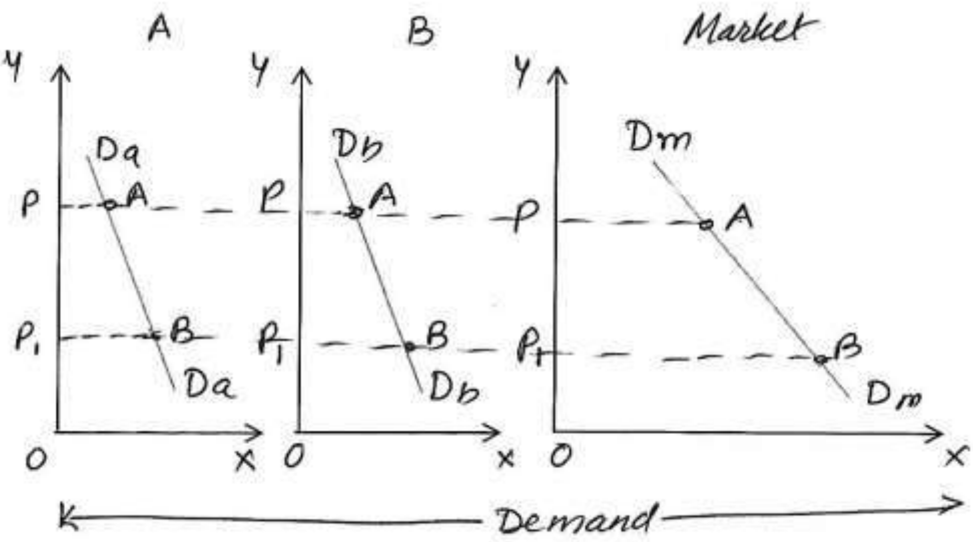
**Demand Curve**

Demand Curve is the graphical representation of demand schedule expressing the relation between different quantities demanded at different possible prices of the commodity**.** There are two type of demand curve:

- Individual Demand Curve: It is a curve showing different quantities of a commodity that one particular buyer is ready to buy at different possible price of the commodity at a point of time. Individual demand curve is shown in figure 3.1-



- Market demand Curve: The market demand consists of the total quantity demanded by each individual in the market. The market demand curve is formed by computing the horizontal summation of the individual demand curves for all consumers. This process is illustrated in Figure 3.2.
- We take a hypothetical case in which there are only two consumers in the market




namely, Mr Ravi and Mr Sahil.The total quantity demanded in the market is just the sum of the quantities demanded by each individual. The market demand curve is derived by adding together the quantities demanded by all consumers at each and every possible price.

Both individual and market demand curvesslope downward from left to right indicating an inverse relationship between price and quantitydemanded of goods.

**Determinants of demand:**

Demand function is show the relation between demand for a commodity and its various determinants. The determinants are also known as the factors which affect demand of a commodity. It shows how demand is related to different factors like price, income etc. the demand function can be expressed as follows-

$D = f(P, P_r, Y, T, FE, S, W, \ldots\ldots)$

**where,**

P – Price of the commodity

Pr – Price of related goods

Y – Income of the consumer

T – Taste and preference

FE – Future expectations of the consumers

S – Size and composition of the population

W – Weather condition

The determinants are explain below -

i) **Price of the Commodity:** Quantity demanded and the price of the commodity is inversely related. It means that with the rise in the price of commodity, quantity demanded decreases and with the fall in the prices there is a rise in the quantity demanded.

ii) **Price of the related goods:**Demand for a commodity is also influenced by change in the price of related goods. There are two types of related goods - Substitutes and Complements.**Substitute Goods**are those goods which can be the goods which can be used in place of each other, such as tea and coffee. If an increase in the price of one causes a rise in the demand for the other then the two goods are substitutes. On the other hand the complementary goods are those goods which are consumed together.

If an increase in the price of one goods causes the reduction in the demand for the otherthen the two goods are complementary goods. Car and petrol are complimentary goods.

iii) **Income of the consumers:**Normally there is a direct relationship between the income of theconsumer and his demand for the commodity.For a **normal good** with the rise in consumer's income demandwill rise and vice versa. Goods like television sets, cars, clothes etc are considered normal goods. If the demand for a goods decreases with the rise in consumers income then that goods are known as **Inferior Goods**. For e.g. coarse grain like Jowar, Bajra,Maize, etc. If the income of the consumer risesshe will reduce the consumption of these goods.

If the demand increaseswith an increase in income and thereafter it remains constant irrespective of the level ofincome then the goods in question are known as **necessities** for example salt, match box, etc.

iv) **Consumer's Taste and Preference:**Consumer's demand for the goods is greatly influenced by the taste and preferences which in turn dependson social customs,habits, fashion, etc.

**Consumer's Expectation:**If a consumer expects a fall in the price of a commodity in a nearfuture, then he will postpone his present demand and if he anticipates a rise in price then he will increase his current demand. For instant if you are thinking about purchasing a computer and you obtain information that may lead to rise in the future price then you will buy the computer today itself. However, a reduction in the expected future price will result in a reduction in current demand.

If expected future income rises, demand for many goods today is likely to rise. On the other hand, if expected future income falls, individuals may reduce their current demand for goods so that they can save more today in anticipation of the lower future income.

v) **Size and Composition of Population:**Larger the population, larger is likely to be the numberof consumers thus greater will be the demand. The composition of population refers to number of children, adults, males,females, etc. in the population. If the number of children are more in the population then more of baby products will be demanded whereas in an education township like Vallabh Vidya nagar in Anand district of Gujarat where 50 to 60 per cent of the population is of students (between the age group of 18 to 24 years) more of stationary, hostels, fast foods etc will be demanded.The type of people inhabiting the country will also influencethe consumer demand.Since the market demand curve consists of the horizontal summation of the demand curves of all buyers in the market, an increase in the number of buyers would cause demand to increase. As the population increases, the demand for food, houses, cars and virtually all other commodities, is expected to increase. A decline in population will result in a reduction in demand.

vi) **Weather condition:** Another factor which affects demand is the weather conditions. For example during summer there will be greater demand for sun glasses, cotton wears, ice creams etc, whereas during rainy season the demand for umbrellas and raincoats will increase.

**Law of Demand:** Law of demand expresses the functional relationship between the price of commodity and its quantity demanded. It states that the demand for a commodity is inversely related to its price, other things remaining constant. In other words a fall in price of a commodity will lead to a rise in demand of that commodity and a rise in price will lead to fall in demand. Thus there is an inverse relationship between the price of a good and the quantity demanded in a given time period, ceteris paribus.

**Assumption:**

The law of demand is based on certain assumptions. These are as follows -

- **a.** There is no change in the Income of the people.
- **b.** Taste, preference and habits of consumers unchanged.
- **c.** Prices of related goods i.e., substitute and complementary goods remainingunchanged
- **d.** There is no expectation of future change in price of the commodity.
- **e.** The commodity in question is not consumed for its prestige value.

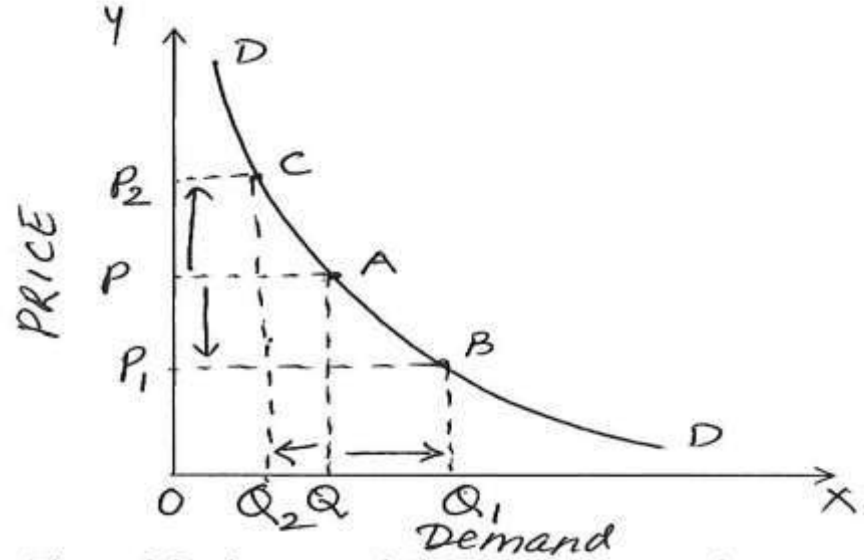



Figure 3.3 – inverse relationship between price and quantity demanded

As shown in figure 3.3 the relationship between price and quantity demanded is represented by a demand curve. At price OP the quantity demanded is OQ when the price increase from OP to $OP_1$ quantity demanded decreases from OQ to $OQ_1$. Thus when the price increases, demand decreases and vice versa. Demand curve slopes down ward from left to right showing inverse relationship between price and quantity demanded. This downward slope of demand curve is expression of law of demand.

**Reasons for downward slope of demand curve:**

Downward slope of demand curve indicates that consumers buy more of a commodity at lower prices and vice versa. Thus, there is Negative relationship between price and quantity demanded. The reasons for downward slope of demand curve are –

**(i) Law of Diminishing Marginal Utility:** This law states that when a consumer buyers moreunits of same commodity, the marginal utility of that commodity continues to decline. The consumer will buy more of that commodity when price falls. When lessunits are available the utility will be high and consumer will prefer to pay more for that commodity.Thus the demand would be more at lower prices and less at a higher price and so thedemand curve is downward sloping.

**(ii) Income effect:** As the price of the commodity falls the real income of the consumer will increase and consumer can increase hisconsumption.He will spend less to buy the samequantity of goods. On the other hand, with a rise in price of the commodities the real income ofthe consumer will reduce and consumer will buy less of that good.

**(iii) Substitution Effect:** Whenthe price of a commodity falls, the price of its substitutesremaining the same, the consumer will buy more of that commodity and this is called thesubstitution effect. The consumer will like to substitute cheaper good for the relatively expensivegood. On the other hand, with a rise in price the demand falls due to unfavorable substitutioneffect. It is because the commodity has now become relatively expensive which forces theconsumer's to buy less.

**iv) Number of uses of a Good:** Goods which can be put to a number of uses like milk which can be used for making tea, curd, cold drinks, paneer etc. When the price of milk commodity is higher, it willsparingly used. On the other hand, if the price of milk decreasesconsumer will use it for a variety of purposes leading to a rise in demand. Thus the demand for the product with the change in price is determined by the number of uses of a commodity.

**v) Change in number of buyers:** Lower price will attract new buyers and higher pricereduces the buyers. Such buyers are known as marginal buyers.

Owing to the above mentioned reasons thedemand falls when price rises and so the demand curve is downward sloping.

**Exceptions to the law of demand:**

Law of demand has some exceptions as well. There are some goodswhose demand increases when price rises and decrease when price falls. They are –

**i)** **Conspicuous Goods** These are the goods which are purchases by the consumers to project their status andprestige.Expensive cars, diamond jewellery, etc. are such goods. The conspicuous goods are purchased more at a higher price and less at a lower price.

**ii)** **Giffen Goods :** Giffen goods named after Sir Robert Giffen. These are inferior goods whose demand increases evenif there is a rise in price. For e.g.: - coarse grain, clothes, etc.

**iii)** **Share's speculative Market :** It is often found that people buy shares of those companies whoseprice is rising in anticipation of further rise in price. Whereas, they buyless shares in case the prices are falling as they expect a further fall in price of such shares. Herethe law of demand fails to apply.

**iv)** **Bandwagon effect:** Here the consumer demand of a commodity is affected by the taste and preference of the social class to which he belongs to. If sports car fashionable amongbusiness community, then as the price of sports cars rises, these consumers may increasethe demand for such goods to project their position in the society.

**v)** **Veblen Effect:** Many a times consumer judge the quality of a product by its price. Consumer feels that a higher price means better quality and lower price means poorquality. So the demand goes up with the rise in price for example branded consumer goods.

### 3.2 Change in Quantity Demanded and Change in Demand

A change in **quantity demanded** refers to increase or decreases in quantity purchased of a commodity in response to decrease or increase in its price, other things remain constant. It is expressed through movement along the demand curve.On the other hand a**change in demand**,refers to increase or decrease in quantity demanded of a commodity in response to change in factors other than price. It is expressed through shift in demand curve-forward shift or backward shift.

**(a) Movement of Demand curve or Extension and Contraction of Demand or change in quantitydemanded.**

With the change in the price of a commodity the quantity demanded will increases or decreases depending upon the fall or rise in the price ofa commodity alone, ceteris paribus.This is called movement along the demand curve or extension or contraction of Demand. As shown in figure 3.4, when the price increases, other factors affecting demand remain constant, the quantity demand will decreases and vice versa

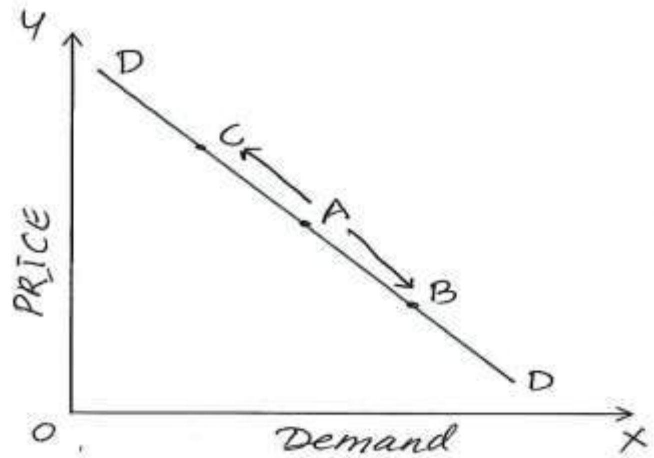



Figure 3.4: Change in quantity demanded

The figure 3.4 show that when price increases from OP to OP1 the demand decreases from OQ to $OQ_1$. Thus with the fall in price there is a movement on the demand curve from point A to point B. Similarly with the rise in price from OP to $OP_2$ the quantity demanded decreases from OQ to $OQ_2$ causing a shift from point A to point C on the demand curve. The increase in demand due to fall in price is also called extension of demand. The reduction in quantity demanded due to increase in price is known as contraction.

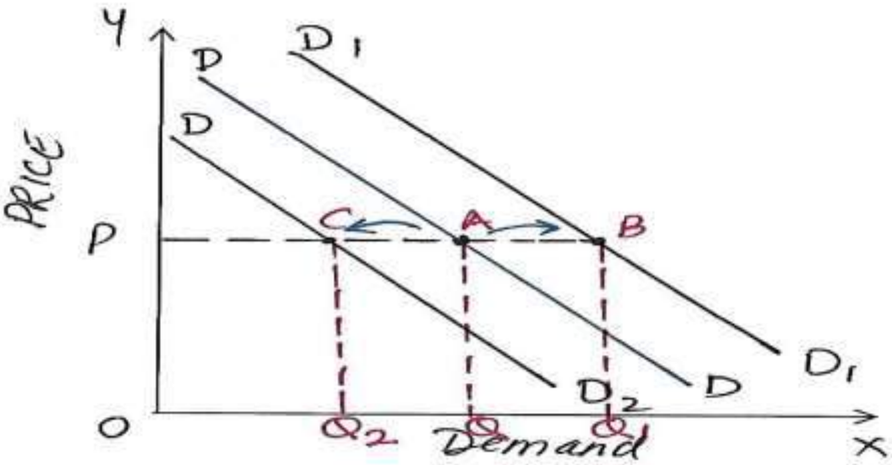


Figure 3.5: Shift in Demand

**Change in Demand or shift of demand or Increase and Decrease in demand**:

When the quantity demanded a commodity increases or decreases due to change in factors other than price of the product like income of the consumer, price ofrelated goods, etc. it is known as change in demand or shift in demand.

In Figure 3.5 DD is the original demand curve and the consumer in buying OQ units of the commodity at price OP. For example with an increase in the income of the consumer , price of the product remains constant, the demand increases the new demand curve is $D_1D_1$. This new curve is an outward shift in the demand curve and shows an increase in the demand for the product from OQ to $OQ_1$. Similarly due to the fall in the income of the consumer, the demand curve will shift inward from DD to $D_2D_2$. Quantity of good purchased will reduce from OQ to $OQ_2$. This is called decrease in demand.

Thus in the above figure quantity demanded has increased from OQ to $OQ_1$, the price of commodityremaining constant at OP. This is shown by a right ward shift of the Original demand curve toform new demand curve $D_1D_1$. This is called increase in demand in demand.The left ward shift from the original demand curve DD to $D_2D_2$ is known as decrease in demand, price of the product remains same at OP.

**3.3 THEORY OF SUPPLY**

Supply is defined as a quantity of a commodity offered by the produces to besupplied at a particular price and at a certain time. Same as demand supply has three elements namely quantity of commodity, particular price and particular time.

The term ‘supply’ is different from ‘stock’ of a commodity. The total amount of the commodity which a seller can bring out for sale in the market is his stock. However, producer often does not offer his entire stock for sale in the market.Supply has been defined as that part of the stock of a commodity which is offered for sale at a particular price during a period of time. For example a farmer produces 500 tons of potatoes during a given period. He may offer only 300 tones for sale at Rs 1000 per ton. In this case the stock of potatoes is 500 tons but supply is only 300 tones at a given price.

**Individual Supply and Market Supply**

Individual supply refers to the quantity of a commodity which a producer is willing to produce andoffer for sale. On the other hand, the quantity which all producers are willing to produce and sell isknown as market supply. If, at a given price, producer A is willing to sell 200 units of a commodity and producer B is willing to sell 500 units, and then if there are only two firms producing this particular commodity, market supply will be 700 units.

**Law of supply**

Law of supply states that, other thing remaining constant, as the price increase quantity supplied will increase and with the decrease in price the supply will reduce. Thus there is a positive relationship between price of a commodity and its quantity supplied. More is supplied at higher price and less at the lower price. The law of supply is based on following assumptions -

**Assumption of the law of supply**

(1) Prices of the factors of production are constant.

(2) Price of the related goods remain constant

(3) Technique of production is constant.

(4) No change in the Objectives of the firm

(5) Producers do not expect any change in the future price of the product.

The law can be explained with the help of following supply schedule and supply curve.

**Supply Schedule**

Supply schedule is a table which shows various quantities of a commodity offered for sale at different possible prices of that commodity. There are two types of supply schedule –

(i) Individual supply schedule, and

(ii) Market supply schedule.

(iii) An individual supply schedule shows the different quantities of a commodity that a producer would offer for sale at different prices.

Table 3.3 shows a hypothetical individual supply schedule of apples. When the price of apples is Rs 10 per Kg the producer is interested in selling only 1 kg of apples. As the price rises, supply increases. Thus higher the price higher is the supply.

**Table 3.3.Individual supply schedule of Apples**

| Price of Apples (Rs.) | Quantity supplied (Kg) |
|---|---|
| 10 | 1 |
| 20 | 2 |
| 30 | 3 |
| 40 | 4 |

**Market supply schedule:** Market supply refers to supply of all the producers in the market producing a particularcommodity.Firm is an individual unit producing a commodity. A group of firms producing a similar good is called an Industry. Thus, market supply schedule is also referred to supply of the industry as whole.

**Table 3.4:Market Supply schedule.**

| Price of Apples (Rs.) | Supply by Producer 'A' (Units) | Supply by Producer 'B' (Units) | Market supply |
|---|---|---|---|
| 10 | 1 | 0 | 1+0=1 |
| 20 | 2 | 5 | 2+5=7 |
| 30 | 3 | 10 | 3+10=13 |
| 40 | 4 | 15 | 4+15=19 |

From the above table we see that when price of apples is Rs.10 per Kg, then the producer A will supply only 1 kg of apples whereas producer B is not interested any quantity. When price increase to Rs.20, producer 'A' supplies 2 kg and producer 'B' supplies 5 units.

Thus the market supply is 2 + 5 = 7Kg of apples.When the price rise to Rs 30 per kg of apples market supply increase to 13 kg. Thus at higher price the market supply will increases.

**Supply curve:** Supply curve is a graphic presentation of supply schedule. Supply curve has positive slope which indicates positive relationship between price of a commodity and its quantity supplied.

Same as the supply schedule supply curve can be divided into

(i) (i)Individual supply schedule and

(ii) Market supply schedule.

**An individual supply curve** is a graphical representation of supply schedule of an individual producer in the market. It slopes upwards indicating positive relationship between price of a product and its quantity supplied. The individual supply curve is given in figure 3.6

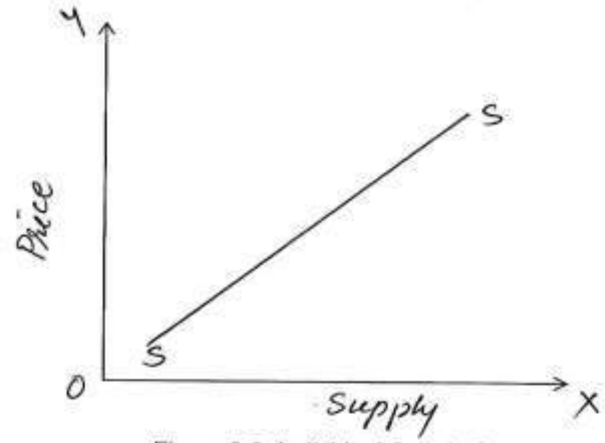



Figure 3.6: Individual Supply Curve

In the above figure SS is the supply curve which has positive slope. It shows that more of a commodity is supplied at a higher price.

**Market supply curve** as shown in figure 3.7 is the horizontal summation of all individual supply curves. This is also known as the supply curve of the industry as a whole. Supply curve SS is of producer A and S1S1 is the supply curve of producer B.

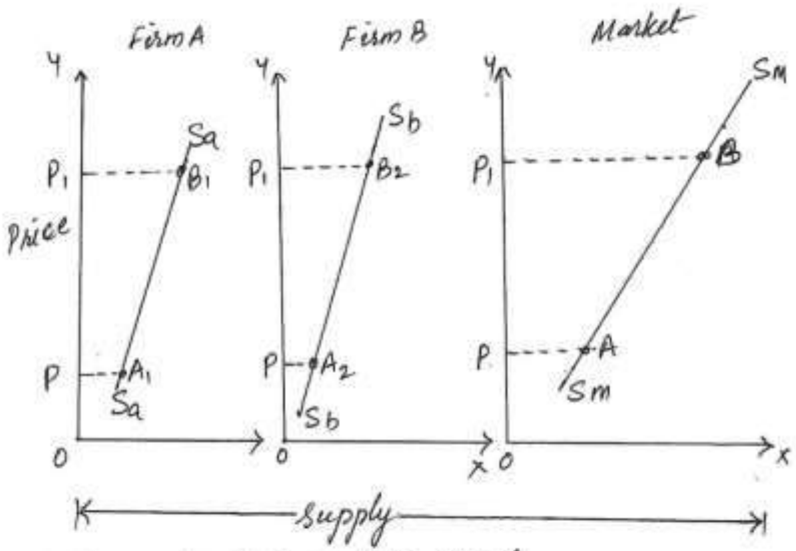


Fig 3.7 Market Supply

For deriving the market supply curve, same as the market demand curve explained earlier in this chapter we add the individual supply curves horizontally.

**Factor Determining supply or supply function**

Supply function represents the functional relationship between supply of a commodity and its various determinants. The supply of a commodity mainly depend on the objective of the firm, price of the commodity, price of related goods, price of factors of production and the state of technology.

Supply function can be written as –

S =*f* (P, O, Pr, F, T, G,…….)

Where

P- Price of the commodity

O – Objectives of the firm

Pr – Price of related goods

I – Input Prices

T – State of Technology

G – Government Policies

E- Future expectation of the prices

F – Number of sellers in the market

N – Natural Factors

The above mentioned determinants of supply are explained below –

**(i)** **Price of the commodity (P):** With change in the price of the product the supply changes. When the price increases, producer increase the supply and vice versa.With no change in cost of production, higher the price, higher will be the profit margin. This will encourage the producers to supply larger quantity at higher prices. When the price decline the supply will also decline.

**(ii)** **Objectives of the firm (O):**Firms have several objectives such asprofitmaximization, sales maximization, employee satisfaction maximization etc. If the objective is tomaximize profit, then higher the profit from the sale of a commodity, the higherwill be the quantity supplied by the firm and vice-versa. Thus, the supply of goods willalso depend upon the priority of the firm regarding these goals and the extent towhich it is prepared to sacrifice one goal to the other.

**(iii)** **Expectation about future prices (E):** If the produces expect an increase in the future price of acommodity, then the present supply will reduce as producer will stock the goods to sell in future at higher prices. On the contrary if he expects a fall in future prices then he will increase the present supply.

**(iv)** **Input Prices (I):**Supply depends upon the prices of inputs like raw materials,labour and other inputs. Any rise in the input cost will reduce the profitmargin and ultimately lead to a lower supply. However, with the fall in inputs prices , profit margin will increase and the supply will also increase.

(v) **State of Technology (T):**An improved and advanced technology is used for the productionof a commodity will reduce its cost of production and increases the supply. On the contrary, outdated and old technology will increase the cost of production and reduced supply.

(vi) **Government policies (G):P**olicies of Government such as fiscal policy which leads to imposition of taxes,excise duty, sales tax etcwill affect the production of commodities and supply adversely. Any reduction in the taxes will increase the supply. Subsidy policy also influences the supply of a commodity. When government increase the subsidy the profit margin will increase and supply will increase.

(vii) **Prices of the related goods (Pr):**An increase in the prices of related goods othercommodities makes the production of that commodity whose price has not risenrelatively less attractive we thus, expect that other things remaining the same, thesupply of one good falls as the price of other goods rises. For instance a farmer produces bananas as well as potatoes his farm. If the price of potatoes increases hewill grow more of potatoes and less of bananas. Hence the supply of bananas will reduce.

(viii) **Number of Sellers in the market (F):M**arket supply is the sum total of the supply by number of individual suppliers. Larger the number of the firmsin the market the greater will be the supply. Adecrease in the number of firms reduces the supply and vice versa.

(ix) **Natural factor (N):**Natural factors too affect the supply**.** In case of natural calamities like flood, drought, earthquake etc. the supply of acommodity especiallyof agricultural products is adversely affected.

**Exceptions to the Law of Supply**

(i) **Agricultural Goods:** For agricultural goods it is not possible for the supply to be adjusted to marketconditions. As the production and supply of agricultural goods is largely dependent on naturalfactors like rainfall, temperature etc. and it is mostly seasonal in nature it cannotbe increased with a rise in price.

(ii) **Rare Objects:**The supply of certain commodities like rare coins, classical paintings oldmanuscripts, etc. cannot be increased or decreased with the changein price. Therefore, such goods have inelastic supply.

(iii) **Labour Market:**with a rise in wages workers will work for less number of hours,and will prefer leisure over work. Thus the labour market, the behavior of the supply of labour goesagainst the law of supply.

**Change in Quantity Supplied and Change in Supply**

A change in **quantity supplied** refers to change in quantity purchased of a commodity in response to change in price, other things remain constant. It is expressed through movement along the Supply curve. On the other hand a **change in Supply** refers to change in quantity Supplied of a commodity in response to change in factors other than price of the commodity. It is expressed through shift in Supply curve-forward shift or backward shift.

**(a) Movement of Supply curve or Extension and Contraction of Supply or change in quantity Supplied.**

With the change in the price of a commodity the quantity Supplied will increases or decreases depending upon the rise or fall in the price ofa commodity alone, ceteris paribus.This is called movement along the Supply curve or extension or contraction of Supply. As shown in figure 3.4, when the price increases, other factors affecting Supply remain constant, the quantity Supply will decreases and vice versa.

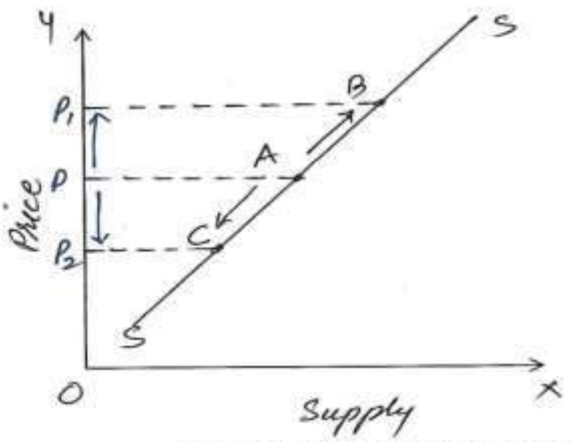


Figure 3.8: Change in quantity Supplied

The figure 3.8 show that when price increases from OP to $OP_1$ the Supply increases from OQ to $OQ_1$. Thus with the rise in price there is a movement on the Supply curve from point A to point B. Similarly with the fall in price from OP to $OP_2$ the quantity Supplied decreases from OQ to $OQ_2$ causing a shift from point A to point C on the Supply curve. The increase in Supply due to rise in price is also called extension of Supply. The reduction in quantity supplied due to fall in price is known as contraction.

**Change in Supply or shift of Supply or Increase and Decrease in Supply**:
When the quantity supplied of a commodity increases or decreases due to change in factors other than price of the product like price ofrelated goods, prices of inputs etc. it is known as change in supply or shift insupply.

In Figure 3.9 SS is the original Supply curve and the consumer in buying OQ units of the commodity at price OP. If the input cost reduces, price of the product remains constant, the supply will increase,and the new supply curve is $S_1S_1$. This new curve is an outward shift in the supply and it shows an increase in the supply for the product from OQ to $OQ_1$. Similarly due to the rise in input cost, price of the product remaining same, the supply curve will shift inward from SS to $S_2S_2$. Quantity of good purchased will reduce from OQ to $OQ_2$. This is called decrease in Supply.

Thus in the above figure quantity supplied has increased from OQ to $OQ_1$, the price of commodityremaining constant at price OP. This is shown by a right ward shift of the original supply curve toform new supply curve $S_1S_1$. This is called increase in supply.

The left ward shift from the original supply curve SS to $S_2S_2$ is known as decrease in Supply, price of the product remains same at OP.

**3.4 EQUILIBRIUM OF DEMAND SUPPLY AND PRICE DERTEMINTION**

Equilibrium means a state of balance. The term equilibrium in Economics means the state in which there is no tendency on the part of consumers and producers to change. Market equilibrium is a situation of the market in which demand for a commodity is equal to supply of the commodity at a particular price. Hence when there is equilibrium between demand and supply of a commodity at a particular price, there is neither excess demand nor excess supply. At this position the prevailing price is called the equilibrium price and the corresponding quantity supplied/demand is called equilibrium quantity

**Determination of equilibrium price:**

According to Alfred Marshall demand and supply are the two blades of pair of scissors. Through intersection of demand and supply the equilibrium price and equilibrium quantity of a commodity is determined.

The force of demand and supply determinethe price of a commodity. There is a conflict in the aim of producers and consumers. Consumers are interested in buying the goods at the lowest price to maximize satisfaction and producer aim at selling the goods at the highest price to maximize profit.Equilibrium price will be determined where quantity demanded is equal to the quantity supplied. This called market price. The determination of equilibrium price is explained with the help of a schedule given in table 3.5 and figure 3.10.

**Table 3.5 – Equilibrium Price**

| Price of Apples (Rs.) | Quantity demanded (Kilogram) | Quantity supplied (Kilogram) |
|---|---|---|
| 10 | 4 | 0 |
| 20 | 3 | 1 |
| 30 | 2 | 2 |
| 40 | 1 | 3 |

Table 3.5 gives a hypothetical schedule which depicts different price and the respective quantity demanded and supplied. When the prices increases from Rs 10 to Rs 40, the quantity demanded decreases from 4 Kg to 1 Kg and the quantity supplied increases from nothing to 4 Kg respectively. At price Rs 10 the quantity demanded is 4 Kg and suppliers are not interested in supplying at all. Thus at lower price consumers will demand more and suppliers will supply less. At price Rs 40 per Kg demand is 1 Kg and supply is 4 Kg. With an increase in price the demand decrease and supply increases. We can observe in table 3.5 at price at price Rs 30 the quantity demanded is equal to quantity supplied, and that is the equilibrium price and equilibrium quantity is 2 Kg. At prices less than Rs 30 there is an excess of demand over supply and at price higher than Rs 30 per Kg the supply is more than demand.

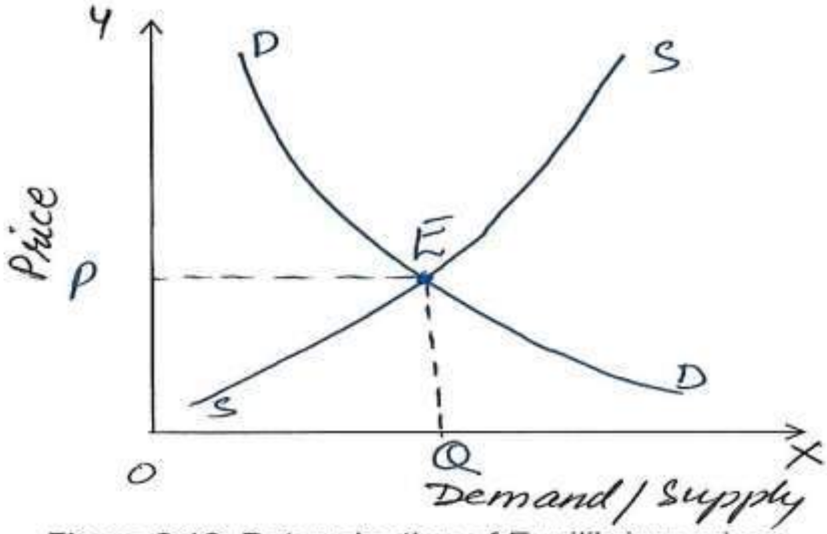


Figure 3.10: Determination of Equilibrium price

In figure 3.10 price is measured on Y axis and quantity demanded and supplied taken on X-axisprice per unit. DD is the demand curve and SS is the supply curve. The demand curve and supply curve intersect each other at point E. At the equilibrium point E the quantity demanded is equal to the quantity supplied i.e. PE and therefore the equilibrium price is OP the equilibrium quantity is OQ.

Above this equilibrium price OP, at $OP_1$ the quantity demanded decrease to $P_1G$and quantity supplied increase to $P_1H$. At price higher than equilibrium price there is an excess of supply over demand GH. At price $OP_2$, which is lower than the equilibrium price quantity supplied decreases to $P_2I$ and quantity demanded increases to $P_2K$. Hence at price lower than the equilibrium price there is an excess of demand over supply.

**Effect of change in supply and demand:**

The equilibrium price and quantity changes with the shift in supply curve demand remaining same or shift in demand curve supply remaining same or shift in both. The change in equilibrium due to change in demand with no change in supply can be seen in figure 3.11, which shows price on Y axis and quantity demanded and supplied on x axis.

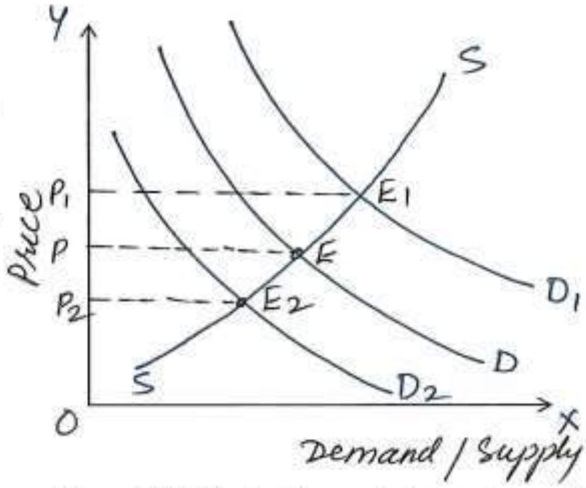



Figure 3.11: Effect of change in demand on equilibrium price

Demand curve DD intersects supply curve SS at point E, which determines the equilibrium price OP and equilibrium quantity OQ. With an increase in demand the demand curve shifts from DD to $D_1D_1$. And the new equilibrium is at $E_1$. Thus with the increase in demand supply remaining same there is an increase in the price to $OP_1$. When the demand decreases from DD to $D_2D_2$ an inward shift in the demand curve the equilibrium shifts to $E_2$ leading to a reduction in the equilibrium price. With the increase in demand the equilibrium price increase and vice versa.

The effect of change in the supply is shown in figure 3.12, where price on Y axis and quantity demanded and supplied on x axis.

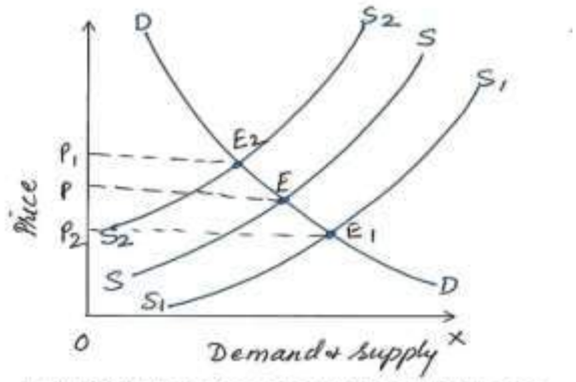


Figure 3.12: Effect of change in supply on equilibrium price

Demand curve DD intersectssupply curve SS at point E, which determines the equilibrium price OP and equilibrium quantity OQ. With an increase in supply the supply curve shifts from SS to $S_1S_1$. And the new equilibrium is at $E_1$. Thus with the increase in supply demand remaining same there is a reduction in the price to $OP_1$. When the supply decreases from SS to S2S2 an inward shift in the supply curve the equilibrium shifts to $E_2$ leading to an increase in the equilibrium price to $OP_2$.Thus with the increase in supply the equilibrium price decrease and vice versa.

Thus we learnt that

**i)** When the demand increases equilibrium price will increase,

**ii)** When the demand decreases equilibrium price will decrease,

**iii)** When the supply increase equilibrium price will decrease, and

**iv)** When the supply decreases equilibrium price will increase.

### 3.5 Importance of Time Element

Marshall, who propounded the theory that price is determined by both demand and supply, also gave a great importance to the time element in the determination of price. Time elements is of great relevance in the theory of value, since one of the two determinants of price, namely supply, and depends on the time allowed to it for adjustment. It is worth mentioning that Marshall divided time into different periods from the viewpoint of supply and not from the viewpoint of demand.

Time is short or long according to the extent to which supply can adjust itself. Marshall felt it necessary to divide time into different periods on the basis of response of supply because it always takes time for the supply to adjust fully to the changed conditions of demand.

The reason why supply takes time to adjust itself to a change in the demand conditions is that nature of technical conditions of production is such as to prohibit instantaneous adjustment of supply to changed demand conditions. A period of time is required for changes to be made in the size, scale and organisation of firms as well as of the industry.

Another point is worth noting. When Marshall distinguished short and long periods he was not using clock or calendar time as his criterion, but 'operational' time in terms of economic forces at work. In this regard, as said above, supply forces were given the major attention and a time was short or long according to the extent of adjustment in the forces of supply. The greater the adjustability of the supply forces, the greater the length of the time irrespective of the length in clock-time.

**Time can be divided into following three periods on the basis of response of supply to a given and permanent change in demand:**

1. **Market Period:**

   The market period is a very short period in which the supply is fixed, that is, no adjustment can take place in supply conditions. In other words, supply in the market period is limited by the existing stock of the good. The maximum that can be supplied in the market period is the stock of the good which has already been produced.

   In this period more good cannot be produced in response to an increase in demand. This market period may be a day or a few days or even a few weeks depending upon the nature of the good. For instance, in case of perishable goods, like fish, the market period may be a day and for a cotton cloth, it may be a few weeks.

2. **Short Run:**

   Short run is a period in which supply can be adjusted to a limited extent. During the short period the firms can expand output with given equipment by changing the amounts of variable factors employed. Short periods is not long enough to allow the firm to change the plant or given capital equipment. The plant or capital equipment remains fixed or unaltered in the short run. Output can be expanded by making intensive use of the given plant or capital equipment by varying the amounts of variable factors.

3. **Long Run:**

   The long run is a period long enough to permit the firms to build new plants or abandon old ones. Further, in the long run, new firms can enter the industry and old ones can leave it. Since in the long run all factors are subject to variation, none is a fixed factor. During the long period forces of supply fully adjust them to a given change in demand; the size of individual firms as well as the size of the whole industry expands or contracts according to the requirements of demand.

   **From above, it is clear that because of the varying response of supply over a period of time to a sudden and once-for-all increase in demand Marshall found, it necessary and useful to study the pricing process in:**

   a. The market period,
   b. The short-run and
   c. The long-run depending respectively upon whether the supply conditions have time to make (i) no adjustment, (ii) some adjustment of labour and other variable factors, and (iii) full adjustment of all factors and all costs. Therefore, Marshall explained how the equilibrium between demand and supply was established in three time periods and determined market price, short-run price and long-run price.

We thus see that the price that will prevail depends upon the period under consideration. If a sudden and a once-and-for all increase in demand take place, the market price will register a sharp increase, since supply cannot increase in the market period. In this market period, firms can sell only the output that has already been produced. However, in the short run some limited adjustment in supply will take place as a result of the firms moving along their short run marginal cost curves by expanding output with the increase in the amount of variable factors. Consequently, the short run price will come down from the new high level of the market price.

But this short-run price will stand above the level of original market price which prevailed before the increase in demand occurred. In the long run the firms would expand by building new plants, that is, by increasing the size of their capital equipment.

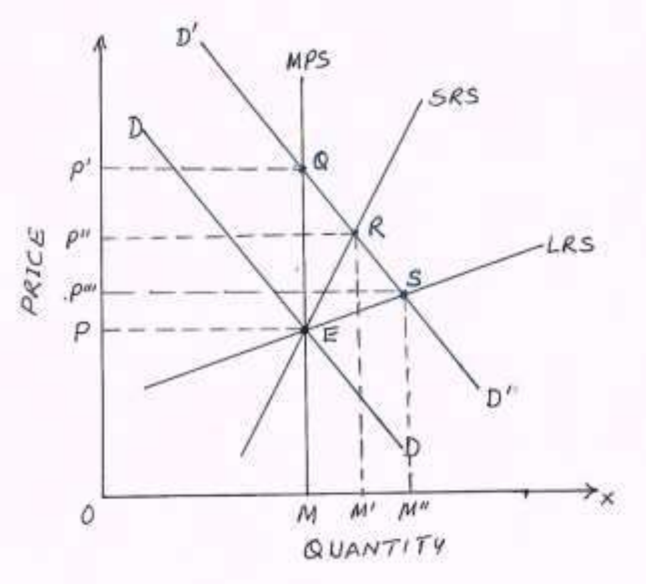
In other words, firms would expand along the long-run marginal cost curves. Besides, the new firms will enter the industry in the long run and will add to the supply of output. As a result of these long-run adjustments in supply, the price will decline.

Thus the long run price will be lower than the short-run price. But this long-run price will be higher than the original price which ruled before the increase in demand took place, if the industry happens to be increasing-cost industry.

The adjustment of supply over a period of time and consequent changes in price is illustrated in figure above where long-run supply curve LRS of an increasing-cost industry along with the market-period supply curve MPS and the short-run supply curve SRS have been drawn. Originally, demand curve DD and market-period supply curve MPS intersect at point E and price OP is determined. Suppose that there is a once- for-all increase in demand from DD to D'D'.

Supply cannot increase in the market period and remains the same at OM. Market-period supply curve MPS intersects the new demand curve D'D' at point Q. Thus, the market price sharply rises to OP". Short-run supply curve SRS intersects the new demand curve D'D' at point R.

The short-run price will therefore be OP" which is lower than the new market price OP'. As a result of the long-run adjustment the price will fall to OP'" at which the long-run supply curve LRS intersects the demand curve D'D'.




The new long-run price OP'” is lower than the new market price OP’ and the short-run price OP”, but will be higher than the original price OP which prevailed before the increase in demand took place. This is so because we are assuming an increasing-cost industry. If the industry is subject to constant costs, the long-ran price will be equal to the original price. Further, if the industry is subject to decreasing costs, the long-run price will be lower than the original price.

It follows from above that the price which prevails in the market depends upon the period under consideration. It is thus clear that the time plays an important role in the determination of price. Another significance of the time-period analysis of pricing is that it enabled Marshall to resolve the controversy current among economists whether it is demand or supply which determines price.

Marshall propounded the view that both demand and supply took part in the determination of price. But, “as a general rate”, said Marshall, “the shorter the period which one considers the greater must be the share of our attention which is given to the influence of demand on value, and the longer the period more important will be the influence of cost of production on value.

Actual value at any time—the market value as it is often called—is often influenced by passing events and causes whose action is fitful and short-lived than by those which work persistently. But in the long run these fitful and irregular causes in a larger measure efface one another’s influence so that in the long run persistent causes dominate value completely”.

From the above quotation from Marshall it follows that in the market period, demand exercises a predominant influence over price but in the long run it is the supply which is of overwhelming importance as a determinant of price. Roughly speaking, we can say that in the market period it is the force of demand which determines price and in the long period it is the force of supply which governs price.

Thus those economists who held that value was governed by demand were in a way right and so were those who contended that cost of production (i.e., force working on the supply side) determines price. The difference in the two views was due to the fact that one group of economists was emphasising the determination of the market price over which demand has determining influence and over which cost of production does not exercise much influence, while the other group was stressing on the determination of long-run price over which cost of production has got paramount influence. It is thus clear that Marshall by putting forth the view that both demand and supply determine price by their interaction brought about synthesis between the views of earlier economists.

Both the two opposite views of earlier economists were in a way right but each was one-sided. Each view provided us with a force which governed price. The two forces of supply and demand furnished by the two opposing views were sufficient determining factors.

Therefore, Marshall gave equal importance to both demand and supply as determinants of price, though the influence of the two varied in different time periods. Marshall introduced time period analysis into pricing process to bring out the varying influence of each of two forces over price of the product in different time periods.

It follows from what has been said above that Marshall and modern economists following him study the effect of the varying response in supply in different time periods on price to a sudden and permanent change in demand conditions.

On the contrary, economists do not study the effect on price of the adjustment in demand over time in response to a change in supply conditions. The reason why we do not study adjustment in demand to a change in supply and consequent effect on price is better brought out in the worlds of Professors Stonier and Hague. “There is no reason why, if supply conditions change, demand conditions should change as well, or if they do, why they should change differently in the short run and the long run.

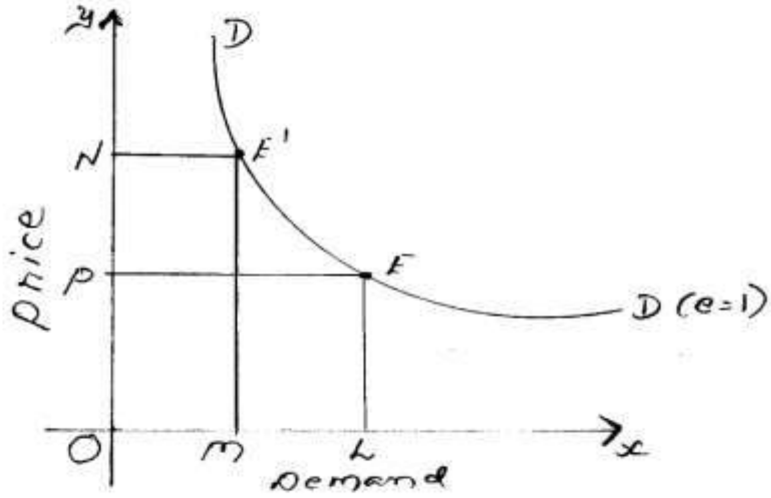
Changes in consumer's tastes are not dependent on technology in the way that supply conditions are. Admittedly, consumers' tastes may and probably will change as time goes on. But this will be a change of data and not a change induced by changed supply conditions.

There is no necessary reason why the long-run demand curve should differ from the short-run demand curve, however odd the behaviour of supply has been-we must expect that the longer is the period during which demand and supply are coming into equilibrium, the more changes will have time to take place. If we were to study the changes in demand and supply which would take place in respect to any change of data during many successive very short periods of time, we should find that we had introduced unnecessary and intolerable detail into the analysis."

We shall explain below in detail the market-period equilibrium, short-run equilibrium, long-run equilibrium between demand and supply and thus the determination of market price, short-run price and long-run price under conditions of perfect competition.

### 3.16 Elasticity of Demand

The law of demand fails to tell us as to what extent demand for a commodity vary when there is a change in price. In other words, the law of demand merely indicates the direction to which demand moves when there is a change in price. But concept of elasticity explains the exact change in demand when there is a change in price. The price elasticity of demand is defined as "The degree of responsiveness or sensitiveness of demand to a change in price of a commodity or service."




Algebraically, it is stated as

$$e(p) = \frac{\Delta Q}{Q} \div \frac{\Delta P}{P}$$

Where $\Delta$ = means a change

$Q$ = Quantity

$P$ = Price

e(p) = Price elasticity of demand

There are five cases of price elasticity of demand.

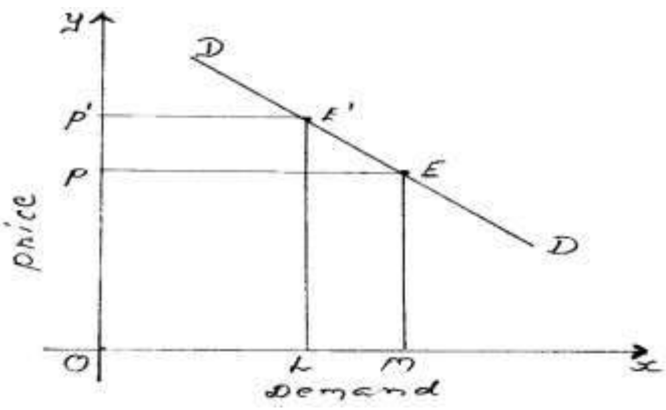
1. **Unitary elastic demand (e = 1)**

   Demand is said to be unitary elastic when proportionate change in price is equal to proportionate change in quantity demanded of any commodity. The value of the elasticity is equal to one (e=1) in such cases demand curve is convex to the origin as shown in the diagram.

$$e(p) = \frac{\Delta Q}{Q} \div \frac{\Delta P}{P} = \frac{ML}{OL} \div \frac{NP}{OP} = \frac{ML}{OL} \times \frac{OP}{NP} = 1$$

2. **Relatively elastic demand (e > 1)**

   Demand for a commodity is said to be elastic when proportionate change in quantity demanded is greater than proportionate change in price. In such cases value of the elasticity is greater than one and shape of the demand curve is flatter as shown in the following diagram.



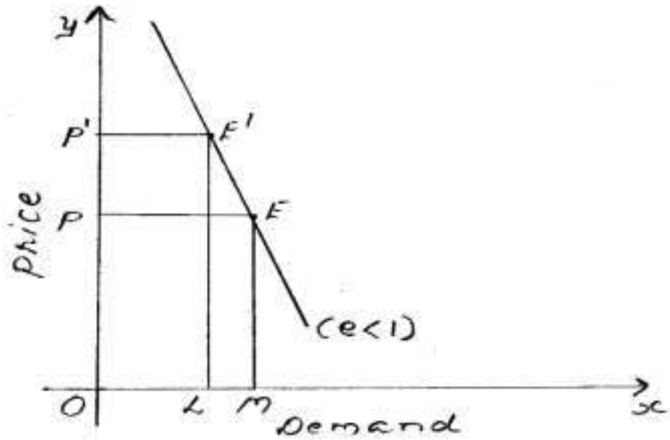

$$e(p) = \frac{\Delta Q}{Q} \div \frac{\Delta P}{P} > 1$$

$$= \frac{LM}{OM} \div \frac{PP'}{OP}$$

$$= \frac{LM}{OM} \times \frac{OP}{PP'} > 1$$

3. **Relatively inelastic demand (e<1)**

Demand for a commodity is said to be relatively inelastic when proportionate change in demand is smaller than proportionate change in price of the commodity. In such cases, value of the elasticity is less than one (e<1) and the demand curve is steeper. The following diagram exhibits the said demand curve.



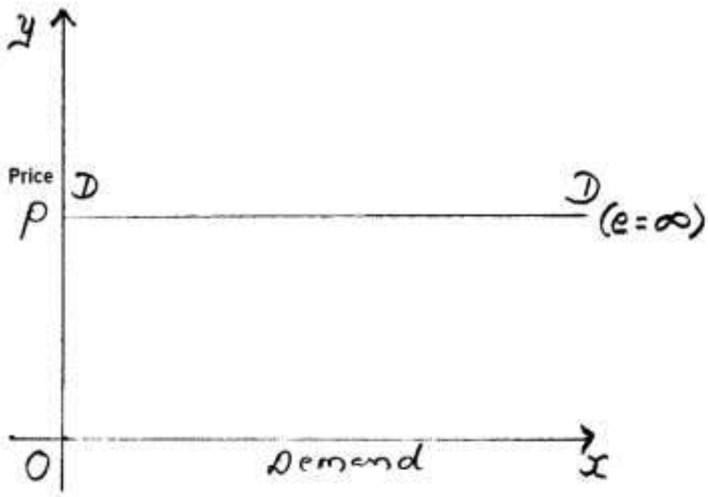

$$e(p) = \frac{\Delta Q}{Q} \div \frac{\Delta P}{P} < 1$$

$$= \frac{LM}{OM} \div \frac{PP'}{OP}$$

$$= \frac{LM}{OM} \times \frac{OP}{PP'} < 1$$

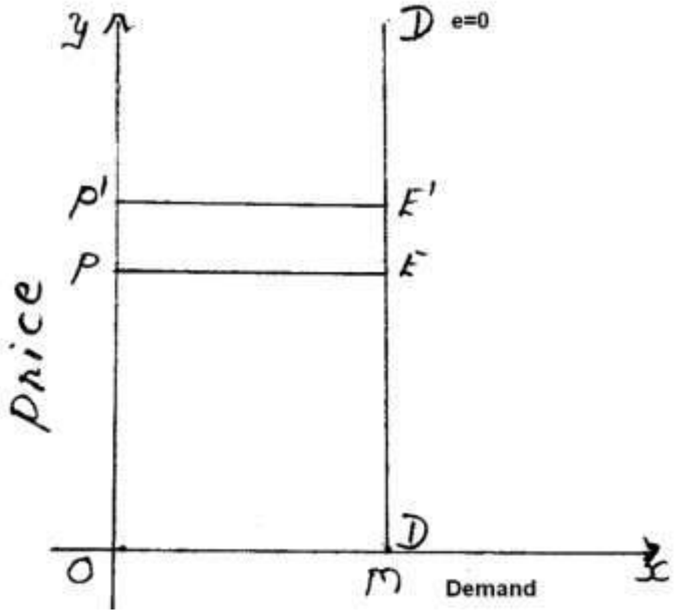
4. **Perfectly elastic demand (e=$\infty$)**

Demand for a commodity is said to be perfectly elastic when a small change (rise or fall) in price brings about either complete contraction or infinite expansion in demand. In such cases value of the elasticity is infinity (e=$\infty$) and demand curve is horizontal to 'x' axis. The following figure depicts the same.




5. **Perfectly inelastic demand (e=0)**

   Demand for any commodity is said to be perfectly inelastic when there is no change in demand at a high or low price. The value of the elasticity is zero in such cases and demand curve is vertical to 'x' axis. The following figure depicts the perfectly inelastic demand.



3.17 **Determinants of Elasticity**

1. **Nature of commodity**

   In case of necessaries of life demand is inelastic while luxuries relatively elastic.

2. **Number of uses**

   In case of large number of uses, demand is relatively elastic and in case a few uses, it is relatively inelastic.

3. **Number of substitutes**

   If the substitutes are more demand is relatively elastic while less number of substitutes, demand is relatively inelastic.

4. **Durability of goods**

   Durable goods have relatively elastic demand while perishable goods have relatively inelastic demand.

5. **Low priced commodities**

   Low priced commodities like salt, newspapers, matchboxes etc. have relatively inelastic demand.

6. **Proportion of income spent**

   Commodities needing less expenditure generally have relatively inelastic demand.

**3.18 Importance of Elasticity**

The concept of elasticity is very much useful in day-to-day life. Firstly, it deeply analyses price-demand relationship. Secondly, it helps producers in fixing prices of their product. Thirdly it is helpful to government to declare certain industries as public utility services. Fourthly it also helps the government to frame economic policies. Fifthly it helps finance minister in matter of taxation. The concept elasticity explains why there exists poverty in the midst of plenty. It is also helpful in international trade to determine terms of trade between the two countries.

**3.19 Income Elasticity of Demand**

$$e(i) = \frac{\text{Proportionate change in quantity demanded}}{\text{Proportionate change in income}}$$

It is defined as "the degree of responsiveness or sensitiveness of demand to a change in income." In other words, it shows a degree of responsiveness of demand to a change in income.

$$e(i) \quad = \quad \frac{\Delta Q}{Q} \div \frac{\Delta I}{I}$$

## 3.20 Cross Elasticity

It measures elasticity of demand of related goods. It means that when price of say 'x' good changes, the demand for related good say 'y' changes. Thus, the cross elasticity of demand measures the response of the quantity demanded of a particular commodity to the change in price of some other related commodity. Generally it takes place in complementary goods and substitutes

$$Cross\,Elasticity \quad = \frac{\text{Pr}\,oportionate\,change\,in\,quantity\,demanded\,of\,say\,'x'\,good}{\text{Pr}\,oportionate\,change\,in\,price\,or\,related\,good\,say\,'y'\,good}$$

The cross elasticity in case of substitutes is always positive but it is negative in case of complementary goods.

## 3.21 Exercise :

1. What is Law of demand? Explain with the help of schedule and diagram.(10 Marks)
2. What is a demand schedule? (5 Marks)
3. Write a note on demand curve.(5 Marks)
4. What are the exceptions of Law of demand? (5 Marks)
5. Explain the derivation of demand curve with the help of diagram.(5 Marks)
6. Discuss demand function.(10 Marks)
7. State law of supply and explain it with the help of a suitable diagram and schedule.(10 Marks)
8. Examine the factors affecting supply.(10 Marks)
9. What do you understand by equilibrium price?(10 Marks)
10. Discuss the effect of change in supply and demand on the equilibrium price. (10 Marks)
11. What is elasticity of demand? When does it become perfectly elastic, unitary elastic and inelastic?

# UNIT – IV

## PRODUCTION

### 4.1 Introduction

Production virtually means value-addition to natural resources. Men and nature are the basic elements in the production process. The valuers have to understand that commodities become saleable in the market after they are produced and every product acquires new value in this process. The output of production takes the form of goods as well as services.

In the next unit we shall see how to capture the value added through production. The product is meant primarily for exchange in return for money. The process of exchange is called transaction and return in terms of money is called price. The valuer has to make an estimate of price as it ought to be. In this way price is differentiated from value. However, value-addition is the goal of production and price is the stage in the process.

Now, in economics the following agents are usually considered as the factors for production:-

- Land
- Labour
- Capital
- Organization

We have already stated that men and nature are the primary agents. But in course of time the production process become more complex. Modern production said to be capitalistic in the sense that capital plays a predominant role. This takes us to consider what capital is.

### 3.1.1 Capital :

Capital is produced means of production. In the olden days, at the dawn of human civilization, man used to produce by working upon natural resources with simple tools and implements. The farmer used to produce harvest of crops with plough, cobbler used to produce shoes and other lather products with aid of simple tools, the potter used turn-out utensils with the help of earth wheels, the weaver used to weave cloths with the help of an unsophisticated spinning wheel and loom.

But, with the advancement of civilization, growth of population and multiplication of demand, production has to be augmented many-folds by division of labour and intervening capital as the dominant media of production. The process of production also became round-about. Thus, irrigation became a prior need for investment, so that ultimate scale of production may be augmented, the spindles and looms are come to be replaced by power looms, weaving machines, etc. The cobbler simple tools became replaced by machine for mass production. The potter's simple earthen wheel paved the way for appropriate machineries. These intermediate machineries and means of production are again the resultant of initial production, the purpose of which is not directly to yield consumable items but to fill-in needs for produced means called capital, which can propel the quantum of ultimate production of consumable items in a big way. In course of time, this intermediate product called capital has gradually assumed the centre stage of production, so as to be recognized as a distinctly separate factor.

### 3.1.2 Organization :

An organization is the typical task of coordinating and harnessing the functions of other factors of production. The person or a group of persons who take the leading role of such organization constitute a distinct class called entrepreneur. They are not simple labour as to be merged in he concept of men interacting with natural resources to make production at the primary stage. Just as capital is an offshoot of natural resources as a distinct agent of production so is an enterprise or an organization, an offshoot of man or labour.

### 3.1.3 The Future Scenario :

In course of time, the four factor of production, i.e., Land, Labour, Capital and Organization, are yielding place to more items through split. The factor of capital is going to be split into tangible capital and intangible capital. The latter consists of intellectual properties, developed through research and development, which again relegates the process of production to a more remote region away from directly turning-out consumable commodities. These intellectual properties are distinctly given shape as intangible rights in the form of patterns, copyrights, design, trademark, know-how, trade secret, etc.

Entrepreneurship is gradually being divided into proprietorship and management, the latter being developed as distinct cadre aiding the process of production and gradually emerging as an indispensable agent of production.

Labour has to be split-up as skilled and unskilled, as because the role of one is distinctly different from the other.

Finally, we may for the future generation of valuers, classify the factors of production in the following manner:-

| | | |
|---|---|---|
| Land | - | all natural resources |
| Labour | - | skilled and unskilled |
| Capital | - | tangible as well as intangible |
| Entrepreneurship | - | including management |

## 4.2 ECONOMIC ANALYSIS OF COSTS

### 4.2.1 Total Cost : Fixed and Variable

Consider a firm that produces a quantity of output (denoted by *q*) using inputs of capital, labour, and materials. The firm buys these inputs in the factor markets. A profit-minded firm will keep an eagle eye on its cost to maintain profitability. The firm's accountants have the task of calculating the total dollar costs incurred at each level of *q.*

**Table 1** shows the total cost (*TC*) for each different level of output *q*. Looking at columns (1) and (4), we see that *TC goes* up as *q* goes up. This makes sense because it takes more labour and other inputs to produce more labour and other inputs to produce more of a good; extra factors involve an extra money cost. It costs $110 in all to produce 2 units, $130 to produce 3 units, and so forth. In our discussion, we assume that the firm always produces output at the lowest possible cost.

| (1)<br>Quantity<br>q | (2)<br>Fixed cost<br>FC ($) | (3)<br>Variable cost<br>VC ($) | (4)<br>Total cost<br>TC ($) |
|---|---|---|---|
| 0 | 55 | 0 | 55 |
| 1 | 55 | 30 | 85 |
| 2 | 55 | 55 | 110 |
| 3 | 55 | 75 | 130 |
| 4 | 55 | 195 | 160 |
| 5 | 55 | 155 | 210 |
| 6 | 55 | 225 | 280 |

***Table 1 : Fixed, Variable, and Total Costs***

The major elements of a firm's costs are its fixed costs (which do not vary at all when output changes) and variable costs (which increase as output increase). Total costs are equal to fixed plus variable costs: *TC = FC + VC.*

**Fixed Cost**

Columns (2) and (3) of **Table 1** break total cost into two components: total fixed cost (FC) and total variable cost (VC).

What are a firm's **fixed costs?** Sometimes called "overhead" or "sunk costs", they consist of items such as rent for factory or office space, contractual payments for equipment, interest payments on debts, salaries of tenured faculty, and so forth. These must be paid even if the firm produces no output, and they will not change if output changes. For example, a law firm might have an office lease which runs 10 years and remains an obligation even if the firm shrinks to half its previous size. Because *FC* is the amount that must be paid regardless of the level of output, is remains constant at $55 in column (2).

**Variable Cost**

Column (3) of **Table 1** shows variable cost (*VC*). **Variable costs** are those which vary as output changes. Examples include materials required to produce output (such as steel to produce automobiles), production workers to staff the assembly lines, power to operate factories, and so on. In a supermarket, checkout clerks are a variable cost, since managers can easily adjust the clerks' hours worked to match the number of shoppers coming through the store.

By definition, *VC* begins at zero when *q* is zero. It is part of *TC* that grows with output; indeed, the jump in *TC* between any two outputs is the same as the jump in *VC*. Why? Because *FC* stays constant at $55 throughout and cancels out in the comparison of costs between different output levels.
Let us summarize these cost concepts:

*Total cost* represents the lowest total dollar expense needed to produce each level of output *q*-*TC* rises as *q* rises.

*Fixed cost* represents the total dollar expense that is paid out even when no output is produced: fixed cost is unaffected by any variation in the quantity of output.

*Variable cost* represents expenses that vary with the level of output – such as raw materials, wages, and fuel – and includes all costs that are not fixed.
Always, by definition

$$TC = FC + VC$$

### 4.2.2 Definition of Marginal Cost

Marginal cost is one of the key concepts of economics. **Marginal cost** (MC) denotes the extra or additional cost of producing one extra unit of outputs. Say a firm is producing 1000 compact discs for a total cost of $10,000. If the total cost of producing 1001 discs is $10,006, the marginal cost of production is $6 for the 1001$^{st}$ disc.

Sometimes, the marginal cost of producing an extra unit of output czn be quite low. For an airline flying planes with empty seats, the added cost of another passenger is imply the cost of the peanuts and snack; no additional capital (planes) or labour (pilots and flight attendants) is necessary. In other cases, the marginal cost of another unit of output can be quite high. Consider an electric utility. Under normal circumstances, it can generate enough power using only its lowest-cost, most efficient plants. But on a hot summer day, when everyone's air conditioners are running and electric demand is high, the utility may be forced to turn on its old, high-cost, inefficient generators. This added electric power comes at a high marginal cost to the utility.

| (1) Output q | (2) Total cost *TC* ($) | (3) Marginal cost *MC* ($) |
|---|---|---|
| 0 | 55 | |
| | | 30 |
| 1 | 85 | |
| | | 25 |
| 2 | 110 | |
| | | 20 |
| 3 | 130 | |
| | | --- |
| 4 | 160 | |
| | | 50 |
| 5 | 210 | |

**Table 2 : Calculation of Marginal Cost**

Once we know total cost, it is easy to calculate marginal cost. To calculate the *MC* of the fifth unit, we subtract the total cost of the four units from the total cost of the five units, i.e., *MC = $210 - $160 = $50*. Fill in the blank for the marginal cost of the fourth unit

**Table 2** uses the data from **Table 1** to illustrate how we calculate marginal costs. The rust-colored *MC* numbers in column (3) of **Table 2** come from subtracting the *TC* in column (2) from the *TC* of the subsequent quantity. Thus, the *MC* of the first unit is $30 ( = $85 - $55). The marginal cost of the second unit is $25 (= $110 - $85). And so on.

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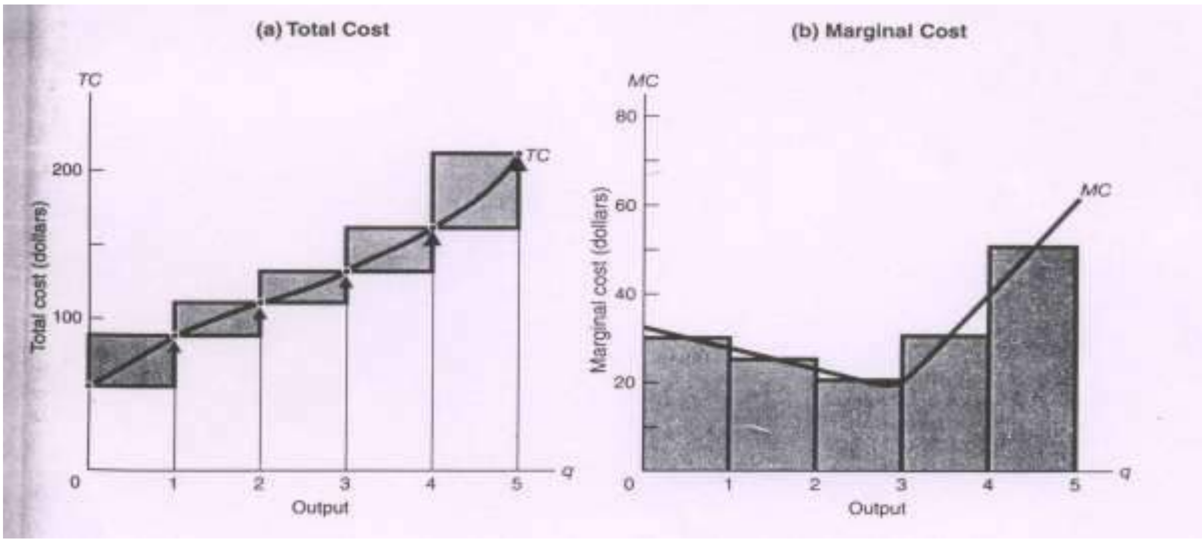
***Figure 1 : The Relationship between Total Cost and Marginal Cost***

This figure graphs the data from **Table 2**. Marginal cost in **(b)** is found by calculating




the extra cost added in **(a)** for each unit increase in output. Thus to find the *Mc*of producing the fifth unit, we subtract $160 from $210 to get *MC* of $50. A smooth black curve has been drawn through the points of *TC* in **(a)**, and the smooth black *MC* curve in **(b)** links the discrete steps of *MC*

Instead of getting *MC* from the *TC* column, we could get the *MC* figures by subtracting each *VC* number of column (3) of **Table 1** from the *VC* in the row below it. Why? Because variable cost always grows exactly like total cost, the only different being that *VC must – by definition – start out from 0 rather than from the constant FC* level. (Check that 30 – 0 = 85 – 55, and 55 – 30 = 110 – 85, and so on.)

The marginal cost of production is the additional cost incurred in production one extra unit of output.

**Marginal Cost in Diagrams**

**Figure 1** illustrates total cost and marginal cost. It shows that *TC* is related to *MC* in the same way that total product is related to marginal product or that total utility is related to marginal utility.

What kind of shape would we expect actual. MC curves to have? Empirical studies have found that for most production activities in the short run (i.e., when the capital stock is fixed), marginal cost curves are U-shaped like the one shown in **Figure 1 (b)**. This U-shaped curve falls in the initial phase, reaches a minimum point, and finally begins to rise.

### 4.2.3 Average Cost

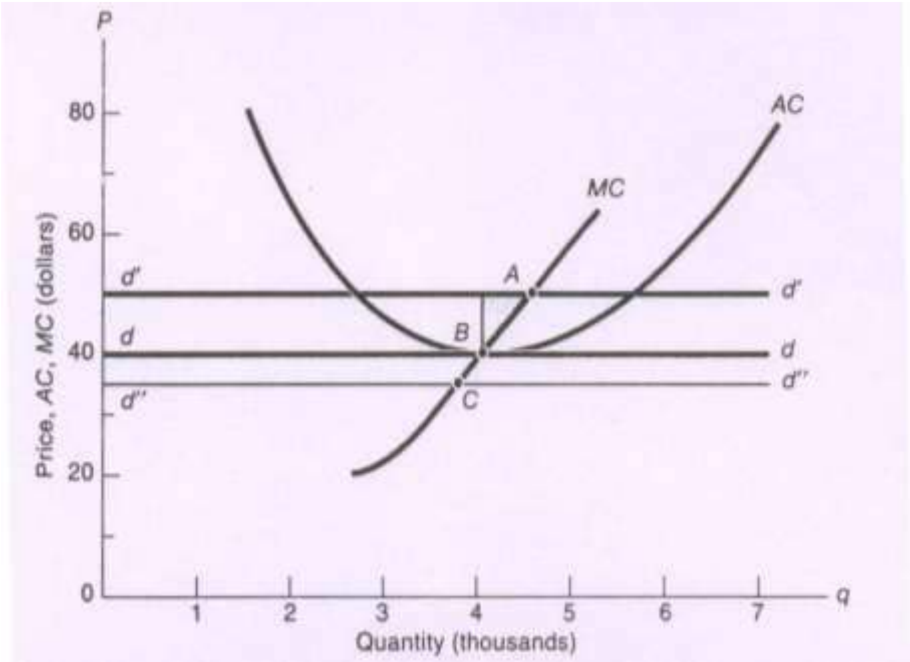
We complete out catalogue of the cost concepts important in economics and business with a discussion of different kinds of average or unit cost. **Table 3** expands the data of **Table 1** and **2** to include three new measures average cost, average fixed cost, and average variable cost.

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|
| | Fixed cost | Variable cost | Total cost | Marginal cost per unit | Average cost per unit | Average fixed cost per unit | Average variable cost per unit |
| Quantity | *FC* | *VC* | *TC=FC+VC* | *MC* | $AC = \frac{TC}{q}$ | $AFC = \frac{FC}{q}$ | $AVC = \frac{VC}{q}$ |
| q | ($) | ($) | ($) | ($) | ($) | ($) | ($) |
| 0 | 55 | 0 | 55 | 33 | Infinity | Infinity | |
| | Undefined | | | | | | |
| | | | | 30 | | | |
| 1 | 55 | 30 | 85 | 27 | 85 | 55 | 30 |
| | | | | 25 | | | |
| 2 | 55 | 55 | 110 | 22 | 55 | 27½ | 27½ |
| | | | | 20 | | | |
| 3 | 55 | 75 | 130 | 21 | 43⅓ | 18⅓ | 25 |
| | | | | 30 | | | |
| 4* | 55 | 105 | 160 | 40* | 40* | 13¾ | 26¼ |
| | | | | 50 | | | |
| 5 | 55 | 155 | 210 | 60 | 42 | 11 | --- |
| | | | | ----- | | | |
| 6 | 55 | 225 | 280 | 80 | 46⅔ | 91/6 | 37½ |
| | | | | 90 | | | |
| 7 | 55 | ----- | 370 | 100 | 526/7 | 76/7 | 45 |
| | | | | 110 | | | |
| 8 | 55 | ----- | 480 | 120 | 60 | 6⅞ | 53⅛ |

*Table 3 : All Cost Concepts Derive from Total Cost Schedule*

***Figure 2 : Firm's Supply Curve is Its Rising Marginal Cost Curve***

For a profit-maximizing competitive firm, the upward-sloping marginal cost (*MC)*curve is the firm's supply curve. For market price at d'd' , the firm will supply output at intersection point at A. Explain why intersection points at B and C represent equilibria for prices at d and d" respectively




**Rule for a firm's supply under perfect competition**

A firm will maximize profits when it produces at that level where marginal cost equals price:

$$\text{Marginal cost} = \text{price} \text{ or } MC = P$$

**Figure 2** illustrates a firm's supply decision diagrammatically. When the market price of output is $40, the firm consults its cost data and finds that the production level corresponding to a marginal cost of $40 is 4000 units. Hence, at a market price of $40, the firm will wish to produce and sell 4000 units. We can find that profit-maximizing amount in **Figure 2** at the intersection of the price line at $40 and the *MC* curve at point *B.*

In general, then, the firm's marginal cost curve can be used to find its optimal production schedule the profit-maximizing output will come where the price intersects the marginal cost curve.

We choose the example so that at the profit-maximizing output the firm has zero profits, with total revenues equal to total costs. (Recall that these are economic profits and include all opportunity costs, including the owner's labour and capital). Point *B* is the **zero-profit point**, the production level at which the firm makes zero profits; at the zero-profit point-price equals average cost, so revenues just cover costs.

What if the firm chooses the wrong output? If the market price were $50, the firm should choose output at intersection point *A* in **Figure 2**. We can calculate the loss of profit if the firm mistakenly produces at *B* when price is at $50 by the shaded gray triangle in **Figure 2**. This depicts the surplus of price over *MC* for production between *B* and *A*. Draw in a similar shaded triangle above *A* to show the loss from producing too much.

The general rule then is:
*A profit-maximizing firm will set its output at that level where marginal cost equals price. Diagrammatically, this means that a firm's marginal cost curve is also its supply curve.*

### 4.5 Exercise

1. What are the different factors of production and how are they remunerated?
2. Distinguish between fixed cost and variable cost. How marginal cost is determined?
3. Explain the relationship between marginal product and average product by referring to a diagram.

# UNIT – V

## PRICING OF PRODUCT

### 5.1 What is a Market?

#### 5.1.1 Not Chaos, but Economic Order

We usually take for granted the smooth running of the economy. When you go to the supermarket, the items you want – bread, cereal, and bananas – are usually on the shelf. You pay your bill, pop the food in you mouth, and have a juicy meal. What could be simpler?

If you pause for a moment and look more closely, you may begin to appreciate the complexity of the economic system that provides your daily bread. The food may have passed through five or ten links before getting to you, traveling for days or months from every state and every corner of the globe as it moved along the chain of farmers, food processors, packagers, truckers, wholesalers, and retailers. It seems almost a miracle that food is produced in suitable amounts, gets transported to the right place, and arrives in a palatable form at the dinner table.

But the true miracle is that this entire system works without coercion or centralized direction by anybody. Literally millions of businesses and consumers engage in voluntary trade, and their actions and purposes are invisibly coordinated by a system of prices and markets. Nobody decides how many chickens will be produced, where the trucks will drive, and when the supermarkets will open. Still, in the end, the food is in the store when you want it.

Markets perform similar miracles around us all the time, as can easily be seen if only we observe our economy carefully. Thousands of commodities are produced by millions of people, willingly, without central direction or master plan. Indeed, with a few important exceptions (like the military, police, and schools) most of our economic life proceeds without government intervention, and that's the true wonder of the social world.

### 5.2 The Market Mechanism

A market economy is an elaborate mechanism for co-ordinating people, activities, and business through a system of prices and markets. It is a communication device for pooling the knowledge and actions of billions of diverse individuals. Without central intelligence or computation, it solves problems of production and distribution involving billions of unknown variables and relations, problems that are far beyond the reach of even today's fastest supercomputer. Nobody designed the market, yet functions remarkably well. *Is a market economy no single individual or organization is responsible for production, consumption, distribution, and pricing.*

How do markets determine prices, wages, and outputs? Originally, a market was an actual place where buyers and sellers could engage in face-to-face bargaining. The *marketplace* – filled with slabs of butter pyramids of cheese, layers of wet fish, and heaps of vegetables – used to be a familiar sight in many villages and towns, where farmers brought their goods to sell. In the United States today there are still important markets where many traders gather together to do business. For example, wheat and corn are traded at the Chicago Board of Trade, oil and platinum are traded at the New York Mercantile Exchange, and gems are traded at the Diamond District in New York City.

More generally, a market should be thought of as a mechanism by which buyers and sellers can determine prices and exchange goods and services. There are markets for almost everything, from art to pollution. A market may be centralized, like the stock market. It may be decentralized, as in the case of houses or labour. Or it may exist only electronically, as in the case of many financial assets and services which are traded by computer. The crucial characteristic of a market is that it brings buyers and sellers together to set prices and quantities.
A market is a mechanism by which buyers and sellers interact to determine the price and quantity of a good or service.

In a market system, everything has a price, which is the value of the good in terms of money (the role of money will be discussed in Section B of this chapter), Prices represent the terms on which people and firms voluntarily exchange different commodities. When I agree to buy a used Ford from a dealer for $4040, this agreement indicates that the Ford is worth more than $4050 to me and that the $4050 is worth more than the Ford to the dealer. The used – car market has determined the price of a used Ford and, through voluntary trading, has allocated this good to the person for whom it has the highest value.

In addition, Prices serve as *signals* to producers and consumers. If consumers want more of any good, the price will rise, sending a signal to producers that more supply is needed. For example, every summer, as families set out on their vacations, the demand for gasoline rises, and so does the price. The higher price encourages oil companies to increase gasoline production and, at the same time, discourages travelers from lengthening their trips.

On the other hand, if a commodity such as cars becomes overstocked, dealers and automobile companies will lower their prices in order to reduce their inventory. At the lower price, more consumers will want cars, and producers will want to make fewer cars. As a result, a balance, or equilibrium, between buyers and sellers will be restored.

What is true of the markets for consumer goods is also true of markets for factors of production, such as land or labour. If computer programmers rather than textile workers are needed, job opportunities will be more favourable in the computing field. The price of computer programmers (their hourly wage) will tend to rise, and that of textile workers will tend to fall, as they did during the 1980s. The shift in relative wages will attract workers into the growing occupation.

The nursing crisis of the 1980s shows the labour market at work. During that decade the growth in the healthcare sector led to an enormous expansion of nursing jobs with far too few trained nurses to fill them. Hospitals offered all sorts of fringe benefits to attract nurses, including subsidized apartments, low-cost on-site child care, and signing bounces as high as $10,000. One hospital even ran a lottery for nurses, with the prize being a gift certificate at a nearby department store. But what really attracted people into the nursing profession was raising wages. Between 1983 and 1992, the pay for registered nurses rose almost 70 percent, so they were making about as much money as the average accountant or architect. The rising pay drew so many people into nursing that by 1992 the nursing shortage had disappeared in most parts of the country.

Prices coordinate the decisions of producers and consumers in a market. Higher prices tend to reduce consumer purchases and encourage production. Lower prices encourage consumption and discourage production. Prices are the balance wheel of the market mechanism.

## 5.3 Market Equilibrium

At every moment, some people are buying while others are selling; firms are inventing new products while governments are passing laws to regulate old ones; foreign companies are opening plants in America while American firms are selling their products abroad. Yet in the midst of all this turmoil, markets are constantly solving the *what, how,* and *for whom.* As they balance all the forces operating on the economy, markets are finding market **equilibrium of supply and demand**.

A *market equilibrium represents a balance among all the different buyers and sellers.* Depending upon the price, households and firms all want to buy or sell different quantities. The market finds the equilibrium price that simultaneously meets the desires of buyers and sellers. Too high a price would mean a glut of goods with too much output; too low a price would produce long lines in stores and a deficiency of goods. Those prices for which buyers desire to buy exactly the quantity that sellers desire to sell yield equilibrium of supply and demand.

## 5.4 How Markets Solve the Three Economic Problems

We have just described how prices help balance consumption and production (or demand and supply) in an individual market. What happens when we put all the different markets together – gasoline, cars, land, labour, capital, and everything else? These markets work simultaneously to determine a *general equilibrium* of prices and production.

By matching sellers and buyers (supply and demand) in each market, a market economy simultaneously solves the three problems of *what, how, and for whom*. Here is an outline of market equilibrium:

1. What goods and services will be produced is determined by the dollar votes of consumers – not every 2 or 4 years at the polls, but in their daily purchase decisions. The money that they pay into businesses' cash registers ultimately provides the payrolls, rents, and dividends that consumers, as employees, receive as income.

Firms, in turn, are motivated by the desire to maximize profits. Profits are net revenues, or the difference between total sales and total costs. Firms abandon areas where they are losing profits; by the same token, firms are lured by high profits into production of goods in high demand. A familiar example is Hollywood. If one film makes huge profits – say, a film about a cute dinosaur and an evil scientist – other studios will rush to produce imitations.

2. How things are produced is determined by the competition among different producers. The best way for producers to meet price competition and maximize profits is to keep costs at a minimum by adopting the most efficient methods of production. Sometimes change is incremental and consists of little more than tinkering with the machinery or adjusting the input mix to gain accost advantage, which can be very important in a competitive market. At other times there are drastic shifts in technology, as with steam engines displacing horses because steam was cheaper per unit of useful work, or airplanes replacing rail-roads as the most efficient mode for long-distance travel. Right now we are in the midst of just such a transition to a radically different technology, with computers replacing typewriters, paper, and many white-collar workers.

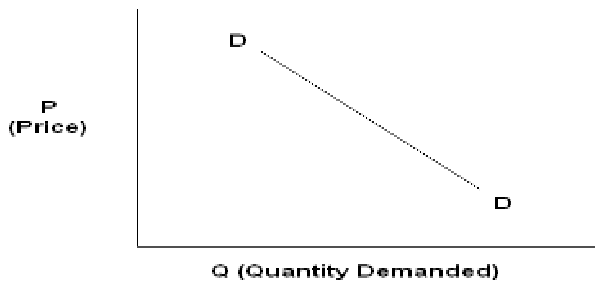
3. For whom things are produced – who is consuming, and how much – depends, in large part, on the supply and demand in the markets for factors of production. Factor markets (i.e., markets for factors of production) determine wage rates, land rents, interest rates, and profits. Such prices are called *factor prices*. The same person may receive wages from a job, dividends from stocks, interest from a certificate of deposit, and rent from a piece of property. By adding up all the revenues from factors, we can calculate the person's market income. The distribution of income among the population is thus determined by the amounts of factors (person-hours, acres, etc.) owned and the prices of the factors (wage rates, land rents, etc.).

   Be warned, however, that incomes reflect much more than the rewards for sweaty labour or abstemious saving. High incomes come also from large inheritances, good luck, favourable location, and skills highly priced in the marketplace. Those with low incomes are often pictured as lazy, but the truth is that low incomes are generally the result of poor education, discrimination, or living where jobs are few and wages are low. When we see someone on the unemployment line, we might say, "There, but for the grace of supply and demand, go."

## 5.5 The demand and Supply Framework

The working of the market mechanism can be most simple illustrated by the apparatus of demand-supply curves which is employed by economists for a variety of purposes. In order to introduce the reader to this powerful tool we take a very simple example.

Suppose we want to understand how the price of milk is determined by the market mechanism. On one side of the market are 'consumers' who in this case includes households as well as makers of sweets and other milk products. On the other side are producers who may be dairy farmers, and public and privet dairies. Consumers' demand for milk is determined by, among other things, price of milk, consumers' incomes, number of consumers, their tastes, prices of product like eggs and meat which are alternative sources of proteins etc. Now, imagine a hypothetical experiment in which we confront a group of consumers and enquire what quantity of milk they would like to purchase per day at a price of, say, Rs. 5 per liter. We repeat the question with varying prices of milk. All other determinants of demand for milk – consumer income, price of substitute etc., - are assumed to remain fixed. We will obtain a schedule of milk price and the quantities the consumers would like to purchase at each price. This relationship between the price of milk and the quantity demanded other thing remaining fixed is called the demand curve for milk. Note carefully that we are talking of quantity and not quantity purchased. The former is an expression of consumers' intentions or desires, when faced with a set of hypothetical prices. The actual quantity purchased is the result of the consumers translating their intentions into action when faced with an actual price asked for milk by the suppliers. The demand curve is depicted in figure below.



THE DEMAND CURVE

Quantities demanded per day are plotted on the horizontal axis (measured in liter) while prices in rupees per liter are plotted on the vertical axis.

As shown in the figure,  the curve is downward sloping i.e. as price of milk declines, other things remaining constant the quantity demanded increases and vice versa. Why should this be so? While a rigorous argument is outside our scope, we can sketch a plausible explanation.

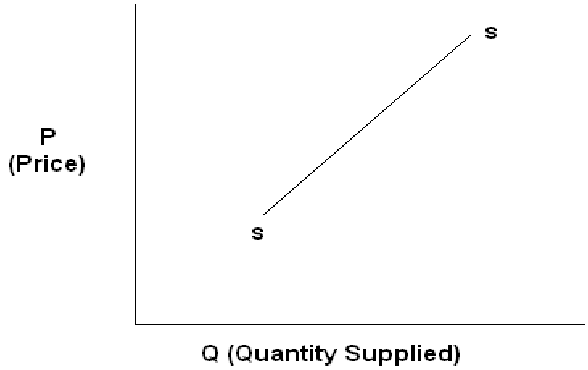
First consider a consumer faced with alterative prices. If the price is very high - say Rs.25 per liter - he might decide to go entirely without milk or decide to purchase the minimum essential quantity (suppose there is a baby in the family). As the price is reduced, the consumer would think of satisfying less urgent needs — milk for adding to tea, coffee, making butter etc. As the price decreases, less and less urgent needs would come into play. Each additional unit bought is satisfying a lesser (front the consumer's point of view) want; the price the consumer would be willing to pay for a unit of milk would be governed by the consumer's valuation of the satisfaction to be derived from consuming that unit which in turn  would be a function of the quantity already consumed. Apart from this, but for similar reasons, more and more consumers would demand milk as price decreases - a family which cannot afford to buy any milk when the price is Rs.25 may want to buy some if the price goes down to say Rs.8.

A change in the price of a good has actually two effects. Consider at hypostatical consumer who consumes only three goods — rice, milk and meat. His monthly budget is Rs.500 and the prices are Rs.6 per kg of rice, Rs.5 per liter of milk and Rs.40 per kg of meat. His current consumption pattern is 30 litre of milk, 24 kg of rice and 5 kg of meat per month. Now suppose the price of milk decreases to Rs.4 per litre. The consumer can now purchase the same basket of goods (though he may not wish to) and have Rs. 30 left over with which he can purchase additional quantities of some or all of the three goods. The same effect could have been achieved by keeping the prices at the original level but giving the consumer an additional income of Rs.30. Thus a price reduction has an effect which is equivalent to an increase in income. Presumably, some of the extra income will be spent on milk thus increasing the quantity demanded. There is an additional effect.

Relative to mea, milk has become cheaper than before; this might include the consumer to substitute some milk for meat since milk can, at least partly, satisfy similar needs. Thus, there is a substitution effect- away from the relatively more expensive goods towards the relatively cheaper good. On both counts the demand for milk increases as its price decreases.

Now, consider the supply side of the market. Production of milk requires a number of inputs. For some of these, their quantities cannot be varied in the short run e.g., stock of milch cattle, grazing land, dairy machinery etc. For others, quantities can be varied e.g., cattle feed, labour, etc.

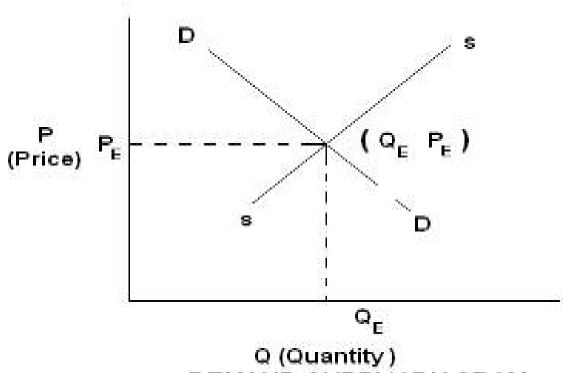
Consider a typical milk producer. He has a set of fixed inputs which are combined with varying quantities of variable inputs to produce milk. At a given price how much milk would he like to supply? It depends upon the behavior of cost of production and the objectives of the producer. If his goal is to maximise his profits - defined as sales revenue minus cost of production he will push production upto the point where the cost of production of the last unit just equals the price, and subsequent units will cost more. Thus his quantity decision will depend upon the behaviour of incremental or marginal cost. A well known law in economics, called the law of diminishing marginal products says that when the increasing quantities of variable inputs are applied to given quantities of fixed inputs, the incremental output from successive doses of variable inputs eventually declines. This implies that the incremental cost of production starts increasing beyond a point and hence the producer will be willing to supply larger quantity only if the price is higher. Figure below shows the supply curve which is the relation between the price and quantities which the producers would like to supply at each price.




THE SUPPLY CURVE

Now, combine the two sides of the market. In figure given below we have shown a demand curve and a supply curve. The point at which they intersect, shown as ($P_E$, $Q_E$) is the price – quantity combination at which the producers' and consumers' intentions are simultaneously realized. At any price above $P_E$, the producers would like to supply more than the consumers would like to purchase. The result would be unsold stocks (which in the case of milk may have to be simply thrown away). Obviously, this situation cannot last; the producers will reduce the price and bring a smaller quantity to the market. At a price below $P_E$ there would be a shortage of milk with a number of consumers unable to buy the quantities they would like to buy at such a price.

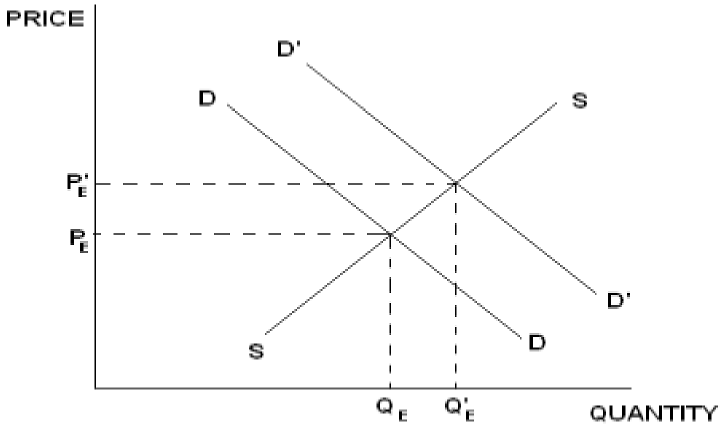
The result would be a clamour for larger quantity with willingness to pay a higher price. The market would be in 'equilibrium` at (PE, QE) in the sense that neither the producers nor the consumers would have an incentive to depart from it unless other factors governing demand and supply change.



DEMAND-SUPPLY DIAGRAM

There are number of questions regarding the notion of equilibrium. First, there is the question of what is the actual process by means of which a market finds the equilibrium. Since individual participants do not know the plans of others, what mechanism brings about the equality of quantity demanded and quantity supplied? Second, there is the problem of stability of equilibrium. Suppose the milk market is in equilibrium at the price-quantity combination (PE QE). Now there is a temporary disturbance e.g. power failure in a large cold storage facility used to preserve milk. There is a temporary shortage, price shoots up and long queues are seen at milk booths. After the disturbance is eliminated, will the market return to its original equilibrium or move away from it? Related to this is the question of market dynamics.

Suppose as a result of increase in consumer income, more milk than before is demanded at every price. In terms of our demand-supply framework, we show this as a shift of the demand curve upward and to the right. The new equilibrium is the price-quantity combination ($P_E$, $Q_E$). What is the path of the market as it moves from the old to the new equilibrium i.e. how do price and quantity adjust to the change in demand? Can we say anything neither about markets which are nor in equilibrium?




These are some of the questions which have been and are being investigated by economists. There are no fully satisfactory answers.

The demand supply framework is a convenient representation of the working of the market mechanism. The notion of equilibrium forms a point of reference. In real life markets may not be permitted to function in the manner described above because of price controls, rationing and lack of information about prices and insufficient mobility of goods and factors of production. Nevertheless, the demand-supply framework has been found to be a useful analytical device.

Effect of changes in other factors can be depicted in the demand-supply diagram. Suppose consumers' incomes increase. At every price, consumers will now demand a larger quantity than before in figure this is shown as a rightward-upward shift of the entire demand curve. The result is a higher price and larger quantity in the new equilibrium. On the other hand suppose a drought causes shortage of fodder with a resultant increase in its price; the result would be an increase in the cost of production of milk.

At every price producers would be willing to supply a smaller quantity than before. In figure this is shown as a leftward-upward shift of the entire supply curve resulting in a higher price and a smaller quantity in the new equilibrium. You must be always careful to distinguish between movement along a demand or a supply curve, and shifts of curves.

## 5.6 Pure Competition

Pure competition is said to exist when the following two conditions are fulfilled:

(1) **Large Number of Buyers and Sellers**

The first condition is that there should be operating in the market a large number of buyers and sellers. If that is so no single producer or purchaser will be able to influence the market price. The output of any single firm is only a small portion of the total output and the demand of any single purchaser is only a small portion of the total demand. Hence, the market price has to be taken as given and unalterable by every purchaser and seller. Thus no individual purchaser can influence the market price by varying his own demand and no single firm is in a position to affect the market price by varying its own output.

(2) **Homogeneous Product**

The second condition is that the articles produced by all firms should be standardized or identical. In case all farms produce kalian wheat, it is immaterial for the purchaser as to who has produced it. He can buy it as well from the one as from the other. This condition ensures that the same price rules in the market for the same commodity. In case the output is not standardized (i.e., it is differentiated) each individual firm will be in a position to influence the market price.

*Whether the products are identical or not, has to be looked at from the purchaser's angle.* Even if the products are identical, the purchaser may have a prejudice against the output of a particular firm and may consider it different. That is, if the consumers regard the commodities as different, they should be considered different for purposes of classification in spite of the fact that they are actually identical. The consumers generally believe that the products are different. They generally believe that the commodities that they purchase from a particular shop are superior, even though they may actually be of the same quality.

When the quality is the same, the commodities are perfect substitutes of one another and their cross-elasticity is infinity. In these circumstances, if a firm raises its price, it will lose all customers. It can sell as much as it likes at the prevailing price. Why should it then think of lowering its price? Hence it cannot raise its price and it need not lower it. That is why the prevailing market price is accepted and acted upon by all dealers.

Thus, if the above two conditions, viz., homogeneous products and large number of buyers and sellers, are found in a market, it is said to be under pure competition.

Examples of pure competitions are to be found in the case of farm products, e.g., wheat, cotton, rice. There is a large number of producers, each producing an insignificant proportion of the total market supply. Their product is similar and none of them is in a position to influence the market price by his own individual action. In other fields we seldom come across pure competition.

## 5.7 Perfect Competition

Perfect competition is wider than pure competition. In addition to the two conditions of pure competition mentioned above, several other conditions must be fulfilled to make it perfect competition.

These conditions are:

(1) **Free Entry or Exit**

There should be no restriction on the firm's entry into, or exit from, that industry. This will happen when all the firms are making just normal profit. If the profit is more, new firms will enter and extra profit will be competed away; and if, on the other hand, profit is less, some firms will quit, raising the profits for the remaining firms. But if there are restrictions on the entry of new firms the existing firms may enjoy super-normal profit. Only when there are no restrictions on entry or exit, the firms will be in equilibrium.

(2) **Perfect Knowledge**

Another assumption of perfect competition is that the purchasers and sellers should be fully aware of the prices that are being offered and accepted. In case there is ignorance among the dealers, the same price cannot rule in the market for the same commodity. When the producers and the customers have full knowledge of the prevailing price, nobody will offer more and none will accept less and the same price will rule throughout the market. The producers can sell at that price as much as they like and the buyers also can buy as much as they like.

(3) **Absence of Transport Costs**

If the same price is to rule, it is necessary that no cost of transport has to be incurred. If the cost of transport is there, prices must differ in different sectors of the market.

(4) **Perfect Mobility of the Factors of Production**

This mobility is essential in order to enable the firms to adjust their supply to demand. If the demand exceeds supply, additional factors will move into the industry and in the opposite case, move out. Mobility of the factors of production is essential to enable the firms and the industry to achieve an equilibrium position.

## 5.8 Pure and Perfect Competition Distinguished

As would have become evident from the above discussion, the main difference between pure competition and perfect competition is that in pure competition there is no element of monopoly enabling a producer to charge more. If the two conditions of pure competition are fulfilled, there can be no question of monopolistic control. In perfect competition, apart from absence of monopoly, other conditions are also essential, e.g., free entry and exit, absence of transport cost, perfect knowledge, etc.

## 5.9 Imperfect Competition

It refers to conditions which are quite opposite of those that prevail under perfect competition. For instance, the number of dealers is not large, at any rate not as large as under perfect competition, the products are not homogeneous; they are on the other hand differentiated by means of different labels attached to them such as different brands of toilet requisites. Either in ignorance or on account of transports costs or lack of liability of the factors of production, same price does not rule in the market throughout. Rather different prices are charged by different producers of products which are really similar but are made to appear different through advertisements, high pressure salesmanship and labeling and branding. The result is that each producer comes to have a hold on a client from whom he can charge higher prices. In this case the demand curve or sales curve or what is also called average revenue curve, is not a horizontal straight line. It is, on the other hand, a downward sloping curve, i.e., the seller can sell more by reducing price. Under perfect competition, he need not reduce the price, for he can sell any amount at the prevailing price. He can also charge higher prices because his customers are attached to him.

He can thus have a price policy of his own whereas a seller under perfect competition has no price policy; he has merely to accept the market price. The demand for his product is not perfectly elastic; it is responsive to change in price.

This form of market is a blend of monopoly and competition and has been called *"monopolistic competition"* by Chamberlain, an American economist. In the real world, we have neither monopoly (i.e., absence of competition) nor competition but imperfect competition, i.e., partly monopoly and partly competition. The products are not complete substitutes for one another but they are close substitutes. But monopolistic competition is only one form of imperfect competition where there is a large number of sellers but products are differentiated. Other forms of imperfect competition are oligopoly and ordinary monopoly.

## 5.10 Monopolistic Competition

The last category of imperfect competition is monopolistic competition; this occurs when a large number of sellers produce differentiated products. This market structure resembles perfect competition in that there are many sellers, none of whom have a large share of the market. It differs from perfect competition in that the products sold by different firms are not identical. *Differentiated products* are ones whose important characteristics vary; for example, for example, for automobiles, important characteristics include size, performance, fuel economy, and safety. Because companies sell slightly different products, they can sell at slightly different prices.

The classic case of monopolistic competition is the retail gasoline market. You may go to the local Exxon station, even though it charges slightly more, because it is on your way to work. But if the price at Exxon raises more than a few pennies above the competition, you might switch to the Mobil station a short distance away.

Indeed, this example illustrates that one important source of product differentiation comes from location. It takes time to go to the bank or the grocery store, and the amount of time needed to reach different stores will affect our shopping choices. In economic language, the total opportunity cost of goods (including the cost of time) will depend upon how far we live from a store. Because the opportunity cost of local shops is lower, people generally tend to shop in nearly locations. This consideration also explains why large shopping complexes are so popular they allow people to buy a wide variety of goods while economizing on shopping time. The product differentiation that comes from different locations in an important reason why these tend to be monopolistically competitive markets.

Product quality is an increasingly important part of product differentiation today. Goods differ in their characteristics as well as their prices. Most IBM compatible personal computers these days can all run the same software, and there are many manufacturers. Yet the personal computer industry is a monopolistically competitive industry, because computers differ in speed, size, memory, repair services, and ancillaries like CD-ROMs, internal moderns, and sound systems. Indeed, a whole batch of monopolistically competitive computer magazines is devoted to explaining the differences between the computers produced by the monopolistically competitive computer manufacturers!

The main features of monopolistic competition are:-

(i) In monopolistic competition, the number of dealers is quite large but not as large as under perfect competition.

(ii) The products are not homogeneous; they are, on the other hand, differentiated by means of different labels attached to them, such as different brands of toilet requisites.

(iii) Either in ignorance or on account of transport costs or lack of mobility of the factors of production, the same price does not rule in the market throughout. Rather different prices are charged by different producers for products which are really similar but are made to appear different through advertisements, high pressure salesmanship and labeling and branding. The result is that each produce comes to have a hold on a clientele from whom the producer can charge higher prices.

(iv) Under monopolistic competition, the demand curve or sales curve, or what is also called average revenue curve, is not a horizontal straight line. It is, on the other hand, a downward sloping curve, i.e., the seller can sell more by reducing price. Under perfect competition, he need not reduce the price, for he can sell any amount at the prevailing price. Under monopolistic competition, the seller can also charge higher prices because his customers are attached to him. He can thus have a price policy of his own, whereas a seller under perfect competition has no price policy; he has merely to accept the market price as given.

(v) Under imperfect competition, the demand for the product is not perfectly elastic; it is responsive to changes in price.

This form of market is a blend of monopoly and competition and has been called monopolistic competition by Chamberlain, an American economist. In the real world, we have neither monopoly (i.e., absence of competition) nor competition but imperfect competition, i.e., partly monopoly and partly competition. The products are not perfect substitutes for one another but they are close substitutes.

### 5.11 Price – Output Determination under Monopoly Market:

### 5.11.1 What is Monopoly?

The term monopoly is split up into mono and poly. 'Mono' means one and 'Poly' means seller. Thus monopoly means a single seller of the product having complete control on the supply of the product secondly, there should be no close substitute to monopoly product or the cross elasticity of demand between monopoly product and other's product must be either zero or very small. Zero cross and small elasticity implies total absence of substitutes and small elasticity implies distant substitute. Thirdly, there must be strong barriers to the entry of new firms in the market. Under monopoly condition, no rival firm is allowed to enter the market. Thus a single firm will face the market demand for the product. Therefore, the single firm constitutes the entire industry. Hence, there is no difference between firm and industry under monopoly form of market.

### 5.11.2 Nature of Demand Curve under Monopoly:

There is a marked difference between the demand curve faced by the firm under perfect competition and the demand curve faced by a monopoly firm. A firm under competitive conditions faces perfectly elastic demand curve where as a monopoly firm faces relatively elastic demand curve. In case of monopoly market, a single firm constitutes the whole industry. Therefore the market demand for the product is faced by a single monopoly firm. Since individual demand schedules for the product slope down ward the monopoly firm faces a down ward sloping demand curve. This means that if the firm wants to increase sales of its products, it must lower the price. Monopoly firm can make two decisions viz (i) how much to produce i.e. fixing the size of output or naming the price for the product. But it can not make both the decisions at a time. It can make either of the decisions at a time.

It means that the firm may either fix the size of output to be produced and leaves it to consumers to determine the price for the product or it may name the price for the product and leaves to the consumers to buy whatever quantity they want to buy at that price.
However, the monopoly firm is a price maker and not merely a quantity adjuster like a firm under perfect competition. So the problem faced by a monopoly firm is one of picking up right price – quantity combination which is optimum for the firm.

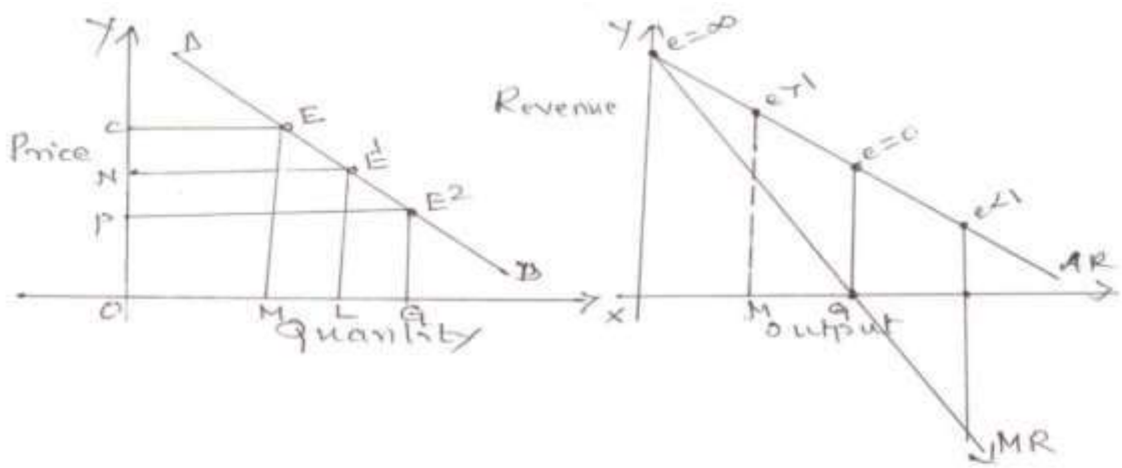
Demand curve of a monopoly firm is its average revenue curve. Since individual demand schedules slope downward, the average revenue curve of the monopoly firm also slopes downward through out its length. The marginal revenue curve lies below the average revenue curve. It is so because every additional unit of the product is sold at a lower and lower price. That is why marginal revenue is less than average revenue. The shape and the relationship between AR and MR are shown and explained in the following diagram. The MR curve lies below the AR curve because every additional unit is sold at lower price than the previous one. Though MR is less than AR, they are related to each other through price elasticity of demand. The price elasticity on AR curve will tell whether MR is positive or negative at a particular size of output. As long as price elasticity is positive i.e. between infinity and unity MR is positive and between unity and zero elasticity, MR is negative. At unity elasticity MR is zero as shown in the diagram below.

The relationship between AR and MR is explained by the following formula.

$$MR = AR \left( \frac{e - 1}{e} \right)$$

Where (a) MR → Marginal Revenue (b) AR → Average Revenue (c) e = elasticity of demand. The value of $(e - 1)/e$ is less than one therefore MR is always less than AR or Price. So price or AR under monopoly market is always higher than MR. The extent to which the MR curve lies below the AR curve depends upon the value of the fraction $(e - 1)/e$ However at infinity on AR curve both are equal, at unity MR is zero, at elasticity greater than one it is positive and elasticity less than one it is negative. Thus it can be observed that the higher the elasticity on AR curve, the closer will be the MR curve to the AR curve and lower the elasticity the farther off will be the MR curve from the AR curve. Beyond unity, MR becomes negative.

## 5.12 Price – Output Equilibrium Under Monopoly :

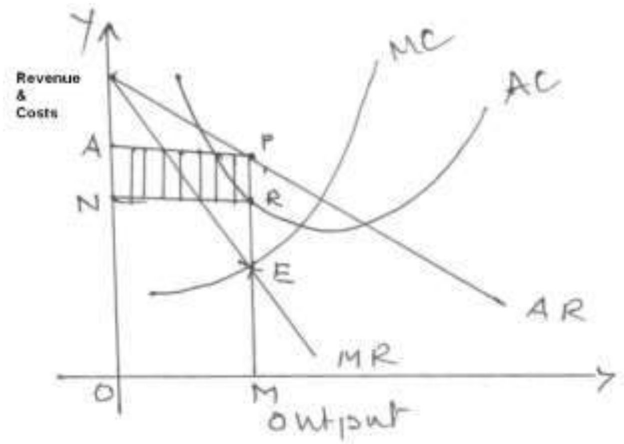



Monopoly firm like any other firm keeps before itself two objectives viz (i) Maximistion of profit or minimisation of losses. It is rather surprising that monopoly firm incurs losses. Yes, it does when demand for its product is inadequate in the short run.

As we have seen earlier that the monopoly firm makes either of the decisions at a time that is fixing the size of output or naming the price for its product.

Generally, price for the product is named. Once price is fixed, then it is up to consumers to buy whatever quantity they want to buy at that price.

The monopoly firm will continue production up to that point at which Marginal cost (MC) becomes equal to marginal revenue (MR). In other words, the essential condition for monopoly equilibrium is the equality between MC = MR. However this is essential condition but not a sufficient condition. The sufficient condition is that the elasticity of demand on the AR curve must be greater than one at the point of equilibrium. Thus the monopoly firm will never fix its size of output at that level where the elasticity is less than one because there after MR becomes negative. Therefore total receipts of the monopoly firm always falls if it increases its sales. Thus the problem faced by the monopoly firm is to pick up that price quantity combination which is the best for the firm i.e. which enables the firm to earn maximum possible profits. The following diagram depicts the monopoly equilibrium. Revenue and costs are measured along 'OY' axis and output along 'OX' axis. The diagram indicates MC and MR are equal at OM size of output and 'OA' is the price named by the monopolist.




ON is the average cost of production. Thus AN is the profit per unit ( OA – ON = AN). The firm is in equilibrium at 'E' point where MR = MC and elasticity of demand at 'P' point on AR curve is also greater than one. The firm makes excess

Profit = TR – TC

= Price X output – Average cost X out put

= AO X OM – ON X OM

= AOMP – NOMR

= ANRP ( shaded Area)

One point is to be noted in the case of monopoly equilibrium is that the monopoly price is not equal to marginal cost. It is always higher than marginal cost but it stands in certain relation with MC through elasticity. This relationship is explained with the help of the formula given by Prof (MS) Joan Robinson, English Economist.

$$MR = AR \left( \frac{e-1}{e} \right)$$

$$\therefore AR = MR \left( \frac{e}{e-1} \right)$$

But in equilibrium MR = MC

$$\therefore AR = MC \left( \frac{e}{e-1} \right)$$

$$\text{AR or Price} = MC \left( \frac{1}{e-1} \right)$$

Since the Value of the fraction $\frac{e}{e-1}$ is greater than one for a given value of elasticity, it follows that under monopoly, price is always greater than MC

AR > MC. However, the extent to which price differs from MC depends upon the value of the elasticity on AR curve at the point corresponding to the equilibrium. The smaller the elasticity, the greater is the value of expression $\frac{e}{e-1}$ and hence the greater the extent to which price would differ from MC. Thus the monopoly price is the function of marginal cost and the elasticity of demand.

However MC curve which represents the supply curve of the product under perfectly competitive conditions does not function as such under monopoly. Since MC can never be negative, equality between MC and MR can not be achieved where elasticity is less than one because then MR becomes negative. Thus the monopoly equilibrium will always lie at a point where elasticity is greater than one.

### 5.13 Price Discrimination or Discriminating Monopoly :

Price discrimination refers to the practice of a seller of selling the same product at different prices to different buyers or groups of buyers. In other words, the monopolist sells the same product to different customers at different prices. This he does it to maximize profit. According to Prof. Stigler, price discrimination refers to "The sales of technically similar products at prices which are not proportional to marginal cost". This implies that the monopolist improves the quality of the product and sells it at a much higher price than the cost he incurs on improving the product.

There are three types of price discrimination namely personal price discrimination, local price discrimination and price discrimination according to use of the product.

(1) **Personal Price Discrimination :** It refers to charging of different prices or fees for the same services or the product to different persons. This is possible in all personal services.

(2) **Local Price Discrmination :** It refers to charging of different prices to customers living in different localities or places under this type of price discrimination, the monopolist divides his total market in to various sub-markets based on elasticity of demand or on the basis of economic conditions of the people.

(3) **Price Discrimination According to use of the Product :** It refers to charging of different prices for the same product or service in its different uses. For example electricity charges, or railway fares.

### 5.13.1 Conditions For Price Discrimination :

(i) Price discrimination takes place only when it is not possible to transfer units of the product from one market to another. In other words sub-market must be separated from each other either by a long distance or by tariff walls otherwise buyers in the dear market may come down to the cheap market and buy the product or buyer in the cheap market may resell the product in dear market. Thus, there should be no seepage between the two sub-markets.

(ii) The second condition for price discrimination is that the buyers in the dear market should not convert themselves into the buyers of cheap market for the purpose of buying the product. It means that the rich should not pretend themselves to be the poor. If they do so then in that case price discrimination will break down.

### 5.13.2 Price Discrimination is possible in the following cases :

(1) It is possible in all personal services because there is no resale possible.
(2) It is possible when sub-markets are separated by long distance or by tariff walls.
(3) Legal sanction permits the price discrimination. The government allows the monopolist to charge different prices to different customers for the same product.
(4) People's prejudices and preferences for certain products enable the monopolist to charge different prices to different groups of people for the same product.
(5) Price discrimination is possible on account of ignorance and laziness of the people.
(6) When several groups of buyers need the same service for clearly differentiated commodities or use, Price discrimination takes place.

### 5.13.3 When Is Price-Discrimination Possible & Profitable?

Price discrimination is possible, yet it may not be profitable. Price discrimination is possible only when there is different elasticity of demand in different sub-markets. If the demand curves in all the sub-markets are iso–elastic, then price discrimination may not be profitable even though it is possible. It is so because marginal revenue in all the sub markets at a price will be the same.

This is better explained by the formula

$$MR = AR\left(\frac{e-1}{e}\right)$$

We suppose, that there are two sub – markets namely 'A' and 'B'. Price elasticity in both the markets is the same i.e. 2. So, at price Rs. 10 per unit MR in both the markets A and B would be the same. Therefore, it will not pay the monopolist to transfer any amount of the product from one market to another. He will get same revenue in both the markets. If he sells one extra unit in either of the markets.

$$MRa = AR\left(\frac{e-1}{e}\right)$$

$$MRa = 10\left(\frac{2-1}{2}\right)$$

$$MRa = 10 \times \tfrac{1}{2}$$

$$MRa = 5$$

$$MRb = AR\left(\frac{e-1}{e}\right)$$

$$MRb = 10\left(\frac{2-1}{2}\right)$$

$$MRb = 10 \times \tfrac{1}{2}$$

$$MRb = 5$$

e = 2, Price Rs. 10/- Per Unit

MR in both the market is Rs. 5/- . It is thus clear from the above example that it will not be profitable for the monopolist to discriminate prices between the sub-markets A and B. When elasticity is the same in both markets.

But it is possible and profitable only when elasticity of demand in different sub-markets is different. In such cases, it will be profitable for the monopolist to charge different prices if elasticity of demand in sub-markets at single monopoly price is not the same. Monopolist will make maximum profit by discriminating prices in the sub-markets having different price elasticity of demand. This is better understood by the formula.

$$MR = AR \left( \frac{e-1}{e} \right)$$

When elasticity is different in sub-markets, MR in different sub-markets is different. Let us use the same example but elasticity as e = 2 in 'A' market and e = 4 in 'B' market. Therefore MR in 'A' market and MR in 'B' market are as follows

$$Mra = AR \left( \frac{e-1}{e} \right) \qquad MRb = AR \left( \frac{e-1}{e} \right)$$

$$MRa = 10 \left( \frac{2-1}{2} \right) \qquad MRb = AR \left( \frac{4-1}{4} \right)$$

$$MRa = 10 \text{ X } ½ \qquad MRb = 10 \text{ X } \frac{3}{4}$$

$$MRa = Rs.\ 5/- \qquad MRb = 15/2$$

$$Mrb = Rs.\ 7.5$$

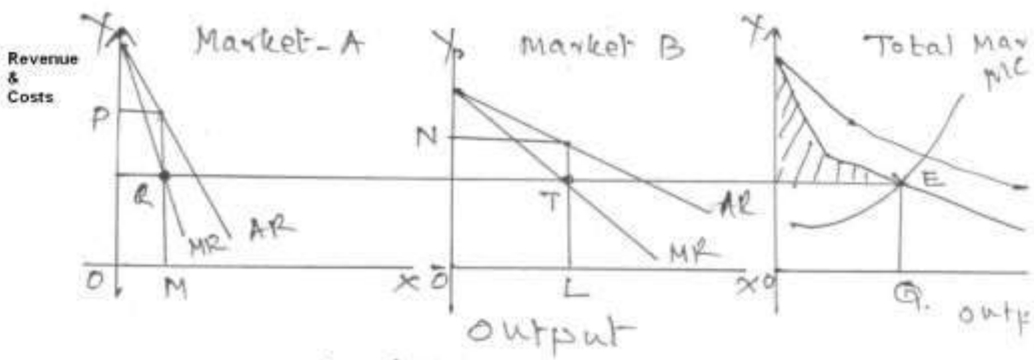
The above example makes clear that MR is higher in 'B' market than the MR in 'A' market. Thus it is profitable to transfer some quantity of the product from 'A' market to ' B' market. If he transfers one unit from A to B market, he will gain 7.5 – 5 Rs. 2.5 per unit. Thus, he will go on transferring unit of the product from A to B market until MRs. In both the markets become equal. Now, he will charge different prices for the same product in A and B markets. A higher price in 'A' market and a lower price in 'B' market . Generally a high price is charged in low elasticity market and a low price in a high elasticity market.

### 5.13.4 Monopoly Equilibrium Under Conditions of Price Discrimination :

To study equilibrium of discriminating monopoly we have to assume that the monopolist has divided his market in two submarkets. On the basis of elasticity of demand in each market. Having divided the markets, he has to make two decisions to attain equilibrium. These decisions are (a) How much out put is to be produced? and (b) How to share the total output between various sub-markets. In other words, how much quantity of the product is to be sold in each sub –market and at what prices. To illustrate the equilibrium under price discrimination, let us suppose that there are only two sub-markets namely ‘A’ and ‘B’. Market ‘A’ is having low elasticity and market ‘B’ is having high price elasticity for the monopoly product.

The equality between marginal cost and aggregate marginal revenue will tell the monopolist how much to produce. It means that the monopolist would continue production up to a point at which MC = AMR or CMR. AMR or CMR = MRa + MRb + MRc--- MRnth market. So, AMR refers to aggregate marginal revenue

Which is obtained by adding marginal revenues in all the sub-markets [AMR = MRa + MRb + MRc … … MRnth]. The seond condition necessary for equilibrium is that MC = MRa = MRb = MRnth market. The equality between AMR = MC will guide the monopolist as to how much to produce? And equality between MC and MR revenue in all the sub-market would tell him as to how much to sell in each sub-market. The AMR curve show the total output that would be sold in the sub-market taken together corresponding to each value of the marginal revenue. He will then distribute that total output in such a way that marginal revenue in the two sub-markets are equal. Marginal revenues in sub-markets must be equal if profits are to be maximized. The following diagram depicts the equilibrium of monopolist under discriminating conditions.




Conditions For Equilibrium

### 5.13.5 Conditions For Equilibrium

(i) AMR = MC (ii) MC = MRa = MRb = Mrnth. The above figure shows that the monopolist attains equilibrium at 'E' point where MC = AMR at OQ size of output. So the total output is OQ. Of the total output, OM quantity is sold in 'A' market and OL quanity in B market OQ = OM + OL. This sharing of OQ output is obtained by equating MC with MRa and MRb. In market 'A' he charges OP price and market 'B' he charges ON price per unit. Op price is higher than On price because price elasticity in 'A' market is lower than that of B market. The shaded area in total market depicts the profit. Thus it can be said that given the demand for the product and the cost conditions, the discriminating monopolist will produce OQ size of output and will sell Om part of the total output in 'A' market and OL part in 'B' market and thus will maximize profits.

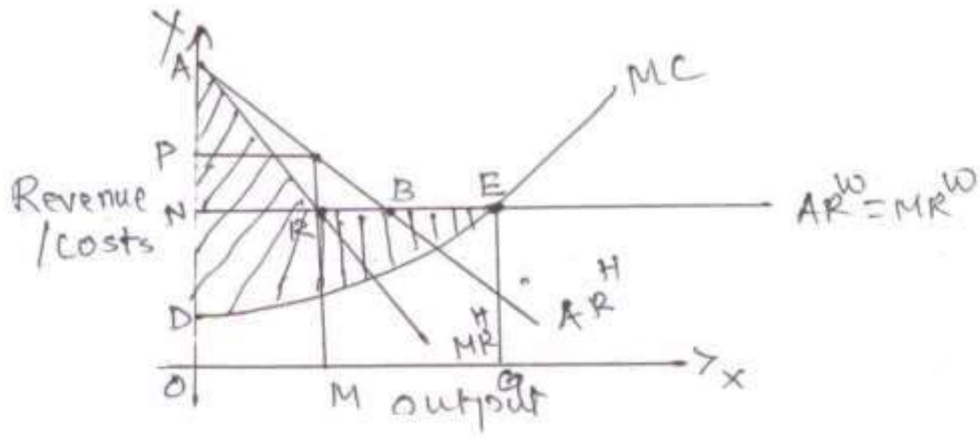
### 5.13.6 DUMPING – A Special case of Price – discrimination :

Dumping is nothing but price discrimination but it is a special type of price discrimination. It takes place when monopolist sells his product in two markets; one in which he faces perfect competitions and monopoly in the other; so demand curve for his product in perfect market will be perfectly elastic while in monopoly market relatively elastic or downward sloping demand curve. This happens when a producer is monopolist in home market and one of the sellers in the world market. In international market he is one of the sellers and therefore he faces keen competitions there. It is for this reason; he sells his product in international market at prevailing price. The international price is much lower than the price charged in domestic market.

Dumping may also refer to the practice of the monopolist to sell his product in the world market at a price less than the cost of production. He does this to enter and capture the world market. Secondly he may resort to dumping to clear off his excess output as domestic market is not large enough to sell his entire output. Thirdly, he may resort to dumping to earn foreign exchange for modernisation and lastly to maximise profits. The conditions for equilibrium of dumping monopoly are the same as ordinary discrimination.

1) MC = AMR 2) $MC = MR^H = MR^w$

The second condition complies that MRs in world market as well as home market must be equal to marginal cost of production. The following diagram show equilibrium of the monopoly under conditions of dumping.




Revenue and costs are measured along 'OX' axis and output along OX axis. $AR^H = MR^W$ represents average and marginal revenue in home market while $AR^W = MR^W$ in world market. $AR^W = MR^W$ line is perfectly elastic because in the world market monopolist faces perfect competition. In the home market he faces relatively elastic demand curve. That's why $AR^H$ and $MR^H$ slope downwards. The monopolist attains equilibrium at that size of output at which MC = AMR or aggregate marginal revenue. This equality is attained at 'E' point at OQ size of output. Now question of sharing of output between home market and world market arises. The monopolist solves this problem when he equates MC with $MR^w$ and also $MR^H$. Market i.e. $AR^W = MR^{W.}$ This condition is fulfilled at 'R' point in the diagram. At 'R' point MC = $MR^H$ that is RM = EQ = $MR^W$. Thus OM size of output he will sell in the home market and MQ size of output in the world market. Thus the total output in the market outside. Thus, the total output OQ is divided between home market (OM) and the world market (MQ) i.e. O = OM + MQ.

The AMR curve, in this case is the composite curve i.e. ARBE which is the lateral summation of $MR^H$ and $MR^W$. Total profit earned is equal to the area APNDE (shaded Area). He will charge OP price in the home market and ON price in the world market.

CVSRTA

## 5.14 MONOPOLISTIC COMPETITON

In reality, there exists neither perfect competition nor pure monopoly. Both are extreme forms of market. The reality lies between the competition and monopoly. It was Prof. E. H. Chamberlin who developed this kind of market. It is a blending of competition and monopoly. This form of market includes some features of monopoly and some features of competitions. The term monopolistic implies 'Mono' means one and 'Polistic' means competitions. Thus, it is the competition among the producers who produce similar products and not the same product. So each firm faces a keen competition from its rivals.

Therefore each firm so far as supply of its product is concerned is monopolist because no one else can supply that product. So, it becomes a single seller of that product. But it faces competitions from other firms who produce close substitute. In other words, cross elasticity between the products of the firms under monopolistic market is very high. Therefore, it is called as the blending of monopoly and competitions.

Product differentiation is the characteristic feature of this market. This means that the products of different firms are heterogeneous but are closely related to each other. Product differentiation doesn't means that the products of different firms are totally different but they are slightly different. That's why they are called similar and not the same. If the degree of product differentiation is greater, the presence of monopoly element is greater and if the degree of product differentiation is smaller, the greater is the competitive element. Since this form of market exhibits features of monopoly and competitions, we call it as monopolistic competitions.

### 5.14.1 Characteristics of Monopolistic competition :

1) **Large numbers of buyers:** Like perfect competition there are large number of buyers. But how large is the number can not be ascertained. Each firm has its own group of buyers. They are attached to particular brand of product. Therefore, they follow their own pricing policy. Prices of different products therefore differ. Because tastes and preferences of the people differ, each firm finds demands for its products. However the large numbers of buyer are divided among many sellers supplying the similar products.

2) **Large numbers of sellers:** Existence of large number of sellers is the second condition of this form of market. Each seller supplies similar products. If the number of firms is larger, the product differentiation may be smaller., Again, if the number of firms are smaller differentiation is generally greater. Thus, this form of market offers an opportunity to everyone who wants to enter the market but on one condition that the product is differentiated from the existing ones. So, there is no limit to the number of firms like perfect competitions. In this way, the market also resembles perfect competition.

3) **Product Differentiation:** This is the distinguished feature of this market. Each firm produces non identical product and not the same product. The degree of product differentiation depends upon the numbers of firms. The larger the number of firms, the smaller is the difference and vice-versa. However each firm's product is close substitute to other firms. Therefore, product differentiation is the soul of this market. The product differentiation is based on certain characteristic of the product itself like exclusive patented features, trade marks, trade names, designs, colour, weight, packaging price etc. also conditions surrounding sales of the product like making available free home delivery etc. Besides, location of the seller, the way of doing business seller's reputation for fair dealing courtesy etc also determine product differentiation.

4) **Free Entry and Exit of Firms:** There are no barriers on entry and exit of firms under this market. But new firms will have to supply differentiated product from the existing ones. Thus any numbers of firms are welcomed provided they produce similar products. This brings about automatic adjustment in the supply of the product. The larger the number of firms, the greater is the competition and vice – versa.

5) **Selling Costs:** This is another marked feature of this form of market. There is no need of advertising either under perfect competitions or under monopoly. But under, this form of market, without selling costs, no firm can survive. Each firm will have to advertise its product to inform the consumers about the new product for creating demand. A skillful and imaginative advertisement is necessary to convince the consumers to buy the product. Thus, the selling cost refers to the cost incurred on advertisement. It may be informative or competitive.

6) **Informative:** The purpose of this type of advertisement is to inform the consumers about the new product. It can be done through newspapers, magazines, sign boards, radio, T.V. cinema houses etc so that the people know about the new product. The purpose of this type of advertisement is not to boost demand but to inform the people about the new product to make their rational choice. It also enlightens them about the market situation and helps them to make rational choice.

7) **Competitive Advertisement:** The objective of this type of advertisement is either to create demand or boost the demand for the product. Generally, all means moral immoral are made use of to create demand for the product and rattle down the rivals. Public media like newspapers, radios, TV, cinema houses, models, window dressing, sign-boards, magazines etc are used to convince the consumers to choose a particular product from among many. Even popular figure like film star, sportsman are employed to advertise the product. This category of advertisement tries to establish that the advertised product is the best or superior to all and appeals the consumers to buy that product some times, even free gifts are offered on purchase of the product.

   However, this type of advertisement misleads the consumer. It becomes difficult for consumer to make correct and rational choice from among host of advertised products. Many times, they make wrong choice based on false and exaggerated advertisement. Therefore on moral and economic grounds such advertisement is not desirable. The selling cost influences the shape and the position of the demand curve because it influences the elasticity of demand. When demand curve shifts to the right, it means that the selling cost has proved successful in improving demand for the product.

### 5.14.4 CONCEPT OF GROUP

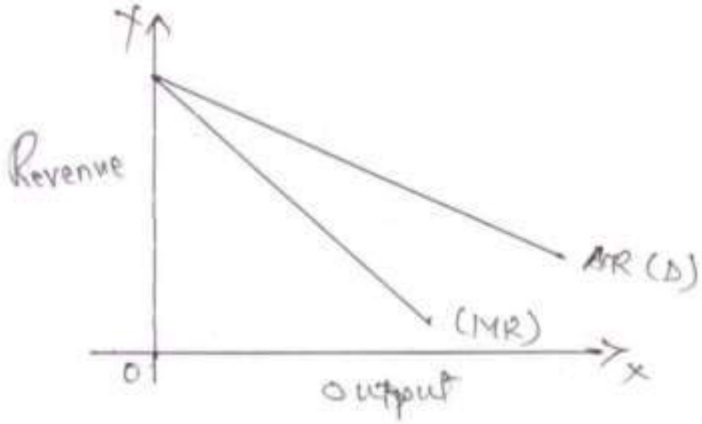
Since all the firms under monopolistic competition produce non – identical products, therefore they are said to be in a group. The concept of industry is peculiar with perfect completion only because all firms under perfect competition produce identical products. But under monopolistic competition each firm produce close substitute to other is product. It is for this reason within the group firms has greater affinity and their products become close substitutes. They offer stiff competition to each other. The larger the number, the keener is the competitions and vice versa.

### 5.14.3 NATURE OF DEMAND CURVE

The shape of the demand curve under this form of market is determined by the tastes and preference of the consumer, pricing policy of rivals, output, selling costs and product decision of rivals firms. The problems of monopolistic competitions are therefore more complicated than those under perfect competition. The demand curve faced by a firm under monopolistic competition is its average revenue (AR) curve. It is neither perfectly elastic nor perfectly inelastic. It lies between the two elasticities. It is more elastic than it is under monopoly and less elastic than the demand curve under perfect competition.

This makes clear that the demand faced by the firm under this form of market is flatter and elasticity of demand is greater than one. The degree of elasticity depends upon the extent of product differentiation and the number of firms operating.

If the degree of product differentiating is greater, then in that case monopoly element will be larger and so the demand curve will be relatively inelastic. But if the degree of product differentiation is smaller then in that case competitive element will be greater and therefore demand curve will be more elastic. Secondly number of firms in the group also determines the position and shape of the demand curve. If the number is larger, the smaller is the product differentiation and hence greater is the competitive element and hence the demand curve will be relatively elastic. If the degree of product differentiation is smaller then in that case competitive element will be greater and therefore demand curve will be more elastic. Secondly, the numbers of firms in the group also determine the position and shape of the demand curve. If the number is larger, the smaller is the product differentiation and hence grater is the competitive element and therefore the demand curve will be more elastic. If the number is smaller, the greater is the product differentiation and therefore greater is the monopoly element so demand curve will be relatively inelastic. The following diagram depicts the shape and position of demand curve. Since individual demand schedule slopes downward, AR curve of the firm also slopes downward. The marginal revenue curve lies below the AR curve. MR like monopoly is always less than price because additional sale of output involves cut in price.




### 5.14.4 Production & Selling Costs

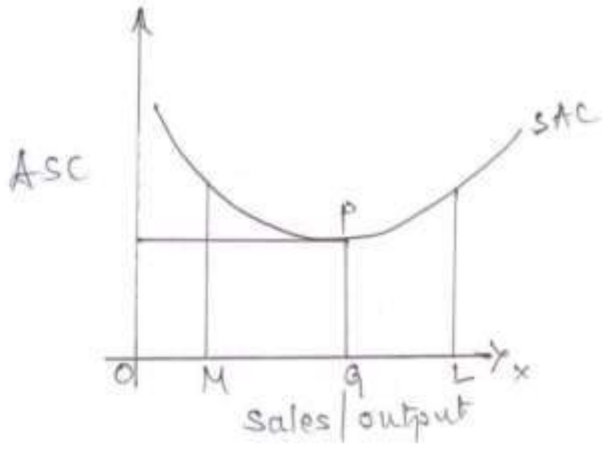
Selling costs occupy an important place in marketing the product. In fact, in certain cases selling cost exceeds the production cost because marketing of the product becomes difficult. To market the product means to create the demand for the product. Thus to convince the consumers to buy the product an intensive and skillful advertisement campaign needs to be undertaken. Many a times a good product does not get sales for want of proper and effective advertisement.

Therefore, we should know the difference between the two.

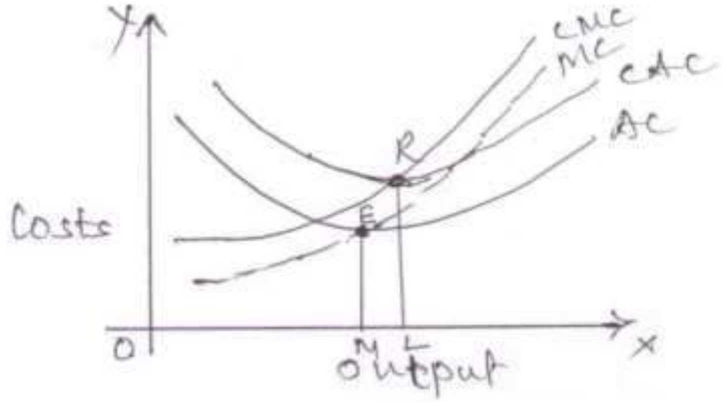
1) Production cost is incurred to produce and supply good and services whereas selling costs are incurred to raise sales of the product.
2) Production cost is generally incurred to satisfy the exiting wants whereas selling costs are incurred to create future demand.
3) Selling costs change the shape and position of demand curve. It makes it more elastic but production cost does not do the same.
4) Production costs create utility but selling costs do not create any utility
5) Production costs increase supply of goods and services while selling costs create or increase demand for the product.
6) Production cost increases national income in real terms whereas selling costs bring about merely transfer of resources without adding anything to the national income.

### 5.14.5 NATURE AND SHAPE OF THE AVERAGE SELLING COST:

Average Selling Costs (ASC) refers to the selling cost incurred per unit of sale. It is also U shaped. Thus in the beginning it is high but as the sales of the product increases, the average selling cost starts falling. It falls due to operation of the law of increasing sales. Therefore ASC declines. But this will not happen indefinitely. After having reached the minimum point, it begins to rise due to the operation of the law of decreasing sales. In other words, the operation of the law of non – proportional sales is the cause of ASC being U shaped. The following diagram depicts the shape of ASC.




Total cost of production includes TFC, TVC and total selling costs. Therefore AC of production is equal to AFC + AVC + ASC. In the following diagram combined AC and MC are shown.



## 5.14. Exercise

1. What is meant by market in equilibrium? How does the demand curve and the supply curve enable us to arrive at it? Explain with the diagrams.
2. What are the essentials of pure and perfect competition? When does it turn imperfect?
3. Explain the main features of monopolistic competition. How product differentiation helps to distinguish a monopolistic competition?
4. Explain the mechanism of price determination under monopoly with reference to a diagram where the area of excess profit is shown.
5. Explain the market situation which enables price discrimination possible & profitable.
6. Write short notes on :-
   (a) Dumping
   (b) Selling cost
   (c) Product differentiation
   (d) Discriminating monopoly

# UNIT – VI

## PRICING OF FACTORS

### (DISTRIBUTION)

### 6.1 THE GENERAL THEORY OF DISTRIBUTION

Production is the result of joint endeavor of four factors of production namely land, labour, capital and entrepreneur. Since their services are economic goods, they are to be paid for. Thus, the national income is distributed among these factors of production. The theory, which refers to the distribution of national income among the factors of production, is called as the general theory of distribution. It deals with the pricing of the productive resources. It determines the relative share of land, labour, capital and entrepreneur in the national income. Thus land is paid in terns of rent, labour in wages, capital in interest and entrepreneur in profits from the national income.

National Income = Rent + wages + interest + profit. Distribution of national income is studied in two ways namely personal distribution and the functional distribution. Personal distribution refers to the study of individual incomes. It analyses how much is earned by individuals in the country. However, it is very difficulty to explain earning of individual incomes because they earn from different sources. Earning of individual incomes depends upon social and political structure of the country, system of ownership, of property and the laws of inheritance. It is for these reasons study of personal distribution becomes a complex one.

Functional distribution on the other hand deals with the study of factor incomes. It analyses the relative share of each factor in total national income in terms of rent, wages, interest and profit. In other words functional distribution of national income studies pricing of factors in tern\ms of function they perform in producing goods and services or national income. Thus, the functional distribution is named as the theory of factor pricing.

## 6.2 MARGINAL PRODUCTIVITY THEORY

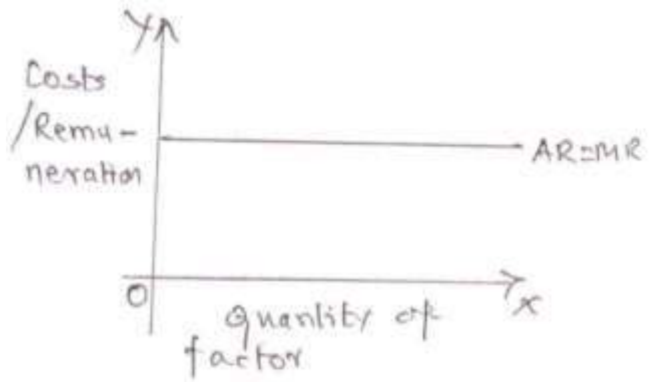
The marginal productivity theory of distribution is only an extension of general theory of distribution. It explains determination of incomes of factors of production. Theory is associated with names of J. B. Clarke, Wicksteed and others. The theory states that income of the factor of production is determined by its marginal product. Marginal product refers to the addition made to the total product by employing one more extra unit of the same factor of production, quantity of other factors remaining constant.

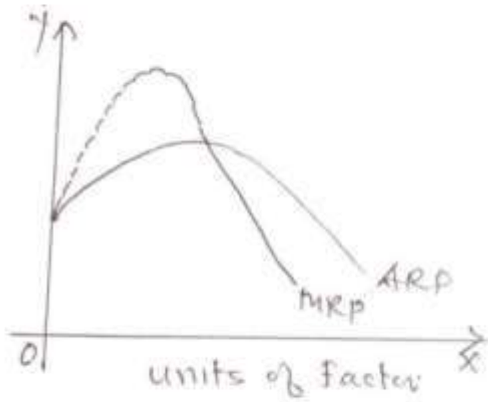
J. B. Clark, held the view that in a static economy, every factor of production including entrepreneur receives reward equal to its marginal product. The marginal product can be measured in marginal physical product or marginal revenue product. Marginal Physical Product (MPP) refer to the addition made to the total product in physical form by employing one more unit of the same factor keeping quantity of other factors the same. While marginal revenue product (MRP) is money value of MPP i.e. MPPX price of the product. Since factors of production are paid in their revenue productivity, the theory is studied in terms of revenue productivity.

## 6.3 THE STATEMENT OF THE THEORY

The marginal productivity theory relates the reward of a factor of production to the revenue productivity of that factor. Thus price of any factor of production depends upon its revenue productivity. An employer will continue employing units of a factor up to the point at which rewards paid to the marginal unit of that factor is equal to the contribution made to the total production by that unit in terms of money. No rational producer would go beyond this point of equality because the cost (Reward) exceeds the contribution (income). At the margin, the reward of the factor is equal to tits productivity or marginal productivity. Thus, the marginal productivity theory states that 1) rewards of a factor would depend upon the contribution of that factor to the total production. 2) the reward of a unit of factor of production would be determined by and would be equal to the marginal productivity of that factor unit. 3) Under certain conditions, the reward of the factor unit would be equal to both, the average productivity of factor under consideration.

Here two points are to be noted. First the reward which a factor of production receives is income for that factor but it is the cost to the employer under perfect competition, rewards which pays is the same for all units of factor. Therefore cost curve of the factor is horizontal straight line indicating that average cost and marginal cost are the same to the employer. Secondly that the factors of production are paid in money and not in




what they produce. Therefore, employer is interested in revenue productivity. Physical productivity is converted into revenue productivity through price mechanism or prices. Average revenue productivity (ARP) refers to the total revenue divided by number of units of the factor employed to produce the given output. Marginal Revenue Productivity (MRP) refers to the net contribution made to the total revenue productivity by employing one more unit of the same factor. Both revenue productivity depend upon the law of variable returns that is they increase, reach maximum and then decline.

The marginal productivity theory of distribution states that under perfect competition in the long run, the reward paid to the factor units will be equal to both average revenue productivity as well as marginal revenue productivity. The following figure show the ARP and MRP curves and the average and marginal remuneration (Cost) curves under competitive conditions

## 6.4 EQUILIBRIUM OF THE FIRMS IN FACTOR MARKET

To understand the equilibrium of a firm with regards to employment of factors of production, one assumption is made i.e. quantity of other factors of production is kept fixed quantity of one variable factor say labour is increased. In other words, more and more units of labour are employed until contribution made by the last unit employed becomes equal to the reward that unit of labour receives from the employer.

The following diagram illustrates the firm is equilibrium. Revenue productivity and costs are measured along vertical axis while labour along horizontal axis.

## 6.5 CONDITIONS FOR FIRM'S EQUILIBRIUM

The firm would be in equilibrium with regards to employment of factors of production if the following conditions are fulfilled.

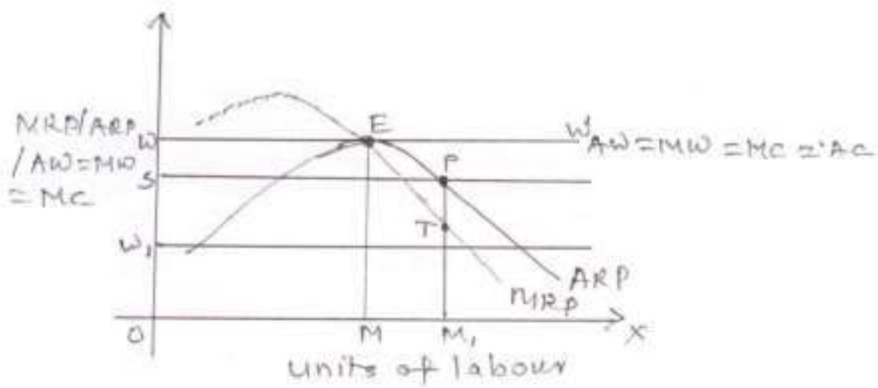
Marginal Revenue productivity (MRP) = Marginal Cost (MC or MW). This is essential condition but not the sufficient condition for a firm to be in equilibrium. Therefore, the second sufficient condition for firm's equilibrium is that the marginal revenue productivity curve must cut marginal cost curve or marginal wage line from above. If these two conditions are fulfilled, the firm would be in equilibrium earning maximum profit.

WW is the supply curve faced by the firm parallel to the OX axis. It depicts the supply curve of labour to the individual firm. Since there is perfect competition in the labour market, the firm can hire as many units of labour as it desires at the ruling wage rate of rupees i.e. OW per worker. Under competitive conditions, the firm would have to accept the ruling price. The firms demand for labour is so insignificant in comparison with total demand of the industry that any change in the firm's demand for labour will not affect the price anyway. The marginal revenue productivity of labour to the firm is the firms demand curve for labour. Demand for labour is a derived demand because labour is hired only for what it produces. So in the following figure the MRP curve indicates derived demand curve for labour of the firm under consideration.

Conditions for equilibrium

1) MRP = MC = AC = AW = MW

2) MRP curve must cut ARP curve at its highest point from above to maximize the profit.




Where

| | | | |
|---|---|---|---|
| 1) | MRP | = | Marginal Revenue Productivity |
| 2) | ARP | = | Average Revenue Productivity |
| 3) | AW | = | Average Wage |
| 4) | MW | = | Marginal Wage |
| 5) | MC | = | Marginal Cost |
| 6) | AC | = | Avenge Cost |

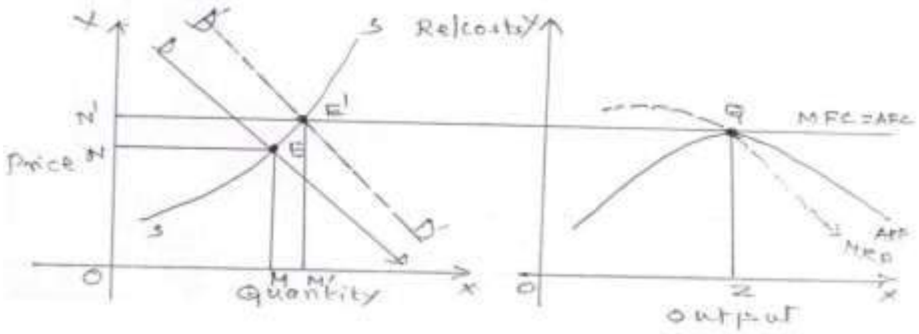
In the above diagram WW' curve represents both the average and marginal wage. The average amount of money paid to a worker is OW. Since, the firm is operating under competitive conditions, what is paid to one worker would be paid to all the workers employed. Therefore WW wageline is horizontal to 'x' axis. The firms will be in equilibrium and maximizes its profit when the MRP of the factor (ME) unit is equal to the marginal cost of the factor which is equal to marginal and average wage.

This takes place when OM amount of labour is employed. If less than OM amount of labour is employed, the firm would suffer unnecessary losses. If it wants to raise its receipts, it must increase the employment of labour which would go on adding to the receipts of the firm more than the marginal cost. The MRP exceeds the MW = AW = MC. In the same way if more than OM amount of labour is employed, the marginal cost of labour, that is marginal wage would exceed its MRP; the firm would be paying more to its marginal employees than their contribution. This results into losses.

At OM employment of labour, the firm would be in equilibrium and its profit would be maximized. It is so because the last unit of labour employed would contribute equal amount to the firm's receipts. In other words, the firm would be in equilibrium when it equates marginal revenue productivity of labour with its marginal cost (MRP = MC = MW). But this equality must realized at falling MRP.

And that is why economists are more keen to show that the MRP must ultimately decline otherwise equilibrium would be impossible. Assuming rationality on the part of entrepreneur, a firm will be in equilibrium when MRP of a factor to the firm equals its marginal cost. Fulfillment of this condition enables the firm to maximize profit. This condition realizes at OM amount of labour Not only MRP is equal to marginal cost but it is also equal to average wage and average revenue productivity of labour. This also implies that the industry is in full equilibrium earning normal profit. Though price of any factor of production including labour is determined by the demand for and supply of it, it is always equal to its MRP. The next diagram depicts the industry equilibrium.

Price is measured along 'OY' axis and quantity along 'OX' axis. With increase in demand for the factor shown in the diagram above, price of the factor shoots up to 'ON'. As soon as price goes up at 'ON', the firm will be in equilibrium at 'Q' using OZ amount of that factor earning normal profits. At OZ amount of that factor, the price of it is equal to its MRP as well as ARP of the factor. At equilibrium point 'Q' the firm earns just normal profits. Thus in the long run under perfect competition in the factor market, price will always equal to MRP and ARP of the factor.

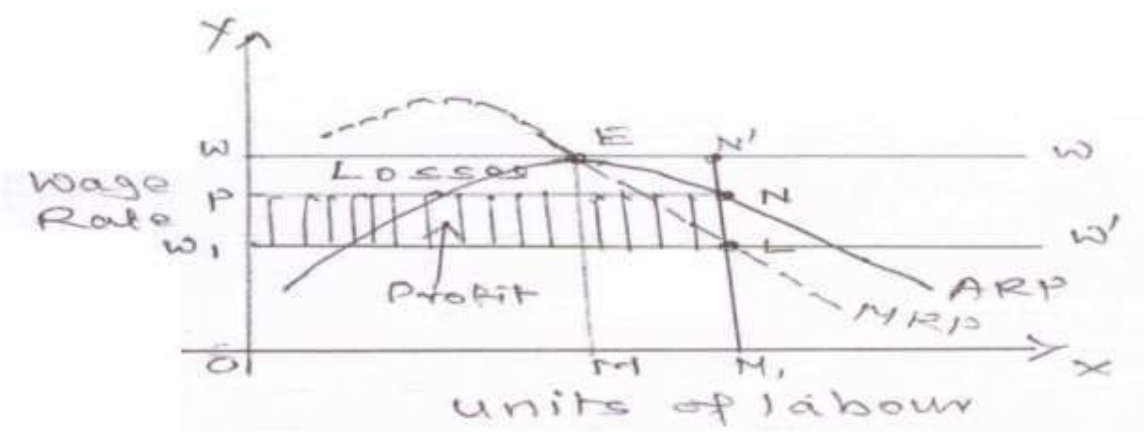



In other words, long run equilibrium between demand for and supply of the factor is established at the level where the price of the factor is equal to both MRP as well as ARP of the factor which means only normal profit is made.

## 6.6 EQUILIBRIUM OF AN INDUSTRY

Industry equilibrium will be attained only when each and every firm constituting that industry is in equilibrium earning normal profits. This means that each firm would be equating MRP with marginal wage or marginal cost. If it happens, the whole industry would be in equilibrium earning normal profits. Diagrammatic representation of the industry equilibrium is the same as that of equilibrium of a firm. It is also explained in terms of costs and receipts. For industry equilibrium, it is assumed that the entrepreneurs are homogenous and each firm would be in equilibrium when ARP curve is tangential to the wageline.

In short run, some frims will be earning super normal profits while some will be earning normal profits and some will be minimizing losses by just covering variable cost. But in long run, this will not happen. Frims incurring losses will quit the industry and if excess profit is made new firms will enter the industry and compete out the excess profit. This entry and exit of firms in and out of industry will continue until equilibrium is established. So, the industry equilibrium will realized when MRP = ARP = MW = AW = MC. The following diagram depicts the same.



The industry equilibrium takes place at employment of OM amount of labour and the OW wage is paid to every unit of labour. So ‘E’ is the equilibrium point where MRP = ARP = MW = AW = MC are equal. MRP and ARP curves are tangent to wage line WW. Industry is earning normal profit. If less than OM amount of labour is employed, industry will unnecessarily reduce its profits and if more than OM amount of labour is employed say OM’, the industry will incur losses because its labour cost would be more than the receipts. Wage rate would exceed receipt. If the wage line shifts down ward that is W’W’, equilibrium position would change. Now it would be at ‘L’ point at ‘OM’ employment of labour. At ‘L’ point MRP = MW = AW and MC of the firm. But ARP is M’N which is higher than MRP (L’M) which means that the industry would be making excess profit. This will invite new firms in the industry which will compete out the excess profit bringing the industry to the level of normal profit. The entry of new firms will lower the price of its products and this will bring down the MRP and ARP. Likewise an increase in demand for labour may raise wages. The ARP curve will fall and wage line will rise until they are tangent to each other.

### 6.6.1 Principle of an industry Equilibrium:

$$\frac{\text{MRP of Land}}{\text{Rent}} = \frac{\text{MRP of Labour}}{\text{Wages}} = \frac{\text{MRP of Capital}}{\text{Interest}}$$

$$= \frac{\text{MRP of Entrepreneur}}{\text{Profit}}$$

If this condition is fulfilled, the industry will be in equilibrium earning normal profit. This is the same principle as the consumer’s equilibrium with regards to more than one good i.e. the law of substitution. To conclude an entrepreneur employs units of any factor of production until its MRP becomes equal to the marginal cost.

**ASSUMPTIONS :**

The above stated theory holds good only when certain conditions are fulfilled. These conditions are the foundation stones of the theory.

1) There exists perfect competition in both the markets, factor as well as commodity market.
2) All units of labour are homogeneous in all respects.
3) Problem of overtime is ignored.
4) Theory would hold good only in long run.
5) It considers only stationary conditions.
6) There is equal bargaining power on the part of buyer seller.
7) The theory assumes that there is perfect mobility of factor of production.
8) It is based on belief that entrepreneurs can predict and measure MRP of labour in advance.
9) The theory holds that entrepreneurs always try to maximize profit.
10) No government intervention any where in the process of determing rewards of factor of production.

**Criticism / Limitations :**

Through the theory is pioneer in explaining as to what determines prices of factors of productions, it is not free from drawbacks.

1) Perfect competition is not reality. Reality is imperfect markets.
2) Units of labour are not homogeneous; On the contrary, the world is full of heterogeneity.
3) The theory is static where as problems it attempts to solve is dynamic. Therefore it is illogical to solve problems of dynamic world with tools of static theory.
4) The theory is applicable in long run only. But Lord Keynes says that we are all dead in long run. What concerns us most is the short run.
5) The theory doesn't solve the problems of individual income.
6) There is no equal bargaining on the part of buyers and sellers. Actually labour is exploited by the employers.
7) The government interference is in every walks of life. A number of labour laws shows that there is a great deal of government interference in determing reward for labour.
8) The theory is not useful in determing reward of such factors which are used in fixed proportions.
9) According to this theory, trade unions are superfluous and collective bargaining is a futile activity.
10) Marginal productivity ignores the positive inter relation between rewards of factors of production and their productivity especially between the wages and efficiency of labour.
11) The theory is based on the principle of maximization of profit which is not true.
12) The various factors are jointly demanded for the production of a commodity.
13) The theory fails to explain the remuneration of entrepreneur that is profit. Marginal productivity of a factor can be known if it can be varied by keeping the other factors fixed. However, the entrepreneur in a firm is only one and therefore variation in it is not possible.

### 6.6.2 IMPORTANCE OF THE THEROY :

(1) The theory enables us to determine the levels of employment of factors of production. Price of factor depends upon its demand.

(2) The theory is useful in bring about the efficient and optimum allocation among their alternative uses. The movement of factors is essential for best and efficient use of scarce natural resources.

(3) The theory also guides us to determine the incomes of factor owners and thereby determines the relative share of factors of production in the national income.

### 6.7 RENT

**Introduction :** Land is a primary and original factor of production. Its total supply to the entire society is perfectly inelastic. It is a free gift of nature. However for an individual or an industry it is relatively elastic. The reward paid for use of land is called rent. The economic rent refers to payment for the use of land. It excludes any return on capital investment. Economic rent is also called as surplus because it does not result from any exertion on the part of land owner. Adam Smith held," The landlords like all other men love to reap where they never sow". It was Ricardo an English Economist who explained why rent is paid.

## 6.7.1 Ricardian Concept of Rent :

Ricardo held, "Rent is a return for the use of the original and indestructible powers of the soil; and high rents are not a sign of the bounty of nature. On the contrary, they are an indication of the niggardliness of nature." He defined rent as," that portion of the produce of earth which is paid to the landlord for the use of original and indestructible powers of the soil." The above definition makes it clear that rent is payment for the use of land only and it is different from contractual rent. It does not include return on the capital investment. However, Physiocrats laid great stress on the bounty of nature as the reason of the rent of land. Ricardo argued that though the land was useful, it was also scarce. While the productivity of nature may be a sign of its usefulness and of the bounty of nature, the fact is that the total supply of land is fixed is a sign of nature's niggardliness. The contention of Ricardo that rent is a return for the use of the original and indestructible powers of the soil does not throw any light on the powers of the land that are said to be original. By the term Original Powers, Ricardo perhaps meant that it must be distinguished between money spent on improvement of land and the economic rent.

Though, the land itself can not be destroyed, its fertility can be destroyed . If depends upon the climatic conditions, use of irrigation, improved farming methods and so many other factors. Therefore, it would be entirely unreasonable to regard the powers of the land as indestructible. The Ricardian theory of rent is based on two basic principles viz. The Law of Diminishing Returns which operate in agriculture and the Mal thus principle of population. These two principles are the foundation stones of Ricardian theory of rent.

**Assumptions of the Theory :**

(1) The elasticity of supply of land is zero which means supply of land to the society is fixed.

(2) The land is used to produce food grains only. No other use of land is considered.

(3) Land differs in fertility. This means that there are different grades of land differing in fertility.

(4) There exists perfect competition in factor market. This only means that there are a number of land owners who are willing to rent out their pieces of land at ruling rate of rent.

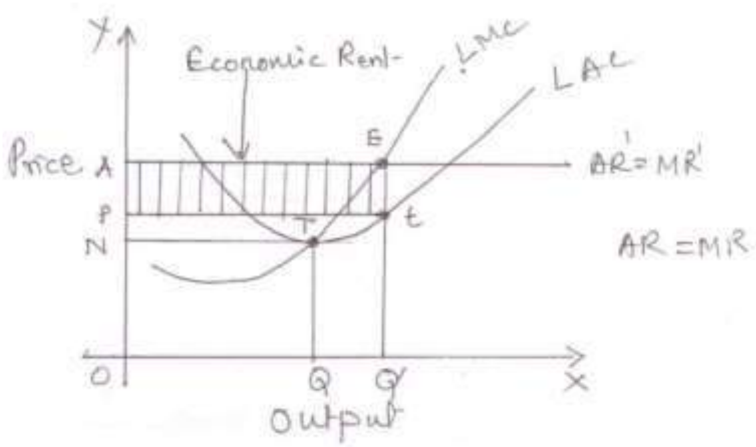
(5) The theory operates only in long run.

(6) The concept of marginal piece of land plays a dominant role in the classical theory of rent.

In the light of above assumptions, it is stated that if the land is of same quality, scarcity of land in relation to its demand gives rise to rent. Ricardo calls it as the scarcity rent. And if land differs in quality, then in that case superior quality pieces of land earn rent. Ricardo calls it as differential rent.

**6.7.2 Scarcity Rent Theory :**

To explain the scarcity rent theory, it is assumed that a new piece of land is discovered which was not occupied by man. As the people start occupying this new land, it starts earning rent because demand for land exceeds supply of land for producing food grains. As long as vacant pieces of land are available for producing food grains, its production cost would be equal to average cost of production. So, cost of production and price of the food grains would be the same. So there would be no surplus. But once, the entire land is brought under cultivation, further demand for food-grains would raise the price of food-grains above the average cost of production. This happens because population goes on increasing. Since there is perfect competition in factor as well as product markets, the cultivator's equilibrium will be established at the lowest point on long run average cost curve. But as the population grows, demand for food grains also increase but supply can not be increased on account of fixity of supply of land. This raises, the price and therefore, there appears a difference between price or average revenue and average cost of production. It is this difference between revenue and cost Ricardo calls it as the scarcity rent. The following diagram illustrates the scarcity rent phenomenon. Price is measured along OY axis and output along OX axis.



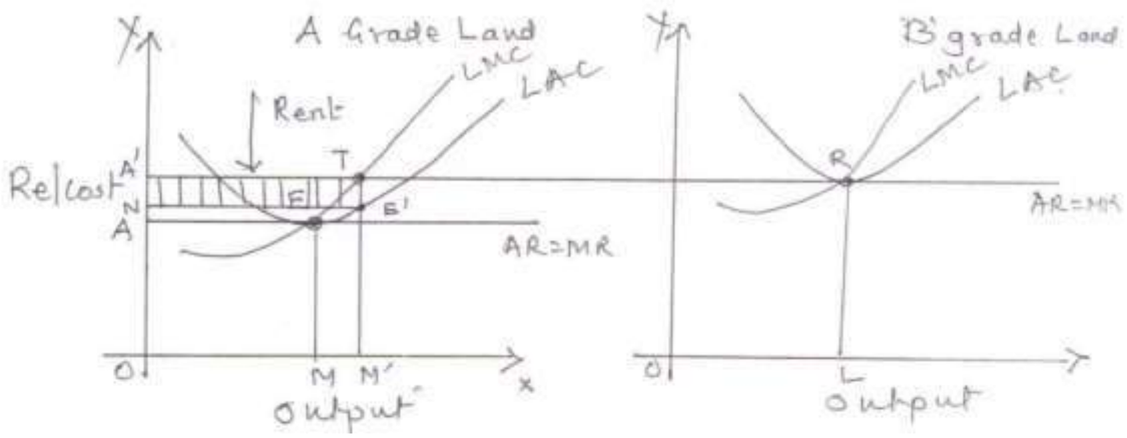

The cultivator is in equilibrium at OQ size of output. At this level of output price of corn i.e. ON. Is equal to average cost of production i.e. TQ. Thus, at this size of output price and long run average cost are equal and hence there is no surplus. But as output is raised to OQ', price shoots up to OA or EQ' but the average cost of production remains at OP or TQ' level. Thus, there appears a surplus to the extent of APLE rectangle which Ricardo calls as economic rent. It must be noted that there exists perfect competition among landlords so it is not possible to earn any rent as long as surplus land exists. As demand for food grains increases, the vacant pieces of land are brought under cultivation to produce more food grains to meet increased demand for food grains. But once entire land is put to use, there is no scope to improve the supply of food grains . So, demand for food grains exceeds supply of food grains which shoots up the price of the food grains. Now, price can not fall back to original level that is ON because there is no idle land to be put to use. Now, cultivator's equilibrium realizes at 'E' point at OQ' size of output because LMC is equal to new price OA' but LAC is tQ. So, 'Et' or AP surplus arises which is scarcity rent according to Ricardo. Thus, contention of Ricardo rent arises, due to niggardliness of nature is true. The classical thinking holds that rent is a surplus over and above cost of production. They never held rent as a part of cost of production. Thus scarcity rent arises due to the fixity of supply of land.

## 6.7.3 RENT UNDER INTENSIVE CULTIVATION :

The Ricardian concept of surplus rent applies to intensive cultivation also. Intensive cultivation refers to usage of same piece of land again and again for the production of same food grains. In such cultivation fertility of land goes on declining and so additional doses of labour and capital applied to produce food grains from the same piece of land yields less and less quantity of food grains. The cost of last dose of labour and capital must be at least equal to the yield which we get in return from the land to make application of the dose of labour and capital worth while. So the last dose is called marginal dose because it simply covers its cost. It doesn't give rise to any surplus. Whereas earlier doses produce more than the cost incurred on them. So, it is this Surplus over and above cost of doses of labour and capital is called rent. Thus Ricardian theory of rent is true in case of intensive cultivation of land also.

## 6.7.4 THE DIFFERENTIAL RENT THEORY :

This concept of rent is based on assumption that of land differs in quality or productivity. So superior pieces of land earns rent when interior quality pieces of land area brought under cultivation. It is held that on new island people begin cultivating the best piece of land for production of food grains. But as the population goes on increasing, interior pieces of land are brought under cultivation to produce more and more food grains to meet increase demand for food grains. As the inferior pieces of land are brought under cultivation cost of production increases and therefore price of food grains. So, there appears a surplus over and above the cost of production in case of superior pieces of land; and it is this surplus which Ricardo calls a differential rent.



The following diagram illustrates the phenomenon.

The cost of production on ‘B’ grade land is higher than that of on A grade land. Therefore ‘A’ grade land earns rent i.e. a difference between price of food grains and cost of production. Total rent earned by ‘A’ grade land is equal to shaded area A’NET’. In case of ‘B’ grade land, there is no rent because price and cost of production are equal. Hence it doesn’t earn any rent.

### 6.7.5 RENT UNDER EXTENSIVE CULTIVATION :

Extensive cultivation is defined as the cultivation of different pieces of land of different quality for the production of same food grains. As inferior quality pieces of land are brought under cultivation, cost of production rises and so price of food grains. So, there appears a difference between price of food grains and cost of production of superior quality pieces of land and it is this difference which is called as differential rent. The cost on last piece of land must be equal to price to make cultivation of that piece of land worthwhile. According to classical economists rent does not form a part of the cost of production. It is an earnings over and above the cost of production of marginal land which is no rent land. That is why it is said that rent is not price determining but price determined. David Ricardo contends, “Corn is not high because rent is paid but a rent is paid because corn is high.” This means that it is the price of food grains that determines rent. Thus it can be summed up as follows:

(1) Rent is a differential surplus because it is a Surplus over and above cost of production which arises due to differences in fertility of soil. In other words if all pieces of land were of equal quality no rent would arise.

(2) Rent is price determined and not price determining.

(3) Rent is peculiar to land alone. It means that other factors of production do not earn rent.

### 6.7.6 APPRAISAL OF THE RICARDIAN THEORY :-

(1) In modern thinking, it is the interaction between demand for and supply of land will determine price of land. Rise in population, raise demand for food grains and so for land. But land is fixed in supply. That is why price of food grains increases which creates surplus over and above the cost of production. But Ricardian theory does not explain what determines wages of labour, interest on capital, transport cost etc.

(2) Ricardo holds that the land has no transfer earnings or it has no alternative use. But in modern times, it is held that every factor of production has alternative use.

(3) Supply of land for the whole economy is perfectly inelastic but for a firm or a particular industry supply of land is not fixed. Supply of it can be varied depending demand for its product. Thus, demand for land also depends upon its marginal productivity.

(4) The contention of Ricardo that land is indestructible is also not true. In the age of atomic energy, fertility of land could be destroyed converting it totally barren. That is why his contention that rent is reward paid for the use of original and indestructible powers of soid does not hold good.

(5) Two foundation pillars of the Ricardian theory are the Malthusian Principle of population and the law of diminishing returns. But operation of both the principles can be postponed with the help of modern technique of cultivation, irrigation, use of fertilizers and pesticides. Growth of population can also be controlled. Ricardo failed to take cognizance of it.

(6) Land has transfer earnings. It can be put to alternative uses. Therefore transfer earnings of land enters into the cost of production and hence determines the price of the product.

(7) The Ricardian theory is not applicable in short run. But according to J.M. Keynes we are all dead in the long run in which theory holds good what concerns us most is the short run and not the long run.

(8) Perfect competition doesn’t exist in the real world. Our world is full of imperfections.

(9) Ricardo had predicted economic stagnation on the basis of his rent theory. But modern economists do not agree with his stagnation theory.

(10) Lastly, David Ricardo did not use forces of demand for and supply of to explain the emergence of rent. He uses them indirectly. The Ricardian model of scarcity rent can be better and easily explained with the forces of demand and supply.

This brings us to the conclusion that demand and supply theory would have been enough to explain the phenomenon of rent.

In fine, it can be said that from the view point of individual firm or industry or cultivator, rent enters into the cost of production and therefore determines price. Ricardo was wrong in contending that the rent does not enter into the price. Rent does enter into cost of production.

### 6.7.7 MODERN THEORY OF RENT :-

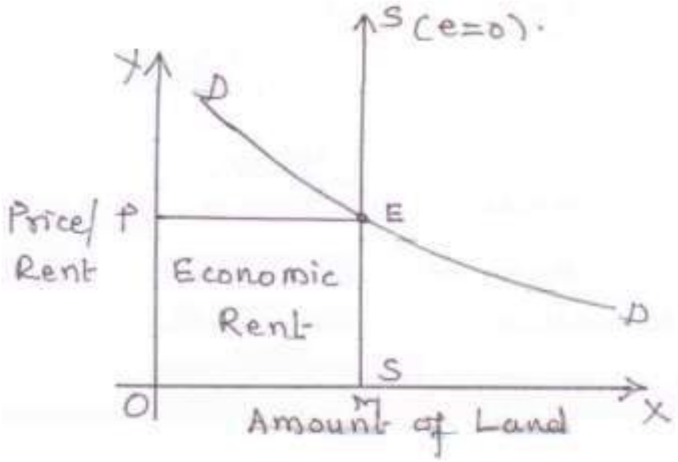
Surplus payment made to any factor of production over and above its transfer earnings is called rent in modern theory of economics. This means that labour, capital and even entrepreneur earn rent which is called as rent of ability. According to Pareto, "Economic rent means the excess payment to a factor of production over and above the minimum amount necessary to keep a factor in its present occupation." Benham held," Economic rents are the sum paid to the factors which need not be paid in order to retain the factors in the industry." It means that income received by a unit of factor of production in its present employment or industry in excess of its transfer earnings is therefore called rent.

Transfer earnings of any factor of production can be defined as the minimum payment that must be made to a unit of factor of production in order to retain it in its existing employment and that it must be equal to the earnings of what that unit of factor of production would earn in the next best alternative use or employment. For individual farmer the whole rent will be a cost that is cost of preventing the land from transferring to other uses. Thus, in modern theory, economic rent is not merely confined to land alone. It refers to the surplus payments made to units of factors of production in excess of what is necessary to keep them in the present employment or use. Economic rent emergences when supply of a factor is less than perfectly elastic. According to Joan Robinson whenever supply of factors units is not perfectly elastic, a part of the earnings of that factors will consist of surplus or economic rent since the full price they get is not necessary to make all the units available.

If supply is not perfectly elastic, some units of that factor would be available at lower price than what it would receive at equilibrium price. The difference between the actual price and the one necessary to make it available is economic rent. Since land has no supply cost, entire earnings of it is economic rent.

A) **PERFECTLY INELASTIC SUPPLY ( e = o) :-**

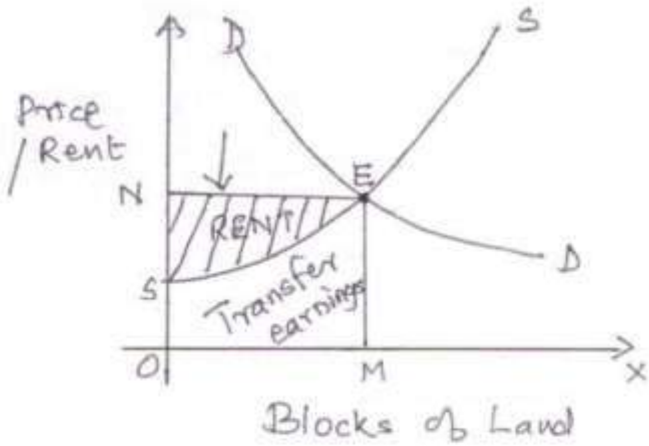
The whole earnings of land is considered as surplus earnings since land is free gift of nature. The following diagram explains the phenomenon of economic rent. 'SS curve represents perfectly inelastic supply curve of land and 'DD' is the demand curve. Intersection of demand and supply curves, determines the price of land i.e OP or EM. Since transfer earnings are zero, the entire earnings or price will be economic rent per unit of land. The total earnings or economic rent is OM XOP = POME. (e = o).




Economic rent is defined as payment for any factor whose supply is perfectly inelastic. This is depicted in the along side diagram. If the quantity of land is in plenty in relation to its demand, there would be no reward for its use, and therefore no economic rent will arise. In Ricardian theory land is considered to have specific use only i.e. it is used only for production of a particular food grains but in real world, land is used for different commodities. According to modern economists, supply of land is fixed to the society but not to a particular industry or firm. There are various uses of land competing with each other. If in its next best alternative use, it earns more than what it earns in present use, it would get transferred to that use.

**(B) RELATIVELY ELASTIC SUPPLY ( e > 1) :-**

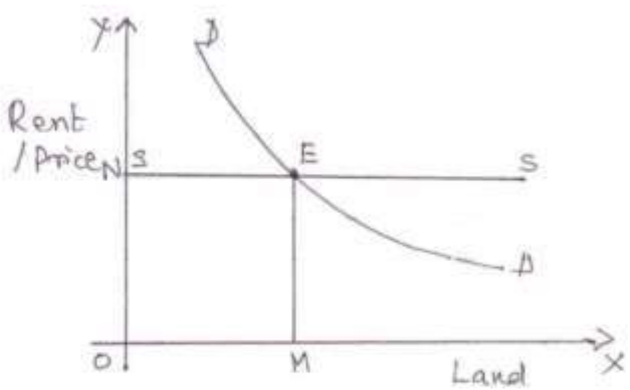
If supply of land or any other factor is relatively elastic, then in that case, there arises a difference between actual earnings and its transfer earnings; and it is this difference which is called rent in modern theory. The following diagram illustrates the phenomenon. The diagram shows that equilibrium between demand for and supply of land takes place at 'E' point where demand and supply intersect each other. So equilibrium price is ON.




Transfer earnings of last block of land and price are equal that is ON = EM. Hence last block of land earns no rent. But earlier blocks earn rent because there is difference between actual earnings and transfer earnings. At ON equilibrium price, total actual earnings of 'OM land is NOME (ONXOM) where as transfer earnings is SOME. So the difference between actual earnings and transfer earnings is NOME – SOME = NSE (Shaded Area). This difference is economic rent.

**(C) PEFECTLY ELASTIC SUPPLY ( e = ∞):-**

When supply of land or any other factor is perfectly elastic, no economic rent arises or earned. To illustrate the point, we suppose all blocks of land are homogeneous in all respects. So, each block of land will have equal transfer earnings which means supply curve will be straight line and horizontal to the 'X' axis 'DD" is the demand curve. It cuts supply curve at 'E' point. It means that at 'E' point demand for land and supply of land become equal. 'ON' will be the equilibrium price. Since supply of land is perfectly elastic, price ON and transfer earnings EM will be equal hence there is no rent paid to any piece of land. This is depicted in the following diagram.



Here no rent is paid because transfer earnings and actual earnings are the same. Hence, there is no difference between the two. That is why no rent is paid. Hence we can conclude if supply of land or any other factor is perfectly elastic no rent is paid.

### 6.7.8 CONCEPT OF QUASI – RENT :

It was Dr. Marshall who introduced this concept in economic theory. It is Just expansion of Ricardian concept of rent to the short run earnings of the capital equipments or factors of production whose supply is perfectly inelastic (e=0) in short run. It is therefore quasi-rent is essentially a short run phenomenon. Earnings of specialized capital equipments depends upon the demand conditions and thus similar to rent of land. However, supply of fixed capital assets is not perfectly inelastic in long run like land. Therefore, Dr. Marshall instead of calling this earnings as economic rent called it as quasi-rent. Quasi rent refers to an excess earnings of any factor of production over and above its marginal productivity. It is temporary surplus earned by such capital assets in the short run.

Quasi-rent arises because specialized equipments like machinery has no alternative use. So its supply is limited in short run. Its transfer earnings will be zero since it has no alternative use in short run. So entire earnings of such factors will be the surplus since its transfer earnings of such factors will be the surplus since its transfer earnings is zero. There may be some maintenance cost to keep it in running conditions. It can be defined as the short run earnings of a fixed factor or capital assets minus the short run cost of keeping it in running condition. Supply of capital assets is fixed in short run but not in long run. That is why this surplus vanishes in long run as supply of fixed factor gets increased to match increased demand for it. This makes the quasi-rent disappear. Quasi-rent is also defined as the excess of total revenue earned in the short run over and above the total variable costs of production.

## 6.8 WAGES

**Introduction :-** The term wage has a broad connotation it includes pay, salary, emoluments, fees, commissions, bonus etc. In other words, it includes all types of income earned by labour as a factor of production. The term wage may refer to piece-wage, time wage, money wage, real wage and piece wage. It may be paid per hour, per day, per week and per month or annum.

### 6.8.1 NOMINAL WAGES & REAL WAGES :

Nominal Wages means money wages. It refers to total amount of money paid to labour as its price for its service in the process of production. So nominal wages are measured in terms of money while real wages refer to the amount of purchasing power received by a labour through his money wages. It refers to the net advantages of labourer's remuneration. It means the amount of necessaries, comforts and luxuries of life which a labour can enjoy in return for his services through his money wages.
It is the real wages which determine the standard of living of the people. Real wages depend upon the money wages and the general price level. Thus it is stated as

$$\text{Real wages} = \frac{\text{Money Wages}}{\text{Price level}}$$

### 6.8.2 DETERMINANTS OF REAL WAGES :

(1) **Price Level :-** The Purchasing power of money determines the real wages. But purchasing power of money depends upon the general Price level in the economy. The purchasing power refers to amount of goods and services which a unit of money can buy. There is inverse relationship between general price level and purchasing power of money. When general price level rises, the purchasing power falls and vice-versa.

(2) **Working Conditions :-** The working conditions also determines the real wages. It includes, number of hours of work put in and number of days worked per years; educational and recreational and other facilities made available to the labour. If a worker works in a poorly ventilated, hot and unhealthy surroundings, he would be dissatisfied and his estimation of real wages would definitely be low. This brings home that payment of high money wages alone would not raise real wages.

(3) **Trade Expenses :-** Jobs requiring high trade expenses tend to reduce real wages. Doctors, lawyers, C.A. etc need high trade expenses and therefore estimation of their real wages would be very low.

(4) **Incidental Benefits :-** There are some jobs in which money wages are low but other benefits like free lodging and boarding, subsidized canteen facilities, free transport and free medical treatment etc raise the real wages.

(5) **Possibility of Extra-Earnings :-** In certain areas, workers may have a plenty of scope to under take other lucrative work along with their regular work. This fetches them additional income. This tends to increase their real wages.

(6) **Period and Cost of Training :-** While estimating real wages, the period required for completion of training and cost incurred on that training is also taken into account. The longer the period and higher the cost, the lower would be the real wages.

(7) **Nature of Job :-** If a Job is precarious or insecured , estimation of real wages in such jobs would be much low. Estimation of real wages in all risky employment is very low.

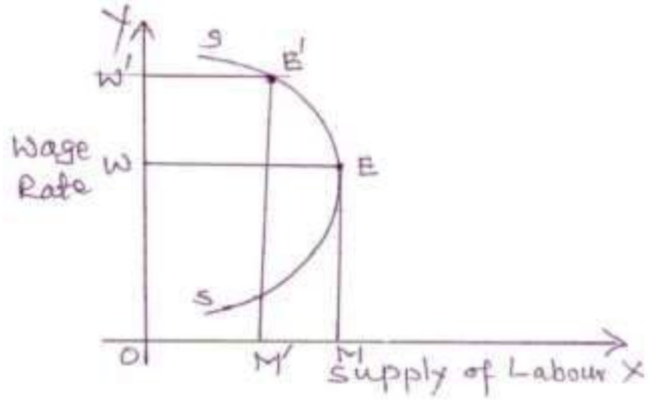
(8) **Possibility of Promotion :-** An allowance should be made for prospects of success while estimating real wages. A labourer may be prepared to work on low wages if he knows that there is a bright prospects of possible promotion in future. Besides, social prestige attached to jobs, regularity of payment, permanency of work and uncertainty etc are to be considered while calculating real wages.

### 6.8.3 SUPPLY OF LABOUR :

Supply of labour depends upon size and composition of population, skills of workers and their willingness to work. One must understand one thing and that is supply of labour can not be adjusted to demand overnight. However advocates of the subsistence theory of wages believed that the size of population depends upon wage rate. But it is known fact that apart from wage-rate, size of population depends upon social, cultural, religious and economic factors. But ability to work and willingness to work are the most important factor in determining the supply of labour. However willingness to work is influenced considerably by the wage-rate. Rise in wage rate has a great effect on supply of labour. Changes in wage-rate has composite effect on supply of labour that is some may offer more hours of work while others may contract and women might withdraw and therefore it is said that rise in wage rate has negative effect on supply of labour because of substitution effect. Workers may substitute more leisure for work efforts.

That is why supply curve of the labour force slopes backward. It is generally held that the total supply curve of labour rises up to a certain wage level and then it slopes backward. The following diagram depicts the backward sloping supply curve of labour. As the wage rate rises to OW, the total quantity of labour offered increases to OM amount but beyond OW wage rate say OW', the total quantity of labour supplied instead of increasing contracts from OM to OM'.

But supply of labour to a particular firm or industry is elastic. If the wage rate is increased, workers from other industries are attracted and supply will match the increased demand, supply of labour also depends upon transfer earnings of workers.




Long run supply curve of labour is more elastic than short run supply curve. It is so because to acquire skill of particular trade or occupation required some time to switch over to other employments. That is why supply of labour is more elastic in long run than in the short run.

### 6.8.4 WAGE DETERMINATION UNDER COMPETITIVE CONDITIONS :

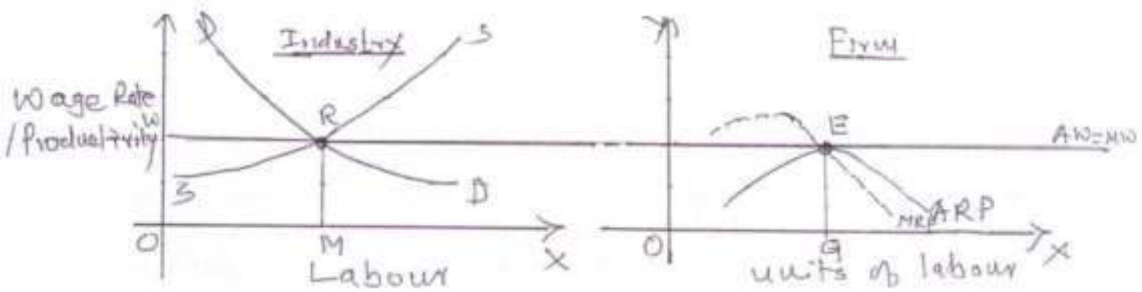
Assuming that there are competitive conditions in both the markets that is labour as well as commodity markets, we shall take up for discussion wage determination under competitive conditions, under competitive conditions, wage rate would be determined by the interaction between demand for labour and supply of labour. In other words, wage rate is determined by the equilibrium between the demand for and supply of labour. Demand for labour is governed by marginal revenue product (MRP). The equilibrium wage rate would be equal to marginal revenue product of labour which is also equal to average revenue product (ARP). Since there are Competitive conditions in factors as well as product markets.

This brings home that under competitive conditions a firm would employ that much amount of labour at which wage-rate would be equal to MRP of the last unit of labour employed under competitive conditions wage rate would be equal to average revenue product which is also equal to marginal revenue product. A rational entrepreneur therefore goes on employing additional unit of labour up to that level at which wage rate becomes equal to MRP of the last unit of labour employed.

In short run, firms can make profit or incur losses but in long run free entry and exit of the firms will force every firm in the industry to pay wage rate equal to marginal product of labour which is also equal to average revenue product . At this, the industry will be earning normal profits Equilibrium position would be attained only when MRP curve cuts average wage and marginal wage line from above and at this point of cutting average revenue product curve will be tangent to the wage line (AW=MW). MRP curve will intersect ARP curve at its highest point from above. At the point of equilibrium MRP = MW = ARP =AW. When this equality is attained each and every firm in the industry will be in equilibrium earning normal profits. The following diagram illustrates the position.

### 6.8.5 BILATERAL MONOPOLY & WAGE DETERMINATION :

It is a market situation under which a single buyer faces a single seller of the same commodity. When a single seller of labour and single buyer of it carry on transaction in buying and selling of labour at an agreed wage-rate; it is called a bilateral monopoly. There are two limits which could be reached by collective bargaining. They are the upper and lower limit. The upper limit is set by the trade union of workers and a lower limit is set by an employer or the employer’s association. However, the actual wage rate is determined between these two limits. Relative bargaining strength of trade union and employer’s association would determine whether the wage-rate is nearer to upper or lower limit. It becomes difficult to predict at what rate the wage-rate is fixed between these two limits. Therefore wage determination under bilateral monopoly remains indeterminate. But definitely it would be fixed between the upper and lower limit. The upper limit can not be higher than MRP of labour and lower limit set by employers must be acceptable to the union. Thus the range of wage-rate would be upper and lower limits in which actual wage rate is determined. If entrepreneurs try to set wage-rate below the acceptable ware-rate to the union, it will ask its members to go on strike and if wage-rate demanded by union is higher than MRP entrepreneurs stop employing labour as it meant losses to them.



But the concept of lower limit is not clear. It is ambiguous but there would be a certain minimum wage below which workers will refuse to work. Thus the wage-rate would be fixed some where between these two limits namely the upper and lower limits as a result of bargaining powers between the two parties. The distance between the upper limit and the lower limit indicates the bargaining range within which the wage rate would be actually set. One can not know exactly at what particular point the wage-rate would be fixed within the bargaining range. That is why wage determination under collective bargaining remains indeterminate.

### 6.8.6 EXPLOITATION OF LABOUR :

Under conditions of imperfections, labour is exploited. If imperfect conditions exist either in product or factor market labour is exploited. If imperfect market exists in product market, it is called monopolistic exploitation and in case of imperfections in labour market, it is called monopolistic exploitation.

Prof (MRS) Joan Robinson defined exploitation of labour as the payment to the labour less than its value of marginal product. The value of marginal product is equal to price multiply by MRP of labour i.e. ARX MRP. In the works of Mrs. Robinson, "what is actually meant by exploitation is usually, that the labour valued at its selling price." This means that exploitation of labour does not take place under competitive conditions in both the markets. When there is imperfect competition in the product market, MR differs from the price of the product (AR). That is why under such conditions of Market, MRP of the factor differs from value of the marginal product.

(1) Value of Marginal Product = Marginal Product X Price i.e.
MPP X AR or Price

(2) Marginal Revenue Product = Marginal Product X Marginal Revenue
MPP X MR

Since under imperfect market, average revenue or price is always greater than marginal revenue, the Value of marginal product (VMP) will be always greater than marginal revenue product (MRP).

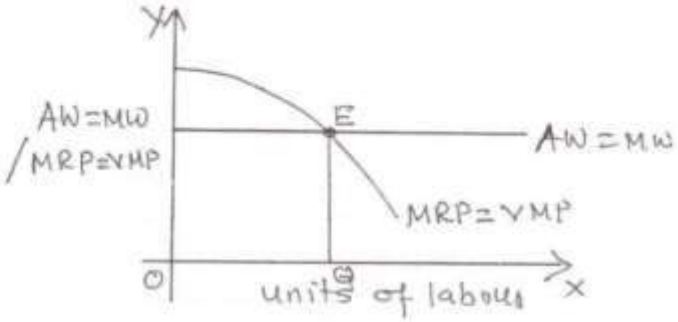
Thus,

(a) MRP = MP X MR

(b) VMP = MP X AR. Since under imperfect market price (AR) of the product is greater than MR (AR > MR)

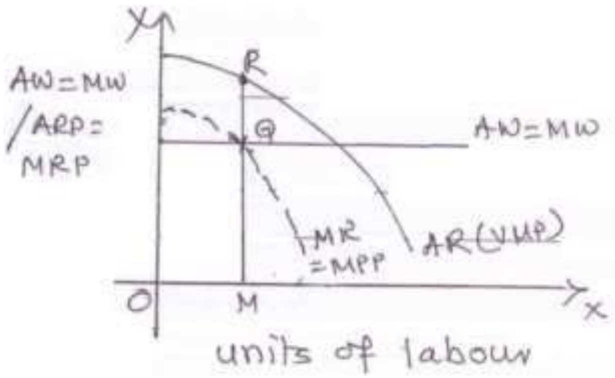
.

. . VMP > MRP.



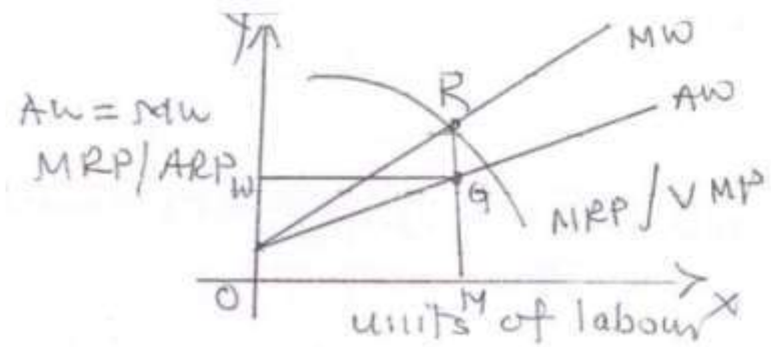

But under perfect competition both VMP and MRP are equal since there is no difference between AR and MR. Therefore, there would be no exploitation of labour under perfect competition. The following diagram depicts the same. Since wage rate is equal to MRP as well as VMP under perfect competition, there is no exploitation of labour under perfect competition. The firm under consideration employs OQ quantity of labour and pays each labourer wage equal to its MRP or VMP and so there is no scope for exploitation of labour.

Now let us consider the situation where in there is monopoly in product market and competition in labour market under such situation labour would be exploited. The wage line would be perfectly elastic and horizontal to 'X' axis. But existence of monopoly in product market means sloping down ward AR as well as MR curves. There is a difference between the two. This means that every additional labourer adds more to the total revenue than what he is paid i.e. he is paid less than what is due to him. The following diagram depicts the phenomenon.



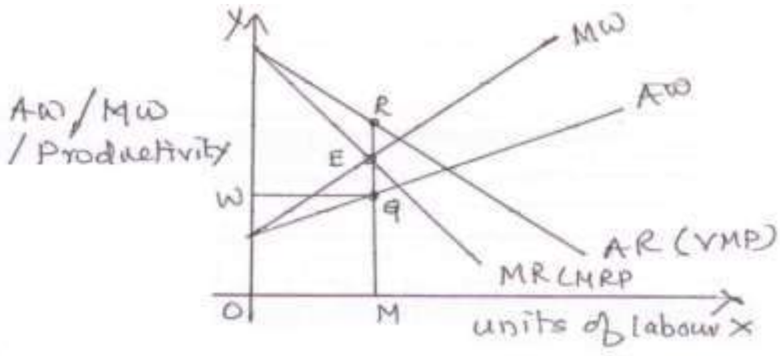
Because there is competition in the labour market wage line would be straight line horizontal to X axis. But there is a difference between AR and MR and therefore, there is a difference between VMP and MRP. So labour is exploited to the extent of RQ. It is also said that exploitation of labour occurs when there are imperfections in labour market even though there is perfect market in product market.

Imperfections in labour market means monopoly in labour market. In this case, supply curve of labour (AW) is not perfectly elastic but it slopes down ward. It is for this reason marginal wage curve would lie above the average wage. Under this situation also labour is exploited because there is a difference between the value of marginal product and the wage rate. Because, there is perfect competition in product market MRP and VMP will be the same. The diagram below explains the situation.




The firm will attain its equilibrium when it equates marginal wage with the marginal revenue product or the value of marginal product. OM, amount of labour is employed and 'OW' wage is paid. But it is less than the value of marginal product. The value of marginal product is greater than the wage. The wage-rate is less than the value of marginal product by RQ amount and this is nothing but exploitation of labour. This kind of exploitation of labour occurs because the supply curve of labour is not perfectly elastic and that is why marginal wage line lies above the average wage line.

If imperfections exist in factors as well as product market i.e. it may be monopsony in labour market and monopoly in product market. In such cases, labour would be doubly exploited. The following diagram depicts the same.




The above diagram shows that labour is exploited to the extent of RQ. It could be split up as RE monopolistic exploitation and EQ amount as monopolistic exploitation. This explains why labour is doubly exploited. According to Prof. Pigon and Prof. Joan Robinson perfect competition is an ideal situation. So, wage-rate determined under it would be just and fair. Any change in this ware-rate will result in the exploitation of labour.

However Prof. Chamberlin did not accept Prof. Pigou Robinson concept of exploitation of labour and has supplied his own concept of exploitation of labour. According to him all factors of production receive less than the value of their MPP under imperfect market under conditions of imperfect competition in the product market MRP is always less than price (AR).

If all factors are paid equal to the value of their marginal product then in that case total payment to all factors exceed total revenue of the firm. Therefore, it becomes impossible for a firm to pay all factors equal to their value of marginal product. He holds the view that labour would be exploited only when he is paid less than his marginal revenue product. Nevertheless exploitation of labour would be removed by creating conditions of perfect completion in product market. The government can take measures to remove imperfections from the product market. In case of monopolistic exploitation, it can be removed by raising the wage rate through the activities of trade unions and the government.

### 6.8.7 DIFFERENCES IN WAGES :

It is generally observed that all units of labour do not get same wage rate. Some get higher while others get lower. Why this happens? Why can't be there equal wage rate for all ? Answers to these questions we find in following factors.

(1) **Demand Conditions :-** Demand for labour is derived demand. So if demand for the product labour produces is greater, then demand for that kind of labour would also be greater. This raises its wage-rate as in the short run it is the demand for labour which plays dominant role in determining the wage rate. That is why wage rate of such labour is very high.

**(2)** **Non-monetary Factors :-** Certain jobs enjoy non-monetary benefits which tend to reduce wage rate. For example college teacher. He has to work only for 3 to 4 hours a day. Moreover he works comparatively in healthy and decent atmosphere. In sharp contrast to this a medical practioner will have to work round the clock. He has to work in unhealthy conditions and all the time in midst of deadly diseases. Naturally remuneration received by a doctor is always more than a college teacher. It is so doctor does not get non-monetary benefits like that of college teacher.

(3) **Imperfections In Labour Market :-** Imperfections like immobility of labour, cost of transporting, customs and traditions, social surroundings, climatic conditions, cost of settling down else where etc. help a unit of labour to move from low paid job to a high paid job.

(4) **Non-Competing Groups :-** There are certain trades which do not compete with each other. Their scale of pay is determined by different principles. This is due to differences in skills in these trades or professions. Therefore higher payment in one trade does not lead to the movement of a unit of labour from low paid trade to a high paid trade. Besides, it is not possible for a person to change his trade in short run due to high skill. For instance, an engineer can not become a doctor or lawyer in short run.

(5) **Risk and uncertainty :-** The higher the risk and uncertainty, the higher would be payment. In other words, risk and uncertainty involved determines the level of payment of labour.

(6) **Specificity of labour :**- If a Person does the same kind of job again and again, his mobility is restricted. He becomes expert in that kind of job. He can not be then transferred to any other job. Hence, this brings about the differences in wage-rate.

(7) **Customs And Traditions :-** Customs and traditions also play a role in fixing fees and remuneration in certain skilled professions like medicine and law. In these profession rates of remuneration are based on old established practice and traditions. So price of labour in these professions is not adjusted by competitive forces.

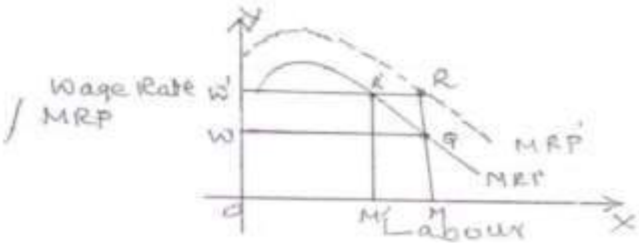
(8) **Artificial Restrictions :-** Certain occupations and professions put some restrictions on the entry in these professions on the pretex of maintaining high standard of those professions. For example, Medical Council of India, Bar Councils etc.

### 6.8.8 COLLECTIVE BARGAINING :

In the past, it was believed that trade unions or collective bargaining could not raise the wages of labour. They thought that trade unions were superfluous or ineffective in bettering workers lot. According to them, it was futile undertaking. That is why almost all the theories which attempted to explain what determines wage-rate neglected collective bargaining altogether. The subsistence wage theory, the Iron Law of Wages. The Residual claimant theory of wages and the marginal productivity theory. All these theories considered that in long run wage-rate would remain equal to the subsistence level. As per these theories, long run supply curve of labour (LRS) perfectly elastic at subsistence wage rate. It implies that any attempt by trade unions to raise wages will be useless. An increase in wage rate above subsistence wage-rate will lead to increase in population and working force. This will bring down the wage-rate to level of subsistence because supply of labour would exceed demand for labour. Secondly, supply curve of labour being perfectly elastic, a change in demand for labour would not alter the wage-rate. Even marginal productivity theory holds that there is no scope for collective bargaining. Nevertheless, modern thinking holds that collective bargaining plays a very important and positive role in bettering the conditions of working class.

## 6.8.9 COLLECTIVE BARGAINING & WAGE RATE

It is widely accepted that marginal productivity curve as the employer's demand curve for labour and wage-rate will be settled at the point where MRP will be equal to the marginal wage. It was argued further that any attempt by trade union to raise wage rate above MRP will lead to unemployment. This argument is rebutted by saying that when wage rate goes up, the marginal productivity schedule will shift upward. The higher wages make the labour force better off which increases their efficiency and it is this increased efficiency which raises their marginal productivity. So, an increase in wage-rate would not create unemployment. This is illustrated in the along side diagram.




At OW wage-rate OM amount of labour is employed. Now we suppose that wage rate raises to OW due to collecting bargaining by the train unions. If the MRP schedule remains the same, MM' amount employment is created. But, increased wage increases the efficiency of labour, the MRP schedule would shift to NRP' which would not create unemployment. The diagram makes clear that the OW wage-rate same amount of labour is employed. This brings us to the conclusion that a powerful trade union would prove successful of raising wage-rate without creating any amount of unemployment.

However, one point is to be noted that in case of collective bargaining when the wage rate is raised, the supply of labour might fall because supply curve of labour is backward sloping. It means that as the wage-rage goes up, workers contract their labour. Therefore, the higher wage-rage might create unemployment which would be due to backward sloping supply curve and not due to collective bargaining. According to Prof. Rothchild, "the imposition of higher wage-rate may lead initially to some unemployment but then produce such a change in the determinants of the wage-employment situation that the unemployment disappears and the higher wage rate becomes an equilibrium wage rage"

## 6.8 INTEREST

### 6.8.1 INTRODUCTION

Capital is a man made factor of production. That is why it is considered to be secondary factor of production. The term capital is defined as "all those instruments of production which are deliberately made by man to undertake production of goods and services. It is also called as "Produced means of Production". Capital is the only factor of production over which man has a complete control in production. Capital goods have a complete control in production. Capital goods have a long life and therefore the time of expenditure and expected receipts from them will have to be carefully predicted in making decision of creation of them. This makes the problem all the more difficult and complicated.

Interest is defined as reward paid to the capital for having used its services in production of goods and services. According to Alfred Marshall. "Interest is nothing but the price paid for the use of capital in the market." J.M. Keynes defines, "Interest as the premium which has to be offered to induce people to hold their wealth in some other than hoarding."

Distinction is always made between gross interest and net interest. The total income received by owner of capital is called gross interest. It includes payment of the loan and capital, payment to cover risks of loss, payment for the inconvenience of investment and the last payment for administrative work and worry involved in the process whereas net interest is a payment for the loan of capital when no rise no inconvenience and no administrative work is involved. It is a pure income to capital owner. Dr. Marshall holds, "Net interest is the reward for waiting while gross interest includes some insurance against risk and the cost of management."

Natural rate of interest refers to that rate of interest at which demand for saving and the supply of savings are in equilibrium whereas market rate of interest corresponds to this equilibrium rate of interest. If market rate of interest tends to be higher than natural rate of interest, supply of savings will exceed the demand for savings at that rate of interest. This will bring down market rate of interest. Likewise if market rate of interest tends to be lower than the natural rate of interest, demand for saving would exceed supply of savings taking market rate of interest upto the level of natural rate of interest. This shows that there are remote chances of market rate of interest differing from natural rate interest. However, price stability could guarantee identify between natural rate and the market rate of interest.

The time preference theory of interest was presented by many economists. Those who supply capital abstain from current consumption. That's why interest is regarded as a compensation for this abstinence. Since lending involves waiting on the part of people, interest should be paid to induce to wait and delay their consumption until the time investment becomes fruitful. Normally people prefer present consumption to future consumption. Secondly, future is always uncertain and thirdly, good in present command a technical superiority over goods in future, according to senior", Interest is the price paid for the use of capital and this price depends upon the forces of demand for and supply of capital:

### 6.8.2 THE CLASSICAL THEROY OF INTEREST

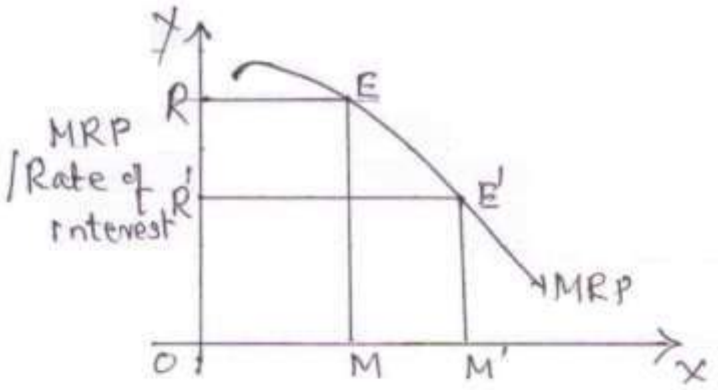
The classical economists held MRP of capital as the interest. Rate of interest is the rate of return over investment in physical capital. It is the role of waiting or time preference. In determination of interest is more important than anything else. But some economist held productivity of capital more important. Prof. Fisher and Prof. Bohm Bawerk held that the determination of rate of interest in terms of demand for and supply of investible funds. However, classical economists stressed the time preference and marginal productivity which are called the real factors of determination of rate of interest. That's why the classical theory is called as the real theory of rate of interest. Neo-classical economists developed a new theory called as the Loanable Funds or Neo-Classical theory of interest. According to them monetary as well as non-monetary factors determine the rate of interest. But J.M. Keynes holds phenomenon and rate of interest is determined by the forces of demand for money which he called as liquidity preference and the forces of supply of money. Interest is the price of parting with liquidity. All theories which attempt to explain the phenomenon of rate of interest either take demand side into consideration or supply side.

A theory of interest has to answer (1) why is interest paid? And (2) how is the rate of interest determined? Since capital is one of the factors of production, its price is also governed by its marginal productivity. But MRP of capital is very difficult to ascertain because capital has long life. It yields incomes for years. But future is uncertain. People prefer present to future. Because of number of uncertainties, entrepreneur will have to take into consideration, all those uncertainties of the future and estimate prospective yields from capital investment after deducting depreciation charges.

### 6.8.3 DEMAND FOR CAPITAL

Demand for capital comes from entrepreneurs to be used for production of goods and services. Since capital is productive, it earns series of income. Therefore, interest is to be paid to those who supply capital. The price of capital is governed by its MRP. The higher the MRP, the higher would be the rate of interest offered by entrepreneurs and vice-versa. As long as MRP of capital exceeds the rate of interest, demand for capital would continue and would come to an end at that point at which both rate become equal. A rational entrepreneur will go on demanding capital assets with the borrowed funds as long as expected net returns from the capital asset would be equal to the price he pays for the borrowed funds. In other words, it would be the rate of interest paid to the people for surrendering their liquidity. Investment in capital assets would be worth while till the rate of interest equates with the prospective rate of return from the capital asset and at this point of equilibrium investment in capital assets will come to an end. If the entrepreneur continues to investment beyond equilibrium point, he would incur losses; the rate of interest being higher than the prospective rate of return. Since MRP schedule slopes downwards, it would be profitable for an entrepreneur to purchase more units of capital provided the rate of interest falls. Since rate of interest is expressed in terms of percentage, both marginal efficiency of capital and rate of interest schedules follow the same course. But they do not depend upon each other. They are independent and not interdependent classical economists held the view that investment demand is interest elastic.

MRP schedule of capital and rate of interest schedule slope downwards from left to right indicating thereby more will be invested if the rate of interest comes down and as more and more units of capital are demanded for investment, the return from each marginal unit of capital goes on falling. So more will be invested if the rate of interest falls and also MRP of capital declines as more and more units of capital are demanded for investment. The following diagram shows the MRP schedule of capital.




It falls from left to right. 'OR' is the market rate of interest. At this rate of interest OM amount of investment is undertaken. The curve MRP depicts the falling marginal net expectations as more and more investment is undertaken. Here one must note that rate of interest becomes equal to MRP of the capital. Now let us suppose that rate of interest falls from OR to $OR^1$. This will make further investment more profitable. Therefore $MM^1$ additional fresh investment is undertaken to equalise MRP with new rate of interest. It is therefore concluded that investment demand slopes downward from left to right with a change in rate of interest.

### 6.8.4 SUPPLY OF CAPITAL

Capital is productive and hence capital owner is required to pay some income to make it available for producing goods and services. To make people to surrender their savings or investible funds, they must be offered something and that is rate of interest. The suppliers of capital prefer present consumption to future consumption. When they lend their investible funds, they would have to postpone their present consumption of goods and services. This involves a sacrifice on the part of lenders. Interest is the reward for this sacrifice or waiting. The investible funds come from general public. They supply these funds out of their savings. Therefore, savings schedule slopes upward from left to right indicating the direct relationship between rate of interest and supply of funds. Thus according to the classicists savings is interest elastic or s = f (r). It means that it is a function of rate of interest.

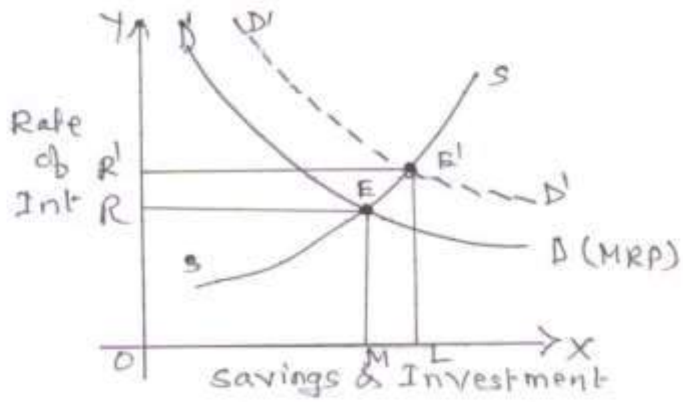
## 6.8.5 DETERMINATION OF EQUILIBRIUM RATE OF INTEREST

The classical economists held that interaction between demand for and supply of investible funds determines the equilibrium rate of interest. According to classical economists savings is interest elastic. If the demand for investible funds exceeds supply of investible funds, the rate of interest would shoot up and vice – versa.

The classical economists held to view that the rate of interest is equilibrium force between demand for and supply of investible funds. This equilibrium rate of interest demand for savings for investment. If saving exceeds demand for it, the rate of interest would fall. This would result into a fall in rate of interest and reduction in supply of savings. So, the rate of interest is the mechanism which brings two into equality. The classical economists always held.

(1) S = f (r)  (2) I = f (r)

where, 'S' stands for savings and 'I' stands for investment, 'r' for rate of interest & 'f' for function. So, Savings would be equal to investment always. Aggregate savings and investment are treated to be flows; and secondly, it is the rate of interest that brings about equality between the two. The following diagram depicts determination of rate of interest. The diagram shows DD demand curve is nothing but MRP schedule of capital.




'DD' demand schedule cuts supply schedule at 'E' point at 'OM' size (MRP) of investment. Thus OR is the equilibrium rate of interest. If any change either in demand for or supply of investible funds takes place, a new equilibrium rate of interest would be established. Thus according to classical economists rate of interest is determined by the interaction between demand for and supply of investible funds.

### 6.8.6 ASSUMPTIONS OF THE THEORY

1) Existence of full employment of natural resources.
2) Government policy of laissez-faire.
3) Long Run operation.
4) Existence of perfect competition
5) Savings and investment are the function of rate Interest S = f (r), I = f (r)
6) Accepting the marginal productivity theory as the base and rate of interest as a mechanism which brings savings and investment into equality. The classical theory is also called as real theory of rate of interest because it is based on real factors like capital and abstinence form consumption neglecting totally monetary factors.

### 6.8.7 LIMITATIONS OF THE THEORY

1) **Full Employment:** The classical theory of rate of interest is based on full employment. i.e. all natural resources are fully employed. But there can be cyclical, frictional, voluntary or involuntary unemployment in the economy. So, assumption is unrealistic.
2) **Savings is not interest elastic:** The classicists held that savings is the function of rate of interest. But this is not correct. Saving is basically income elastic and then interest elastic. It means that savings depends upon the level of national income which classicists failed to recongnise.
3) **Investment is not interest elastic:** Though the classical economists held investment also function of rate of Interest but it is not so. Investment is primarily function of marginal efficiency of capital or prospective rate of return over cost. Rate of interest on one side and marginal efficiency of capital on the other determines the volume of investment in the economy. But classical economists failed to consider this fact.
4) **Monetary Forces Neglected:** Another drawback of the theory is that they totally neglected monetary forces such as bank money, hoardings etc. these factors equally influence rate of interest. The classicist emphasized only real forces.
5) **Rate of Interest Is A Weak Mechanism:** The Classical economists held the view that the equality between savings and investments is brought through rate of interest. It is so because according to them both are interest elastic. But there are many other forces which are equally important in bringing about equality between the two.

Whatever may be the drawbacks of the classical theory, it can not be discarded because it is based on real factors such as productivity, time preference, waiting, sacrifice etc. Therefore, it is termed as real theory of rate of interest.

### 6.9.8 THE LOANABLE FUNDS THEROY OF RATE OF INTEREST

This theory of interest associated with the name of Neo-classical economists like Wicksell, Marshall Robertson etc. This theory holds that rate of interest is determined by the interaction between the demand for and supply of loanable funds. Not only real factors but monetary factors also like bank money hoardings, disinvestment etc. determine the equilibrium rate of interest. So, the loanable funds theory takes much more broader view of demand for as well as supply of loanable funds.

### 6.9.9 SUPPLY OF LOANABLE FUNDS

Funds for investment come from four different sources which are as follows :

1) **Savings (S) :** Savings of general public as well as of institutions forms the major source of supply of funds. It is interest elastic. The higher the rate of interest, the greater would be volume of savings and vice-versa. Savings is defined as an excess of income over consumption expenditure. It depends upon the level of income and the prevailing rate of interest. Besides, industrial houses accumulates savings out of undistributed profits and reserved funds. Since savings is interest elastic, saving function slopes upward from left to right.
2) **Dis-hoarding (DH):** Hoardings means idle cash balances or money kept out of circulation. If the rate of interest goes up, people dishoards their hoardings and make funds available for investment. It is also interest elastic and therefore dishoarding curve also slopes upward.
3) **Bank Money (BM):** The credit created by the banking system forms the another source of loanable funds. The expansion or contraction of credit creation increases or decreases the supply of funds for investment. The BM function also slopes upward.
4) **Dis-investment (DI):** Investments which do not remain attractive are liquidated and funds are made available for fresh investment. Old investment is liquidated because rate of return over cost is less than the current rate of interest. That is why old investment is liquidated and funds are made available for new investment. So, the supply of funds comes from savings, dishoardings, bank money, and dis-investment.

Thus, SL = S + DH + BN + DI

6.9.10 DEMAND FOR LOANABLE FUNDS

The demand for loanable funds come from investment, consumption and hoardings.

1) **Investment Demand (I):** Demand for funds mainly come from investors. The businessmen borrow funds for the purpose of investment. It depends upon the rate of interest. So long as the rate of profitability is higher than the current rate of interest, funds will be demanded for investment. The moment the rate of profitability comes down to the level of current ate of interest, further demand for funds would come to an end. The higher the rate of interest, the lower would be the demand for funds for investment and vice-versa.

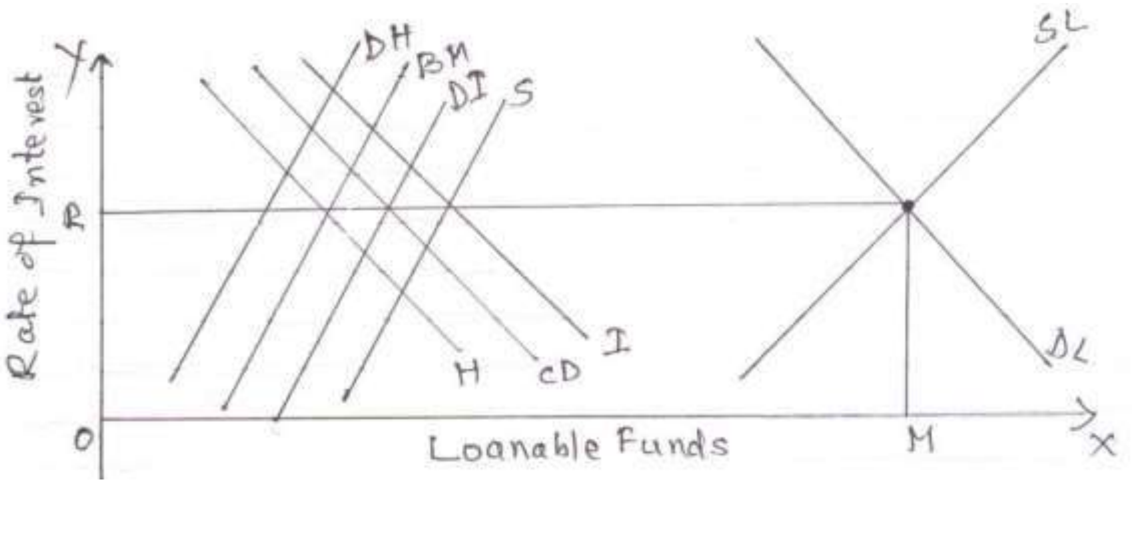
2) **Consumption Demand (CD):** For buying durable goods such as vehicles, houses, air-conditioners, refrigerators etc. people demand funds. They do so because their current income may not be sufficient to buy these goods. Demand for funds for this purpose is also interest elastic. That is why CD function slopes downwards from left to right.

**3) Hoardings (H):** When people decide to maintain high liquidity when rate of interest is very low, they demand funds simply for hoardings. In other words they keep funds idle without making any investment. But at high rate of interest they dishoard it. So the rate of interest and demand for funds are inversely related.

Thus total demand for funds (DL) = I + CD + H

**6.9.11 DETERMINITATION RATE OF INTEREST**

The equilibrium rate of interest is determined by the equality between the total demand for and supply of funds. This equality is reached at the point of intersection between total supply of funds and total demand for funds. Thus SL and DL curves intersect at each other at 'E' point at which equilibrium rate of interest is determined as OR and funds demanded supplied are OM. This implies that any other rate of interest will bring disequilibrium between the SL and DL. The following diagram depicts the equilibrium rate of interest.



**LIMITATIONS**

1) No clarity about the concept of hoardings.
2) The theory is indeterminate, in the sense that what determines what is not made clear.
3) National Income never remains constant. It always fluctuates which the theorists failed to recognize/
4) The assumption of full employment is not true.
5) Saving-Investment are not only interest elastic. They depend upon income and marginal efficiency of capital.
6) The theory is synthesis of the real theory and liquidity preference theory.
7) It is also states to be static whereas our world is dynamic. We can not solve the problems of dynamic world with static tools.

## 6.10 PROFITS

### 6.10.1 INTRODUCTION

Profit is regarded as the reward for entrepreneur. An entrepreneur means undertaker; one who undertakes the task of producing goods and services. He hires the services of factors of production. He also co-ordinates their services to complete the process of production. In the past, the owner of a business was considered entrepreneur. But in modern times business enterprises have not remained one man enterprise. Therefore, it has become more difficult to conceive the proper and clear cut meaning of the term entrepreneur.

There is a controversy over the meaning and functions of entrepreneur. Entrepreneurial work is regarded as special type of labour. His job is to hire, combine and co-ordinate the factors of production. In order to complete the process of production. All are expected to lead to maximum profit. One point to be noted that all other factors are hired but entrepreneur can not be hired. The entrepreneur is paid profit as his reward. However, it is considered as non-contractual income. It is the left over income. So, profit can be positive as well as negative. But in case of other factors, their rewards would always be positive. Net profits are calculated after having deducted imputed values of the land and capital owned by the entrepreneur himself. He must also deduct the value of his services rendered to the production. There is also a difference between profit and profits. Profits are those which an entrepreneur hopes to earn in near future while profit is one which already earned.

### 6.10.2 GROSS PROFIT & NET PROFIT

Gross profit refers to the total income received by an entrepreneur after having deducted total explicit cost from total earning. Total explicit cost includes all the money expenditure incurred by a business man to produce a commodity or a service payment made to outside parties whereas Net profit or pure profit refers to the total revenue minus total cost inclusive of implicit cost. Gross profit includes, wages, rent and interest and this imputed value while net profit is a left over income after having made all contractual and non-contractual payments. it is quite possible, therefore that net profit may be either positive or negative. It would be positive when total revenue exceeds total costs including implicit costs. It would be negative when total cost exceed total revenue. If all the factors of production are paid equal to their MRPs, then that case, there would not be any net profit. Except perfect competition, there would be always left over income which goes to entrepreneur.

### 6.10.3 NORMAL PROFIT

Normal profit can be defined as the minimum profits which entrepreneur must earn to make him remain or continue in the same business. In other words, it is the transfer earnings of the entrepreneur. If he fails to get the minimum expected profit in the existing business, he would transfer his services to some other lucrative business. Normal profit is treated as a part of total cost. It is regarded as the return for entrepreneur for managing and bearing uncertainly of the business. While abnormal profit or excess profit refers to any surplus over and above normal profit. It is residue surplus which can be referred as rent of ability. Earning of excess profit is not necessary for continuance of the business.

### 6.10.4 FUNCTIONS OF ENTREPRENEUR

Profit is closely related with functions of entrepreneur. It is the entrepreneur who hires the services of other factors of production and pays them fixed contractual remuneration to them but entrepreneur himself is not employed by any one and is not paid a fixed salary. Entrepreneurship includes all those productive functions which are not rewarded in the form of rent, wages and interest. It is a residual income which he earns for performing special functions.

1) **ORIGINATING :** The entrepreneur introduces new products, new techniques or processes of production and explores the new opportunities of earning profits.

2) **RISK BEARING:** It is the entrepreneur who shoulders the entire risk of the business. He bears all risk because he is the originator and executor of the business.

3) **CO-ORDINATING:** It is he who hires and employs the services of other factors of production. He combines and co-ordinates the work of other factors of production so that production is made possible and goods and services are produced.

### 6.10.5 PROFITS & UNCERTAINTY

Before production is undertaken, an entrepreneur has to make various decisions on certain figures of cost and revenue. If his calculations regarding costs and revenue come true, he will certainly make profits. But these calculations go wrong, he will incur losses and these calculations vary from entrepreneur to entrepreneur. Therefore, these estimates regarding costs and revenue are subjective. But if these calculations are not known then in that case everything becomes uncertain. Therefore, whether he would earn profits or incur losses, all depends upon his expectations, calculations and guesses. And if these all come true, he will definitely make profits but unfortunately if these go wrong, he would incur losses. So, there is a great amount of uncertainty in these calculations with uncertainty. That is the reason why profits are associated with uncertainty. However, one thing must be noted that if the world is static, there would be no uncertainty and so scope for losses. But things may not shape as we want them to be. That's why there is uncertainty which gives rise to risk in business. Dr. H.L. Ahuja holds, "Profits arise due to disequilibrium caused by the changes in demand and supply conditions."

### 6.10.6 RISK & UNCERTAINTY

As other factors of production namely land, labour and capital have their MRP schedules, in the same manner entrepreneur also has his MRP schedule. It means that he is also productive like all factors of production. The risks which entrepreneur shoulders can be insurable and non-insurable. This distinction is of great importance. There are number of risks and uncertainties that the entrepreneur is confronted with besides the risk of losing his money invested in the business. These risks take place partly due to his misjudging the market movements and partly due to natural uncertainties. The risks like fire, theft, death, earthquakes can be insured against. So over such risks entrepreneur is not to worry. He has to shoulder those risks which can not be insured against.

These risks are connected with his business decisions about what to produce? Where to produce? When to produce? Which technique to follow? Etc. predictions regarding demand conditions are very difficult. These predictions may come true or may go wrong. Therefore, it is impossible for any insurance company to ensure such risks and uncertainties. If an entrepreneur uses his own capital, land and his own labour he is entitled to rent, wages and interest. Such payments are called as imputed values.

### 6.10.7 PROFIT AS A DYNAMIC SURPLUS

J.B. Clarke developed this theory of profit. He holds that profits are a dynamic surplus. In a static economy where there are no changes in conditions of demand and supply, remuneration paid to the factors of production on the basis of their MRP would exhaust the total revenue and hence no profit would occur to the entrepreneur. Profit results when total revenue is in the excess of total cost of production.

In a competitive market, in the long run price equals average cost (AR = AC) and no profit. Profits arise due to disequilibrium caused by the changes in demand and supply conditions and therefore there would be no profit since both demand and supply forces balance each other. The size and composition of population, incomes, tastes and preferences, existence of substitutes, changes in government, economic and fiscal policies bring about change in demand conditions. Similarly, introduction of a new commodity or a new technique or a process of production or a new method of selling or a change in supply which cause disequilibrium leading to profit. But in a static economy demand and supply are taken to be constant hence cost and price do not change and so no profit.

But in reality, everything is subject to changes or uncertainty. Nothing can be anticipated before hand. A dynamic economy is one in which demand and supply conditions undergo change constantly. These changes lead to profit or losses. Thus, disequilibrium between demand and supply causes profit or losses. Like internal changes, there are external changes which affect entire manufacturing units in the economy. These changes are, war, inflation and depression, change in monetary and fiscal policies, change in the technique of production, change in spending habits of the people and lastly statutory changes. These changes either bring changes in demand or supply conditions resulting into disequilibrium leading to either profits or losses.

## 6.10.8 LIMITATION OF THE THEORY

1) According to F.H. Knight, dynamic surplus theory does not make any difference between a foreseen changes and unforeseen changes. Certain changes can be predicted in advance. The moment this aspect we take into account, the entire clarkian thesis based upon the effects of changes falls flat on the ground. Thus, it is not change as such but uncertainty about this change that gives rise to profit. Uncertainty is the permanent feature of economic system.
2) The theory ignores completely the role of uncertainty in making profit. He also rejects the view that profits are nothing but the reward for shouldering risk of the business. Risk and uncertainty exist in entrepreneurial function. The one can not exist without other. Therefore, the theory is one sided.
3) Clark's concept of profit as a dynamic surplus is worked out in the context of static background and is too mechanical. Nothing is static in the world. Hence, the role of uncertainty creeps into it. Thus Clark overlooks the active role played by uncertainty and expectations in shaping the course of things. In the words of professors Stonier and Hange "In an economy where nothing changes, there can be no profits." There is no uncertainty about the future, so there are not risks and no profits."

## 6.10.9 INNOVATION THEORY OF PROFIT

It was Joseph Schumpeter who developed the innovation theory of profit. Innovation is an important factor responsible for the occurrence of profit to the entrepreneur. According to Schumpeter the main function of the entrepreneur is to introduce innovations in the economy and profits are reward for performing this function. Schumpeter held that innovations are not only the cause of profits but also the root cause of economic fluctuation. He explained the phenomenon of trade cycles in terms of innovation and the behavior of entrepreneurs. The term innovation is not the same as invention. Innovation has wider meaning. Any new measure or technique or policy introduced by an entrepreneur to reduce the costs of production or to increase the demand for his product is an innovation. So, innovations can be put into two categories namely cost saving or demand boosting. In either case profit is made.

Cost saving innovations do change the production function. These innovations are introduction of a new machinery, new and cheaper technique or process of production, exploitation of a new source of raw materials and better method of organizing the business, etc. The second category innovations are the measures which increase the demand for the product and these measures alter the utility function. They include introduction of new product, a new design of product, a new and superior method of advertisement or discovery of new market etc. If the introduction of an innovation proves worthwhile or successful in reducing either cost or raising demand for the product, it would generate profit. One who introduces innovation first will reap the maximum profit. But later on others will imitate the pioneer entrepreneur and the profit margin will start declining due to keen competition from other entrepreneurs.

Introduction of innovation which gives rise to profits are temporary. Profits are earned till the effects of innovation remain. Once that innovation is completely exploited, the cost of production starts rising and profits come to zero. Economic activity comes to an end. But if any other entrepreneur introduces a new innovation at the time when the desirable effects of previous innovation are dying out, he would be monopolist for new innovation is confined to him. So, he makes profits. Others may try to imitate him but take some time and during this period the pioneer entrepreneur makes profits. When others succeed to imitate him, excess profits would be competed out by imitators until another innovation emergences. It must be noted that innovations appear in cluster i.e. one after the other and take economic system to its climax. It is so because in a competitive and progressive economy true and rational entrepreneurs are always after the new method of production or technique or any device that reduces the cost of production. Therefore as long as innovations exist, profits continue to emerge out of them.

**LIMITATIONS OF THE THEORY**

1) Role of uncertainty is not analysed. He gave all importance to innovation without considering the role of risk and uncertainty.

2) Joseph Schumpeter denies the much accepted contention that the entrepreneur is the risk bearer. He says "The entrepreneur is never risk bearer. The one who gives credit comes to grief if the undertakings fails." But this is not a correct view. Ultimately the entire responsibility of business lies on one who makes all the production decisions. These decisions may go wrong and hence one who makes wrong decisions will have to face losses. Even introduction of innovation may be wrong time but it may prove successful who knows? This means uncertainty and risk of making such decisions.

## 6.10.10. PROFIT AS A REWARD FOR RISK BEARING

This theory is developed by Hawley. According to him risk bearing is the main function of the entrepreneur and this results into profit. Before undertaking any business, the entrepreneur expects to earn a certain mount of profit because the business involves some element of risk. The higher the risk, the greater would be the gain. If the gain is not a proportion to the risk, no entrepreneur would undertake that business. Therefore to start any business, the entrepreneur is required to be rewarded sufficiently. Thus risk bearing is an essential function of entrepreneur and therefore is the basis of profits.

### LIMITATIONS OF THE THEORY

1) Firstly profits arise because of the reduction of risk in the business by above and efficient entrepreneur and not by merely shouldering risk.
2) Secondly, it is not true to hold that every risk leads to profits. Some risks can be insured against whereas others can not. Risks of making production decisions can not be insured against. It is only these risks which are responsible for occurrence of profits.

In conclusion, we can add that the root cause of profits is innovation. Profits are the necessary incentives for entrepreneurs to undertake economic development of the country. Since innovations generate profits, profits are incentive to introduce innovations. So both are there as cause and consequences of each other. Both are required to take up economic system of the country to the level of full employment.

## Exercise

1. Explain the marginal productivity theory of distribution with special reference to marginal revenue productivity.
2. What are the conditions of equilibrium of an industry? What are the assumptions behind it and what are the limitations thereof.
3. Explain the Ricardian concept of “rent” and the assumptions on which it rests.
4. What is the modern theory of rent? How elasticity of supply of land affect it? Explain quasi-rent.
5. Distinguish between nominal wage and real wage. How wage is determined under competitive conditions.
6. Discuss the effect of collective bargaining on wage rate.
7. What is meant by ‘interest’? What determines the equilibrium rate of interest? Explain with diagram.
8. Explain the theory of profit as a reward for risk bearing. What are the limitations of the theory?

# MACROECONOMICS

**INRODUCTION**

The weightage of utility arising out of consumption is recorded through money. Such utility arising out of consumption is referable to commodity which means goods as well as services. The immediate effect of demand and supply of a commodity is recordable as price and ultimate effect is the value. The aspect of pricing had been our subject matter of microeconomics. We are concerned with valuation which goes beyond pricing and analysis the forces as well as the factors that go to determine the ultimate effect, determining value.

In pricing, we are concerned with behaviuor of demand schedule and supply schedule under different market conditions – perfect, imperfect and monopoly. In valuation, we have to take into account various other forces which are deeply laden in macroeconomics that means monetary polices, distribution of national income, price level and inflation, demographic patterns, changes in consumer behiviour, rate of saving and investment, parallel economy, etc., which lie within the domain of macroeconomics. That is how the study of macroeconomics assumes extreme importance in the context of valuation.

The goals of macroeconomic policy are:

1. A high and growing level of national output (i.e., of real GDP)
2. High employment with low unemployment
3. A stable or gently rising price level

**The Tools of Macroeconomic Policy**

Governments have certain instruments that they can use to affect macroeconomic activity. A *policy instrument* is an economic variable under the control of government that can affect one or more of the macroeconomic goals. That is, by changing monetary, fiscal, and other policies, governments can avoid the worst excesses of the business cycle and can increase the growth rate of potential output.

***Fiscal Policy.*** Begin with **fiscal policy,** which denotes the use of taxes and government expenditures. *Government expenditures* come in two distinct forms. First there are government purchases. These comprise spending on goods and services-purchases of tanks, construction of roads, salaries for judges, and so forth. In addition, there are government transfer payments, which boost the incomes of targeted groups such as the elderly *or* the unemployed. Government spending determines the relative size of the public and private sectors, that is, how much of our GDP is consumed collectively rather than privately. From a macroeconomic perspective, government expenditures also affect the overall level of spending in the economy and thereby influence the level of GDP.

The other part of fiscal policy, *taxation,* affects the overall economy in two ways. To begin with, taxes affect people's incomes. By leaving households with more *or* less disposable *or* spendable income, taxes tend to affect the amount people spend *on* goods and services as well as the amount of private saving. Private consumption and saving have important effects *on* output and investment in the short and long run.

In addition, taxes affect the prices of goods and factors of production and thereby affect incentives and behaviour. For example, the more heavily business profits are taxed; the more businesses are discouraged from investing in new capital goods. From 1962 until 1986, the United States employed all investment tax credit, which was a rebate to businesses that buy capital goods, as a way of stimulating investment and boosting economic growth. Many provisions of the tax code have an important effect *on* economic activity through their effect on the incentives to work and to save.

***Monetary Policy.*** The second major instrument of macroeconomic policy is monetary policy, which government conducts through the management of the nation's money, credit, and banking system. You may have read how *our* central bank, the Federal Reserve System, operates to regulate the money supply. But what exactly is the money supply? Money consists of the means of exchange *or* method of payment. Today, people use currency and checking accounts to pay their bills. By engaging in central-bank operations, the Federal Reserve can regulate the amount of money available to the economy.

How does such a minor thing as the money supply have such a large impact *on* macroeconomic activity? By changing the money supply, the Federal Reserve can influence many financial and economic variables, such as interest rates, stock prices, housing prices, and foreign exchange rates.

Restricting the money supply leads to higher interest rates and reduced investment, which, in turn, causes a decline in GDP and lower inflation. If the central bank is faced with a business downturn, it can increase the money supply and lower interest rates to stimulate economic activity.

The exact nature of monetary policy-the way in which the central bank controls the money supply and the relationships among money, output, and inflation-is one of the most fascinating, important and controversial areas of macroeconomics.

# UNIT – VII
## NATIONAL INCOME

### 7.1 CONCEPT OF NATIONAL INCOME

The total income of the nation is called "national income." The aggregate economic performance of the whole economy is measured by the national income data. In fact, national income data provide a summary statement of a country's aggregate economic activity.

In real terms, national income is the flow of goods and services produced in an economy in a particular period - a year.

Modern economy is a money economy. Thus, national income of the country is expressed in money terms. A National Sample Survey has, therefore, defined national income as: "money measures of the net aggregates of all commodities and services accruing to the inhabitants of a community during a specific period."

More elaborately, however, we may say that national Income is a money measure of value of net aggregate of goods and services becoming available annually to the nation as a result of the economic activities of the community at large, consisting of households or individuals, business firms, and social and political institutions.

An important point about national income is that it is always expressed with reference to a time interval. It is meaningless to speak of the income of an individual without mentioning the period over which it is earned, say per week, per month, or per year. Similarly, it is meaningless to talk of national income without mentioning the period over which it is generated. This is because national income is a flow and not a stock *i.e*., income is generated every year, and at different rates and, therefore, it is necessary to mention the period during which that income is generated. National income is usually measured and shown with reference to a year or as annual flow; it is, thus, an amount of total production per unit of time.

Like many other terms in common use, the concept "national income" has various connotations. For instance, national income is variously described. Sometimes it is known as "national income" at other times, "national product", or "national dividend." As a matter of fact, all these terms mean one and the same thing.

In national income accounting, thus, the concept of national income has been interpreted in three ways, as: (1) National Product, (2) National Dividend, (3) National Expenditure.

***National Product***

It consists of all the goods and services produced by the community and exchanged for money during a year. It does not include goods and services, which are not paid for, such as hobbies, housewives' services, charitable work, etc.

***National Dividend***

It consists of all the incomes, in cash and kind, accruing to the factors of production in the course of generating the national product. It represents the total of income flow which will exactly equal the value of the national product turned out by the community during the year.

***National Expenditure***

This represents the total spending or outlay of the community on the goods and services (of all types, capital as well as consumption) produced during a given year. Since income is the source of expenditure, national expenditure constitutes the disposal of national income, which is evidently equal to it in value or in other words, National Expenditure equals National Income.

Indeed, one man's income is another man's expenditure. When a person buys milk, it is his expenditure, but this very expenditure is the milkman's income. When the milkman spends part of this income in buying sugar, it becomes income for the sugar merchant and so on. In a sense, therefore, the sum of expenditure of all agents of production is equal to the total income received by the factors of production during that year. National Income can, therefore, be also defined as a sum of the expenditure on producer goods; consumer goods and services of agents of all production.

In fact, there is a fundamental equality between the total income of the community and its total expenditure, as one's expenditure becomes another's income in the economy. Hence, there is a large circular flow established in which each expenditure, creates an income, which in its turn is spent and creates other incomes. Therefore, this total national income will be equal to the total national expenditure.

Briefly, thus, the identity of the three factors of the flow of national income may be expressed as follows:

National Expenditure = National Product = National Income or Dividend

When we analyse, the above three concepts, we find that national income is nothing but “the total flow of wealth produced, distributed and consumed." National income is not a stock but it is a flow. It is not that the income is first earned and then gradually spent or distributed, or alternatively, it is not that the expenditure first takes place and then an income is earned. As a matter of fact, the process of income creation and income distribution goes on at one and the same time.

There are, thus, three alternative definitions of national income. The first definition is that it is the money value of goods and services produced by agents of production during the course of a year. We might call this "total production approach.”

The second definition is that it is the sum of incomes of agents of production, profits of public enterprises, income from government companies. This we might describe as "income approach."

The third definition is that national income is the sum of total expenditure of agents of production. We might call it "Total expenditure approach.”

Corresponding to these approaches, we observe that national income has been defined in three ways in the publications of the United Nations:

*(a)* "Net National Product" as the aggregate of the net value added in all branches of economic activity during a specified period, together with the net income from abroad.

*(b)* "Sum of the distributive shares" as the aggregate of income accrued to the factors of production in a specific period, these payments taking the shape of wages, profits, interest, rent etc.

*(c)* "Net national expenditure" as the sum of expenditure on final, consumption of goods and services, plus domestic and foreign investment.

Incidentally, Keynes has suggested three approaches to national income, which are more suitable and practicable in the microanalysis of income and employinent, as follows:

1. Income-expenditure approach: in which total expenditure on consumption and investment goods constitute total income.
2. Factor-income approach: in which national income is measured as the aggregate of incomes received by all the factors of production.

   Keynes wrote: Y = F + Ep where, Y stands for national income, F stands for payments received by land, labour and capital owners, and Ep refers to entrepreneurial profits.
3. Sales proceeds minus cost approach: in which Keynes considered that national income is based on aggregate sales minus cost.

In fact, Keynesian analysis has revolutionized thinking of the national income analysis. Prior to Keynes's General Theory, national income data were not collected officially from the economic analysis point of view. Keynes developed a theory which showed how consumption and investment expenditure can affect the national income flow. From the Keynesian analysis, modern concepts of national income has been evolved which are more dynamic in content.

Modern economists consider national income as a flow in three forms: income, output and expenditure. When goods are produced by the firms, factors of production comprising households are paid income, these income receipts are spent by the household sector on consumption and their savings are mobilised by the producers for investment spending. Likewise, a circular flow is constituted between income and expenditure. Obviously, income, output, and expenditure flows are always equal per unit of time. There is, thus, a triple identity:

Output = Income = Expenditure

## 7.2 Concepts Associated with National Income Total

### 7.2.1 Gross National Product (GNP)

In calculating national income, we add up all the goods and services produced in a country. Such a total represents the gross value of final products turned out by the whole economy in a year, which is technically called Gross National Product. The word "gross" indicates the inclusion of the provision for the consumption of capital assets, *i.e.,* depreciation or replacement allowances.

GNP, thus, may be defined as the aggregate market value of all final goods and services produced during a given year. The concept of final goods and services stands for finished goods and services, ready for consumption of households and firms, and exclude raw materials, semi-finished goods and such other intermediary products. More specifically, all sales to households, business investment expenditures, and all government expenditures are treated as final products: But, intermediary goods purchased by business firms are obviously regarded as final goods. For example, when a textile mill purchases a machine or showroom, it is regarded as final goods, but when it buys cotton, it is not regarded as final goods. This is to avoid double counting because when cotton is transformed into cloth, its value will be included in the price of cloth.

In an open economy (an economy subject to international trade), GNP may be obtained by adding up:

1. The value of all consumption goods, which are currently produced.
2. The value of all capital goods produced which is defined as Gross Investment. Gross investment, in the real sense, here implies the increase in inventories plus gross products of buildings and equipments. It, thus, includes the provision for the consumption of capital assets, i.e. depreciation, or replacement allowances.
3. The value of government services which are measured in terms of governmental expenditure on various goods and services for rendering certain services to the benefit of the entire community.
4. The value of net products, viz., the difference between total exports and total imports of the nation. This value may be positive or negative.

5. The net amount earned abroad. This represents the difference between the income received by the nationals from abroad on their foreign investment, minus the income paid by them abroad on the foreigner's investment.

GNP at market price, thus, represents:

$$GNP = C + I + G + (X - M) + (R - P),$$

Where,

C stands for consumption goods,

I stands for capital goods/or gross investment,

G stands for government services,

X stands for exports,

M stands for imports,

R stands for income receipts from abroad, and

P stands for income paid abroad.

In a closed isolated economy, however, GNP = C + I + G.

GNP is the basic social accounting measure of the total output. It represents the final products, ready for consumption, valued at current market prices.

### 7.2.2 Gross Domestic Product (GDP)

When we take the sum total of values of output of goods and services in the country, without adding net factor incomes received from abroad, the figure so obtained is called Gross Domestic Product (GDP).

$$GDP = C + I + G + (X - M).$$

This is measured at market prices.

A measurement of GNP has been illustrated in the **Table 1** below.

| Item | Value of Current Market Price (Rs. Crores) |
|---|---|
| Consumption (C) | 654 |
| Investment (I) | 334 |
| Government Purchases (G) | 123 |
| Net Exports (X – M) | + 15 |
| Net Income from the rest of world (R – P) | + 2 |
| Total | 1128 |

**Table 1 : Final Output (GNP)**

In measuring GNP, each finished product is multiplied by its price. Thus, the relative importance of particular good is expressed by its relative price. Further, with changes in prices the GNP also changes. During inflation, thus GNP appreciates simply on account of rising prices. To know the real GNP, therefore, we must deflate a given GNP total from the market price to the constant price.

GDP at factor cost is obtained as follows:
GDP at market price + (S – T),

Where,

S = Government subsidies, and
T = Indirect taxes.

GNP represents the measure of the economic output in an economic system. The final output included in the GNP is composed of the following uses:

1. Consumption,
2. Investment,
3. Government spendings, and
4. Net exports.

As Schultze points out, all output flows to one of these four uses.

The consumption expenditure component of national product constitutes the expenditure on durable goods, perishable goods, and services which are marketed during the year.

The investment component implies that part of the current product which is not consumed but used for adding further or replacing the real capital assets. It refers to gross investment. Gross investment minus depreciation (for replacement requirement) is equal to net investment.

Schultze lists the following main categories of investment in the GNP accounts:

1. Fixed investment, relating to the purchase of durable capital goods by firms.
2. Inventory investment, representing that part of output which is absorbed by firms as an increase in their stocks of finished goods, intermediary products and raw materials.
3. Residential building constructions for households. Here only new buildings are to be accounted for.

Full employment level of GNP is the potential GNP, Potential GNP is, thus, the value of final goods and services which a country can produce by operating at a point of its production possibility frontier by fully exploiting its available resources and industrial capacities. Actual GNP is rarely equal to potential GNP. Thus, potential GNP minus actual GNP is the measure of the size of unemployment of excess capacity in the economy.

### 7.2.3 Net National Product (NNP)

It refers to the value of the net output of the economy during one year. NNP is obtained by deducting the value of depreciation or replacement allowance of the capital assets from the GNP. To put it symbolically :

NNP = GNP - D, Where, D = Depreciation allowances

This value is measured at current prices, while GNP is expressed at current market prices. Net National Product, in fact, is the value of total consumption plus the value of net investment of the community.

What is the difference between GNP and NNP? In our definition of Gross National Product, we have not made any allowance for depreciation, capital appreciation and obsolescence. Depreciation means wear and tear of machinery in the process of production. Machines used for production have to be replaced at some future time, as due to their constant use they become useless over time. In other words, fixed assets are not everlasting and must be constantly renewed to keep production running smoothly and steadily. Similarly, some machinery becomes out of date with the passage of time. This old type of machinery needs to be replaced by an up-to-date one, if competitive efficiency is to be maintained. Capital appreciation means an increase in the value of fixed assets like machinery, building, tools, etc. due to rise in their prices. It usually happens during the period of inflation. A rise in the value of fixed assets does not mean that there is any increase in national income, because the total quantity of fixed assets remains the same. Thus, when the amount of estimated depreciation and obsolescence, i.e., capital consumption, is subtracted from Gross National Product, we get Net National Product.

However, national income, in its technical sense, is obtained by deducting indirect taxes from the net product measured at current market prices. Such a figure is also called NNP at factor cost, as it represents payments made to the factors of production during the process of production.

### *7.2.4 National Income at Market Price and National Income at Factor Costs*

In the national income analysis, usually a distinction is made between national income at market price and national income at factor costs. National income at market price means the money value of goods and services produced. It is the price of the aggregate output and services at current market prices. This price also includes some element of taxes and subsidies. A simple example will illustrate this point.

Let us suppose that the price of a bottle of beer is Rs.6/-. In this case, the national income at market price is Rs.6/-. But there is some element of tax in the above price. Let us suppose, the tax is Rs.2/-. Then, the national income at factor cost is Rs.4/- because the factor of production which has contributed to the production of one bottle of beer will get only Rs.4/- and the balance of Rs.2/- will go to the government as tax.

Let us now analyse the implications of the elements of subsidy. Let us suppose the fair price of a kilogram of sugar is Rs.4/-, but its actual cost of production is Rs.5/-. The difference of Re.1/- between the actual cost of production (Rs.5/-) and the fair price shop price (Rs.4/-) is borne by the State. In this case, the national income at market price is Rs.4/-, but it is Rs.5/- at factor cost because the factors of production would receive Rs.5/- for the production of one kilogram of sugar.

| | | |
|---|---|---|
| Gross domestic product at factor cost | = | Income earned by the factor of production + Depreciation |
| Net Domestic Product at factor cost | = | Income earned by the factor of production - Depreciation + Taxes - Subsidy |

National Income at market price + National Income at factor cost + Taxes - Subsidies - Depreciation

We are now in a position to examine the interrelationship between the three definitions of national income given above. There is close relation between national income as a flow of goods, as a flow of expenditure, and as a flow of income. In fact, they are so interrelated that total production; total income and total expenditure are described as a circular flow of income activities. The firms hire the factors of production to produce goods and services. The factors of production create real income. The factors of production are paid out of this real income, in terms of money as a reward for their services. They, in turn, spend this income. Thus, income leads to expenditure, i.e., expenditure creates demand for goods.

This demand, in turn, leads to production. The flow is from production to income generation to expenditure, and from expenditure to production. National income is, therefore, the total flow of wealth produced, distributed and consumed by the economy as a whole during the course of a year. These three things – total production, total income and total expenditure – are really one and the same thing when reviewed from different angles. Each approach with suitable adjustment, will give exactly the same GNP or NNP.

### *7.2.5 Other related Concepts and Relationships*

1. **Personal Income**

   Personal income is the total money income received by individuals in the community. Personal income is the aggregate earned and unearned income. Undistributed profits of the corporations reduce the personal income of individuals to that extent. Thus, personal income (PI = NI - undistributed profits, (U). Again personal income includes transfer payments made by government as well as the private business sector to individuals.

   Thus, personal income (PI) = NNP + transfer payments (R)

   $\therefore$ PI = NI + R - U

2. **Disposable Personal Income**

   Disposable personal income is the sum of the consumption and saving of individuals.

   Thus, DI = C + S

Disposable personal income (DPI) rather than National Income is the determinant of consumption, because the consumption of a person depends on his take home pay.

Disposable income includes an unearned element (transfer payments) which is excluded in community's earned income estimates, i.e., national income. Disposable income is the total income, earned and unearned, of individuals minus direct taxes.

Thus, DPI or simply DI = PI - T*d* ,

where T*d* = direct personal taxes such as income tax, wealth tax, etc.

DPI is also symbolized as Y*d* by money economists.

$PI = Y_d = C + S$

Keynes, however, assumed that Td = 0.

$\therefore \quad Y = Y_d \qquad\qquad \therefore \quad Y = C + S$

3. **Personal Savings**

Personal savings refer to the difference between disposable personal income and personal consumption expenditure.
A bird's eyeview of the calculation of related concepts in national income data is presented in **Table 2.**

| | Rs. Crores |
|---|---|
| GNP | 500 |
| Capital Consumption allowance | - 50 |
| | --------------- |
| Net National Product (NNP) | 450 |
| Indirect Taxes | - 60 |
| Subsidies | 10 |
| | --------------- |
| National Income (NI) | 400 |
| Corporate Profits | - 70 |

| | | |
|---|---|---|
| Dividends | | 15 |
| Government Transfer payments and business transfer payments | | 25 |
| | | --------------- |
| Personal Income | | 370 |
| Personal direct taxes | - | 70 |
| | | --------------- |
| Disposable personal income (DPI) | | 300 |
| Personal Consumption expenditure | - | 275 |
| | | --------------- |
| Personal savings | | 25 |

**Table 2 : Relation of GNP, NI, Personal Income Saving (Imaginary Data)**

### *7.3 Methods of Estimating National Income*

In national income estimates, by definition, we have to count all those goods and services produced in the country and exchanged against money during a year. Thus, whatever is produced is either used for consumption or for saving. Thus, national output can be computed at any of the three levels, viz., production, distribution and expenditure. Accordingly, we have three methods of estimating national income: (i) the census of products method, (ii) the census of income method, and (iii) the expenditure method.

#### *7.3.1 The Census of Products Method or Output Method*

This method measures the output of the country. It is also called the inventory method and involves the assessment, through census, of the gross value of production of goods and services produced in different economic sectors by all the productive enterprises in the economy. (For instance, the producing sectors in India are agriculture, forestry, fisheries, mining, industries, transport, commerce and other services.)

To the aggregated value of total output, real income earned from abroad is added (i.e. add the net difference between the value of exports and imports). And indirect taxes like excise and customs duties, plus depreciation allowances are to be reduced from the total obtained. Thus, to this net difference of the income earned from the rest of the world, a symbolic expression for this method may be given as follows:

$$Y = (P - D) + (S - T) + (X - M) + (R - p)$$

Where,

| | | |
|---|---|---|
| Y | = | Total income of the nation, |
| P | = | Domestic output of all production sectors, |
| D | = | Depreciation allowance, |
| S | = | Subsidies, |
| T | = | Indirect taxes, |
| X | = | Exports |
| M | = | Imports |
| R | = | Receipt from abroad, and |
| *p* | = | Payments made abroad |

Mostly, this method is adopted in the calculation of national income. However, there are certain precautions against the danger of double counting, etc., which must be strictly avoided if a correct result is to be achieved.

The following precautions are necessary:

1. To avoid double counting, we must add only the final products. Raw materials and intermediate goods should not be included, as that would lead to double counting.
2. Goods for self-consumption by the producer should be excluded; they have not been marketed, so it is difficult to ascertain their true market value.
3. While evaluating the output, changes in the price levels between the years must be taken into account. It is usual to denote national income with reference to prices of a particular year.
4. Indirect taxes, included in prices, are to be deducted for getting the exact value of the products. Similarly, subsidies given by government to certain products should be added in evaluation of the product.
5. Add the value of exports or the income earned abroad and deduct the value of imports.

This method is widely used in the underdeveloped countries, but it is less reliable because the margin of error in this method is large. However, in India, this method is applied to agriculture, mining and manufacturers, including handicrafts. But the census of product method is not applied for the transport, commerce and communication sectors in India.

*Value Added vs. Final Goods Approach*

There are two approaches to avoid the possibility of double counting in the measurement of GNP:

(i) Final goods method, and
(ii) Value added method.

In the final goods method of estimating GNP, only final values of goods and services are computed, ignoring all intermediate transactions. Intermediate goods are involved in the process of producing final goods – the final flow of output purchased by consumers. Thus, the value of final output includes the value of intermediate products. Hence, to avoid double counting, only final values relating to final demand of the consumers should be reckoned.

For example, the price of bread incorporates the cost of wheat, flour etc. Wheat and flour are both intermediate products and are not treated as the final consumer's demand. Their values are paid up during the process of production. In the value of final product, bread, the values of these intermediate goods are hidden. Hence, a separate accounting of the values of intermediate goods, along with the accounting of the value of final product, would mean double counting. To avoid this, the computation of the value of final products only has been suggested.

Another method, however, is the "value added" method in which a summation of the increase in value (the value added), at each separate production stage, leading to output in final form, gives the value of GNP.

To avoid double counting of intermediate goods, one must carefully estimate the value added at each stage, of the production process. From the total value created at a given stage, we should thus subtract all the costs of materials and intermediate goods not produced in the stage.
Or, the value of inputs, at a given stage, should be deducted from the value of output. Even the value of inputs purchased from other firms or sectors should be subtracted. In short, GNP is obtained as the sum total of the values added by all the different stages of the production process till final output is reached in the hands of consumers to meet the final demand. The point may be clarified further with the help of an illustration as given in **Table 3**.

| | (1) Production Stages | (2) Firm | (3) Sales Receipts | (4) Cost of intermediate | (5) Value added (Net Income) (3) - (4) |
|---|---|---|---|---|---|
| 1. | Wheat | Farmer | 500 | 0 | 500 |
| 2. | Flour | Flour Mill | 700 | 500 | + 200 |
| 3. | Bread | Baker | 900 | 700 | + 200 |
| 4. | Trading | Merchant | 1000 | 900 | + 1000 |
| | | | | | ------------- |
| | | Total : | Sum of value added | | = 1000 |

**Table 3 : Value Added Method**

In **Table 3** we have assumed a much simplified method or model of an economy, producing only a single final product, bread. In satisfying the consumer final demand for bread, it is assumed that there are four productive stages. First, a farmer cultivates wheat and sells it at Rs.500/-. Thus, Rs.500/- is the value added to the economy's output. We assume that this wheat is purchased by the flour mill to grind into flour. The mill sells the flour to the baker and fetches Rs.700/-. So, its net income is Rs.700/- - Rs.500/- = Rs.200/-. Thus, in turning wheat into flour (that is, the creation of form utility), the value added is Rs.200/-. The baker bakes a quantity of bread out of the flour and sells it to the merchant for Rs.900/-. In the process, the value added is Rs.200/-. The merchant renders trading service of creating place and time utility, and thus sells the stock of bread to the final consumer at Rs.1,000/-. The net income of the merchant is Rs.100/- which is his profit for merchandise business, a "productive" activity. Thus, the value added is Rs.100/- in the economic system. Obviously, the sum total of value added at each stage of production, Rs.500/- + Rs.200/- + Rs.200/- + Rs.100/- = Rs.1,000/- is the final value.

Evidently, the value of that product is derived by summation of all the values added in the path of the productive process. To avoid double counting, either the value of the final output should be taken in the estimate of GNP or the sum of values added should be taken. Value added is the difference between value of output and input at each given stage of production. The final product method reckons the quantum of goods and services and the aggregate of their values (measured at market prices) at the end of the year, while the value added method measures the flow of output and takes the sum total of net values created at each production stage during the year.

Apparently, both the methods given the same results, because both relate to the same phenomenon, though each in a different manner. Some economists, however, prefer the value added method on the following counts:

(i) It provides a method to check up or tally the accuracy of GNP estimates.

(ii) It enables us to know the contribution of each productive sector to the creation of GNP. Thus, national income at industrial origin can be easily compiled from the value added approach. Again, it is also helpful in constructing the input-output table and trading inter-industry transactions.

***Circular Flow of Activity***

Incidentally, the economic system contains the flow of goods and services in the transactions between two economic sectors: households and firms. There is a circular flow of economic activity. Households buy the final goods and services produced by the firms. Thus, households' total expenditure becomes the income of the firms which is equal to the value of final output by the firms. The range of transactions which take place within the boundaries of firms – "the productive area" – are regarded as intermediate transactions or inter-industry relations. Values are created in the productive area. All net values added together determine the value of the final output, i.e., GNP. The final output flows from the productive area of firms to the consumption area of households. This point has been illustrated diagrammatically in **Figure 1**.

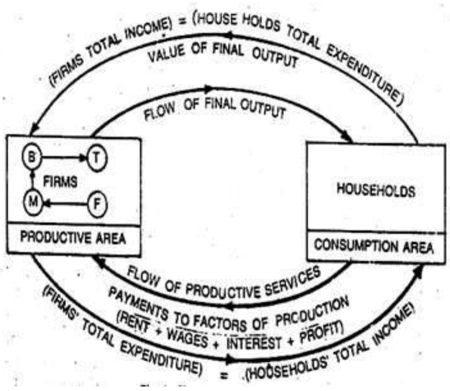



**Figure 1: Circular Flow of Activity**

In **Figure 1**, one can observe that intermediate transactions occur within the productive area or firms. It represents intermediate transactions from the farmer (F) to the flour mill (M), to the baker (B), to the trader or merchant (T) – all taking place within the boundaries of the firms. The firms sell their final output to consumers – the households. Thus, there is a flow of final goods from the productive area or firms to the consumption are of households. Households' total expenditure = the value of final output - the income of the firms' sector. Again, there is a flow of productive services of factors from households to firms. The factors are rewarded in the form of rent, wages, interest and profits. The total factor income = the aggregate value of factor services = the total expenditure of firms = the total income of households. In short, total expenditure of firms = total income of households and total expenditure of households = total income of firms = the value of final output. Thus, the final value of output is just the same as final expenditure. It follows thus:

Total output = Total expenditure

Again, total expenditure = Total income

$\therefore$ Total output = Total income

### *7.3.2 Census of Incomes Method*

In this method, income of all factors of production is added together. The data are compiled from books of accounts, reports, and published accounts. The following classification of incomes is considered as comprehensive:

(a) Wages and salaries,
(b) Supplemental labour income (social security, etc.),
(c) Earnings of self-employed or professional incomes,
(d) Dividends,
(e) Undistributed profits,
(f) Interest,
(g) Profit of state enterprises.

However, transfer payments like gift subsidies etc. are to be deducted from the total of factor incomes. Thus, National Income is equal to the factor incomes minus transfer payments.

This method is also called the Factor Cost Method. Thus, the national income of a country, at factor cost, is equivalent to the sum total of the disbursements of their (factors) income. The symbolic expression of this method is as follows:

$$Y = (w + r + i + n) + (X - M) + (R - P)$$

Where,

$w$ = wages

$r$ = rent

$I$ = interest

$n$ = profits

However, certain precautions are necessary while following this method.

1. All transfer payments (government and personal) like gifts, pension etc., are to be deducted. Similarly, gambling, being transfer activity, is to be excluded.
2. All unpaid services (like services of housewife) are to be excluded. Thus, only those services for which payments are made should be included.

3. Financial transactions and sales of old property (including land) are to be excluded, as they do not add anything to the real national income. Thus, all capital gains and losses which are related to wealth, but not to real income, should be excluded.
4. Direct tax revenue to the government should be subtracted from the total income as it is only a transfer of income. Or else, it should not be reckoned at all.
5. Similarly, government subsidies should be deducted.
6. Add the value of exports and deduct the value of imports.
7. Add undistributed profit of companies, income from government property, and profits from public enterprises.

In India, the National Income Committee used the income method for adding up the net income from trade, transport, public administration, professional and liberal arts, and domestic services. Since, under Indian conditions, due to lack of popularity of personal accounting practices, it is difficult to ascertain the personal income of individuals, the income method is not wholly practicable

### 7.3.3 The Expenditure or Outlay Method

National income on the expenditure side is equal to the value of consumption plus investment. In this method, we have to :

(i) estimate private and public expenditure on consumer goods and services.
(ii) add the value of investment in fixed capital and stocks, with due consideration for net positive or negative inventories, and
(iii) add the value of exports and deduct the value of imports.

This method is not as popular as the previous ones.

To express it in symbolic terms,

$$Y = (C + I + G) + (X - M) + (R - P)$$

Where,

C = Consumption expenditure,

I = Investment expenditure, and

G = Government purchases

The Bowley-Robertson Committee has suggested the adoption of the Census of Products Method for major sectors of India, and the Census of Income Method for some minor sectors, while the National Income Committee relied mainly upon the Census of Income Method. However, none of the above methods alone is perfect. Therefore, an integrated computation of them will give a wider perspective of the estimate.

The proess of calculation of national income (by using the above discussed three methods) has been illustrated in a summarized way, with hypothetical data of an imaginary economy, in **Table 4 (A, B and C)**.

| A. Income Method | | Rs. (Crores) | |
|---|---|---|---|
| Income: Wages, salaries, etc. | | | 1,000 |
| Profits: Private and Public operations | | | 500 |
| Rent | | | 200 |
| Interest | | | 100 |
| | | | ------------------- |
| Total domestic income : | | | 1,800 |
| Less: Stock appreciation | - | 250 | |
| Residual error | | - | 50 |
| Net property income from abroad | | 100 | |
| | | | ------------------- |
| FNP | | | 1,600 |
| Less: Capital consumption | - | 150 | |
| | | | ------------------- |
| National Income | | 1,450 | |
| | | | ------------------- |
| **B. Expenditure Method** | | **Rs. (Crores)** | |
| Consumer’s expenditure (C) | | | 1,100 |
| Public authorities’ current expenditure on goods/services (G) | | 600 | |
| Gross Capital formation (Investment) at home including increase in stocks (I) | | | 500 |
| | | | ------------------- |
| Total domestic expenditure at market prices | | 2,200 | |
| Plus: Exports and income from abroad | | | 600 |
| Minus: Imports and income paid abroad | | - | 200 |
| Less: Taxes in expenditure | | - | 1,000 |
| Plus: Subsidies | | | 50 |
| | | | ------------------- |
| GNP at factor cost | | | 1,600 |
| Less: Capital consumption | - | 150 | |
| | | | ------------------- |
| National Income | | 1,450 | |
| | | | ------------------- |

| C. | Output Method | Rs. (Crores) | |
|---|---|---|---|
| | Agriculture, Forestry and Fishing | 250 | |
| | Mining and quarrying | | 100 |
| | Manufacturing | | 200 |
| | Construction | | 100 |
| | Gas, electricity and water | 50 | |
| | Transport and communication | | 200 |
| | Distributive traders | | 300 |
| | Insurance, banking and finance | | 200 |
| | Public administration and defence | 150 | |
| | Other services | | 100 |
| | | | ------------------- |
| | Total domestic output | | 1,800 |
| Less: | Stock appreciation | - | 250 |
| | Residual error | - | 50 |
| | Net property income from abroad | 100 | |
| | | | ------------------- |
| | GNP at factor cost | | 1,600 |
| | Less: Capital consumption | - 150 | |
| | | | ------------------- |
| | National Income | 1,450 | |
| | | | ------------------- |

**Table 4 : Estimate of the National Income of Country X during a given year**

To be more realistic on this account, we have purposely assumed that the results in these three methods are not identical due to incomplete information. Thus, the expenditure statistics are taken as data. The difference between expenditure statistics and income and output statistics is regarded as a residual error in the above table.

## 7.4 Difficulties in National Income Estimate

While estimating national income statisticians and economists usually encounter the following sets of difficulties :

(i) conceptual and

(ii) statistical or practical

The conceptual problem relates to how and what is to be included and what is not in the measurement of national income. Logically, the concept of national income would imply that everything that is produced must be reckoned.

However, by definition, we consider only those things which are exchanged for money or carry some price. By convention, on the basis of the availability of information, certain guidelines have been laid down in the process of national income estimates.

A few of them are:

1. Farm products kept for self-consumption. These are to be included as national income and estimated by a guess and at the rate of market price of agricultural products that have been marketed.
   However, output of food from domestic poultry keepings or vegetables grown in the home or terrace gardens etc. are not included in national income, as no accurate estimate of their production is available.

2. Services of housewives. These are not to be included in national income as they have no price and no market for the services rendered for their own household work. But the value of the services of domestic servants are to be considered as national income. Obviously then, a person who marries his maidservant reduces the national income to that extent.

3. Unpaid services are not reckoned as national income.

4. Defence services, being indirectly productive must be included as national income. Their value will be equivalent to the defence expenditure incurred by the government.

There are statistical problems too. Great care is required to avoid double counting, otherwise there will be an exaggerated valuation of national output. Again, statistical data may not have perfect reliability when they are compiled from numerous sources. Skill and efficiency of the statistical staff and co-operation of people at large are also equally important in estimating national income.

In India, a special conceptual problem is posed by the existence of a large, unorganized and non-monetised subsistence sector where still barter system prevails for transacting goods. Here, a proper valuation of output is very difficult. A large part of India’s national income is, therefore, as guess work without much accuracy.

Further, rural folk in India have no specific employment. Their occupation is of divergent nature. A person is a farmer as well as a carpenter at one and the same time. So, it is very difficult to decide the structure of national income by industrial origin.

Further, in a country like India, statistical difficulties are still more severe. Some of these are:

1. Accurate and reliable data are not adequate, as far as output in the subsistence sector is not completely informed. Small-scale and cottage industries also do not report their targets. Indigenous bankers do not furnish reliable data and so on.
2. India, is a country with large regional diversities. Thus, different languages, customs, etc. also create a problem in computing the estimates.
3. People in India are indifferent to the National Income Committee's inquiries. They are non-co-operative also.
4. Statistical staff is also untrained and inefficient.

Therefore, national income estimates in our country are not very accurate nor are they adequate.

## 7.5 Method of Deflating National Income

Usually, national income estimates are computed at current market prices. To know the real changes, therefore, we have to deflate them. That is, convert the given national income figures at market prices into constant prices.

Deflation is done with the help of wholesale price index number or the cost of living index number. Usually, cost of living indices are used for deflating per capita income series.

The following formula may be used for the purpose:

$$R = \frac{P_0}{P_t} \times Y$$

Where,

$P_0$ = base year price index

$P_t$ = current year price index

$Y$ = national income, or GNP at current price for the current year

The following illustration clarifies the point:

**Example**: Deflate the following:

| | | | | | |
|---|---|---|---|---|---|
| Year | 1970 | 1971 | 1972 | 1973 | 1974 |
| National Income (Rs. '00 crores) | 250 | 280 | 300 | 350 | 360 |
| Wholesale price index | 100 | 120 | 150 | 160 | 180 |

**Solution**:

| *Year* | $\gamma$ | *P* | $R = \frac{P_0}{P_t} \times \gamma$ | | *National income at constant prices* |
|---|---|---|---|---|---|
| 1970 | 250 | 100 | $\frac{100}{100} \times 250$ | = | 250.00 |
| 1971 | 280 | 120 | $\frac{100}{120} \times 280$ | = | 233.00 |
| 1972 | 300 | 150 | $\frac{100}{150} \times 300$ | = | 200.00 |
| 1973 | 350 | 160 | $\frac{100}{160} \times 350$ | = | 218.75 |
| 1974 | 360 | 180 | $\frac{100}{180} \times 360$ | = | 200.00 |

## 7.6 Importance of National Income Data

Thus, national income data are a collection of facts or estimates of the total real income of a country expressed in terms of money. They provide a quantitative measurement of the country's economic activity during a defined period. They are the most important statistical measures of the economic activity of a nation and are very useful in analyzing current economic conditions. National income data furnish a comprehensive view of the country's economic functioning.

The national income statistics may be said to be the index numbers of the economic progress of a nation. A continuous series of annual estimates of national income would suggest the trend of economic growth of the nation and how rapidly it is taking place. National Income trend clearly reveals the basic changes in the country's economy in the past and suggests trends for the future.

Simon Kuznets says: "Since the end product of each country's economic system is an index of its producing power, national income estimates furnish a comparison of the productivity of nations, per capita income figures, especially when adjusted for differences in the purchasing power of money, appear to measure the nation's economic welfare."

National income statistics contain data on consumption and investment expenditure. Hence, for studying changes in the disparities, the standard of living can easily be compared with the help of such statistics. Fiscal authorities can use them to study the incidence of taxation as well as for projecting the tax yields. For the purpose of economic planning, national income data furnish information about the aggregate and per capita income, the rate of capital formation and industrial sectional breakdown and the relative contribution of each sector.

## 7.7 National Income Accounts

National income accounts are the systematic records and presentation of national income statistics. Thus, national income accounting, also known as "economic accounting" or "social accounting," transcends the mere compilation and publication of statistical information. Its purpose is to present data in such a form that interrelations among items are most easily discerned from the structure of statements.

Thus, national income accounts and statistics are two related but different things. Statistics are a collection of facts which are useful in themselves but which do not depend uniquely on the values expressed in other statistical collections. An accounting statements, on the other hand, is an integral grouping of statistical series, each of which is functionally connected to all others. National income accounts or social accounting means a systematic arrangement of data relating to the economic activity of the country.

A social accounting framework is useful for economists a well as policy-makers, as it represents the major economic flows and statistical relationships among the various sectors of the economic system. It is of particular interest and significance to the policy-makers because by studying national income series over a period of time, it becomes possible to forecast the trends of the economy more accurately. In many countries, annual economic planning is in the form of national budgets which are in fact nothing but forecasts of social accounts.

## 7.8 Social Accounting Method

Recently, with the development of social accounting, national income is also being measured by the social accounting method. In the social accounts, transactions among various sectors such as firms, households, governments, etc. are recorded and their interrelationships are traced. From the total value of these transactions recorded in matrix form, the national income value is known.

The social accounting framework is useful for economists as well as for policy-makers, because it represents the major economic flows and statistical relationships among the various sectors of the economic system. It is of particular interest and significance to the policy-makers because by studying the national income series over a period of time, it becomes possible to forecast the trends of economy more accurately. In many countries annual economic planning is in the form of national budgets which are, in fact, nothing but forecasts of social accounts for the following years.

**Sectors for Social Accounts**

In social accounting, the economy as a whole is divided into certain parts called "sectors." "Sector" is a group of individuals or institutions having common interrelated economic transactions. Thus, sectors are usually delineated in such a manner that economic entities whose functions are similar are contained in one group. Thus, sectors are distinguished on a functional basis and not on any institutional criterion.

Conventionally, under the scheme of social accounting, the economy is divided into the following sectors:

(i) Firms,
(ii) Households,
(iii) Government,
(iv) Rest of the world, and
(v) Capital sector.

"Firms" are producing entities of the economy. They undertake productive activities. Thus, they are all organizations which employ the factors of production to produce goods and services.

"Households" are consuming entities and represent the factors of production, who receive payments for services rendered to firms. Households consume the goods and services that are produced by the firms.

Thus, firms make payments to households for their services. Households spend money income so received, again on the goods/services produced by the firms. There is, thus, a circular flow of money between these two groups.

"The Government sector" refers to the economic transactions of public bodies at all levels, center, state and local. In their work concerning social accounting, Edey and Peacock have defined government as a "collective person" that purchases goods and services from firms. These purchases may be financed through taxation, public borrowings or any other fiscal means. The main function of the government is to provide social goods like defence, public health, education, etc. means to satisfy the collective wants of society. However, public enterprises like post offices and railways are separated from the government sector and included as "Firms."

“The rest of the world sector” refers to saving and investment activities. It includes the transactions of banks, insurance corporations, financial houses, and other agencies of the money market. These are not included as firms. These agencies merely provide financial assistance to the firms’ activities.

**The System of Social Accounts**

Social accounting is based on double-entry book-keeping principles. Like debit and credit sides, each sector account contains a balancing item (credit) of one sector is the allocation item (debit) of the other related sector.

A Firm’s account usually contains the following items:

**Debit side**

1. Payments to factors of production – households in the form of wages, interest, rent, dividend, profits.
2. Imputed cost retained by the firm such as depreciation allowances and undistributed profits.
3. Payment of corporate taxes, excise duties and licence fees, etc. to the government sector.
4. Payment to the government for buying its factor services.
5. Payment to firms for buying raw materials, machines etc.

**Credit side**

1. Households spending on goods and services produced by firms.
2. A firm’s items sold to other firms.
3. Government spending in buying goods from the firms.
4. Net export earnings.
5. Net income earned from abroad.

A Household account usually contain –

**Debit side**

1. Payment to firms for buying their goods and services.
2. Tax payment to government.
3. Transfer payments.
4. Individual saving.

**Credit side**

1. Income received by selling factor services to the firms.
2. Transfer payment made by the government to individuals.
3. Transfer payment made from a foreign country.

A Government sector account usually contains the following items:

**Debit side**

Public spending on goods and services of firms.

1. Government payment to administrative staff.
2. Amount of subsidies given to producers.
3. Debt servicing charges.
4. Transfer payments to individuals.
5. Transfer payments made abroad.

**Credit side**

1. Taxes received from firms and households.
2. Collection of fees, penalties, etc.
3. Interest, rent, dividend, etc. receipts of the government.
4. Foreign aid.

A Capital sector account will have the following items:

**Debit side**

1. Firms' savings
2. Households' savings.
3. Savings of the government.
4. Net external public borrowings.

**Credit side**

1. Aggregate expenditure on capital assets (investment in capital goods industries).
2. Net change in business inventories.

Assuming a close economy with only two sectors, firms and households, we may illustrate the sectoral accounting as shown in **Table 5.**

(Rs. Crores)

| Firms' Account | | | |
|---|---|---|---|
| Payments | (Dr.) Rs. | Receipts | (Cr.) Rs. |
| Purchase of factors services from households | 1,000 | Sale of consumption goods and services to households | 1,000 |
| **Households' Account** | | | |
| Payments | (Dr.) Rs. | Receipts | (Cr.) Rs. |
| Purchase of consumption Goods and services from firms | 1,000 | Sale of factor services to firms | 1,000 |

***Table 5 : Sectoral Accounts***

Another method is to present these data in the form of a matrix, a rectangular arrangement of entries into a set of rows and columns. Receipts or credit items of a sector are placed in the rows of the matrix, while payments or debit items are presented in the columns. A single matrix may be used for all sectoral items.

The above given data can be represented in a matrix form as shown in **Table 6**.

(Rs. Crores) Matrix

| Receipts by: | Firms Payments by: (1) | Household (2) | Total (3) |
|---|---|---|---|
| (a) Firms | - | 1,000 | 1,000 |
| (b) Households | 1,000 | - | 1,000 |
| (c) Total | 1,000 | 1,000 | 2,000 |

***Table-6 : Matrix***

Matrix is very important for tracing the inter-relationship between different economic entities or sectoral transactions.

While measuring the national income of any country, it must be remembered that –

(i) Income is a "flow" concept. Thus, we do not measure the stock of economic goods or wealth at a given moment of time, but we measure the flow of economic goods produced by the nation in a year. Actually, there is a continuous flow production. But we, for the sake of convenience, take a time interval of one year into account and measure national income every year.

(ii) The national income is measured as a “realized” flow. Thus, final goods which have already been produced during the year are to be accounted for. The value of incomplete goods are therefore to be excluded. We should not predict the values of the goods yet to come. We measure only what has already been produced. Remember, national income is a realized flow of goods and services. Thus, we can estimate national income for the year 1981 only in 1982, because then only can we have data of production between January, 1981 and December, 1981.

**Exercise :**

1. What is 'national income' interpreted in terms of (1) national product, (2) national dividend and (3) national expenditure?
2. What is Gross National Product as distinguished from Net National Product?
3. What is Disposable Personal Income? Is it relevant in the field of determination of National Income? Explain the difficulties of estimating National Income.
4. Explain the method of measuring National Income by the social accounting process system based on double-entry book-keeping principles.
5. Write short notes :-
   (a) Base year price index
   (b) Personal Savings
   (c) National Income at Factor Costs
   (d) Circular flow of activities

# UNIT – VIII

## THEORY OF MONEY

### 8.1 What is money?

'Money' is a generic term which denotes primarily the currency in vogue in any particular country.

History of the world indicates that man found it necessary to use money at an early stage of man's development because of the difficulties and inconveniences of exchange by direct barter. The inconvenience of barter system could be avoided by the use of money. Money is demanded because it is useful and does away with difficulties of barter system. Therefore, money is regarded as one of the most important discoveries of mankind. Since money represents generalized purchasing power, it has been the object of man's desire through ages.

Prof. Walker defines money as "Money is what money does".

Robertson defines it as "A commodity which is used to denote anything which is widely accepted in payment for goods or in discharge of other business obligations."

Economists stress that a thing which could be considered as money should be such that it should command general acceptability. Without general acceptability there could be no free and smooth exchange transactions.

Crowther holds "Anything that is generally acceptable as a means of exchange and that at the same time acts a measure and as a store of value is money". The analysis of this definition implies that money should perform three important functions, namely, it should be capable of being used as a medium of exchange, as a measure of value and a store of value. That does not mean that the role of money ends with the performance of these functions. In addition to these three functions, it performs other functions, the important among which is that also action the standard of deferred payment. Thus, primarily money is said to have functions four - medium, measure, standard and store.

**(i) Medium of Exchange**

The quality of general acceptability of money facilitates exchange. People want goods and services for various purposes. They can obtain them in exchange of money. Under the barter system, goods were exchanged against goods. However, it was very inconvenient to people from various angles such as lack of double coincidence of wants, difficulty of divisibility, storing of value etc. Consequently, the system had to be replaced by money. Money has removed all these difficulties. That's why now with the use of money buying and selling of goods has become easy and possible.

**(ii) Measurement of Value**

The another important function of money is the measurement of value of various goods and services which are exchanged. Money is the common measure of value. This has facilitated the determination of rate of exchange between money on one side and goods and services on the other. Now-a-days prices of various goods and services are expressed in terms of money which is an indication of the fact that money has been accepted as a common measure of value of goods and services.

**(iii) Store of Value**

Money serves as a store of value of goods and services. Man wants to provide for the future out of rewards he receives for his labour. He wants to keep some part of his earnings for tomorrow. This would possible only if the means through which savings is to be made is non-perishable not only physically but also from the point of its future value. Money has become a convenient means through which savings can be done easily. This facilitates capital formation too which is essential for economic development of the country. Thus, money plays a paramount role in capital formation and standard of storage of savings.

**(iv) Standard of Deferred Payment**

Payments which are made at some future dates are made in money since the value of money remains stable over a period of time. Lending involves future payment. Development of trade and commerce has also necessitated future payments. Thus, deferred payments have become a normal feature of modern commercial world. Since money remains stable in value and is non-perishable along with its general acceptability, deferred payment becomes possible. Thus, the money acts as a standard of deferred payment and thereby it has made a great contribution not only to modern commercial world but to transactions promoting human civilization.

## 8.2 CONTINGENT FUNCTIONS

There are also some contingent functions that money perform in an economic world.

**(i) Equalization of Marginal Utilities**

A rational person tries to spend his limited money income in such a manner that he obtains the maximum satisfaction or utility there from. If he were to spend his money on only one commodity, the problem would have been easy. But he has to spend his money upon a choice over various goods and services as well as various purposes in such a way that the spending yields maximum satisfaction to him. This could be done by equalizing marginal utilities in all directions as derived from consumption of various commodities. A principle of equi-marginal utility has to be applied and in doing so, money comes to our rescue because prices are measured in terms of money.

**(ii) Equalization of Marginal Productivity**

Producer is concerned with the marginal productivity. He would maximize production and profit when marginal productivity of factors of production is equalized. Even here, money plays an important role in determining rewards of the factors of production because factors of production are paid in terms of money equal to their marginal productivity.

**(iii) Distribution of National Income**

Distribution of national income is also undertaken in terms of money. National Income is generated by the four factors of production. It is to be distributed among the factors in accordance with their contribution. This is done in terms of money. Thus rent wages, interest and profit, as the share of remuneration for land, labour, capital and entrepreneurship is respectively determined in terms of money out of generated national income.

**(iv) Development of Credit System**

In the modern economic system with fast growing industrialization credit system has become very important. It is this credit system that gave rise to rapid development of industrial and commercial advancement. In business and commercial activities, instrument of credit is at the center and money is the basis of the credit system. Thus, money plays a great role in the development of credit system and also the banking system.

## 8.3 RESIDUARY FUNCTIONS

**(i) Capital is given liquid form**

Money is the most liquid form of capital. Money imparts liquidity to other forms of capital. People need to keep capital in liquid form for various purposes or motives such as transaction, precautionary and speculative. All this become possible because of money.

**(ii) Full utilization of resources**

It is also possible to ensure full utilization of various resources by means of money. Idle resources can be mobilized and harnessed for the productive purpose with the help of money. If these resources are not mobilized, they cannot be properly utilized so as to increase production of goods and services.

In the light of functions of money discussed above, one would come to know the importance and dynamic role played by money. Economic and commercial development in modern times is made possible by the introduction of money. Through suitable changes in monetary policy of the country desired direction can be given to the economy to achieve socio-economic objectives. Thus money has occupied extra-ordinary place in the modern economy and so in the life of people.

## 8.4 INFLATION

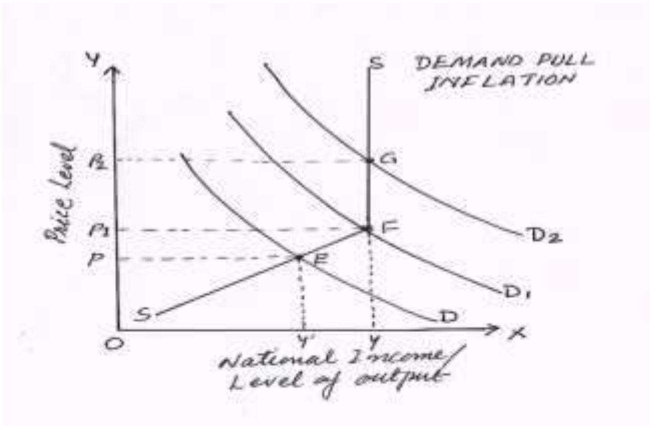
**Types and Causes of Inflation**

Basically, there are two types of inflations. They are also termed as the causes of inflation because of changes in demand have been identified, namely:

Demand-pull inflation
Cost-push inflation

Demand-pull Inflation:

This type of inflation is caused by an increase in the conditions of demand. It may be defined as a situation where total monetary demand persistently exceeds total supply of goods and services at current prices, so that prices are pulled upwards by the continuous upward shift of the aggregate demand function. It arises as a result of an excessive aggregate effective demand function and aggregate supply of goods and services in a slowly growing economy. Supply of goods and services will not match with rising demand. The productive ability of the economy is so poor that it is difficult to increase the supply at a quicker rate to match the increase in demand for goods and services.




In the above diagram on X axis we are measuring national income or level of output produced and on Y axis we are measuring price level. SS is the aggregate supply curve of economy. In the initial level the aggregate demand curve D intersects the aggregate supply curve SS at point F which is equilibrium position and equilibrium price is determined at OP level and Oy indicates the supply of goods and services.

As aggregate demand increases further, supply being constant, the price level will start increasing from OP to OP1 and OP2. But output will remain Oy as it indicates the full capacity utilization.

FOLLOWING ARE THE FACTORS THAT CAUSE THE INCREASE IN THE AGGREGATE DEMAND

1. Increase in money supply:Supply of money in circulation increases on account of the following reasons; deficit financing by government, expansion in public expenditure, expansion in bank credit and repayment of past debt by the government to the people, increase in legal tender money.

2. Increase in disposable income: Aggregate effective demand rises when disposable income of the public increases. Disposable income rise due to; reduction in the tax rate, increase in national income while tax level remains constant and decline in the level of savings.

3. Increase in private consumption expenditure and investment expenditure: An increase in the private expenditure, both on consumption and investment leads to the emergence of excess demand in an economy. When business is prosperous, business expectations are optimistic and prices are rising, more investment is made by private entrepreneurs causing an increase in factor prices. When the income rise, expenditure on consumer good rises.

4. Increase in Exports: An increase in the foreign demand for a country’s exports reduces the stock of goods available for home consumption. This creates shortage in the country leading to the price rise in the country.

5. Existence of Black Money:The existence of black money in the country due to corruption, tax evasion, black marketing etc. increases the aggregate demand. People spend such unaccounted money extravagantly thereby creating unnecessary demand for goods and services, causing inflation.

6. Increase in population growth causes an increase in the demand for everything in a country.

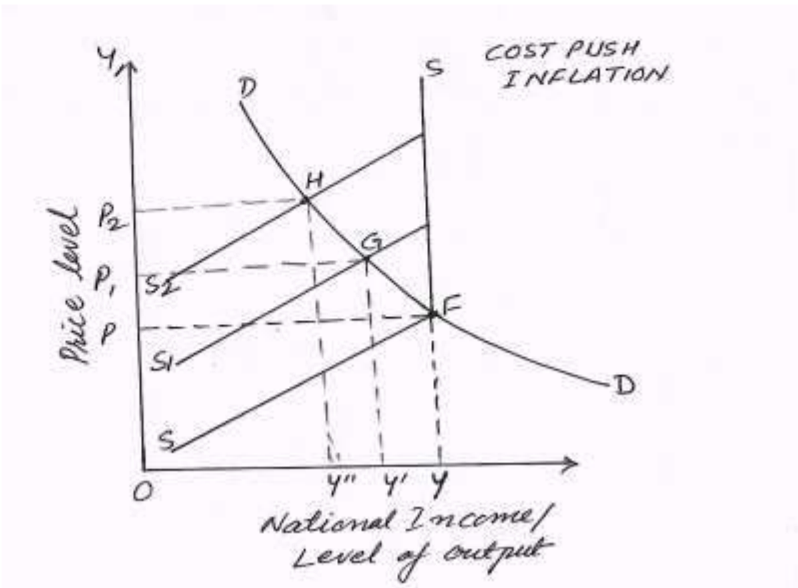
7. High rates of indirect taxes would lead to rise in prices.

8. Reduction in the rates of direct taxes would leave more cash in the hands of people including them to buy more goods and services leading to an increase in prices.

9. Reduction in the level of savings creates more demand for goods and services.

**Cost-push Inflation:** Cost-push inflation arises from anything that causes the conditions of supply to decrease. Some of these factors include a rise in the cost of production, an increase in the government taxation and a decrease in the quantity of goods produced. It refers to the situation where the prices are rising on account of increasing cost of production. Thus in this case, the rise in price is initiated by the growing factor costs. Such a price rise is termed as "Cost Push Inflation" as prices are being pushed by the growing factor costs. There are number of factors causing the increase in cost of production.Cost-push inflation may occur due to wage-push or profit-push.

1.



Demand for higher wages by the labour class.
2. Fixing up of higher profit margins by the manufacturers.
3. Introduction of new taxes and raising the level of old taxes.
4. Increase in the prices of different inputs in the market.
5. Rise in administrative prices by the government etc.

These factors in turn cause prices to rise in the market. Out of many causes, rise in wagesis the most important one. It is estimated and believed that wages cons titute nearly 70%of the total cost of production.
A rise in wages leads to a rise in the total cost of production and a consequentri se in the price level. Thus cost- push inflation occurs due to wage push or profit push.

The phenomenon of cost-push inflation is graphically illustrated in above figure. In the above figure, the **D** curve represent the aggregate demand function, and the **S** curves, the aggregate supply function. The full-employment level of income is **Oy**, which can be maintained only at rising price levels, **P, P1 and P2**.

Now, if we begin with price level **P, F** is the point of intersection of the aggregate supply curve; **SS and D**. Let us assume that the aggregate supply function shifts upward as **$S_1$**, which becomes a vertical straight line at point E, and merges with the **SF** line (the previous supply curve at full-employment level). The leftward shift in the supply curve may be due to either an increase in money wages due to trade union's successful collective bargaining, or to the profit-motivated monopolists or oligopolists, who might have raised the prices of goods.

As the aggregate supply curve shifts to **$S_1$**, the new equilibrium point **A** is determined through the intersection of **$S_1$ and D**and **Oy'** will be thelevel of real output, which is less than the full-employment level. This means that with a rise in the price level, unemployment increases. It is regarded as the cost of holding the price level close to P.

Similarly, a further shift in the aggregate supply curve to **$S_2$** on account of a further wage-push implies a new equilibrium point **B**. This causes the income level to fall further to **y'',** and prices to rise to **$P_2$.**

However, if the government or the monetary authority is committed to maintain full employment, there will be more public spending or more credit expansion, causing the price level to rise to much more – such as from **P to $P_3$** and **$P_4$.** In the case, the sequence of equilibrium points become F-G-H.

**K) Effects of Inflation**

Inflation affects different people or economic agents differently. Broadly, there are two economic groups in every society, ***the fixed income group and the flexible income group.*** During inflation, those in the first group (fixed income) lose while those in the second group (flexible income) gain. The reason is that the price movement of different goods and services are not uniform. During inflation, most prices rise, but the rates of increase of individual prices differ. Prices of some goods and services rise faster than others while some may even remain unchanged.

The poor and the middle classes suffer because their wages and salaries are more or less fixed but the prices of commodities continue to rise. On the other hand, the businessmen, industrialists, traders, real estate holders, speculators and others with variable incomes gain during rising prices. The persons with flexible income become rich at the cost of the fixed income group. There is transfer of income and wealth from the poor to the rich.

**To further determine the effect of inflation on individuals, it will be necessary to discuss the effect of inflation on different groups:**

***a) Creditors and Debtors:*** When there is inflation, creditors are generally worse off because, the real value of their future claims is reduced to the extent of the rate of inflation. On the other hand, when inflation occurs, debtors tend to pay less in real terms than they had borrowed. Therefore, it could be said that inflation favours debtors at the detriment of creditors.

***b) Salaried Persons:*** Those with white-collar jobs lose during inflation because their salaries are slow to adjust when prices are rising.

***c) Wage Earners:*** Wage earners may gain or lose depending on the speed with which their wages adjust to rising prices. If their union is strong, they may get their wages linked to the cost of living index. In this way, they may be able to protect themselves from the negative effects of inflation. Most often in real life there is a time lag between the rise in the wages of employees and the rise in price.

***d) Fixed Income Group:*** These are recipients of transfer payments such as pensions, unemployment insurance, social security, etc. Recipients of interest and rent also live on fixed incomes. These people lose because they receive fixed payments while the value of money continues to fall with rising prices.

***e) Equity Holders and Investors:*** These group of people gain during inflation as the rising prices expand the business activities of the companies and, consequently, increase profit. Thus, dividends on equities also increase.

However, those who invest in debentures, bonds, etc, which carry fixed interest rates, lose during inflation because, they receive fixed sum while purchasing power is falling.

***f) Businessmen:*** Producers, traders, and real estate holders gain during periods of rising prices. On the contrary, their costs do not rise to the extent of the rise in prices of their goods. When prices rise, the value of the producer's inventories rise in the same proportion. The same goes for traders in the short run. The holders of real estates also make profit during inflation because the prices of landed property increase much faster than the general price level. However, business decisions are difficult in an environment of unstable price. In the long-run, there could be an increase in wages which will reduce profit thereby, having an adverse effect on future investment.

***g) Agriculturalists:*** Agriculturalists are of three types, namely, landlords, peasant proprietors and landless agricultural workers. Landlords lose during rising prices because they get fixed rents. Peasant proprietors who own and cultivate their farms gain. Prices of farm products increase more than the cost of production. Prices of inputs and land revenue do not rise to the same extent as the rise in the prices of farm products. On the other hand, the wages of the landless agricultural workers are not raised by the farm owners, because trade unionism is absent among them. But the prices of consumer goods rise rapidly. So landless agricultural workers are losers.

***h) Government:*** Inflation will have both positive and negative effects on the government. The government as a debtor gains at the expense of households who are its principal creditors. This is because interest rates on government bonds are fixed and are not raised to offset expected rise in prices. The government in turn levies less tax to service and retire its debt. With inflation, even the real value of taxes is reduced. Inflation helps the government in financing its activities through inflationary finance. As the money income of people increases, government collects that in the form of taxes on incomes and commodities. So the revenue of the government increases during rising prices.

**i) Measures to Control Inflation**

Inflation is caused by the failure of aggregate supply to equal the increase in aggregate demand. Therefore, inflation can be controlled by increasing the supplies of goods and reducing money income. The various measures to control inflation are discussed below:

**Monetary Measures:**The monetary measures to control inflation generally aims at reducing money incomes. These are:

***(a) Credit Control:*** The central bank could adopt a number of methods to control the quantity and quality of credit to reduce the supply of money. For this purpose, ***it raises the bank rates, sells securities in the open market, raises reserve ratio, and adopts a number of selective credit control measures, such as raising margin requirements and regulating consumer credit.***

***(b) Demonetization of Currency:*** Another monetary measure is to demonetize currency of higher denominations. Such a measure is usually adopted when there is abundance of black money in the country.

***(c) Issue of New Currency:*** The most extreme monetary measure is the issue of new currency in place of the old currency. Under this system, one new note is exchanged for a number of the old currency. Such a measure is adopted when there is an excessive issue of notes and there is hyperinflation in the economy.

**Fiscal Measures:** Monetary policy alone cannot control inflation. Therefore, it should be supplemented by fiscal measures. The principal fiscal measures are discussed below.

***(a) Reduction in Unnecessary Expenditure:*** The government should reduce unnecessary expenditure on non-development activities in order to curb inflation.

***(b) Increase in Taxes:*** To cut personal consumption expenditure, the rates of personal, corporate and commodity taxes should be raised and even new taxes should be levied, but the rates of taxes should not be too high as to discourage saving, investment and production.

***(c) Increase in Savings:*** Another measure is to increase savings on the part of the people so that their disposable income and purchasing power would be reduced. For this the government should encourage savings by giving various incentives.

(***d) Surplus Budgets:*** An important measure is to adopt anti-inflationary budgetary policy. For this purpose, the government should give up deficit financing and instead have surplus budgets. It means collecting more in revenues and spending less.

(e) ***Public Debt:*** In addition, the government should stop repayment of public debt and postpone it to some future date till inflationary pressures are controlled. Instead, the government should borrow more to reduce money supply with the public.

**Other (Direct) Measures**

Other measures to control inflation generally aims at increasing aggregate supply and reducing aggregate demand directly. These are:

***(a) To Increase Production.*** The following measures should be adopted to increase production:

(i) The government should encourage the production of essential consumer goods like food, clothing, kerosene oil, sugar, vegetable oils, etc.

(ii) All possible help in the form of latest technology, raw materials, financial help, subsidies, etc. should be provided to different consumer goods sectors to increase production.

***(b) Rational Wage Policy:*** Another important measure is to adopt a rational wage policy. The best course for this is to link increase in wages to increase in productivity. This will have a dual effect. It will control wage and at the same time increase production of goods in the economy.

***(c) Price Control:*** Price control and rationing is another measure of direct control to check inflation. Price control means fixing an upper limit for the prices of essential consumer goods.

***(d) Rationing:*** Rationing aims at distributing consumption of scarce goods so as to make them available to a large number of consumers. It is applied to essential consumer goods such as wheat, rice, sugar, kerosene oil, etc. It is meant to stabilize the prices of necessaries and assure distributive justice.

***Conclusion:*** From the various monetary, fiscal and other measures, discussed above, it becomes clear that to control inflation, the government should adopt all measures simultaneously.

## 8.4 DEMAND FOR MONEY

According to J.M. Keynes, money is demanded by the people to fulfill three important motives. These motives are the transaction motive, precautionary motive and speculative motive.

1. **The Transaction Motive**

   People receive their income monthly, quarterly or even yearly. They spend this money income at much shorter intervals. Individual is required to spend money on his various wants throughout the month but income he receives once a month. Therefore, he needs to have stock of money to meet his all needs until the next pay day. The transaction motive can be sub-divided into (i) income motive and (ii) business motive.

   **(i) Income motive**

   The amount of money which a consumer holds to satisfy the transaction motive depends upon (i) the size of his income and (ii) the interval of payment. If the size of income is larger he would keep larger amount of his income for this motive and vice-versa. Similarly, it depends upon the length of the interval of time between successive pay days. The greater the interval, the larger is demand for money for transaction motive. In conclusion, it can be said community's demand for money under the income motive is the function of the size of personal incomes and of the average time between successive pay days.

   **(ii) Business motive**

   Business men also wish to hold a certain amount of money to meet day-to-day requirement of money. This stock of money held would be used for payment of raw materials, wages, transport and other current expenses incurred by the businesses. The amount of money held for this purpose is the function of the turnover of the firm. The larger the turnover, the greater would be the amount of money, the firm needs. It would be proportional to the total volume of business transactions carried out. However, the demand for money for transaction motive is a constant function of rate of interest. It is not affected by the changes in rate of interest.

2. **The Precautionary Motive**

   The money people demand for this purpose arises out of its function as store of value. Money held under this motive is kept to provide for uncertainties and emergencies. The individual needs a certain amount of money to keen provisions against unemployment, sickness, accident and many other eventualities. The amount of money held for this purpose depends upon the individual and on the conditions in which he lives. How much money is held for this motive depends upon social security measures of the government, size of income and man's attitude towards safety of future. It is also a constant function of rate of interest. What is true in case of individual, it is as well as true in case of firms also.

**3. The Speculative Motive**

Money held under the speculative motive constitutes a store of value just as money held under the precautionary motive does, but it is a store intended to fulfill a different purpose. It constitutes a liquid store of value. The money demanded for this motive is generally used for gambling to make speculative gains. Therefore, it is a negative or decreasing function of rate of interest. More liquidity is demanded at a low of rate of interest and less at a high rate of interest.

## 8.5 SUPPLY OF MONEY

### The constituents of Money Supply

Money is just like one of the commodities but its supply cannot be increased like any other commodities. The supply of money is adamantly determined by the monetary authority of the country i.e. central bank of the country and treasury department. The supply of money depends upon the decision of the monetary authority whether to increase or decrease the quantity of money in the economy. In case of money, instead of supply getting adjusted to demand, demand will get adjusted to the supply of money. The total money in the economy refers to the total volume of money held by the people in the form of coins and currency notes, bank money and other such liquid assets. Total of all these constitutes the supply of money in the economy. Bank money includes demand deposits, time deposits and current deposits.

Supply of money indicates the demand for goods and services because money represents purchasing power. Under bank money, ready cash held by all the banks is not included because it forms the basis of credit. Likewise, stock monetary gold with Central Bank is also excluded from the total supply of money. It is because gold reserves forms the basis of international money supply and it is not permitted to circulate in the country. In the same manner, ready cash with Central Bank and the government is also not included in money supply of the country. The reason is that it constitutes the reserves on which the demand deposits of the public are supported. Lastly, the liquidity preference of the people also influence money supply in the economy. If it is high, then in that case volume of bank deposits will get reduced and vice-versa. So, even the general public can influence supply of money depending upon their liquidity preference.

**Deflation – concept, causes, effects and** Measure to control Deflation**.**

The concept of deflation is opposite to inflation. It is defined as *a situation when the general income level and price level are falling.* It is also known as negative inflation. During deflation the income level falls against the available supply of goods and services. The stage of deflation arises when -

- Prices are falling continuously
- People prefer to hold money with them and do not keep goods.
- The available supply of goods does not dispose off on the prevailing prices.
- People expect more reduction in prices thus reduce their consumption to bring prices down.

The main causes of deflation are -

- Primary causes are fall in demand for goods and services.
- *People due* to one reason or the other reduce their consumption on the purchase of goods & services due to which *prices* start falling.
- Sometime people start saving more than before which causes reduction in the aggregate demand and *the* available supply is sold at falling prices.
- If due to some reason the level of investment in all economy is falling. It will negatively affect the economy. The demand for capital goods will fall and prices will tend to come down.
- Decline in incomes of the people can also cause deflation in the economy. Due to reduction in the income level of the people the aggregate demand for goods services falls short of the aggregate supply, thus prices start falling.

- Excess of supply due to some reasons can also cause deflation because in this case the aggregate supply will exceed the aggregate demand *hence* the price level will fall.

**Effects of Deflation**

Consistent fall in the general price level in the economy (deflation) might not be good for the economy. Effects of long term deflation are as follows

**Cyclical unemployment:** Deflation usually happens due to a fall in Aggregate Demand in the economy. This will lead to businesses cuting the output levels which will result in retrenchment/laying off of workers. Moreover, if consumers delay spending in anticipation of falling prices economic activity falls, unemployment increases.

**Bankruptcies:** As the value of money is increasing, it becomes difficult for debtors to repay the load. Moreover, during deflation firms will be having lower profits due to falling prices and will find it difficult to meet their liabilities. This might lead to greater number of bankruptcies. Businesses see profits fall; as they do so dividends and investment returns fall and so share prices fall.

**Deflationary spiral:** Consistent fall in prices may trigger deflationary spiral. As firms make less revenue, this leads to less profits, they might not be willing or able to invest which will have negative implications on the economic growth. Further, as firms cut cost by lay off of employees, there is less income for the households and the aggregate demand might fall. Due to a fall in consumer and business confidence the economy might fall into a deflationary spiral.

The principle problem of deflation is that it leads to a **rise in the real value of debt**. In the early stages low interest rates and low prices encourage borrowing but as the real weight of the borrowing is recognised so borrowing is reduced.

It is sometimes difficult to control deflation and **Monetary policy can prove ineffective** when interest rates (nominal) are already low.

**Measure to control Deflation**

Following are the remedies suggested to control deflation.

- If the central bank reduces the interest rate then the commercial banks will also advance loans at a lower interest rate which will boost up the investment, resulting increase in demand for capital goods and employment. Thus incomes will increase price level will start rising.

- In order to increase the aggregate demand the government has to increase its expenditures. By increasing expenditures incomes of the people will rise and price level will tend to move upward.
- By Printing extra money through the central bank and injecting in the economy the government can increase the aggregate demand which will further enhance the price level.
- By encouraging the private sector for investment through various immunities like subsides or tax reduction the aggregate demand can be used
- People should start using their savings on consumer goods or investment.
- To increase exports and reduce the imports, the income level of the people and prices level can be raised

**Exercise :**

1. Define and explain the concept of money.
2. What are the functions fo money?
3. Explain the role of 'money' in an exchange economy. What are it's contingent and residuary functions?
4. Discuss various motives for demand of money.
5. Wht is inflation? What are the types and causes of inflation?
6. Discuss the effects of inflation.
7. Explain measures to control the inflation?
8. What do you understand by deflation? Explain its causes, effects and suggest remedies to solve the problem of deflation.

# UNIT – IX
## SAVING, INVESTMENT AND BANKING

### 8.1 THE CONCEPT OF SAVINGS

Saving means economic surplus. It may be defined as an accounting difference between current income and current consumption. Keynes defined savings as an excess of income over expenditure of consumption.

In the case of an individual, saving is that part of income which is not consumed by him. And in the case of the community, the aggregate of the unconsumed part of the community, the aggregate of the unconsumed part of national income of all members of the community represents saving. Symbolically,

S = Y - C

where, S - denotes saving
Y - stands for income, and
C - stands for consumption.

This symbolic expression of saving is applicable both to the individual as well as to the community.

According to Keynes, saving is the function of income, *i.e.,* S = f*(Y).* That is to say, as income increases, saving also increases and *vice versa.* Saving depends on the propensity to save, which can be derived from the propensity to consume.

Thus, propensity to save (S/Y) is equal to' one minus the propensity to consume (C/Y) symbolically, therefore:

S/Y = 1 – (C/Y)

According to Keynes, the consumption function (or the propensity to consume) is a stable function of income in the short period. It follows from this that the saving function (or the propensity to save) would also be a stable function of income.

It should be noted that though the propensity to save is stable function of income, saving (individual or aggregate) is an increasing function. Thus, the marginal propensity to save ($\Delta S/\Delta Y$) is always greater than zero, but less than unity

Symbolically, $1 > (\Delta S/\Delta Y) > 0$.

Aggregate domestic savings are the sum of savings made by the households, firms and government.

(1) Household's saving = Disposable personal income - Consumption expenditure.
(2) Firms' saving = Profits (or gross income)- (Dividends+ Business taxes).
(3) Government's saving = Public revenue - current expenditure.

Savings of households and firms taken together constitute private savings. Government's savings constitute public savings. Therefore, Total Saving = private saving + public savings. Again, personal savings or household savings is the vital component of aggregate savings. According to RBI's report of Currency and Finance, in India, in 1980-81, of the total savings in the country, the household sector accounted for 80.3 per cent, domestic private corporate sector 5.4 per cent, and government sector 14.3 per cent.

### 8.1.1 Personal Savings

The household sector's savings are called personal savings or the savings of individuals. Professor Irwin Fisher defines individual's savings as "the difference between their current income and their current expenses, the latter including personal tax payment as well as consumption expenditures."

While considering the sum of individuals' savings, it must be noted that there are savers and dissavers. Usually, young people save and old people dissave. A considerable part of all personal saving is done with a view to future liquidation. People save with a view to have assets to spend after retirement or to provide financial help to their dependents in the event of their deaths, which means liquidation of savings in the future.

Therefore, Net individuals' saving of the community = Total personal saving – Total dissavings.

In a modern society, personal savings may take one or more of the following forms.

(i) Contractual saving such as life insurance premiums, contributions to provident funds, etc. These kinds of savings are obligatory in nature. They are relatively stable.

(ii) Holding of liquid assets. Individuals may increase their holdings of liquid assets such as cash balances, bank deposits, shares, bonds and securities.

(iii) Liquidation of old debts. When an individual pays a sum of money to his creditor for cancellation of a debt, it amounts to a saving of his income.

(iv) Direct investments. Some individuals may invest part of their income directly in farm activity, business or purchasing a home. This is also saving.

In rural areas, such savings are found in the form of land improvements, irrigation works, construction of dwellings, etc.

## 8.2 DETERMINANTS OF SAVINGS

The rate and size of savings in an economy are determined by a multitude of factors. A humble attempt is made to analyse a few of them which are vital determinants.

### 8.2.1 The Level of Income

As Keynes stresses, saving is basically a function of income. Saving increases with income. Of course, there can hardly be a proportionate relationship between the size of income and savings, but empirical evidence has proved that there is a marked correlation between the two. However, the amount of personal savings depends primarily on the disposable income. Thus, the saving income ratio (S/Y) tends to rise with an increase in income. It has been observed that the marginal propensity to save ($\Delta S/\Delta Y$) tends to be high in high-income group sectors of community. Indeed, in developed countries, where per capita income is high, the saving income ratio is also high. According to the world Economic Survey 1960, gross domestic saving in the U.S.A. amounted to 18.6 per cent and that of India less than 7 per cent.

(i) *Absolute Income Hypothesis:* According to Keynes, saving is a function of the absolute level of income. Other things being equal, a rise in absolute income causes an increase in fraction of that income to be saved. The absolute income hypothesis of savings was further developed by J. Tobin and A. Smithies as "Drift Hypothesis." In the "Drift Hypothesis", it has been argued that the level of National Income increases over a period of time and along with it, the average propensity to consume tends to diminish so that average propensity to save increases over a period of time.

(ii) *Relative Income Hypothesis:* Rose Friedman and Dorothy Brady have tried to furnish an answer to this inconsistency by propounding the concept of relative income hypothesis. According to them, the rate of savings depends on the relative position of the individual on the income scale rather than on his absolute level of income. That is to say, the consumption spending of a family depends on its relative position in the income distribution of approximately similar families.

(iii) *Permanent Income Hypothesis:* Keynes believed that the current income determines current consumption and savings. Modern economist to like Milton Friedman, however, observe that the expectations of income in the future do have a significant bearing upon the present consumption spending and savings out of a given income of community. Kisselyoff, for instance, mentions that the present dissaving among those people who expect their incomes to rise in future is found to be more frequent. In view of this, Mr. Friedman propounded the "Permanent Income Hypothesis". Friedman holds that the basic determinant of consumption and savings is permanent income. The relationship between saving and permanent income is proportional. A person's permanent income, in any particular year, is not revealed by his current income in that year, but is dependent upon the expected income to be received over a long period of time. Permanent income is the amount which the consumer unit could consume (or believes that it could) while maintaining its wealth intact. Friedman states that permanent income may be interpreted as the mean income regarded as permanent by the consumer unit in consideration. Permanent income depends on the far-sightedness of a person. Indeed, a person's actual income, in any specific year, may be greater than or less than his permanent income.

### 8.2.2 Income Distribution

Aggregate savings rate also depends upon the distribution of income and wealth in the community. If there is a greater degree of inequality of income among the people, that aggregate savings rate, would tend to be high, as the richer section of the community has a high propensity to save. A country with a low per capita income and a fair distribution of national income would imply a low savings rate. Thus, with an improvement in the distribution of income or correction of income inequalities through fiscal and other measures, the aggregate savings rate may tend to decline in the initial stage. Thus, the egalitarian goal of redistribution of income and wealth may come in the way of capital formation by causing a reduction in the domestic aggregate savings. Nonetheless, the ideal of just and fair income distribution cannot be sacrificed on this ground.

### 8.2.3 Consumption Motivations

Saving is the residual part of income left after consumption. Thus, to know the factors affecting saving, we must know what factors determine consumption. The consumption of the community depends upon a variety of factors and motivations. According to Duesenberry, the consumption pattern and its size are determined by *(i)* the consumption of certain types of goods required by physically and socially generated needs, *(ii)* these needs can be satisfied alternatively by a large number of qualitatively different kinds of goods, *(iii)* these different kinds of goods have qualitative variations and ranking which form the community's scale of preference.

In fact, the pattern of consumption and its volume depends, in general, upon the standard of living of the people. Duesenberry, thus, states that "the level of saving actually achieved by anyone represents the outcome of the conflict between his desire to improve his current standard of living and his desire to obtain future welfare by saving." In this context, therefore, motivations regarding saving and consumption expenditure must be analysed. Duesenberry points out that usually while choosing consumption goods, people prefer higher quality goods to lower quality goods with a view to improve their standard of living. A person's physical needs usually remain the same. But, his social need vary from time to time. The social needs of a person depend upon his age, occupation, social position, marginal position and marginal status. The consumption of certain goods – especially ostentatious articles - is caused by maintenance of self-esteem or the acquisition of prestige. In a society where there is a system of differential social status, this is a vital determinant of consumption expenditure.

In short, the consumption pattern of a person is based on his budget constraint and the desire to save. However, any rational balancing in consumption decisions is far from frequent.

### 8.2.4 Wealth

Holding of wealth or liquid assets by a person also affects his consumption decisions. Out of current income a person would consume more and save less if he possesses adequate amount of liquid assets like cash balances, bank deposits, etc. and feels that his life in future is well secured. Similarly, an appreciation in the value of financial assets also would induce the person to consume and save less.

### 8.2.5 Habit

Habit is a major determinant of consumption pattern. As a matter of fact, at anyone moment, a consumer already has a well-established set of consumption habits. The habit of consumption is formed by taste, likings, fashion, and other psychological influences on the minds of consumers. By nature of his habit, when a person is a spendthrift, his saving will be relatively less out of a given income than that of a person who considers saving as a virtue. Thus, aggregate saving in an economy depends upon the types of habits of the people in general.

Habit conforms to the standard of living of the community. Habit, in the long run, may not be a very constant factor. It is subject to change. In general, people want to improve their standard of living by improving the quality of the goods they consume. Public policies are also devised to improve the living standards of the masses. With an increase in income or otherwise, through dissaving, there may be a drive to spend more on superior goods. There is always a psychological impact of "superior effectiveness" of certain goods such as comfort, convenience, beauty, etc. which induces people to spend more and save less, in due course of time.

In this context, Duesenberry mentions that the "demonstration effect" in modern society serves as a powerful habit-breaker. The "demonstration effect" refers to an increase in consumption is reduction in saving through imitation of superior standards. According to Duesenberry the widespread imitation of superior standards causes an upward shift in the aggregate consumption function, thereby reducing the rate of saving.

The "demonstration effect" implies that a high frequency of contact of a person with superior consumption by others will break his habits and induce him to spend more on expensive goods by weakening his desire for saving. It has been observed that when people habitually use one set of goods, they tend to be dissatisfied if there is a demonstration of superior consumption by others. More knowledge of the existence of superior goods is not an effective habit-breaker. It is the demonstration effect which is a powerful habit-breaker. One may be reminded of a common saying here that "what you don't know won't hurt you, but what you do know does hurt you. '

Poor countries are saving-deficient. Their problem of low saving rate is further accentuated by their desire to imitate the superior consumption standard of developed nations induced by international demonstration effect.

### 8.2.6 Population

A high growth of population has an adverse effect on the per capita income which causes an adverse effect on the saving-income ratio.

Again, the age distribution of the population also affects the volume of aggregate saving in the economy. Aggregate personal saving depends upon the dissaving of old, retired people and the saving of the young group. A community's aggregate saving would be zero when the positive saving of the young people is just balanced off by the dissaving of the retired people to maintain their consumption expenses. If a society has a large proportion of young people in relation to old people, net aggregate saving will be positive. Thus, the aggregate saving ratio in a community tends to vary with the age structure of its population, even with constant per capita income. It follows thus that when the population is stable in all respects, net saving will rise with the increasing per capita income in an economy.

### 8.2.7 Objective and Institutional Factors

There are a number of objective factors - mostly institutional by nature which affects the capacity and willingness to save of the people at large. Political stability and security of life and property encourage people to save more. Similarly the existence of a good banking system and other developed financial institutions of money and capital market such as Unit Trust, Life Insurance Corporation, financial houses, shares of good corporations, government bonds and securities, etc. induce people to save more under the economics of interest-earning motive by providing a wide range of remunerative investment opportunities.

The taxation structure and fiscal policy also affect savings in the economy. A vigorously progressive direct taxation leads to a reduction in voluntary personal saving. Similarly, high and widespread indirect taxes will force the consumer to spend more on maintaining his given standard of living. This will cause a reduction in his personal saving. Similarly, high corporate taxation will reduce the net profit of business houses and curb their capacity to save.

On the other hand, certain concessions provided in the taxation schemes can help in promoting voluntary saving. For instance, exemption of interest-earning from bank deposits, outright deductions of life insurance premium, contribution to provident fund, etc. serve as good stimuli to saving.
Price stability or check on inflation by governmental effort can also sustain saving, while hyper inflation may lead to dissaving or reduction in saving.

Likewise, windfall gains and losses also effect saving. The former will lead to a rise in savings and the latter will induce dissaving.

**8.2.8 Subjective Motivations for Savings**

People are induced to save more when there are strong subjective factors which motivate them to save. Keynes enlisted the following main motives which lead to individuals to save:

(1) Precaution - to build up a reserve against unforeseen contingencies.
(2) Foresight - to provide for future needs.
(3) Calculation - to enjoy interest and a larger real consumption at a future date.
(4) Improvement - to improve standard of living gradually.
(5) Independence - to enjoy a sense of independence and the power to do things with accumulated savings.
(6) Enterprise - to make speculation or undertake business projects.
(7) Pride - to bequeath a fortune.
(8) Avarice - to satisfy pure miserliness. .

Likewise, savings of business firms are induced by the following motives:

*(i)* Enterprise - to carry out further capital investment.
*(ii)* Liquidity - to meet emergencies of business.
*(iii)* Improvement - to expand business investments.
*(iv)* Prudence - to have financial prudence in discharging debts.

### 8.2.9 Rate of Interest

According to classical economists, saving is the direct function of the rate of interest. To put it symbolically:

$$S=f\ (i)$$

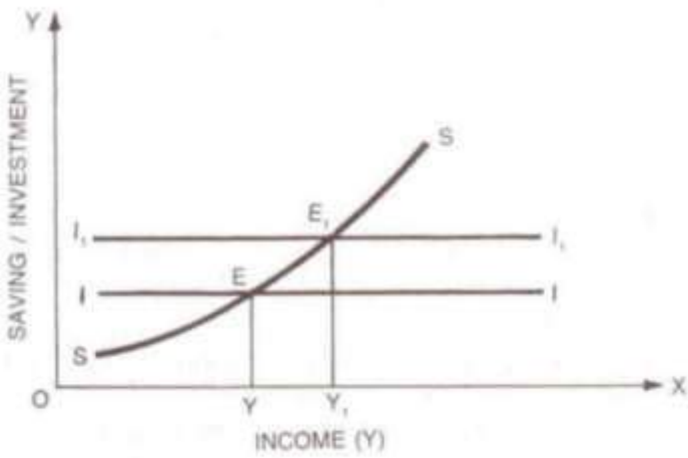
where S stands for saving and *i* stands for the rate of interest. It suggests that saving tends to rise with an increase in the rate of interest and vice versa. Keynes, however, did not agree with this view. He asserted that saving is a function of income.

But, it remains a fact that the personal saving of some individuals who are motivated by economic considerations is certainly induced to save more when the rate of interest rises. They may be willing to curtail their consumption or try to earn more income in order to save more. But, a mere rise in the rate of interest is not enough. Income also must rise. Income is the basic determinant of one's capacity to save. Saving comes out of income and not from rate of interest. But a high rate of interest may give a psychological push to the economic motive behind saving.

However, the rate of interest is an important factor in the mobilisation of saving. People would be induced to pass on their saving to those institutions which offer a high rate of interest. Thus, from the point of view of holding of near money assets, the rate of interest constitutes a significant influence. A person would like to keep his savings in that type of bond from which the relative yields will be highest as against any other type available.

## 8.3 SAVING-INVESTMENT RELATIONS

In Keynes's view, investment does not depend significantly upon the level of income. It mainly depends on dynamic factors such as population growth, territorial expansion, and progress of technology and above all, business expectations of the entrepreneur. Thus, it is unpredictable, unstable and autonomous as against savings which is stable, predictable and induced. Thus, it is fluctuations in investment that cause variations in income which in turn bring about equality between saving and investment. According to Keynes, varying levels of income cannot be sustained in an economy unless the amounts of savings at these levels of income are offset by an equivalent amount of investment. Thus, Keynesian theory draws the equilibrium relations between income, saving and investment. According to Keynes, varying levels of income cannot be sustained in an economy unless the amounts of savings at these levels of income are offset by an equivalent amount of investment. Thus, Keynesian theory draws the equilibrium relations between income, saving and investment. It stresses that the equilibrium level of income is realised where saving out of income is just equal to the actual amount of investment. This is depicted in Figure.




Saving-Investment Equality

In Figure, I-I is the original investment schedule which is a horizontal straight line showing that investment is completely autonomous in the sense that it does not vary much with income. This is the fundamental postulate of Keynesian theory. 1-1 is the new investment schedule indicating a shift in the I-function due to the forces of certain dynamic factors. The curve SS is the saving schedule showing how the amount of saving increases with income. But, it is a stable phenomenon and, therefore, usually, there cannot be a shift in its curve. From the diagram it appears that the income is determined by the saving and investment schedules. Initially, 1schedule and S-schedule intersect at point E, and we have an income level OY, where obviously S=I. Thus, the Keynesian theory of shifting equilibrium shows the S and I equality at varying levels of income.

Of course, the Keynesian formulation of saving-investment relationship in its functional sense admits the divergences between saving and investment, but only at virtual levels and not at observable levels of income. The equilibrium level of national income is obviously the observable level of income where there is corresponding equality between "observable" savings and "observable" investment. And, for given savings and investment schedules, there is, of course, only one equilibrium level of income corresponding to the equality between S and I. In a static Keynesian system, there can be divergence between savings and investment only when the economy is not in equilibrium.

**8.4 UNDEREMPLOYMENT EQUILIBRIUM**

The classical economists held that saving being a function of the rate of interest; it automatically flows into an equal amount of investment, led by changes in the rate of interest which tend to generate a full employment level of income in the economy. Thus, in classical economics, full-employment condition was assumed to be a normal phenomenon. Keynes, however, pointed out that in a modern capitalist economy, usually, the saving-investment equality takes place at an income level which may be significantly below the full-employment level. Thus, more realistically, a modern free-enterprise economy tends to have under-employment equilibrium as its normal feature.

The Keynesian idea of "underemployment" equilibrium has been elucidated by Professor Kurihara in terms of .the following strategic functions in the Keynesian theory of employment: *(i)* the interest-inelastic function, *(ii)* the interest-inelastic liquidity function.

Kurihara observes that from empirical investigation, it has been found that there is no significant correlation between the interest rate and the quantum of investment. Thus, a mere adoption of a cheap money policy cannot be very effective in stimulating the level of investment such that a rise in saving is automatically transmitted into investment to establish the saving-investment equilibrium at full-employment level.

Similarly, the saving schedule is income-elastic, but it is interest inelastic in practice. The interest-inelasticity in saving function suggests that with a fall in interest rate, in view of insufficient investment, demand for liquidity, however, cannot cause a decline in the propensity to save. As such, saving-investment equilibrium is likely to take place at less than full-employment level.

It has been said that drastic changes in the rate of interest can affect the saving schedule. This is true. But, here the liquidity function comes in the way. Kurihara points out that at a very low rate of interest, the liquidity function becomes perfectly interest-elastic, which has two unhealthy influences: *(i)* it tends to discourage inducement to invest, by its depressing effect on the marginal efficiency of capital of high rate of interest, which is essential to overcome a strong liquidity preference of some people, and *(ii)* it is neither feasible nor advisable for the monetary authority to expand money supply indefinitely and lower the rate of interest to the bottom, just for the sake of stimulating private investment. Consequently, the investment functions at a point of full-employment level. The point of effective demand, thus, tends to materialise at an under-employment equilibrium level in a real economy. It must be noted that Keynesian theory refers here to privately induced investment only. Public investment which is autonomous depends on the plan and public policy can be shifted upward up to the full-employment ceiling in a decided manner.

## 8.5 Indian Capital Market

### 8.5.1 MEANING AND FUNCTIONS OF CAPITAL MARKET

Capital market is a growing component of the financial, system in India. The capital market differs from the money market in terms of maturity, structure and liquidity. The money market comprises financial instrument having a maturity period of one year or less than one year. It involves short-term transactions.

Capital market contains financial instruments of maturity period exceeding one year. It involves long-term transactions. Capital market instruments are relatively less liquid in comparison to the money market instruments. Capital market in a broad sense encompasses all kinds of arrangements and financial institutions involved in long term funding. Capital market is, however, commonly referred to the stock markets in the country. From the stock markets point of view, capital market comprises both primary and secondary market. The primary market deals with new issues made by the companies. The secondary market relates to the trading in the existing securities. An investor can buy securities in the primary market, but can sell only in the secondary market.

**Functions of Capital Markets**

Capital market is the financial pillar of industrialized country. It is the catalysts agent of development. It renders several functions, such as:

- Transformation of savings into investment. Capital market mobilizes savings from the households to the producers who are the investors. It provides inter-mediation between savers and investors on a long-term basis.
- Flow of funds. It channelises the allocation of the funds from less profitable to more profitable channels. It thus leads to optimum utilization of resources. It enables surplus and idle funds to be used more effectively, efficiently and productively.
- Macro-economics financial balancing. Capital market mobilises funds from surplus units to deficit units through appropriate financial inter-mediation.
- It facilitates the project financing and growth of corporate sector.
- It provides better returns to the savers by offering numerous alternatives in the portfolio investments.

India is heading on to the growing private sector in its mixed economy. As such, private savings and capital plays pivotal role in its growth process. A healthy growth of capital market is, therefore, essential to promote expanding savings and investment in the country.

### 8.5.2 STRUCTURE OF THE INDIAN CAPITAL MARKET

Usually, capital markets are classified in two ways:

- On the basis of issuer,
- On the basis of instruments.

In terms of issuer type, these are:

(a) Markets for corporate securities, and
(b) Markets for government securities.

In terms of instruments, these are:

(a) Equity markets, and
(b) Debt markets.

Over the years, there has been a substantial development of the Indian capital market. It comprises various sub-markets. In recent years, its structure has grossly changed. Various new instruments and new institutions have cropped in. Broadly speaking, there are the following sub-markets:

(1) Corporate market for both securities (both new and old);
(2) Government securities market;
(3) Debt instrument market; and
(4) Market for institutional schemes. (Such as mutual funds, etc).

There are both primary and secondary markets for all kinds of these markets. The primary market is the source of raising funds directly from the public. The secondary market is meant to provide liquidity and trading facilities.
The Indian secondary market structure comprises:

- Regular stock exchanges. Presently 21 in numbers in major Indian cities.
- Over the Counter Exchange of India (OCEI). This is meant for smaller companies. It has no trading ring.
- National Stock Exchange.

### 8.5.3 CAPITAL MARKET FOR CORPORATE SECURITIES

There has been a growing trend of corporate sector in India. Nearly 2 lakh companies have registered in the country. Exceeding 8,000 companies are listed on all stock exchanges of the country.

Companies enter into the capital market for the following reasons:

- Modernization
- New projects
- Expansion
- Assets acquisition
- Capital restructuring
- For listing their securities on stock exchanges

**Sub-brokers**

With the establishment of Securities and Exchange Board of India (SEBI) and abolition of Controller of Capital Issues, there has been a remarkable shift from 'control' to 'regulatory' system in the Indian capital market.

### 8.5.4 CAPITAL MARKET FOR GOVERNMENT SECURITIES

Indian government is a big borrower. It borrows through gilt-edged securities - i.e., repayments of principal and interest is totally secured with budgetary provisions.

The government securities are of three types:

(i) Long-term : exceeding 10 years;
(ii) Medium-term : ranging between 5-10 years;
(iii) Short-term : between 1-5 years.

Government securities are held in the form of:

- Stock Certificates
- Bearer Bonds

Stock certificate certifies that the holder is registered in the book of the Public Debt Office of the government. It also indicates interest rate. Bearer bond certifies the entitlement to specified sum. It also indicates the interest rate.
Besides, the government of India floats securities called:

(i) Social security certificate,
(ii) Capital investment certificate,
(iii) Deposit certificates,
(iv) Annuity certificates,
(v) Annuity deposit certificates,
(vi) Zamindary compensation bonds and rehabilitation grant bonds,
(vii) National savings certificates,
(viii) National defense certificates, and
(ix) National deposit certificates.

The growth of government securities market depends on the public debt programme of the government.

### 8.5.5 GROWTH PROSPECTS OF INDIAN CAPITAL MARKET

Indian capital market has a vast growth potential. Presently it has captured only about 10 percent of household savings in mobilisation for the corporate sector. In other developed countries more than 20-25 percent of household savings are tapped by their capital markets. Moreover, over 25 percent population goes for share holdings in these countries. In India such percentage is just less than 5.

In 1997-98, however, of the household sectors savings, 2 percent claimed by the UTI , shares and debentures, 12.4 percent by government securities, and 4.3 percent by the non-banking deposits. On the other hand, 45.6 percent share claimed by the bank deposits. This means bank-deposits are still popular avenues in India.
Liberalisation, financial regulations and activities of SEBI as well as positive industrial policy would help in attracting more funds into the Indian capital market.

**Characteristics of Indian Capital Market**

Indian capital has the following main features that may favour more savings mobilisation:

- Fast growth of mutual funds
- Banks subsidiaries for. financial services into the capital market
- Growth of the merchant banking
- Floatation of mega issues
- Growing debt instruments Issue of debentures
- Avoidance of underwriting
- Increased transparency through SEBI's regulations
- Liberalisation policy of the government
- Emerging new financial instruments such as convertible bonds, foreign currency rates, zero coupon bonds, discount bonds, warrants, etc.

**Current Scenario**

The SEBI is playing active role in its regulatory reform to further strengthen investors' protection and monitoring and modernising the Indian capital market. There has been enhancement of integrity, transparency and efficiency of operations of the securities market.

The government has established the National Venture Fund for Software and IT industry (NVFSIT) in the year 2000. It is managed by the Small Industry Development Bank of India (SIDBI) Venture Capital Ltd. (VCL).
In short, capital market in India is an important source of funds for public as well as private sector undertaking.

## 8.6 Commercial Banking

### 8.6.1 EVOLUTION OF BANKING

Banking, in its crude from, is an age-old phenomenon. It was in existence even in ancient times. Revilpout, a French writer, for instance, mentions about bank and bank notes in Babylon 600 B.C. In India, the references to money lending business are found in the *Manu Smriti* also. Chaldean, Egyptian and Phoenician history also records the existence of rudimentary banking in early days.

Prof. Marshall in his book, *Money, Credit and Commerce,* (1923) writes about the activities of money-changers in the temples of Olympia and other sacred places in Greece, around 2,000 B.C. To quote him, "Private money-changers began with the task of reducing many metallic currencies, more or less exactly, to a common unit of value, and even to accept money on deposit at interest, and to lend it out at higher interest permitting meanwhile drafts to be drawn on them."

As a matter of fact, the origin of banking lies in the business of money changing in ancient days.Another factor that supported the emergence of banks in the early period was the need for borrowing by the monarchical governments from finance companies. In the Middle Age, in Italy the first bank called the 'Bank of Venice' was established in 1157, on this ground, particularly, when the authorities of the state of Venice were in financial trouble due to war.

In England, however, the bankers of Lombardy had taken the initiative to start modern banking along with their trading activities in London. But, commercial banking began there only after 1640, when goldsmiths started receiving deposits from the public for safe custody and issued receipts for the acknowledgments which were being used as bearer demand notes later on.

Crowther, thus, speaks about three ancestors of a modern commercial bank, *viz.,* the merchant, the money-lender and the goldsmith. The merchants or traders issued documents like 'hundi' to remit the funds. Modern banks introduced cheques, or demand drafts for remittance purposes. Money-lenders gave loans. Bankers too gave loans. Goldsmiths received deposits and created credit. Banks also received deposits and adopted the process of credit in a similar fashion, by issuing cheques.

In short, the evolution of commercial banking is related to the practice of safe-keeping of gold and other valuables by the people with merchants/goldsmiths/ money-lenders.

Etymologically, however, the word 'bank' is derived from the Greek word *banque,* or the Italian word *banco* both meaning a bench - referring to a bench at which money-lenders and money-changers used to display their coins and transact business in the market place.

In England, initially the Bank of England was established in 1694 on Italian lines to support government with finance.

Modern joint-stock commercial banks, however, came into the picture with the passage of the Banking Act of 1833 in England.

In India, however, modern banking started when the English agency houses in Calcutta and Mumbai began to serve as bankers to the East India Company and the Hindustan Bank was the first banking institution of its kind to be established in 1779.

### 8.6.2 WHAT IS A BANK?

Commercial banks are the most important source of institutional credit in the money market.

A commercial bank is a profit-seeking business firm, dealing in money and credit. It is a financial institution dealing in money in the sense that it accepts deposits of money from the public to keep them in its custody for safety. So also, it deals in credit, *i.e.,* it creates credit by making advances out of the funds received as deposits to needy people. It thus, functions as a mobiliser of saving in the economy.

A bank is, therefore, like a reservoir into which flow the savings, the idle surplus money of households and from which loans are given on interest to businessmen and others who need them for investment or productive uses.

A bank is an important institution of the money market as it gives short-term loans to its customers.

**Definition of Bank**

On account of the multifarious activities of a modern bank, it becomes very difficult to give a precise definition of the world "Bank". The Oxford Dictionary defines a bank as "an establishment for the custody of money, which it pays out on a customer's order." This, however, is not a very satisfactory definition, since it ignores the most important function of a bank that of creating money or creating credit.

Most commonly, than, banks have been defined as dealers in debt. This definition, of course, more aptly describes a bank's activities. Sayers more clearly states: "We can define bank as an institution whose debts (bank deposits) are widely accepted in settlement of other people's debts to each other." Crowther, thus, puts it: "The banker's business is then, to take debts of other people, to offer his own in exchange and thereby to create money."

A banking company in India has been defined in the Banking Companies Act, 1949 as one "which transacts the business of banking which means the accepting, for the purpose of lending or investment, of deposits of money from the public, repayable on demand or otherwise and withdrawable by cheque, draft, order or otherwise. "

Acceptance of chequable demand deposits and lending them to others are the two distinctive features of a banking institution. On this account, Post Office Saving banks are not regarded as banks in the true sense of the term, since they do not lend money, even though some of them have introduced the cheque system. Similarly, there are other financial instiutions like the Unit Trust of India (UTI), the Life Insurance Corporation (LIC), the Industrial Finance Corporation of India (IFCI);-the Industrial Development Bank of India (IDBI), etc. which lend money to others but do not accept chequable demand deposits. Therefore, they are not regarded as banks. They are called non-banking fmancial institutions.

**Difference between Banking and Money-lending**

A banking business is, however, distinct from a pure money-lending business. A money-lender usually advances his own funds. A bank accepts deposits from the public, which are withdrawable by cheques, and the funds so accumulated are lent to its needy customers against goods or securities or by discounting bills. Further, the bank pays interest to its depositors, and the deposits are withdrawable by cheques. Money-lenders generally do not receive deposits from public, and even if they receive such deposits, it is not obligatory on their part to pay a uniform interest rate on such deposits; and these deposits are not chequable. Further, very often; when there is credit stringency, bankers may borrow from other banks or central bank to lend to their customers. Money-lenders obviously do not do so.

**8.6.3 KINDS OF BANKS**

Financial requirements in a modern economy are of a diverse nature, distinctive variety and large magnitude. Hence, different types of banks have been instituted to cater to the varying needs of the community.

Banks in the organised sector may, however, be classified into the following major forms:

(1) Commercial banks; (2) Co-operative banks;
(3) Specialised banks, and (4) Central bank.

**(1) Commercial Banks**

Commercial banks are joint stock companies dealing in money and credit. A commercial bank may be defined as a financial institution that accepts chequable deposits of money from the public and also uses the money with it for lending. The most distinctive function of a commercial bank is that it accepts deposits called demand deposits from the public which are chequable, *i.e.,* withdrawable by means of cheques. Acceptance of chequable deposits alone, however, does not give it the status of a bank. Its another essential function is to make use of these deposits for lending to others.

Commercial banks usually give short-term loans and advances. They occupy a dominant place in the money market. They, as a matter of fact, form the biggest component in the banking structure of any country. The commercial banks in India are governed by the Indian Banking Regulation Act, 1949 brought up to date to include additional rules thereto. Under the law, commercial banks are not supposed to do any other business, except banking.

In capitalist countries, like the UK and the USA, commercial banks are usually in the private sector, owned by shareholders. In socialist countries like Russia, they are completely nationalised. In France, however, though it has a capitalist economy, all commercial banks are state-owned.

**Commercial Banks in India**

In India, however, there is a mixed banking system. Prior to July 1969, all the commercial banks-73 scheduled and 26 non-scheduled banks. except the State Bank of India and its subsidiaries - were under the control of private sector. On July 19, 1969, however, 14 major commercial banks with deposits of over 50 crores were nationalised. In April, 1980, another six commercial banks of high standing were taken over by the government.

At present, there are 20 nationalised banks plus the State Bank of India and its 7 subsidiaries constituting public sector banking which controls over 90 per cent of the banking business in the country.

**(2) Co-operative Banks**

Co-operative banks are a group of financial institutions organlsed under the provisions of the Co-operative Societies Act of the states. These banks are essentially co-operative credit societies organised by members to meet their short-term and medium-term financial requirements..

The main object of co-operative banks is to provide cheap credit to their members. They are based on the principles of self-reliance and mutual co-operation.

The co-operative banking system in India is, however, small sized in comparison to the commercial banking system, Its credit outstanding is just less than one-fifth of the total credit outstanding of the commercial banks. Nonetheless, cooperative credit system is the main institutional source of rural, especially, agricultural finance in India.

Co-operative baking system in India has the shape of a pyramid *i.e.,* a three-tier structure, constituted by: *(i)* primary credit societies; *(ii)* central co-operative banks; and *(iii)* state co-operative banks.
Primary credit societies lie at the total or base level. In rural areas there are primary agricultural credit societies (PACs), which cater to the short and medium-term credit needs of the farmers.

In urban areas, to provide non-agricultural credit, urban co-operative banks and employees' credit societies are formed. Urban banks usually provide short-term loans to their members, who are small borrowers. They also accept deposits from members and non-members, too. Thus, their functions and working are more or less similar to those of commercials banks. But by nature, their form is only co-operative and that is a major distinction between these and commercial banks which are joint stock companies.

The Central Co-operative Banks (CCBs) are federations of primary societies belonging to a specific district. By furnishing credit to the primary societies, central co-operative banks serve as an important link between these societies and the money market of the country. No central co-operative bank lends to individuals. It lends to societies only. The State Co-operative Banks (SCBs) lie at the apex of the entire co-operative credit structure. Every State Co-operative Bank's basic function is to furnish loans to the central co-operative banks in order to enable them to help and to promote the lending activities of the primary credit societies. The State Cooperative Banks, thus, serve as the final link between the money market and the cooperative sector of the country.

**(3) Specialised Banks**
There are specialised forms of banks catering to some special needs with this unique nature of activities. There are, thus, foreign exchange banks, industrial banks, development banks, land development banks etc.

Foreign Exchange Banks or simply exchange banks are meant primarily to finance the foreign trade of a country. They deal in foreign exchange business, buying and selling of foreign currencies, discounting, accepting and collecting foreign bills of exchange. They also do ordinary banking business such as acceptance of deposits and advancing of loans, but in a limited way. In India, there are 15 foreign commercial banks basically undertaking such activities only.

Industrial Banks are primarily meant to cater to the financial needs of industrial undertakings. They provide long-term credit to industries for the purchase of machinery, equipments etc.

In India, there are some special financial institutions which are called "development banks". Presently, at the all-India level, there are five such industrial development banks: *(i)* the Industrial Development Bank of India (IDBI), *(ii)* the Industrial Finance Corporation of India (IFCI), *(iii)* the Industrial Reconstruction Corporation of India (IRCI), for large industries, *(iv)* the Industrial Credit and Investment Corporation of India '(ICICI), and *(v)* the National Small Industries Corporation (NSIC) catering to the needs of the small industries. All these institutions have been founded by the Government, except the ICICI which is owned by the private sector.

Similarly, at the state level, there are: *(i)* the State Financial Corporations (SFCs), *(ii)* the State Industrial Development Corporations (SIDCs), and *(iii)* the State Industrial Investment Corporations (SIICs) serving as industrial development banks.

Land Development Banks (LDBs) are meant to cater to the long and medium-term credit needs of agriculture in our country. They are mainly district level banks. Since the LDBs give loans to their members on the mortgage of land, previously they were called land mortgage banks. There are state land development banks at the top level and primary land development banks at the base or local level.

Agricultural Refinance and Development Corporation (ARDC) is a kind of agricultural development bank which provides medium and long-term finance to agriculture in our country. ARDC operates by making provisions of refinance to State Land Development Banks, State Co-operative Banks and Scheduled Commercial Banks which are its shareholders.

The Export-Import Bank of India (EXIM BANK) has been instituted for planning, promoting and developing exports and imports of the country.
In Western countries, there are specialised banks such as discount houses, investment banks, labour banks etc., catering to the specialised needs of the people.

### (4) Central Bank

A central bank is the apex financial institution in the banking and financial system of a country. It is regarded as the highest monetary authority in the country. It acts as the leader of the money market. It supervises controls and regulates the activities of the commercial banks. It is a service-oriented financial institution primarily concerned with the ordering, supervising, regulating and development of the banking system in the country. As the central bank is able to influence monetary and credit conditions and financial developments in a country, it is charged with the responsibility of carrying out the monetary and credit policies.

India's central bank is the Reserve Bank of India, established in 1935.

A central bank is usually state-owned. But it may also be a private organisation. For instance, the Reserve Bank of India (RBI), was started as a shareholders' organisation in 1935, however, it was nationalised after Independence, in 1949.

Although the central bank is state-owned, it functions as a semi-government institution, free from parliamentary control.

## 8.6.4 FUNCTIONS OF COMMERCIAL BANKS

Commercial banks perform several crucial functions, which may be classified into two categories: *(a)* Primary functions, and *(b)* Secondary functions.

Primary banking functions of the commercial banks include:
1. Acceptance of deposits from the public;
2. Lending of funds;
3. Use of cheque system; and
4. Remittance of funds.

### 1. Acceptance of Deposits from the Public

Accepting deposits is the primary function of a commercial bank. By receiving deposits from the public, commercial banks mobilise savings of the household sector.

Banks generally accept deposits in three types of accounts: *(i)* Current Account, *(ii)* Savings Account, and *(iii)* Fixed Deposits Account.

Deposits in Current Account are withdrawable by the depositors by cheques for any amounts to the extent of the balance at their credit, at any time without any prior notice. Deposits of current account are, thus, known as demand deposits. Such accounts are maintained by commercial and industrial firms and businessmen, and the cheque system is the most convenient and very safe mode of payment.

Savings Accounts are maintained for encouraging savings of households. Withdrawals of deposits from savings accounts are not freely allowed as in the case of current account. There are some restrictions on the amount to be withdrawn at a time and also on the number of withdrawals made during a period. Indian commercial banks have, however, relaxed these rules of savings accounts to a certain extent in recent times. Banks pay a rate of interest on the savings account deposits as, prescribed by the central bank.

Deposits in fixed account are time deposits. In the normal course, deposits cannot be withdrawn before the expiry of the specified time period of the deposits. A premature withdrawal is, however, permitted only at the cost of forfeiture of the interest payable, at least partly. On these deposits commercial banks pay higher rates of interest, and the rate becomes higher with the increase in duration.

By creating such varieties of deposits, banks motivate savers and depositors in a variety of ways and encourage savings in the economy. Further, by keeping deposits with banks, depositors' money is not only secured and remains in safe custody, but it yields interest also. Moreover, banks' demand deposits are in the form of liquid cash, for they serve as money to the business community and, therefore, is called bank money.

**2. Lending of Funds**

Another major function of commercial banks is to extend loans and advances out of the money which comes to them by way of deposits to businessmen and entrepreneurs against approved such as gold or silver bullion, government securities, easily saleable stocks and shares, and marketable goods.

Bank advances to customers may be made in many ways: *(i)* overdrafts, *(ii)* cash credits, *(iii)* discounting trade bills, *(iv)* money-at-call or very short-term advances, (*v*) term loans, *(vi)* consumer credit, *(vii)* miscellaneous advances.

*(i)* Overdraft: A commercial bank grants overdraft facility to an accountholder by which he is allowed to draw an amount in excess of the balance held in the account" up to the extent of stipulated limit. Overdraft is permissible in current account only, Suppose, a customer has Rs.50,000 in his current account with the bank. Bank grants him overdraft facility up to Rs.10,000. Then, this customer is entitled to issue cheques up to Rs.60,000 on his account. Obviously, the overdraft facility sanctioned up to Rs.10,000 by the bank in this case is as good as credit granted by the bank to that extent.

*(ii)* Cash Credit: Banks give credit in cash to business firms in industry and trade, against pledge or hypothecation of goods, or personal guarantee given by the borrowers. It is essentially, a drawing account against credit sanctioned by the bank and is operated like a current account on which an overdraft is sanctioned. It is the most popular mode of advance in the Indian banking system.

*(iii)* Discounting Trade Bills: The banks facilitate trade and commerce by discounting bills of exchange called trade bills. Traders often draw bill of exchange to meet their obligations in business transitions. Such a trade bill is payable in cash on maturity, after a stipulated date. But many times the holder of such bills may be in urgent need of cash before the maturity period. In such circumstances, he may seek help from the bank. Since trade bills are negotiable instruments, the bank will discount them. That is, the bank will pay cash to the endorser of trade bills, equivalent to the amount of bills minus the aount of discount. And, when the bill matures, the bank will claim the amount from the drawee (the person who is liable to honour the bill). Obviously, discounting of bills by the bank amounts to granting of credit to the parry concerned till the maturity date of the bill. This method of bank lending is widely adopted for two reasons: *(i)* such loans are self-liquidatory in character; and *(ii)* these trade bills are rediscountable with the central bank.

*(iv)* Money at Call or Very Short-term Advances: Bank also grant loans for a very short period, generally not exceeding 7 days to the borrowers, usually dealers or brokers in stock exchange markets against collateral securities like stock or equity shares, debentures, etc., offered by them. Such advances are repayable immediately at short notice hence, they are described as money at call or call money.

*(v)* Term Loans: Banks give term loans to traders, industrialists and now to agriculturists also against some collateral securities. Term loans are so-called because their maturity period varies between 1 to 10 years. Term loans as such provide intermediate or working capital funds to the borrowers. Sometimes, two or more banks may jointly provide large term loans to the borrower against a common security. Such loans are called participation loans or consortium finance.

*(vi)* Consumer Credit: Banks also grant credit to households in a limited amount to buy some durable consumer goods such as television sets, refrigerators, etc., or to meet some personal needs like payment of hospital bills, etc. Such consumer credit is made in a lump sum and is repayable in installments in a short time. Under the 20-point programme, the scope of consumer credit has been extended to cover expenses on marriage, funeral etc., as well.

*(vii)* Miscellaneous Advances: Among other forms of bank advances there are packing credits given to exporters for a short duration, export bills purchased/ discounted, import finance - advances against import bills, finance to the self-employed, credit to the public sector, credit to the cooperative sector and above all, credit to the weaker sections of the community at concessional rates.

**(3) Use of Cheque System**

It is a unique feature and function of banks that they have introduced the cheque system for the withdrawal of deposits.

There are two types of cheques: *(i)* the bearer cheque, and *(ii)* the crossed cheque. A bearer cheque is encashable immediately at the bank by its possessor. Since. it is negotiable, it serves as good as cash on transferability. A crossed cheque, on the other hand, is one that is crossed by two parallel lines on its face at the left hand corner and such a cheque is not immediately encashable. It has to be deposited only in the payee's account. It is not negotiable.
In modern business transactions, the use of cheques to settle debts is found to be much more convenient than the use of cash. Commercial banks, thus, render an important service by providing an inexpensive medium of exchange such as cheques. In fact, a cheque is also considered as the most developed credit instrument.

**(4) Remittance of Funds**

Commercial banks, on account of their network of branches throughout the country, also provide facilities to remit funds from one place to another for their customers by issuing bank drafts, mail transfers or telegraphic transfers on nominal commission charges. As compared to the postal money orders or other instruments, bank drafts have proved to be a much cheaper mode of transferring money and have helped the business community considerably.

In addition to these, commercial banks perform a multitude of other non-banking functions which may be classified as *(a)* agency service, and general utility services.

**Agency Services**

Bankers perform certain functions for and on behalf of their clients, such as:

*(a)* To collect or make payments for bills, cheques, promissory notes, interest, dividends, rents, subscriptions, insurance premia, etc. For these services, some charges are usually levied by the banks.

*(b)* To remit funds on behalf of the clients by drafts or mail or telegraphic transfers.

*(c)* To act as executor, trustee and attorney for the customers will.

*(d)* Sometimes, bankers also employ income-tax experts not only to prepare income-tax returns for their customers but also to help them to get refund of income-tax in appropriate cases.

*(e)* To work as correspondents, agents or representatives of their clients.

Often, bankers obtain passports, traveler's tickets, secure passages for their customers, and receive letters on their behalf.

**General Utility Service**

Modern commercial banks usually perform certain general utility services for the community, such as:

*(a)* Letters of credit may be given by the banks at the behest of the importer in favour of the exporter.

*(b)* Bank drafts and traveler's cheques are issued in order to provide facilities for transfer of funds from one part of the county to another.

*(c)* Banks may deal in foreign exchange or finance foreign trade by accepting or collecting foreign bills of exchange.

*(d)* Banks may act as referees with respect to the financial standing, business reputation, and respectability of customers;

(e) Shares floated by government, public bodies and corporations my be underwritten by banks;

(f) Certain banks arrange for safe deposit vaults, so that customers may entrust their securities and valuables to them for safe custody.

(g) Banks also compile statistics and business information relating to trade, commerce, and industry. Some banks may publish valuable journals or bulletins containing. research on financial, economic and commercial matters.

**Banks Play an Important Role in a Modern Economy**

(1) They constitute the very life-blood of modern trade, commerce and industry, as they provide the necessary funds for their working capital such as to buy raw materials, to pay wages, to incur current business expenses in marketing of goods, etc

(2) Banks encourage people's savings habit through their various savings deposit schemes.

(3) They also mobilise idle saving resources from household to business people for productive use.

(4) They transmit money from place to place with economy and safety.

(5) Their agency services are, no doubt, of immense value to the people at large, as they case their difficulties, save their time and energy and provide them safety and security.

## 8.7 Central Bank and Instruments of Credit Control

Central banking is a comparatively new phenomenon. In most countries, except England, the central bank is a twentieth century financial institution. In the U.S.A., the Central Bank of the Federal Reserve System was estabhshed in 1913; in India, the Reserve Bank of India was set up in 1935.

## 8.7.1 CENTRAL BANK: AN APEX FINANCIAL AUTHORITY

The essential feature of a central bank is its discretionary control over the monetary system of the country. A bank is called a central bank because it occupies a pivotal position in the monetary and banking structure of the country in which it operates. Thus, the central bank acts as the leader of the money market and in that capacity; it supervises, controls and regulates the activities of the commercial banks. It is recognised as the apex monetary institution or the highest financial authority.

The central bank has been defined by R.P. Kent as "institution charged with the responsibility of managing the expansion and contraction of the volume of money in the interest of the general public welfare. Thus, we may define the central bank as an institution whose main function is to help, control and stabilise the monetary and banking system of the country in the national economic interest.

The above stated definition of a central bank clearly justifies its need and importance. The banking system can work as a system only if there is an institution at the top to direct its activities. Without such a direction, the system would be nothing but a collection of unconnected units, each following an independent policy, often contradictory to one another. Thus, the central bank is essential to regulate the activities of commercial banks, integrate them, and direct their policies according to the best national economic interest.

## 8.7.2 FUNCTIONS OF A CENTRAL BANK

The powers and range of functions of central banks vary from country to country. But there are certain functions which are commonly performed by the central banks:

1. It issues the currency notes of the country.
2. It is the custodian of the foreign exchange reserves of the country.
3. It serves as banker to the government.
4. It serves as banker to commercial banks.
5. Being a monetary authority, it regulates the banks' credit creation activity and performs the function of a controller of credit.
6. If promotes the economic development of the country.

## 1. Central Bank as a Bank of Note Issue

The central bank is legally empowered to issue currency notes - legal tender. Commercial banks cannot issue currency notes. The central bank's right to issue notes gives it the sole or partial monopoly of note issue, while in India, the Reserve Bank of India has a partial monopoly of note issue, for example, one rupee notes are issued by the Ministry of Finance, but the rest of the notes are issued by the Reserve Bank.

According to De Kock, following are the main reasons for the concentration of the right of note issue in the central bank:

*(a)* It leads to uniformity in note circulation and its better regulation.

*(b)* It gives distinctive prestige to the note issue.

*(c)* It enables the State to exercise supervision over the irregularities and malpractices committed by the central bank in the issue of notes.

*(d)* It gives the central bank some measure of control over undue credit expansion by the commercial banks, since expansion of credit obviously leads to an increased demand for note currency.

The central bank keeps three considerations in mind while issuing currency notes, namely, uniformity, elasticity and security. The right of note issue is regulated by law. According to law, every note issued must be matched with an asset of equal value (assets such as, government securities, gold and foreign currencies, and securities). This is necessary to inspire public confidence in paper currency.

## 2. Central Bank as a Custodian of Foreign Exchange Reserves

The central bank holds all foreign exchange reserves - key currencies such as U.S. dollars, British pounds, and other prominent currencies, gold stock, gold bullion, and other such reserves - in its custody. This right of the central bank enables it to exercise a reasonable control over foreign exchange, for example, to maintain the country's international liquidity position at a safe margin and to maintain the external value of the country's currency in terms of key foreign currencies.

## 3. Central Bank as Banker to Government

As the government's banker, the central bank maintains the banking accounts of government departments, boards, and enterprises and performs the same functions as a commercial bank ordinarily performs for its customers. It accepts deposits of commercial banks and undertakes the collection of cheques and drafts drawn on the bank; it supplies government with the cash required for payment of salaries and wages to their staff and other cash disbursements and transfer funds of the government from one account to another or from one place to another. Moreover, it also advances short-term loans to the government in anticipation of the collection of taxes and raises loans from the public. It also makes extraordinary advances during periods of depression, war, or other national emergencies. In addition, the central bank renders a very useful banking exchange required to meet the repayment of debts and service charges or for the purchase of goods and other disbursements abroad, and by buying any surplus foreign exchange which may accrue to the government from foreign loans or other sources.

The central bank also serves as an agent and adviser to the government. As agent of the government, it is entrusted with the task of managing the public debt and the issue of new loans and treasury bills on behalf of the government. It also underwrites unsold government securities. Moreover, the central bank is the fiscal agent to the government and receives taxes and other payments on government account. By acting as financial adviser to the government, the central bank discharges another important service: it advises the government on important matters of economic policy such as deficit financing, devaluation of currency, trade policy and foreign exchange policy.

The central bank also functions as a representative of the State in international financial matters. It is entrusted with the task of maintaining the nation's reserves of international currency.

## 4. Central Bank as Banker to Commercial Banks

Broadly speaking, the central bank functions as banker to commercial banks in three capacities: *(i)* as custodian of cash reserves of commercial banks; *(ii)* as lender of last resort; and *(iii)* as clearing agent.

Thus, the central bank acts, as a conductor and leader of the banking system of the country. It acts as a friend, philosopher, and guide to commercial banks.

*(i) Custodian of cash reserves of commercial banks:* Commercial banks find it convenient to keep their reserve requirements with the central bank because its notes command the greatest confidence and prestige and the government's banking transactions are conducted by this institution. Thus, in every country, commercial banks keep a certain percentage of their cash reserves with the central bank by custom or by law.

In fact, the establishment of central banks makes it possible for the banking system to secure the advantages of centralised cash reserves. The significance of centralised cash reserves lies in the following facts:

*(a)* Centralisation of cash reserves in the central bank is a source of great strength to the banking system of the country as it inspires the confidence of the public in the commercial banks.

*(b)* Centralised cash reserves can form the basis of a much longer and more elastic credit structure than those scattered among numerous individual commercial banks. .

*(c)* Centralised cash reserves enable the central bank to provide additional funds to those banks which are in temporary difficulties. In fact, the central bank can function as lender of the last resort on the basis of the centralized cash reserves with it.

*(d)* Centralisation of cash reserves is conducive to the growth of the economy and to the increased elasticity and liquidity of the banking system in particular and of the credit structure in general. .

*(e)* Centralisation of cash reserves also enables the central bank to influence and control credit creation of commercial banks by increasing or decreasing the cash reserves of the latter, that is, through the technique of the variable reserve ratio.

*(ii) Lender of the last resort:* As lender of last resort, in periods of credit stringency, the central bank gives temporary financial accommodation to commercial banks by rediscounting their eligible bills. The central bank is the ultimate source of money in the modern credit system. The function of the lender of last resort implies that the central bank assumes the responsibility of meeting directly or indirectly all reasonable demands for accommodation from commercial banks.

The central bank's function as lender of last resort has evolved out of its rediscounting function during emergency periods. The real significance of rediscount functions according to De. Kock, lies in the fact that it increases the elasticity and liquidity of the entire credit structure.

By providing a ready medium for the conversion in cash of certain assets of banks. It helps to maintain their liquidity. It also makes possible a considerable degree of economy in the use of cash reserves, since commercial banks can conduct a large volume of business with the same reserve and capital.

*(iii) Clearing Agent:* As the central bank becomes the custodian of cash reserves of commercial banks, it is but logical for it to act as a settlement bank or a clearing house for other banks. As all banks have their accounts with the central bank, the claims of banks against each other are settled by simple transfers from and to their accounts. This method of settling accounts through the central bank, apart from being convenient, is economical as regards the use of cash. Since claims are adjusted through accounts, there is usually no need for cash. It also strengthens the banking system by reducing withdrawals of cash in times of crisis. Furthermore, it keeps the central bank of informed about the state of liquidity of commercial banks in regard to their assets.

**5. Central Bank as Controller of Credit**

By far the most important of all functions of the central bank in modern times is that of controlling credit operations of commercial banks. Credit, the source of many blessings in a modern economy, also may become, unless we control it, a source of confusion and peril. The social and economic consequences of changes in the purchasing power of money are serious and since credit plays a predominant part in the settlement of business transactions, it is essential that it should be subjected to control. Monetary policy is implemented by the central bank through the weapon of credit control.

**6. Central Bank as Promoter of Economic Development**

The modern central bank accomplishes a number of development and promotional functions. Today, the central bank is regarded as an inevitable agency for promoting the economic growth of a country. It is an institution responsible for the maintenance of economic stability and for assisting the growth of the economy within the framework of the general economic policy of the State. Thus, the central bank has to take all such steps as are necessary, to meet the economic requirements of economic development of the country.

It is responsible for the development of an adequate and sound banking system to cater to the needs not only of the trade and commerce but also of agriculture and industry. The central bank has to ensure, in the interest of economic progress, that the commercial banks operate on a reasonably sound and prudent basis.

Thus, the major task of the central bank lies in the development of highly organised money and capital markets that many help accelerate economic progress by assisting the huge investment activities in capital formation and other productive sectors. During the planning era, the central bank's role as adviser to government on economic matters in general, and on financial matters in particular, is of considerable importance.

Thus, the central bank of a developing country has an important role to play in the process of development. In underdeveloped countries, the central bank has not only to provide adequate funds and to control inflation, through credit regulation, but it also has to undertake the responsibility of spreading banking facilities, providing credit at cheap rates to agriculture and industry, protecting the market for government securities and channeling credit into desirable avenues. Moreover, in underdeveloped countries, there are institutional gaps in the money and capital markets which hinder economic growth. The banking system is not properly organised as a large section of the money market consists of unorganised, indigenous bankers. Thus, promotion of sound, organised, well-integrated institutions and agencies of money and capital market becomes an important function of a central bank in a developing economy. From deficiency of non-existence of institutions such as savings banks, agricultural credit agencies, insurance companies, and the like to collect and mobilise savings and make them available for productive investments is the main cause of the low rate of capital formation. Hence, the growth of such institutions in these countries is a precondition for capital formation which is a key to economic development. Evidently, therefore, the central bank of a developing country has a vital role to play in building such financial infrastructure for rapid economic development.

As the Planning Commission of India puts it, central banking has to take "a direct and active role, first, in creating or helping to create the machinery needed for financing development activities allover the country and secondly, in ensuring that the finance available flows in the directions intended."
The central bank also collects and disseminates economic statistics of a wider range. As such, the government of the country has to lean heavily upon the central bank for seeking economic and financial advice in the course of development planning.

In addition, the central bank may also undertake miscellaneous functions such as providing assistance to farmers through co-operative societies by subscribing to their share capital, promoting finance corporations with a view to providing loans to large-scale and small-scale industries, and publishing statistical reports on trends in the money and capital markets.
In short, a central bank is an institution which always works in the best economic interests of the nation as a whole.

In view of all these functions, as discussed above, it follows that a modern central bank is much more than a Bank of Issue.
Chart 1 summarises the functions of a central bank.

**Chart I: Functions of Central Bank**

Functions of Central Bank
|
Monopoly of Note Issue
|
Custodian of Exchange Reserves
|
Banker to the Government
|
Banker to Commercial Banks
|
Controller of Credit
|
Promoter of Economic Development

### 8.7.3 FUNCTIONS OF RESERVE BANK OF INDIA

The Reserve Bank of India was set up on 1st April, 1935. The central office of the bank is located in Bombay.
The Reserve Bank of India renders all the functions of a good central bank. Its major functions are as follows:

**1. Monetary Management**

The Reserve Bank of India is mainly constituted as an apex authority for monetary management.

According to the Preamble to the Reserve Bank of India Act, 1934, the basic function of the bank is to "regulate the issue of bank notes and the keeping of reserves with a view to securing monetary stability in India and generally to operate the currency and credit system of the country to its advantage."

The Reserve Bank controls and regulates the flow of credit in the economy. It uses quantitative controlling weapons, such as bank rate policy, open market operations, and the reserve ratio requirement. Since 1956, it has increasingly relied on and resorted to selective credit controls for accelerating the rate of growth and for checking inflationary spurts.

**2. Issue of Bank Notes**

The Reserve Bank has the sole right to issue currency notes, except one rupee notes - which are issued by the Ministry of Finance. The RBI follows a minimum reserve system in note issue. Initially, it used to keep forty per cent of gold reserves in its total assets. But, since 1957, it has to maintain only Rs. 200 crores of gold and foreign exchange reserves.

**3. Custodian of Exchange Reserves**

The Bank has been entrusted with the responsibility of maintaining the exchange value of the rupee. It has the custody and management of the country's international reserves.

**4. Banker to the Government**

It is obligatory for the RBI to transact government business. It has to maintain and operate the government's deposit accounts. It collects receipts of funds and makes payments on behalf of the government. It represents the Government of India as the member of the IMF and the World Bank.

**5. A Banker's Bank**

According to the Banking Companies' Act of 1949, originally, each scheduled bank has to maintain with the Reserve Bank of India a balance equal to five per cent of its demand liabilities and two per cent of its time liabilities. The Act, amended in 1962, specifies that three per cent of the total liabilities should be kept as reserve requirement.

The Reserve Bank of India also serves as lender of last resort, by rediscounting eligible bills of exchange of commercial banks, during the period of credit stringency.

**6. Promoter of Development**

The bank performs a number of developmental and promotional functions. Apart from credit regulation, the Reserve Bank effectively channelises credit, especially to priority sectors, such as agriculture, exports, transport operations, and small-scale industries. It makes institutional arrangements for rural and industrial finance. For instance, special agricultural credit cells have been set up by the bank. The Industrial Development Bank of India has been set up to solve the allied problems of the industries.

The bank also assists the government in its economic planning. The bank's credit planning is devised and coordinated with the five year plans of the country. The bank also collects statistical data and economic information through its research departments. It compiles data on the working of commercial and co-operative banks, on balance of payments, company and government finances, security markets, price trends, and credit measures. It publishes a monthly bulletin, with weekly statistical supplements and annual reports, which present a good deal of periodical reviews and comments pertaining to general economic, financial and banking developments, including the bank's monetary policy and measures, adopted for the qualitative and quantitative monetary management.

### 8.7.4 CENTRAL BANK AND MONETARY MANAGEMENT

The significance of a central bank lies in its function of managing the monetary system of the country. It also maintains the monetary standard for the country, internally as well as externally. In the absence of a central bank, the management of the monetary system lies in the hands of the government. But the government cannot carry out this function of monetary management as well as a central bank can, because the government does not have the requisite facilities, in the absence of an apex monetary institution, to know the money market intimately and to recognise its requirements under various changing conditions. Moreover, the government may pursue a monetary policy which is politically biased, and which is, therefore, undesirable in the general interest of the nation. Again, under a democratic set-up, the party in government is subject to change so that it is quite likely that there will be lack of continuity in the pursuit of a uniform and continuous monetary policy. Also, every political party has its own rationale, on fiscal and monetary objectives. Very rarely in history has a country been as fortunate as to be blessed with major political parties which have held nearly identical views on such objectives. This has been a characteristic of human life from the beginning but differences of opinion have deepened since the middle of the 19th century. This political disharmony has traveled like a tidal wave and, today, every country suffers from the uncertainty of a uniform fiscal and monetary policy. A discontinuous, irrational monetary policy followed by the government harms the nation as a whole. Thus, a permanent body, a financial institution, like the central bank acting as an autonomous organisation is inevitable. A central bank though it is nationalised in most cases and is a semi-government institution, is free from the influence of political parties or motives. By the nature of its business, it is intimately connected with the banking system and money market of the country and can definitely regulate the monetary system of the country in the general interest of the nation. Hence, a central bank is an indispensable institution for monetary and financial management in any economy. The mere establishment of a central, autonomous financial authority, however, does not guarantee freedom from political influences. Such an authority can only be created by statute, *i.e.* a law of the national legislature. This financial authority, therefore, is called a Statutory Body. However, a party in power, at a given time, can always amend, rescind or replace the statute by a new statute which will specify regulation aimed at making the central financial authority *a functionary* of government *(i.e.,* a party in a democracy) in power and *not a functional institution.* This is the present position as it exists today.

The modern economy is a credit economy. Credit has assumed increasingly wide significance in sustaining the base of the modern economic system. The entire financial structure of the present money economy is founded upon the base of the credit system.

Although credit is a concomitant of modern economic advancement, it is like money, a weapon, the misuse of which spells disaster to the system. Credit, the source of many blessings in a modern economy, also becomes, unless we can control it, a source of confusion and peril. The social and economic consequences of changes in the purchasing power of money are serious and, since credit plays a predominant part in settlement of business transactions, it is essential that credit should be subjected to control. On the need for control of credit De Kock writes, "For many years it has been almost universally accepted that the creation and distribution of credit, under the intricate economic organisation existing in most counties, should be subjected to some form of control. The main reason for this was that comes to play a predominant part in the settlement of monetary and business transactions of all kinds, and thus to represent a powerful force for good or evil."

The control of credit is recognised as the main function of a central bank. It is a function which embraces, the most important questions of central banking policy. In fact, the heart of monetary policy lies in control, *i.e.,* monetary management.

**Objectives of Credit Control**

The important objectives of credit control may be listed as follows:

1. *Stabilisation of the general price level.* The traditional objective of credit control was that of keeping exchange rates stable through the medium of a mono-metallic or bi-metallic standard. But, in recent times, greater importance is attached to the stabilisation of prices as the ultimate goal of a central bank's credit control policy. Stabilisation of the general price level and hence stability of the value of money were considered essential for the smooth operation of the economic system and for national economic welfare.

2. *Stabilisation of the money market:* Some economists stress that the credit control policy of a central bank should aim at the stabilisation of the money market. Credit control should be such that demand and supply be adjusted at all times. However, this objective has not been widely recognised because it is incompatible with the goal of stabilising the other phase of economic activity.

*3.* *Promoting economic growth.* It is widely realised that credit control should be conducive to economic growth. It should not act as an inhibitory factor. It should promote and maintain a high level of employment and income.

**8.7.5 INSTRUMENTS OF CREDIT CONTROL**

Under the monetary management of the central bank, credit control stimulates expansion of credit at one time and checks it at another. The principal instruments of credit control, at the disposal of the central bank, may be classified as:

(1) quantitative or general, and (2) qualitative or selective.

The general instruments are directed towards influencing the total volume of credit in the banking system, without special regard for the use of which it is put. Selection or qualitative instruments of credit control, on the other hand, are directed towards the particular use of credit and not its total volume.

Quantitative weapons of credit control consist of *(a)* bank rate policy; *(b)* open market operations; and *(c)* variable reserve ratios.
These methods have a quantitative or a general effect on credit regulation. They are used for changing the total volume of credit or the terms on which bank credit is available, without regard for the purpose for which credit is used by borrowers. But the central bank today, also, makes use of certain qualitative or selective methods by which it controls, in addition to the aggregate volume of credit, the flow of credit in particular directions.
Selective credit control aims at regulating (stimulating or restricting) the uses to which credit are put. The main methods of selective credit control are: *(a)* margin requirements; *(b)* regulation of customer's credit; *(c)* control through directives; *(d)* rationing of credit; *(e)* moral suasion and publicity; and *(f)* direct action.

## 7.6 BANK RATE POLICY (BRP)

The bank rate is a traditional weapon of credit control used by a central bank. In order to perform its function as lender of last resort to commercial banks, it will discount first-class bills or advance loans against approved securities.

A specific idea regarding the technique of bank rate can be had from the Reserve Bank of India's definition of the bank rate policy which consists of varying the terms and conditions under which the market may have temporary access to the central bank through discounts of selected short-term assets or through secured advances. Thus, the bank rate policy seeks to influence both the cost and availability of credit to members of the bank. Cost, of course, is determined by the discount rate charged, and the availability depends largely upon the statutory requirements of eligibility of bills for discounting and advances, as also the maximum period for which the credit is available.

The bank rate obviously is distinct from the market rate. The former is the rate of discount of the central bank, while the latter is the lending rate charged in the money market by the ordinary financial institutions.

**The "Modus Operandi" of Bank Rate**

The bank rate policy signifies manipulation of the rate of discount by the central bank in order to influence the credit situation in the economy. The principle underlying the bank rate policy is that changes in bank rate are generally followed by corresponding changes in the money market rates, making credit costlier or cheaper, and affecting its demand and supply.

If the bank rate is raised, its immediate effect is to cause an increase in bank's deposit and lending rates. The prices which bankers are prepared to pay on the amounts deposited with them by their customers increase, so that the volume of the bank deposits increases. Commercial banks employ a substantial proportion of the funds deposited with them to form the basis of loans and advances that they make to their customers, and in as much as the banks are now paying more for these deposits, they must charge higher rates for loans and advances made to their customers. So when the central bank raises the bank rate, the cost of borrowing of the commercial banks will increase, so that they will also charge higher rates for loans and advances made to their customers.

So when the central bank raises the bank rate, the cost of borrowing of the commercial banks will increase, so that they will also charge a higher interest rate on loans to their customers and, thus, the market rate of interest will go up. This means that the price of credit will increase. As many business operations are normally conducted on the basis of bank loans, the price (interest) which has to be paid for this accommodation is, of course, a charge against profit to the business. In consequence, the sudden increase in the interest rate will reduce or wipe out the profit of the business, so that industrial and commercial borrowers reduce their borrowings.

In other words, increased market rate or increase in the cost of borrowing will discourage business activity, *i.e.,* their demand for credit falls. As a result of the contraction of demand for credit, the volume of bank loans and advances is appreciably curtailed. This, in effect, will check business and investment activity so that unemployment will ensue. Consequently, income in general will fall, people's purchasing power will decrease and aggregate demand will fall. This, in turn, will affect the entrepreneurs adversely. When demand falls, prices will come down, and, as a result, profit will decline. The rate of investment is basically determined by the rate of profitability, and thus, in view of falling profits, investment activities will contract further. So, a cumulative, downward movement in the economy sets in.

In brief, an increase in the bank rate leads to a rise in the rate of interest and contraction of credit, which, in turn, adversely affects investment activities and consequently, the economy as a whole.

Similarly, a lowering of the bank rate will have a reverse effect. When the bank rate is lowered, the money market rates fall. Credit, then, becomes cheaply available and the business community will come forward to borrow more. Thus, the expansion of credit will increase investment activities, leading to an increase in employment, income and output. Aggregate demand will increase, prices will rise, and profits will increase which, in turn, will boost production and investment activities further. Consequently, a cumulative upturn of the economy will develop.

**Limitations of Bank Rate Policy**

The following are the chief limitations of bank rate policy:

*(i)* Existence of an Organised and Developed Money Market. Efficacy of the bank rate in controlling credit requires a close correspondence between the bank rate and the structure of interest rates in the money market, so that changes in the bank rate will be followed by changes in the market rates. This presupposes the existence of a highly organised money market. Unfortunately, most underdeveloped countries do not have an organised money market. The wide range and multiplicity of money rates in such an organised money market will make the success of the bank rate policy doubtful. The absence of any conventional relationship between the central bank and other segments of the money market will further add to the ineffectiveness of the bank rate policy.

*(ii)* Existence of Well-developed Bill Market. The canons of eligibility for rediscounting bills by the central bank presupposes, in the operation of the bank rate policy, a soundly developed bill market. Underdeveloped bill markets, thus, limit the bank rate operations. Further, in an unorganised money market like that of India, where the indigenous, unorganised monetary sector lies beyond the ambit of control of the central bank.

*(iii)* Banks' Need for Rediscounting. The need for commercial banks to approach the central bank for rediscounting facilities is an important factor in determining the successful working of the bank rate policy. But commercial banks will have no need to approach the central bank when they have ample liquid resources at their disposal, *i.e.,* when they have enough excess resources.

*(iv)* Practice of Free Exchange Rate System. The successful operation of the bank rate policy in correcting the balance of payments disequilibrium of the country presupposes an economic system in which prices, wages, and interest levels are readily movable, *i.e.,* the economic structure is elastic, the country is on the gold standard and there are no artificial exchange restrictions on the international flow of capital. Obviously, due to the world-wide suspension of the gold standard, government control over prices, wages etc. and artificial exchange restrictions have considerably limited the influence of the bank rate policy.

*(v)* Business Expectations. The psychological reaction to a change in the bank rate should also be considered for the effectiveness of the bank rate policy. If, in a boom period, businessmen are unduly optimistic, their demand for credit will be interest-inelastic and the bank rate will be ineffective. Similarly, during a depression, when businessmen are pessimistic, they will not respond favourably to the incentive of low interest rates.

*(vi)* Interest-inelasticity of Bank Deposits. The axiom that a rise in the bank rate and, thus a rise in interest rates payable on deposits by commercial banks will cause an increase in bank deposits is questionable. A large majority of people save because of the precautionary motive, and their savings depend on their earning capacity, *i.e.,* their income. These savers do look for a rise in the interest rates on deposits, but they usually deposit with banks for the purpose of safety. Thus, it is actually the increases in income rather than interest rate that promote savings by the people which augment bank deposits.

Again, rediscounting of bills by commercial banks is a precondition for the effective working of the bank rate. If rediscounting is a regular practice, it will result in the establishment of a sensitive connection between the market rates and the bank rate. If the practice is only occasional, the market rates may be out of tune with the bank rate. In unorganised money markets, banks usually operate with high cash reserves, so that they do not feel the need to borrow from the central bank. In predominantly agricultural underdeveloped countries, with unorganised money markets, commercial banks find it difficult to secure sound proposals for the investment of their funds; to that extent they are forced to keep their cash balances idle. As a result, they do not need to borrow from the central bank. Besides, the lack of adequate papers eligible for rediscounting in underdeveloped countries also severely limits the significance and operational of the bank rate as a discount rate.

Moreover, commercial banks in such countries are accustomed to rely on themselves to ensure liquidity of their assets because of wide seasonal fluctuations and this has necessitated their keeping high cash reserves. A historical reason for this is that in most of these countries, the central banks were started in the thirties, when a cheap money policy had to be followed, for revival after the Great Depression, and conditions were not favourable to the growth of the practice of rediscounting.

The demand for bank advances being very low, banks had enough cash balances which rendered rediscounting or borrowing from the central bank unnecessary and superfluous. Prof. Sen summarises this fact in the following words: "The absence of rediscounting practices is, therefore, to be explained by the pursuit of a cheap money policy, the habit of banks of keep comparatively large cash reserves, and the lack of demand for bank advances following the onset of the world trade depression of the thirties."

Furthermore, in undeveloped money markets, the bank rate is not generally a "penal" rate, because interest rate in the indigenous banking sector are higher than the bank rate. Thus, the axiom that money rates should follow the bank rate scarcely materialises under such conditions.

Another important factor is that the efficacy of the bank rate demands sufficient elasticity in the economic system, so that cost reduction, prices, and trade tend to adjust with changed conditions. This condition is, however, rarely fulfilled even if developed economies. It is, therefore, meaningless to expect such an economic condition in underdeveloped countries with their bottlenecks and imperfections.

Sir Mitra has observed: "In developing nations with planned economies where the public sector accounts for the larger part of the nation's Investment is equipped with a set of more direct and powerful instruments, the bank rate loses much of its importance and is, in fact, relegated to a secondary place."

Anyway, the Bank rate has great psychological value as an instrument of credit control and enhances the prestige of the central bank. The bank rate is generally a reflection of the central bank's opinion of the credit situation and economic position in the country. As Gibson said, a rise in the bank rate may be regarded as "the amber coloured light" of warning to commercial credit and business activities while a fall in bank rate may be looked upon as "the green light" indicating that the coast is clear and the ship of commerce may proceed on her way with caution."

In conclusion, although it must be admitted that the bank rate policy has very limited significance in underdeveloped as well as developed money markets in view of the present day conditions and government policies, it has nevertheless a useful function to perform in conjunction with other measures of credit control. Central banks of the present day, however, have to rely more upon other instruments of credit control than the bank rate policy alone in regulating the cost, availability and supply of credit money.

## 8.7.7 OPEN MARKET OPERATIONS

Open market operations imply deliberate direct sales and purchases of securities and bills in the market by the central bank on its own initiative to control the volume of credit. In a broad sense, open market operations simply imply the purchase or sale by the central bank of any kind of eligible paper like government securities or any other public securities, or trade bills, etc. In practice, however, the term is applied, in most countries, to the purchase or sale of government securities (short-term as well as long-term) only by the central banks.

Working of Open Market Operations: When the central bank sells securities in the open market, other things being equal, the cash reserves of the commercial banks decrease to the extent that they purchase these securities; by selling securities, the central bank also reduces, other thing being equal, the amount of customers' deposits with commercial banks to the extent that these customers acquire the securities sold by the central bank. In effect, the credit-creating base of commercial bank is reduced and hence credit contracts.

In short, the open market sale of securities by the central bank leads to a contraction of credit and reduction in the quantity of money in circulation. Conversely, when the central bank purchases securities in the open market, if makes payments to the sellers by cheques drawn on itself, the sellers usually being commercial banks or customers of commercial banks. The banker's accounts are credited and, therefore, there is an increase in the commercial banks' cash reserve (which is the base of credit creation) and as also an increase in the customers' deposits with commercial banks (which is the principal constituent of money supply.)

In short, open market purchases of securities by the central bank lead to an expansion of credit made possible by strengthening the cash reserves of the banks. Thus, on account of open market operations, the quantity of money in circulation changes. This tends to bring about changes in money rates. An increase in the supply of money through open market operations causes a downward movement in the money rates, while a decrease of money supply raises money rates. Open market operations, therefore, directly affect the loanable resources of the banks and the rates of interest. Changes in rates of interest in turn tend to bring about the desired adjustments in the domestic level of prices, costs, production and trade.

In short, the central bank follows a policy of open market selling of securities when contraction of credit is desired, especially during a boom period when the stability of the money market is threatened by the over-expansion of credit by commercial banks. Conversely, during a depression when the money market is tight and expansion of credit is desired, the central bank follows the policy of open market buying of securities.

**Limitations of Open Market Operations**

The following are the major limitations of open market operations:

1. Lack of well-developed securities market. There must be a broad, strong and active securities market for large-scale and successful open market operations. Lack of such a market renders open market policy ineffective.
2. Contradictions between bank rate and open market operation. The sale of securities by the central bank may prove ineffective in curbing the loanable resources of the banks so long as the possibility of rediscounting leaves the door open to replenish the reserve as before.
3. Restricted dealings. The success of open market operations is limited by the preparedness of the central bank to incur losses. In the case of short-term securities, the loss is relatively less. Therefore, open market operations are often restricted to dealings in short-term securities only.
4. Difficulties in execution. To execute a purchase policy by the central bank is not as difficult as the sale of securities in open market operations. Similarly, for commercial banks, a policy of credit contraction is easier to implement than a policy of expansion. Thus, by the operation of money factors alone, "open market operations can stop booms but cannot prevent slumps."
5. Precautions for stabilising the government securities market. Another drawback of the open market operations policy is that when a large-scale of securities is effected by the central bank, the prices of securities adversely affect bank assets and upset the government's borrowing programme. In such conditions, the central bank has to stabilise the securities market and, to that extent, the scope of open market operations to influence the credit situation is limited.

6. Assumption of a constant velocity. The theory of open market operations assumes that the circulation of bank deposits and legal tender money has a constant velocity. However, in practice, these conditional relationships are difficult to obtain always. In the first place, neither will the cash reserve of commercial banks, nor the quantity of money in circulation always increase or decrease in proportion to the purchase or sale of securities respectively by the central bank. This can happen if there is another disturbing factor operating simultaneously. For instance, the effect of the purchase of securities by the central bank on the supply of bank cash may be neutralised, partly or fully, by the outflow of capital, or by an unfavourable balance of payments or by the withdrawal of deposits by the public for hoarding purposes. Likewise, an inflow of capital or dishoarding may neutralise the effect of the sale of securities by the central bank. .

Secondly, commercial banks do not always either expand or contract credit in accordance with the change in their cash reserves. According to De Kock, "there are many circumstances of money, economic or political nature, which may deter a commercial bank from employing increased cash reserves fully, if at all or from contracting credit when its resaves are reduced." Moreover, with regard to the relation between an increase in the credit base, *i.e.,* cash reserves, and the creation of credit, there are certain technical factors which must be taken into consideration by all banks. For instance, unless the banking system, as a whole, adopts a policy of credit expansion, the expanding banks would tend to lose some part of their cash reserves to the non-expanding banks and might, thus, be compelled to contract again.
In many countries, a rigid cash ratio is not maintained by the commercial banks and hence, open market operations are not effective. Thus, under favourable conditions of credit expansion and insufficient demand for credit on the part of borrowers, an increase in the cash reserves cannot produce its proportionate effect on credit expansion.

Notwithstanding these limitations, open market operations are a useful instrument of monetary policy. They constitute a more direct and effective way of controlling credit than the bank rate policy.

**Usefulness of Open Market Operations**

The open market operations policy of the central bank can serve the following purposes:

(1) As a complementary to the bank rate policy it tends to enhance the efficacy of the bank rate. It may be used to prepare the ground for changes in the bank rate. When credit contraction is desired, the central bank may raise bank rates as well as sell securities in the open market, so that the cash reserves (credit base) of banks are also reduced. Conversely, when central bank may, at the same time, buy securities in the open market and, thus, provide additional cash to commercial banks to enable them to increase their advances.

(2) It assists government borrowings. By purchasing government bills and bonds and such other securities when the prices are low and selling them when their prices are high, the central bank can maintain stability in the prices of government securities and thereby promote public confidence in the instruments of public debt.

(3) It may be useful in contracting extreme trends in business by buying securities during periods of slack business and selling them in period of inflationary boom.

(4) It may be adopted to influence the balance of payments position favourably. Open market sales operations, for instance, will have a contractionary effect on credit and a deflationary situation will develop so that the domestic price level will fall. Exports will be encouraged due to increased foreign demand on account of lower prices, whereas, imports will be restricted due to high costs of foreign goods. Thus, a favourable balance of payments will follow.

On these accounts, open market operations have come to be recognised as an important technique of monetary management. The growing importance of open market operations is due to the decline of bank rate as an instrument of credit control after the first war and the consequent need for another and more direct method. In the thirties, open market operations became necessary in order to implement the policy of cheap money.

**Superiority of Open Market Operations**

As a method of influencing money supply, open market operations are superior to bank rate because the initiative lies in the hands of the monetary authority, in the case of the former, while it rests with the commercial banks in the case of the latter. In other words, while bank rate policy is only an indirect way of controlling credit, open market operations are more direct. Moreover, the bank rate directly affects only short-term interest rates; long-term rates are affected only indirectly. Open market operations, on the other hand, have a direct influence on the prices of long-term securities and, therefore, on long-term interest rates. They have a direct and immediate effect on the supply of money and credit and, therefore, on money and interest rates. Thus, this method is largely used nowadays to influence interest rates in the country and prices of government securities in the market.

In the opinion of some economists, however, open market operations can achieve little. They can be successful only as a supplement to the discount rate policy. Keynes, on the other hand, maintains that open market operations, undertaken extensively and skillfully, could achieve the purpose without a discount rate policy, if they are supplemented by state organisation of investment or, failing this, by compensatory planning or public works. However, the general opinion is that open market operations must always be supplementary to the bank rate policy.

**Relation between BRP and OMO**

Both these weapons of credit control have their merits and demerits (as discussed above). Each, by itself, will not succeed in producing the desired result, and, therefore, must be supplemented by the others in order to be effective. For instance, when the bank rate is raised, with a view to controlling credit, open market sales of securities should follow so that credit contraction will be more effective. However, if the bank rate is raised and the open market purchase policy is adopted *simultaneously,* the rise in the bank rate will prove to be ineffective, because banks will then increase their cash reserve by selling securities.

They will not, then, feel the necessity of rediscounting bills. Conversely, if the open market purchase policy is adopted, with a view to credit expansion, a simultaneous decrease in the bank rate will help in achieving the desired goal.

In fine, therefore, it can be said that the efficiency of the bank rate and of the open market policy are interrelated. Open market operations are generally undertaken to prepare the market for changes in the bank rate, which has far reaching influence over the market. .

However, as the Reserve Bank of India itself admitted, open market operations in India have not been solely designed to suit the role of a full fledged instrument of credit control. But, open market operations can be carried out for sundry purposes and some of these may achieve success in the underdeveloped money markets of the backward countries. These countries may very well undertake open market operations in order to neutralise seasonal movements in the economy. In busy seasons, the credit stringency can be relaxed by releasing excess liquidity through open market purchase operations.

In India, open market operations have been resorted to more for the purpose of assisting the government in its borrowing operations and for maintaining orderly conditions in government securities market than for influencing the availability and cost of credit. The objectives of what is called grooming the market, such as acquiring securities nearing maturity to facilitate redemption and to make available on tap a variety of loans to broaden the gilt-edged market, have been more striking features of the open market operations in India.

### 8.7.8 VARIABLE CASH RESERVE RATIO (VCRR)

The variable cash reserve ratio is comparatively new method of credit control used by central banks in recent times. In 1935, the U.S.A.'s Federal Reserve System adopted it, for the first time. In countries where the money market is unorganised or underdeveloped, increasing recourse is now taken to this method of credit control.
The variable reserve ratio device springs from the fact that the central bank, in its capacity as *Bankers' Bank,* must hold a part of the cash reserves of commercial banks. The minimum balances to be maintained by the member banks with the central bank are fixed by law and statutory powers have been conferred on the central bank to alter the quantum of these minimum reserves. The customary minimum cash reserve ratio is an important limitation on the lending capacity of banks. Thus, variations in the reserve ratio reduce of increase the liquidity and, consequently, the lending power of the banks also. Therefore, the cash reserve ratio is raised by the central banks also. Therefore, the cash reserve ratio is raised by the central bank when credit contraction is desired and lowered when credit is to be expanded.

Thus, like other techniques of monetary control, the variation of cash reserve requirements has a dual purpose; requirements can be lowered as well as increased. A reduction of reserve requirements immediately and simultaneously augments the lending capacity of all the banks. Conversely, raising a cash reserve ratio immediately and simultaneously reduces the lending capacity of all member banks. The fundamental assumption of this method is that the excess cash reserve (being the base of credit) realised through the lowering of the minimum reserve ratio, results in the expansion of credit, and similarly, the contraction of cash reserve due to the raising of minimum, cash reserve requirements will result in the contraction of credit.

Therefore, the reserve requirement ratio is a powerful instrument which affects the volume of excess reserve with commercial banks as well as credit creation multiplier of the banking system. To clarify the point, suppose commercial banks have Rs. 10 crores of total reserve funds with the central bank and that the legal cash reserve ratio is 10 per cent of the total deposits. If, with the existing deposits, the required reserves of the banks are Rs. 3 crores, the excess reserves amounting to Rs. 7 crores will support a tenfold (the multiplier being ten, as the reserve ratio is ten percent) increase in the deposits, *i.e.,Rs.* 70 crores of credit creation {Rs. 7 x (100/70) crores}. If, on the other hand, the reserve ratio is doubled, *i.e.,* if it is raised to 20 per cent, the required cash reserves are Rs. 6 crores, and the excess reserves would be Rs. 4 crores only. This excess reserve of Rs. 4 crores, with the 20 per cent reserve requirements, would obviously support only a fivefold (the multiplier now being 5) increase in the bank deposits *i.e.,* Rs. 20 crores of credit creation only {*i.e.,* Rs. 4 x (100/20) crores}. Thus, raising of the reserve requirements affect credit contraction, and conversely, a reduction in the reserve ratio brings about credit expansion.

**OMO versus VRR**

The variable reserve ratio, as an instrument of monetary control, is regarded as decidedly superior to open market operations in the following particulars:

*(i)* The variable reserve ratio is a straight direct method of credit control. It can give results more promptly than open market operations. The cash reserves of a bank can be altered by just a stroke of the pen. A declaration by the central bank that commercial banks must maintain a large percentage of their deposit liabilities as balances with the central bank than they have been doing immediately decreases their deposits. Likewise, an expansion of credit can be promptly attained by reducing the minimum cash reserves to be maintained with the central bank.

Thus, the variations in reserve ratio reduce the time lag in the transmission of the effect of monetary policy to the commercial banking system. Aschheim, therefore, opines that "If results of the variation of reserve requirements were the same as the results of open market operations in all respects by the speed of transmission preference for the former weapons over the latter would be quite plausible."

*(ii)* The successful working of open market operations requires a broad-based, developed, securities market. The variable reserve ratio has no such limitations. Thus, in countries where the securities market is not extensively developed, the variable reserve ratio has greater significance as a technique of monetary control.

*(iii)* Large-scale open market operations may affect the value of government securities and, thus, there are chances of loss being incurred by the central government and commercial banks, because their assets consist of a large stock of government securities. The variations in reserve ratios, on the other hand, yield the desired results in the controlling credit, without tear of any such loss.

Unlike the open market operations, the variable reserve ratio is capable of functioning without "ammunition." Thus, it does not tend to increase or decrease the supply of earning assets of the central bank, a fear which is very significant from the point of view of central banking policy and treasury financing.

(iv) The variable reserve ratio is applicable simultaneously to all commercial banks in influencing their potential credit-creating capacity. Open market operations affect only those banks which deal in securities.

Thus, some economists consider that the variable reserve ratio is "a battery of the most improved type" that a central bank can add to its armory. On the other hand, there are economists who opine that the variable ratio reserve has not yet developed as a delicate and sensitive instrument of credit control. To them, as compared to open market operations, the variable reserve ratio lacks precision in the sense that it is inexact, uncertain or rather clumsy as regards changes not only in the amount of cash reserve but also in relation to the place where these changes can be made effective. The changes in reserve involve larger sums than in the case of open market operations. Further, open market operations can be applied to a relatively narrow sector.

The variable reserve ratio is comparatively inflexible in the sense that changes in reserve requirements cannot be well adjusted to meet or localise situations of reserve stringency or superfluity. Moreover, the variable reserve ratio is discriminatory in its effect. Banks with a large margin of excess reserves would be hardly affected, while banks with small excess reserves would be hardly affected, while banks with small excess reserve would be hard pressed. This means that the variable reserve ratio always causes injustice to the small banks, often without reason. On this account, many economists favour open market operations rather than the variations in reserve ratio for achieving monetary control.

It has been suggested, however, that open market operations and the variable reserve ratio should be complementary to each other. A judicious combination of both will overcome the drawbacks of each weapon when used individually and produce better results. Thus, the suggestion is that the increase in reserve requirements, for instance, may be combined with an open market purchase policy rather than open market sales policy.

## 8.8 OBJECTS AND FUNCTIONS OF THE RBI

### 8.8.1 Objectives

The Preamble to the Reserve Bank of India Act, 1934 spells out the objectives of the Reserve Bank as: "to regulate the issue of bank notes and the keeping of reserves with a view to securing monetary stability in India and generally to operate the currency and credit system of the country to its advantage."

Prior to the establishment of the Reserve Bank, the Indian financial system was totally inadequate on account of the inherent weakness of the dual control of currency by the Central Government and of credit by the Imperial Bank of India. The Hilton-Young Commission, therefore, recommended that the dichotomy of functions and division of responsibility for control of currency and credit and the divergent policies in this respect must be ended by setting-up of a central bank called the Reserve Bank of India - which would regulate the financial policy and develop banking facilities throughout the country. Hence, the Reserve Bank of India was established with this primary object in view.

Another object of the Reserve Bank has been to remain free from political influence and be in successful operation for maintaining financial stability and credit.

The fundamental object of the Reserve Bank of India is to discharge purely central banking functions in the Indian money market, *i.e.,* to act as the note-issuing authority, bankers' bank and banker to government, and to promote the growth of the economy within the framework of the general economic policy of the government, consistent with the need of maintenance of price stability.

A significant object of the Reserve Bank of India has also been to assist the planned process of development of Indian economy. Besides the traditional central banking functions, with the launching of the five-year plans in the country, the Reserve Bank of India has been moving ahead in performing a host of developmental and promotional functions, which are normally beyond the purview of a traditional central bank.

As has been stated by the First Five Year Plan document, "central banking in a planned economy can hardly be confined to the regulation of the overall supply of credit or to a somewhat negative regulation of the flow of bank credit. It would have to take on a direct and active role, firstly, in creating or helping to create the machinery needed for financing developmental activities allover the country and secondly, ensuring that the finance available flows in the directions intended."

The Reserve Bank of India, as such, aims at the promotion of monetisation and monetary integration of the economy, filling in the "credit gaps" and gaps in the financial infrastructure, catering to the financial needs of the economy with appropriate sectorial allocation, as well as supporting the planners in the efficient and productive deployment of investible funds with a view to attain the macro-economic goals of maximisation of growth with stability and social justice.

**Functions**

The Reserve Bank of India performs all the typical functions of a good central bank. In addition, it carries out a variety of developmental and promotional functions attuned to the course of planning in the country.

Its major functions may be stated as follows:

(1) Issuing currency notes, *i.e.,* to act as a currency authority.
(2) Serving as banker to the government.
(3) Acting as bankers' bank and supervisor.
(4) Monetary regulation and management.
(5) Exchange management and control.
(6) Collection of data and their publication.
(7) Miscellaneous developmental and promotional functions and activities.
(8) Agricultural finance.
(9) Industrial finance.
(10) Export finance.

**8.8.2 THE RBI AS CURRENCY ISSUING AUTHORITY**

The Reserve Bank has the sole right to issue currency notes, except one rupee notes which are issued by the Ministry of Finance. The RBI follows a minimum reserve system in the note issue. Initially, it used to keep 40 per cent of gold reserves in its total assets. But, since 1957, it has to maintain only Rs. 200 crores of gold and foreign exchange reserves, of which gold reserves should be of the value of Rs. 115 crores. *As* such, India has adopted the "managed paper currency standard."

As a currency authority, the Reserve Bank provides different denominations of currency for facilitating the transactions of the Central and State Governments, and caters to the exchange and remittance needs of the public, banks as well as the Government departments.

The bank has established 14 offices of the Issues Department for the discharge of its currency functions. At all the other centres of the country, the currency requirements are met by the Bank through currency chests. Currency chests are maintained by the bank with the branches of the SBI group, Government Treasures and Sub-Treasures, and public sector banks

**Currency Chest**

A currency chest is a pocket edition of the Issue Department. The stock of notes and coins kept in the currency chests varies as per the needs of the respective areas served by the Treasury or an agency of the bank.

The following advantages are claimed for maintaining currency chests by the bank:

1. The currency chests provides remittance facilities to banks and the public.
2. They facilitate treasuries and bank branches to function by keeping relatively small cash balances.
3. They facilitate the exchange of rupee coins for notes, as well as the issue of new for old/soiled notes.

Above all, the Banking Department of the Reserve bank manages seasonal variations in currency circulation. In the busy season, the currency flow is expanded, in the slack season, it is contracted. During the busy season when there is an increased demand for cash from the public. It is first reflected in the depletion of the cash balances of the commercial banks and through them in the cash balances of the Banking Department. The Banking Department then transfers eligible securities to the Issue Department, on the basis of which the Issue Department issues more currency notes. This is how the currency expansion takes place. During the slack season, the process is reversed.

The following are the important provisions made under the RBI Act, 1934 regarding the issue of currency notes by the Reserve Bank:

*(i)* The Issue Department of the Bank alone can issue notes of Rs. 2 and those of higher denominations.

*(ii)* The assets of the Issue Department should be completely segregated from those of the Banking Department of the Reserve Bank.

*(iii)* All the notes issued by the Reserve Bank of India are legal tender and are guaranteed by the Central Government.

(iv) The design, form and material of the notes issued by the RBI should have the approval of the Central Government.

(v) The Central Government is empowered to demonetise any series of the notes issued by the RBI.

(vi) No stamp duty is payable by the RBI in respect of notes issued by it.

(vii) The Central Government has to circulate rupee coins through the RBI only.

(viii) The RBI is obliged to supply rupees coins in exchange for bank and currency notes or bank and currency notes in exchange for coins.

### 8.8.3 THE RBI AS A BANKER TO GOVERNMENT

The Reserve Bank of India serves as a banker to the Central Government and the State Governments. It is its obligatory function as a central bank. It provides a full range of banking services to these Governments, such as:

(i) Maintaining and operating of deposit accounts of the Central and State Government.

(ii) Receipts and collection of payments to the Central and State Governments.

(iii) Making payments on behalf of the Central and State Governments.

(iv) Transfer of funds and remittance facilities to the Central and State Governments.

(v) Managing the public debt and the issue of new loans and Treasury Bills of the Central Government.

(vi) Providing ways and means advances to the Central and State Governments to bridge the interval between expenditure and flow of receipts of revenue. Such advances are to be repaid by the government within three months from the date of borrowal.

(vii) Advising the Central and State Governments on financial matters, such as the quantum, timing and terms of issue of new loans. For ensuring the success of government loan operations, the RBI plays an active role in the gilt-edged market.

(viii) The bank also tenders advice to the government on policies concerning banking and financial issues, planning as well as resource mobilisation. The Government of India consults the Reserve Bank on certain aspects of formulation of the country's Five Year Plans, such as financing pattern, mobilisation of resources, institutional arrangements regarding banking and credit matters. The government also seeks the bank's advice on policies' regarding international finance, foreign trade and foreign exchange of the country. The Reserve Bank has constituted a sound research and statistical organisation to carry out its advisory functions effectively.

(ix) The Reserve Bank represents the Government of India as member of the International Monetary Fund and the World Bank.

### 8.8.4 THE RBI AS A BANKER'S BANK AND SUPERVISOR

The Reserve Bank of India serves as a banker to the scheduled commercial banks in India. All the scheduled commercial banks keep their accounts with the Reserve Bank.

According to the Banking Companies' Act of 1949, originally, each scheduled bank had to maintain with the Reserve Bank of India a balance as cash reserves equal to 5 per cent of its demand liabilities and 2 per cent of its time liabilities. The Act, amended in 1962, specifies that 3 per cent of the total liabilities should be kept as reserve requirement.

The Reserve Bank of India serves as a clearing agent for commercial banks. It provides clearing and remittance facilities to the scheduled commercial banks at centres where it has offices or branches.

The Reserve Bank of India also serves as 'a lender of last resort' by rediscounting eligible bills of exchange of commercial banks during the period of credit stringency. The bank can, however, deny rediscounting facility to any bank without assigning any reason therefore.

In recent years, however, to contain inflationary pressures and to check heavy borrowings by commercial banks, the Reserve Bank with its tight and discretionary lending policy has been operating as a lender of 'regular resort' rather than of 'last resort.'

**Supervision of Banks**

Apart from being the bankers' bank, the Reserve Bank is also entrusted with the responsibility of supervision of commercial banks.
Under the Reserve Bank of India Act and the Banking Regulation Act, 1949, the Reserve Bank of India has been vested with a wide range of powers of supervision and control over commercial and co-operative banks.

The various aspects of the supervisory/regulatory functions exercised by the Reserve Bank may be briefly mentioned as under:

1. Licensing of Banks. There is a statutory provision that a company starting banking business in India has first to obtain a licence from the Reserve Bank. If the Reserve Bank is dissatisfied on account of the defective features of the proposed company, it can refuse to grant the licence. The bank is also empowered to cancel the license of a bank when it will cease to carry on banking business in India.
2. Approval of Capital, Reserves and Liquid Assets of Banks. The Reserve Bank examines whether the minimum requirements of capital, reserve and liquid assets are fulfilled by the banks and approves them.
3. Branch Licensing Policy. The Reserve Bank exercises its control over expansion of branches by the banks through its branch licensing policy. In September 1978, the RBI formulated a comprehensive branch licensing policy with a view to accelerate the pace of expansion of bank offices in the rural areas. This was meant to correct regional imbalance of the banking coverage in the country.
4. Inspection of Banks. The Reserve Bank is empowered to conduct inspection of banks. The inspection may relate to various aspects such as the banks' organisational structure, branch expansion, mobilisation of deposits, investments, credit portfolio management, credit appraisal, profit planning, manpower planning, as well as assessment of the performance of banks in developmental areas such as deployment of credit to the priority sectors, etc. The bank may conduct investigation whenever there are complaints about major irregularities or frauds by certain banks.The inspections are basically meant to improve the working of the banks and safeguard the interests of depositors and thereby develop a sound banking system in the country.

5. Control Over Management. The Reserve Bank also looks into the management side of the banks. The appointment, re-appointment or termination of appointment of the chairman and chief executive officer of a private sector bank is to be approved by the Reserve Bank. The bank's approval is also required for the remuneration, perquisites and post retirement benefits given by a bank to its chairman and chief executive officer. The Boards of the public sector banks are to be constituted by the Central Government in consultation with the Reserve Bank.
6. Control Over Methods. The Reserve Bank exercises strict control over the methods of operation of the banks to ensure that no improper investment and injudicious advances are made by them.
7. Audit. Banks are required to get their Balance Sheets and Profit & loss Accounts duly audited by the auditors approved by the Reserve Bank. In the case of the SBI, the auditors are appointed by the Reserve Bank.
8. Credit Information Service. The Reserve Bank is empowered *to* collect information about credit facilities granted by individual banks and supply the relevant information in a consolidated manner to the banks and other financial institutions seeking such information.
9. Control Over Amalgamation and Liquidation. The banks have to obtain the sanction of the Reserve Bank for any voluntary amalgamation. The Reserve Bank in consultation with the Central Government can also suggest compulsory reconstruction or amalgamation of a bank. It also supervises banks in liquidation. The liquidators have to submit to the Reserve Bank returns showing their positions. The Reserve Bank keeps a watch on the progress of liquidation proceedings and the expenses of liquidation.
10. Deposit Insurance. To protect the interest of depositors, banks are required *to* insure their deposits with the Deposit Insurance Corporation. The Reserve Bank of India has promoted such a corporation in 1962, which has been renamed in 1978 as the Deposit Insurance and Credit Guarantee Corporation.
11. Training and Banking Education. The RBI has played an active role in making institutional arrangement for providing training and banking education to the bank personnel, with a view to improve their efficiency.

## 8.8.5 EXCHANGE MANAGEMENT AND CONTROL

Under Section 40 of the Reserve Bank of India Act, it is obligatory for the bank to maintain the external value of the rupee.

The Reserve Bank of India is the custodian of the country's foreign exchange reserves. It has authority to enter into foreign exchange transactions both on its own and on behalf of the government. It is obligatory for the bank to sell and buy currencies of all the member countries of the International Monetary Fund to ensure smooth and orderly exchange arrangements and to promote a stable system of exchange rates.

The Reserve Bank of India has resorted to the technique of exchange control to allocate its limited foreign exchange resources according to a scheme of priorities.

In India, exchange control was introduced under the Defence of India Rules in September, 1939. It was, however, statutorily laid down by the Foreign Exchange Regulation Act of 1947. This has been again stipulated by the Foreign Exchange Regulations Act, 1973.

**Objectives of Exchange Control in India**

The primary objective of exchange control in India is to regulate the demand for foreign exchange for various purposes against the supply constraints. When the government finds a shortage of foreign exchange due to the low level of external reserves on account of deficit in the balance of payments, exchange control becomes necessary.

Exchange control implies a kind of rationing of foreign exchange for the various categories of demand for it.

The Reserve Bank of India implements exchange control on a statutory basis. The Foreign Exchange Regulation Act, 1973 empowers the bank to regulate investments as well as trading, commercial and industrial activities in India, of foreign concerns (other than banking), foreign nationals and non-resident individuals. Moreover, the holding of immovable property abroad and the trading, commercial and industrial activities abroad by Indian nationals are also regulated by the Bank under exchange control.

The Reserve Bank manages exchange control in accordance with the general policy of the Central Government.

In India, exchange control is grossly related to and supplemented by trade control.

While trade control is confined to the physical exchange of goods, exchange control implies supervision over the settlement of payments - financial transactions pertaining to the country's exports and imports. Comparatively, exchange control is more comprehensive than trade control, since it covers all exports and imports as well as invisible and capital transactions of the country's balance of payments.

Under the present exchange control system, the Reserve Bank does not directly deal with the public. The bank has authorised foreign exchange departments of commercial banks to handle the day-to-day transactions of buying and selling a foreign exchange. Further, the bank has given money changer's licences to certain established firms, hotels, shops, ete. to deal in foreign currencies and traveler’s cheques to a limited extent.

The Reserve Bank has issued some directions to the authorised dealers and money changers in dealing with foreign exchange which are published in the *Exchange Control Manual.*

Under exchange control, there is check on foreign travel. An Indian visiting abroad is given a fixed sum of foreign exchange only. The present limit is U.S. $ 500.

There is exchange control on exports, whereby all exporters are required to make a declaration on the prescribed from the customs/postal authorities that foreign exchange only representing the full export value of the goods has been or will be disposed of in a manner and within a period specified by the Reserve Bank and shall receive payment by an approved method. To facilitate export promotion, however, the bank issues blanket foreign exchange permits for lump sums for specified purposes to eligible registered exporters.

Similarly, all non-resident accounts are also governed by the exchange control regulations. There are various categories of non-resident accounts such as: *(a)* non-resident accounts, *(b)* ordinary non-resident accounts, *(c)* non-resident (external) accounts, and *(d)* blocked accounts.

"Non-resident bank accounts" refers to the accounts of the overseas branches and correspondents of authorised dealers.

"Ordinary non-resident accounts" are those which are maintained by Indians who have gone abroad for the purpose of employment, business or vacation. Balances in these accounts cannot be transferred abroad without the Reserve Bank's approval.

"Non-resident (External) Accounts" are meant to encourage Indians abroad to remit their savings to India.

"Blocked account" implies that the Reserve Bank is empowered to "block" the accounts in India if any person whether an individual, firm or company, resident outside India and to direct that payment of any sums due to that person may be made to such blocked account. In the normal course, balances in the blocked account cannot be invested in India.

The Foreign Exchange Regulation Act, 1973 also puts a check on foreign investment in India.

In short, in our country, the scheme of exchange control is largely governed by the Foreign Exchange Regulation Act, 1973.

**Exercise :**

1. What is meant by saving? What are the determinants of savings as identified by Keynes?
2. Explain the Saving-Investment relations as viewed by Keynes. What is the role of rate of interest in it?
3. Give an idea of the structure of the Indian Capital Market? What are the prospects of its growth?
4. What is the role of Banks in a modern economy? How many kinds of Banks generally exist in a modern economy?
5. What are the functions of a Central Bank? What is the importance of Central bank in monetary management?
6. State the functions of the Reserve Bank of India as the central banking agency in our country.
7. Write short notes on :-
   (a) Open market operation
   (b) Variable cash reserve ratio
   (c) Weapons of credit control
   (d) Exchange control

# UNIT – X

## PARALLEL ECONOMY

### 10.1 MAGNITUDE OF POVERTY IN INDIA

Poverty is a plague affecting all parts of the world and it has many faces and dimensions. One of the most important and most common manifestations of poverty is the denial of access to the basic necessities of human existence.

#### 10.1.1 'Absolute' and 'Relative' Poverty

Poverty is multidimensional.

'Absolute' poverty is poverty below the breadline. Those who suffer from 'absolute poverty have no guarantee that they will be able to meet the fundamental costs of living as a human being The World Bank has fixed the norm of one dollar one person per day for this purpose.

A situation of need can also be expressed in terms of the living and working conditions of other members of the same society at the same time. In this sense, poverty is 'relative' to disparity of wealth and income. It is the extreme form of inequality in standards of living and degree of protection against insecurity. In this case, poverty applies to individuals and families whose income and other resources, including living conditions and the rules governing poverty, employment and labour, are distinctly below the average level of the society in which they live.

#### 10.1.2 Extent of Poverty in India

In India, poverty has been defined as that situation in which an individual fails to earn income sufficient to buy him bare means of subsistence.

To quantify the extent of poverty and measure the number of ’poor’ in the country, professional economists have made use of the concept of 'poverty line', (The concept of the 'poverty line' was introduced in Indian economic analysis in l971, it was first defined at the end of the nineteenth century in Great Britain.

Among these economists we may specifically mention the studies conducted by Bardhan, Minhas, Dandeknt and Ruth, Ojha, Ahluwalia, Veidyanathzm, Blmttyd lain and Tendulkar, Ravallion and Datt.

All of these studies do not look so much at the whole spectrum of income distribution in India as at the problem of poverty as such. More specifically, the question that has attracted attention most is whether the proportion of the population living below the ’poverty level' has increased or decreased in recent years.

Line of Poverty and Head-Count Ratio: In order to define the 'poverty line', all of these studies –

- have determined the minimum nutritional level of subsistence,
- have estimated the cost of this minimum diet,
- on the basis of the per capita consumption expenditure, have delineated the line of poverty.

Where changes in the magnitude of poverty have to be estimated between two different years, account has been taken of changes in the price level by using deflators of one type or another. Roughly, the same procedures are used in the various studies.

Most of these use the data generated by the NSSO through is consumption expenditure surveys, in which households are asked how much of different goods they consume. These surveys are expected to be representative as they are large surveys. Based on these surveys, NSSO publishes data which says how many persons have a monthly per capita consumption expenditure of say Rs. 0 Rs. 30, Rs. 31-50, Rs. 51-70, etc. Using this distribution one can estimate how many consumed less than the normative poverty line. Such estimates of poverty are also known as "Head-count ratio".

A problem with the head-count ratio is its insensitivity to the intensity of poverty. In other words, a head-count ratio simply measures the number of poor below the poverty line. It does not tell us anything about the income shortfall of the poor.

It may be desirable to group the poor into, say, three distinct categories, viz. (i) the most destitutes, (ii) the destitutes, and (iii) the poor. There are a number of analytical and policy uses to which the disaggregated information can be put to.

The discrepancy between the structures of minimum wages and the poverty line can be easily calculated,

If the official poverty line may be deemed to define the society's norm of subsistence, it would be possible to determine with fair precision the two lower levels of subsistence,

The other correlates of poverty, such as, low calorie intake resulting in low physical strength, perhaps also insufficient development of mental faculties which go with poor education and low educational potential, and low trainability, can be scientifically investigated to determine at least the magnitude of the problem of those families which lie deeply entrapped in these kinds of vicious circles and have lost the ability to escape.

A large body of economists also seems to share this view. What is required is a measure of poverty that includes fulfillment of certain basic human needs.

### 10.2 How to Measure Inequality among Income Classes

How can we measure the degree of income inequality? At one pole, if incomes were absolutely equally distributed, there would be no difference between the lowest 20 per cent and the highest percent of the population: Each would receive exactly 20 percent of the total income. That’s what absolute equality means.

The reality is far difference. The lowest fifth, with 20 percent of the households, garners less than 4 percent of the total income. Mean while the situation is almost reversed for the top 5 percent of house holds, who get more than 20 percent of the income.

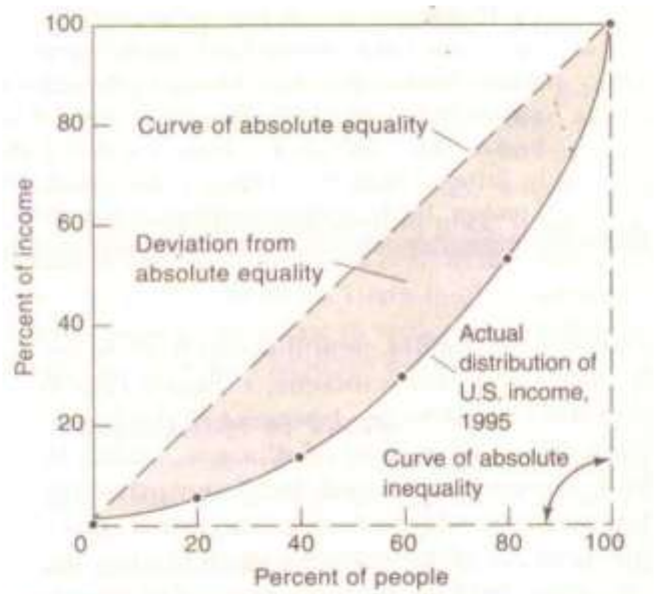



**FIGURE 1. Lorenz Curve Shows Income Inequality**

We see that the solid rust-colored actual distribution-of income curve lies between the two extremes of absolute equality and absolute inequality. The shaded area of this Lorenz curve (as a percentage of the triangle’s area) measures relative inequality of income. (How would the curve have looked back in the roaring 1920s when inequality was greater? In a Utopia where all have equal inheritances and opportunities?)

We can show the degree of inequality in a diagram known as the Lorenz curve, a widely used device for analyzing income and wealth inequality. Figure - 1 is a Lorenz curve showing the amount of inequality listed in the columns of Table-A; that is, it contrasts the patterns of (1) absolute equality, (2) absolute inequality, and (3) actual 1995 American inequality.

Absolute equality is depicted by the gray column of numbers in column (4) of Table-A. When they are plotted, these become the diagonal dashed rust-colored line of Figure 1's Lorenz diagram.

At the other extreme, we have the hypothetical case of absolute inequality, where one person has all the income. Absolute inequality is shown in column (5) of Table A and by the lowest curve on the Lorenz diagram—the dashed, right-angled black line.

Any actual income distribution, such as that for 1995, will tall between the extremes of absolute equality and absolute inequality. The rust-colored column in Table-A presents the data derived from the first two columns in a form suitable for plotting as an actual Lorenz curve. This actual Lorenz curve appears in Figure 1 as the solid rust-colored intermediate curve. The shaded area indicates the deviation from absolute equality, hence giving us a measure of the degree of inequality of income distribution. A quantitative measure of inequality that is often used is the Gini coefficient, which is 2 times the shaded area.

**Distribution of Wealth**

One source of the inequality of income is inequality of ownership of wealth, which is the net ownership of financial claims and tangible property. Those who are fabulously wealthy - whether because of inheritance, skill, or luck - enjoy incomes far above the amount earned by the average household. Those without wealth begin with an income handicap.

| (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| Income class of households | Percentage of total income received by households in this class | Percentage of households in this class and lower ones | Percentage of Income received by this class and lower ones | | |
| | | | Absolute equality | Absolute Inequality | Actual distribution |
| | | | 0 | 0 | 0.0 |
| Lowest fifth | 3.7 | 20 | 20 | 0 | 3.7 |
| Second fifth | 9.1 | 40 | 40 | 0 | 12.8 |
| Third fifth | 15.2 | 60 | 60 | 0 | 28.0 |
| Fourth fifth | 23.3 | 80 | 80 | 0 | 51.3 |
| Highest fifth | 48.7 | 100 | 100 | 100 | 100.0 |

**Table A : Actual and Polar Cases of Inequality**

By cumulating the income shares of each quintile shown in column (2), we can compare in column (6) the actual distribution with polar extremes of complete inequality and quality.

In market economies, wealth is much more unequally distributed than is income, as Figure 2(b) shows in the United States; 1 percent of the house-holds own almost 40 percent of all assets. Studies by New York University's Edward Wolff show that the distribution of wealth has become much more unequal. Because of the booming stock market, the share of wealth held by the top 1 percent of people has doubled over the last two decades. Given the sharp and growing increases in wealth inequality, Wolff, along with legal scholars Bruce Ackerman and Anne Alston, have proposed that the United States consider instituting a progressive wealth tax to go along with its progressive income tax.

The vast disparities in ownership of wealth have spurred radicals over the ages to propose heavy taxation of property income, wealth, or inheritance Revolutionaries have agitated for expropriation by the state of great accumulations of property. In recent years, a more conservative political trend has muted the call for redistribution of wealth. Economists recognize that excessive taxation of property income and wealth dulls the incentives for saving and may reduce a nation's capital formation. Particularly in a world of open borders, countries with high tax rates on wealth may find that the wealth has fled across the borders to tax havens or Swiss bank accounts.

Poverty is caused primarily by unemployment. As a matter of fact, poverty and unemployment go together. The concept of employment is however a complex phenomenon. This is because it has to be related by some notion of value of the work accomplished. The question of valuation is thus very important in this context. Employment cannot always be defined in terms of physical activity only.
The production may arise in the intellectual field or in the aesthetic field, provided it has demand in the commercial sense. The complexity in the field of employment is further aggravated by the fact that a host of activities in an under-developed economy take place in the sphere of self employment that does not bear any record.

Widespread are the “unpaid family labour” for an economy of peasants and artisans where the concept of employment practically loses its straightforward meaning and economic activities merges into the wider complex of family based production. Thus, a huge non-money economy exists side by side with exchange economy but nevertheless adds to the G.N.P.

According to economists, there are three important aspects of employment – the (i) income aspects, the (ii) production aspects and the (iii) recognition aspects. On the one hand, employment begets income to the labour, it generates production for the consuming society and again it gives a recognition or position in the society to the person concerned. Without employment, a person virtually is pushed out of the economic world as a participant. Employment can thus be a factor in self-esteem and indeed in esteem by others.

**Full Employment**

The concept of full employment is not easy to define. In a very simple version, it may mean that the total available supply of labourer is completely absorbed in gainful employment. There is voluntary unemployment in every society. There is frictional unemployment too.

According to Lerner, full employment means that those, who want to work at the prevailing wage rate are able to find work. Beveridge on the other hands defines full employment in way which means, having always more vacant jobs than unemployed man. It means that jobs are at fair wages, of such kind and so located and the unemployed man can reasonable be expected to take them.

Mrs. John Robinson categorically says that frictional unemployment cannot be considered as being consistence with full employment. In her opinion it is difficult to demarket unemployment which is due to frictions and unemployment which is due to deficiency of effective demand. However, in macroeconomic analysis, full employment is viewed as an equilibrium situation in which sum of demands in all labour markets tends to be equal to the sum of the supplies, though of course, there may be excess or deficiency in some pockets.

Unemployment may be open or disguised. The term 'disguised unemployment', is a common feature of an under-developed economy. It refers to a situation of employment with surplus man power in which some workers have such low marginal productivity that their removal from services will not affect the volume of total output; on the contrary, it may leave the aggregate product even increasing.

**THREE SECTORS OF ECONOMY**

It is necessary to understand that value-addition takes place in the region where employment is created for the purpose of production. Thus, if raw material is produced in one country but industrially processed for value-addition in another country, the other country is enriched by way of employment and addition to G.D.P. In this way the rural sector of economy generally produces the primary products, by operating on natural resources in the sphere of agriculture, animal husbandry, forestry, poultry, pisci-culture, etc. Thus, it is called the primary sector of economy.

In the next place, the secondary sector comprises value-addition in manufacture or industries by transforming primary products into improved consumable items. This operation mostly takes place in urbanized regions and are said to constitute the secondary sector of the economy. But, that is not all. In order that consumable items reaches the doors of the consumers, some more inputs become necessary, like transportation, wholesale and retail shopping, financing of all the productive ventures, settlement of disputes, maintenance of law and order and requirement of governmental administration. All these purposes are served by services rendered in the third sector of economy known as the tertiary sector. Since an appropriate stage of density of population as well as bigger size of human settlement is required to sustain such activities, the tertiary sector is a marked feature of the urban region.

Thus, the entire issue of division of economy in different sectors – primary, secondary and tertiary, has to be understood in the context of demographic patterns, reflected in level of urbanization together with economic factor like level of industrialization and the social factor reflected in level of education, health, motivation and efficiency of the people in the performances of production as well as rendering of services.

From valuation point of view all these factors are extremely important in-as- much as the valuation of real estate or plant and machinery depends upon the productivity of the different agents of production like land, labour, capital and organization. In assessing a long-term view of the prospect of value-addition considered in the perspective of the forces at work in the above demographic, economic or social fields and even the political scenario at large claim serious consideration. The treatment of the entire micro economic as well as macro economic issues thus deserves particular focus from the valuation angle.

### *10.3 PARALLEL ECONOMY (Black Economy)*

A particular feature that holds back the economic progress of the country of the third world requires also to be discussed in the realm of economics. As we have seen the urban-rural relationship is an important factor in economic analysis, since rural areas have predominantly primary sector to thrive on, while the urban sector comprises the economic activities in the secondary and tertiary sectors. In the modern world, urbanization is taken as an index of economic development as it means the harbouring of a growing secondary sector and fast growing tertiary sector therein. A note of warning need be added while increasing the rate of urbanization as a marked feature of developing countries.

The growing urbanization of developing countries means high rate of inmigration of population from rural to the urban sectors. Two classes of people are generally marked out as migrants – the upper class comprising the richer section in quest of better amenities of life and the poorer section in search of employment driven by loss of work in the rural hinterland. These people of the poorer section find accommodation in the informal sector of economy comprising day labours, masons, hawkers, vendors, pavement sellers and similar segment who struggle to ekeout a living.

While the flight of richer section deprives the rural economy of adequate purchasing power to sustain a healthy market in the rural sector, the flight of poorer section only deteriorates the urban-economic scenario by swelling an informal sector which remains out of tax net and frustrates monetary measures initiated by the government. However pitiable are the condition in general, there are quite a few who escape the tax-net along with other businessmen and traders in no small measure.

Let us now discuss the parallel economy that is known as underground economy comprising the unreported transactions, the magnitude of which is a major headache.

The parallel economy arises out of the following manner of distorted growth pattern. The economy gets divided in the three following sectors:

(i) Formal sector
(ii) Informal sector
(iii) Illegal sector

The formal sector is suppose to comprise all transactions that are exposed to fiscal intervention and line within the ambit of the influence of the monetary policy pursued by the government. Here, too parallel economy has made a headway by underhand dealings in bribery, corruption and other abuses that have become a part of civic life. Donations to political parties from unaccounted sources constitute another big threat. In this way, the parallel economy grows by abusing the formal sector by using an illegal sector that comprises disbanded activities like drug trafficking, arms selling, etc. and by tolerating an informal sector which has become an unavoidable imperative to provide self-employment at large to helpless people who cannot be employed otherwise.

## 10.4 BLACK ECONOMY IN INDIA

### 10.4.1 Meaning

It is well known that there is a large amount of money income and wealth which has been and is being made and / or owned which is unaccounted in our tax system and, therefore, has not suffered tax. This unaccounted economic sector is referred to as black economy (alias the parallel economy, the underground economy, the unreported economy etc.).

We might distinguish here between 'black money' and ‘black income'. While black money is a stock at a point of time, black income is a flow over a period of time. For policy purposes, the correct concept is that of black income, rather than black money

The black economy in India has been a matter of concern for a number of years. It has grown to enormous dimensions. It has become a threat to the ability of the official monetary—credit policy mechanisms to manage demand and prices in several vulnerable sectors of the economy. The fact is that it has permeated every section of society.

### 10.4.2 Magnitude of Black Economy

A number of efforts have been made to estimate the quantitative dimensions of the problem in the economy: A numerical review of the estimates given by the various economists and others reveals that almost all of them show a growing quantity of black income relative to GNP as well as in absolute terms. The aggregate of black income generated is estimated to have gone up from Rs. 50,977 crores in 1980-81 to Rs.10,50,000 crores in 2006-07. The process has only further accelerated due to ongoing liberalisation.
Raja J. Chelliah has estimated that black money is generated at the rate of 20 per cent of country's GDP. The corresponding figures were between 0 and 20 per cent for the EU, 15 per cent for U.S.A., 30 per cent for Italy and 25 per cent for France.

### 10.4.3 Causes of Black Economy

More important causes of black economy can be discussed as follows:

**Level and Structure of Taxation:** High effective rates of taxation are a major contributory factor to tax evasion and black income generation in India. Improved tax compliance can result from significant and sustained reductions in the effective tax burdens of those who are liable to tax.
As regards the composition of tax structure, it is generally believed that indirect taxes on commodities are more difficult to evade than direct taxes on income and wealth. That is why countries at earlier stages of development normally rely much more heavily on indirect taxes than more developed nations. Thus, there is some presumption that as a country develops over time the composition of its tax revenue would gradually shift in favour of direct taxes. It is urgent to increase the tax-net rather than enhance the tax-net.

**Weaknesses in Tax Administration:** The performance of the tax administration in India has been poor by international standards and has been deteriorating over the years. A recent study on the subject identifies the following as the causes of this:

- Information system. lt is primitive and tamper-prone.
- Organisational structure. Functional specialisation is lacking leading to failure to integrate various information sources available in assessments and prosecution.
- Manpower policies. No serious efforts have been made to adopt incentive systems that induce tax officials to detect or attempt to prosecute tax evasion.
- Penalty and prosecution. These are increasingly oriented towards the punishment of technical violations rather than tax evasion.

**Pervasive Controls**: The controls violate basic economic law of demand and supply and create artificial scarcities by curtailing production, and (or supply) by inducing excessive demand by purchasers. They become a bee-hive af black income dealers, and producers in black markets; administrators of controls get their share in black incomes.

**Public Expenditure Programmes:** The black-market economy has also received sustenance from the poor design and faulty administration of many public expenditure programmes in India, usually through illegal leakages in these expenditures. Public savings have been cheated of taxes on these ill-gotten income, and the programmes' unit costs have also increased.

**Inflation:** Inflation generates black income in several ways.

- With a progressive income (and wealth) tax structure, defined with respect to nominal values, inflation increases the effective burden of taxation at any given level of real income (and wealth), and hence the incentive to evade.
- General inflation encourages illegitimate transactions. lt is usually accompanied by pronounced scarcities and windfall gains in certain sectors which are unlikely to be fully declared to the tax authorities.
- Inflation hits hard fixed salaried income groups which include govemment servants. The pinch of inflation reduces their real income and as such they start misusing their official position by accepting bribes, etc, This generates black money.

**Political finance** It is widely believed that black money has become an important operational component of the Indian economy with many diverse links with the political system. The functioning of the political parties and system of election laws had been identified as a significant factor in black income generation by the various expert committees.

**Standards of Public Morality:** There has been a general deterioration in our moral standards. We may quote Prof B.B. Bhattacharya in this context, when he remarks: "Before 1991, money making was not considered a virtue. The significant change since liberalisation is that being rich is now all important and people, whether a professor, a musician or an industrialist, are evaluated in income earnings". This change is motivating people to be corrupt.

**High Cash-intensity:** The cash-GDP ratio in India, called cash—intensity, works out to about 10 per cent (against 3 to 4 per cent in advanced countries like UK, France, Switzerland, Germany, Japan, Belgium, Netherlands, etc.). The greater the cash transactions in an economy, the greater is the scope for money laundering without detection.

In addition, a peculiar phenomenon which is associated with the black money is the constant interchange between the black and white economies. The extent of this change too is very high. Various methods are adopted to convert black money into white and *vice-versa.*

## 10.5 Effects of Black Economy

Effect of black money on the state of economy can broadly be discussed under the following heads:

**Misinformation About the Economy:** The most obvious effect of substantial black money is misinformation about the actual state of the economy because it remains outside the purview of the economic policies. The presence of a sizeable black money casts doubts on the validity of the· data on national income estimates, distribution of incomes, consumption, savings and the distribution of investment between public and private sectors. The economic planning loses effectiveness and important economic decisions are rendered meaningless because they are based on macroeconomic indicators which ignore the large black money component.

**Impact an Fiscal System:** Evasion of taxes has serious consequences for the economy's fiscal system. The most obvious effect is that the Government is deprived of large amounts of tax revenue.

The long-run consequence of such revenue loss is to reduce the built-in elasticity of the tax system. To raise a given target of revenue the Government is obliged to depend increasingly on discretionary hikes in tax rates or to expand the array of taxes. Both the measures have undesirable effect on the economy. While, as the first measure gives inducement to avoidance and evasion of tax, the second measure is bound to make an already complex tax structure more complicated.

**Implications for Resource Allocation:** It distorts resource allocation in the economy and often leads to wasteful use of money. Black money leads to conspicuous consumption and in turn results in the diversion of large funds to unproductive channels which ultimately put the economy out of gear.

**Effects on Income Distribution:** The household with a higher proportion of black income are more likely to understate their true incomes and to do so to a greater degree. With the given progressive structure of income taxation, the incentive to make black income through under statement of legal source incomes clearly increases with increase in income. So we should expect richer households to earn proportionately greater black incomes through this means. In this way, the distribution of income becomes even more skewed in favour of the rich with the growth of black money. The last manifestation of this is the Report of the IMF that over Rs. 1,800 crores are stashed away illegally in secret accounts in one country, Switzerland, by Indian nationals.

**Implications for Monetary Policy:** As regards stock dimensions of black money it is related to the stock of 'black liquidity'. The stock of 'black liquidity' is defined as the accumulation of black savings (from black incomes) in the form of cash and other readily convertible assets such as gold and silver. It is this 'black liquidity' which creates a lot of problems for monetary authorities to regulate the economy. Even the selective credit control measures which aim at regulating the flow of credit into particular uses and diverting credit from the less urgent to the more urgent uses in the economy are rendered ineffective owing to the existence of sizable ’black liquidity' in our country. In fact, it renders all the anti-inflationary policies of the monetary authorities ineffective.

**Black Income and Inflation:** Black income is more a cause and less an effect of inflation. Black operation lie at the root of fiscal deficit of the government, which is largely responsible for "excessive" increases in high-powered money and so in money supply in India year after year.

Above all, what Wanchoo Committee observed more than three decades ago still holds true: "One of the worst consequences of black money and tax evasion is, in our opinion, their pernicious effect on the general fibre of society. They put integrity at a discount and place a premium on vulgar and ostentatious display of wealth. It is, therefore, no exaggeration to say that black money is like a cancerous growth in the country's economy which, if not checked in time, is sure to lead to its ruination."

## 10.6 Remedies

The various measures adopted by the government to deter income tax evasion and unearth black income can be studied under three parts, viz. (1) measures to deter tax evasion, (2) measures to unearth black money, and (3) new measures for dealing with black money.

### Measures to Deter Tax Evasion

The statutory obligations of taxpayers include compulsory filing of tax returns by everyone with a taxable income, compulsory maintenance of accounts by businessmen and professionals and their compulsory auditing if income or turnover exceeds a specific limit, compulsory canalising of transactions involving payment exceeding Rs. 20,000 through banks, etc. However, in actual sense, these statutory provisions have not made much difference. The self-employed continue to escape the tax net either by not filing returns or by filing false returns with grossly under reported incomes.

### Use of PAN

All income-tax payers are required to get a permanent account number (PAN) from the income tax department. A provision has been made for the compulsory mention of PAN or GIR in certain high value transactions. With increased usage of computerisation the data will be fully utilised for increasing the tax base and for preventing the leakage of revenue.

**Surveys**

To bring new assessees into the tax net and strengthen the information base for the detection of tax evasion by existing assessees, a general survey is conducted by the income tax department. While the surveys have increased substantially the number of taxable new assessees each year, the realised gain is much below the expected potential.

**Tax Raids and Seizures**

Raids are conducted from time to time, by the tax enforcement machinery, on the premises of the people who are suspected of possessing black money. After the raids, wide publicity is usually given to the amount of money, or other assets that are seized. But a large part of these have to be returned to the owners, presumably because acceptable evidence incriminating the owners cannot be produced in the court of law. Hence, raids fail to make the desired impact.

**Penalties and Prosecutions**

To discourage tax evasion, tax laws also provide for monetary penalties and for the prosecution (and imprisonment) of tax evaders. However, in actual practice, penalties have been imposed on only a very small proportion (less than one per cent) of total Assessments and these, too, have been pitiably small.

**The Settlement Commission**

Following the recommendations of the Wanchoo Committtee (1971), the Settiement Commission was established in 1976. Its objective was to provide a mechanism for the quick and final disposal of those cases where a tax evader was willing to make a confession and face the consequences.

**Monitoring of Banks' Transactions**

In a bid to curb black money transactions in the banking system, the RBI has directed all commercial banks to submit details of all cash deposits and withdrawals of Rs. 10 lakh and above to the central bank.

It is urgent to release the country from the octopus grip of a black economy so that a healthy foundation of economic growth can be laid amidst a globalised world.

**Exercise :**

1. Define proverty in "absolute" and "relative" terms. Depict proverty as measured in the Lorenz Curve shown in the diagram.
2. Describe how the economy is usually said to comprise in three sectors. How this division in three sectors matches with the level of urbanization?
3. What do you understand by 'informal sector' in an economy? Explain how the growing urbanization lead to an informal sector in the developing countries.
4. What do you understand by 'parallel economy'? How does it arise?
5. What are the effects of a parallel economy or black economy and how to combat it in the situation prevailing in our country?
6. Write short notes on :-
   (a) Full employment
   (b) Illegal sector
   (c) Black income

# BOOK KEEPING AND ACCOUNTANCY

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# INDEX

# SECTION I

## ACCOUNTING CONCEPTS AND CONVENTIONS

**Introduction**

The basic purpose of accounting statements like the final accounts, cash flow statements etc is to provide financial information about an organization to the interested parties like investors, financial institutions, government, owners, management and even employees. Comparison of various organizations in respect of performance, profitability etc is possible only when there is complete uniformity in the preparation of the accounting statements or else there will be total confusion. In order to have consistency, financial accounting operates within the framework of what is called, as Generally Accepted Accounting Principles or what is popularly known as GAAPs.

**Accounting principles**

Accounting Principles refer to general laws or rules adopted in accounting as a guide or action or as the basis of conduct of practice. It should have universal acceptability. The language of accounting should be understandable to the persons to whom the communication is made. In order to communicate the message in the same sense in which it is sought to be conveyed to them, a number of principles have been agreed upon and followed by accountants in writing of accounts and in the presentation of financial statements. **It is therefore essential to standardize the accounting principles and policies in order to ensure Transparency, consistency and comparability. Accounting principles can be divided in to Accounting concepts and Accounting conventions.**

**Accounting concepts**

Accounting concepts generally mean postulates, assumptions or conditions upon which accounting are based. They have developed to make accounting convey the same meaning to all the people as far as practicable. There are a number of accounting concepts agreed upon by accountants. They are as follows –

1) **<u>Concept of Entity</u>** – For accounting purposes the owner of the business is treated as separate from the business, there can be transactions between the owner and his own business. For example every person acts in two different capacities i.e. at home Ramesh and in business Ramesh & co. This concept helps in keeping private affairs of the proprietor away from the business affairs.

   Thus if proprietor invests Rs.1,00,000/- in the business, it is deemed that the proprietor has given Rs.1,00,000/- to the business and it is shown as liability in the books of the business because business has to ultimately repay it to the proprietor. Similarly if proprietor withdraws Rs.10,000 from business it is charged to him.

2) **<u>Concept of Dual aspect</u>** – This is the basic concept of accounting. As per this concept, every business transactions have a dual effect. For **example** Manohar started business with cash Rs.1,00,000/- there are two effects of this transactions: Asset Account and Capital Account. The business gets Asset (Cash) of Rs.1,00,000 and on the other hand the business owes Rs.1,00,000 to Manohar as capital. This can be expressed in the form of an equation as follows:-

   Capital + Liabilities = Assets.

   1,000 + 2,000 = 3,000

   Thus the total Assets are always equal to total liabilities.

**BALANCESHEET**

| **Liabilities** | **Rs.** | **Assets** | **Rs.** |
|---|---|---|---|
| Capital (Pc) | 1,00,000 | Assets | 1,10,000 |
| Liabilities (Pc) | 10,000 | (Pd & Rd) | |
| | **1,10,000** | | **1,10,000** |

**<u>Note</u>**: - In other words the total of both sides of the balance sheet should tally.

<u>The Balance Sheet or financial statement which is part of accounting tallies because of the following reasons:-</u>

a. Increase of one asset and Decrease of another asset.
b. Increase of one liability and Decrease of another liability.
c. Increase of an asset and simultaneously increase of a liability.
d. Decrease of an asset and simultaneously decrease of a liability.

e. Increase of a liability and simultaneously increase of an asset.

f. Decrease of a liability and simultaneously Decrease of an asset.

3) **Concept of going concern** – It is assuming that business will continues for fairly long time, unless and until it has entered in to a state of liquidation. It is as per this assumption that the accountant does not take in to account forced sales value of assets while valuing them. Similarly, depreciation on assets is provided on the basis of expected lives of the assets rather than their market values.

Since the concern is kept continuously alive for a long period of time, financial and accounting policies are directed towards maintaining such continuity of activity.

**Example**: It is generally assumed that the business will not liquidate in the near foreseeable future because of Going concern.

4) **Realisation concept** – According to this concept profit should be accounted only when it is actually realized. Revenue is recognized only when a sale is affected, or the services are rendered. A sale is considered to be made when the property in goods passes to the buyer and he is legally liable to pay. However, in order to recognize revenue receipt of cash is not essential. Even credit sale results in realisation as it creates a definite asset called Account Receivable.

Incomes like commission, interest, rent etc are shown in profit and loss account on accrual basis though they may not be realized in cash on the date of preparing accounts.

**Example**: A machine was purchased for Rs.1,00,000 on 01.01.2006 and on 31.12.2006 its net realization value was Rs. 1,50,000. Do you prefer to count this profit? If you count which concepts will be violated – Realisation.

5) **Accrual concept** – The accrual system is a method whereby revenues and expenses are identified with specific periods of time like a month, half year or a year. It implies recording of revenues and expenses of a particular accounting period whether they are received/paid in cash or not. Under cash system of accounting, the revenues and expenses are recorded only if they are actually received or paid in cash irrespective of the accounting period to which they belong to. But under accrual method, the revenues and expenses relating to that particular accounting period only are considered.

6) **Concept of accounting period** – Though the life of the business is indefinite, the measurement of income and studying the financial position of the business after a very long period would not help in taking timely corrective steps or to enable periodic distributions of income to proprietor with reasonable safety. Therefore it is necessary for the concern to stop at regular intervals and see back how it is fairing.

An accounting period is the interval of time at the end of which income statements and financial position statements are prepared to know results and resources of the business. Although shorter periods are frequently adopted for purposes of comparative studies, the normal accounting period is twelve months.

**Example**: Economic life of an enterprise is split into the periodic interval as per going concern concept.

7) **Money measurement concept** – In accounting everything is recorded in terms of money. Events or transactions which cannot be expressed in terms of money are not recorded in the books of accounts, even if they are very important or useful for the business. Purchase and sale of goods, payment of expenses and receipt of income are monetary transactions which find place in accounting etc. death of an executive, resignation of a manager are the events which cannot be expressed in money.

**Example**: Human assets have no place in accounting records is based on Money measurement.

**Example**: According to money measurement concept, currency transactions and events are recorded in the books of accounts in the ruling currency of the country in which transaction takes place.

8) **Cost concept.** – According to this concept cost price is the basis for recording the asset in the books of accounts. The current market value or realizable value shall not be considered in recording the capital assets. The cost means the historical cost at which these assets are actually acquired. This cost generally means the expenditure incurred to bring an asset in to its present working condition and location. Their current realizable value may be more or less than cost, but it should be ignored. It should be noted that cost concept does not specify that asset should appear in the balance sheet as cost only. It will be recorded at cost price and then subsequently depreciated as per the rates prescribed.

a) **Example**: "Assets should be valued at the price paid to acquire them" is based on Cost concept

b) **Example**: If a machinery is purchased for Rs. 1,00,000 the asset would be recorded in the books at Rs. 1,00,000 even if its market value at that time happens to be Rs. 1,40,000. In case a year after, the market value of the asset comes down to Rs. 90,000 it will ordinarily continue to be shown at Rs. 1,00,000 and not Rs. 90,000 due to Cost concept.

**Cost attach concept** – An asset is recorded at its cost and cost is calculated after considering cost attach concept. According to this concept, the expenditure incurred in connection to an asset should be considered for making valuation of its cost. It means individual costs are not relevant but all the related costs should be attached or merged. After attaching or adding such related costs, it is possible to have meaningful information regarding actual cost.

a) **Example**:

Expenditure incurred for bringing the asset in to working condition should be added to the cost of asset because they are related to each other. But expenditure incurred for maintaining the asset in working condition is not added to the cost of the asset because such expenses are 5recurring and they are not related to the cost of assets.

b) **Example**:

For calculating cost of finished goods not only the cost of raw materials is considered but also the cost of wages and other manufacturing expenses are required to be considered as they are related to each other.

c) **Example**:

RPG Ltd. purchased equipment from PQR Ltd. for Rs. 50,000 on 1st April, 2005. The freight and carriage of Rs. 2,000 is spent to bring the asset to the factory and Rs. 3,000 is incurred on installing the equipment to make it possible for the intended use. The market price of machinery on 31st April, 2006 is Rs. 60,000 and the accountant of the company wants to disclose the machinery at Rs. 60,000 in financial statements. However, the auditor emphasizes that the machinery should be valued at Rs. 55,000 (50,000+2,000+3,000) according to historical cost concept.

d) **Example**:

Mr. A purchased a machinery costing Rs. 1,00,000 on 1st October, 2005. Transportation and installation charges were incurred amounting Rs. 10,000 and Rs. 4,000 respectively. Dismantling charges of the old machine in place of which new machine was purchased amounted Rs.10,000. Market value of the machine was estimated at Rs. 1,20,000 on 31st March, 2006. While finalizing the annual accounts. A values the machinery at Rs. 1,20,000 in his books. So cost concept was violated by A.

e) **Example:**

Any expenses such as Tea, break fast etc is incurred at the time of Travelling should be debited to Travelling expenses account and not to the sundry expenses account as per cost attach concept.

9) **Periodic matching of cost and revenue concept** – This concept is based on accounting period concept. Making profit is the most important objective that keeps proprietor engaged in the business activities. It is necessary to match revenues of that period with the expenses of that period. Profit earned by the business during a period can be measured only when the revenue earned by the business during period can be compared with the expenditure incurred to earn that revenue. The question when payment was made/received is irrelevant. Therefore as per this concept, adjustments are made for all outstanding expenses, prepaid expenses, income receivable and income received in advance.

a) **Example**: Mohan purchased goods for Rs. 15,00,000 and sold 4/5$^{th}$ of the goods amounting Rs. 18,00,000 and paid expenses amounting Rs. 2,70,000 during the year, 2005. He paid Rs. 5,000 for an electricity bill of Dec, 2004 and advance salaries amounting Rs. 15,000 was paid for the month of Jan. 2006. He counted net profit as Rs. 3,50,000. The profit calculated by him is correct according to matching concept.

b) **Example**: The determination of expenses for an accounting period is based on the principle of Matching

10) **Verifiable objective evidence concept** – According to this concept all accounting transactions should be evidenced and support by objective documents. Theses documents include invoices, contracts, correspondence, vouchers, bills pass book, cheque books etc. such supporting documents provide the basis for making accounting entries and for verification by the auditors later on. This concept also has its limitations. For example, it is difficult to verify internal allocation of costs to accounting periods.

**Conventions of Accounting –** Accounting conventions refer to customs. Traditions, usages or practices followed by accountants as a guide in the preparation of financial statements. They are adopted to make the financial statements more clear and meaningful. Following are some of the accounting conventions followed

1) **Convention of Disclosure** – This means that the accounts must be honestly prepared, and they must disclose all material information. The accounting reports should disclose full and fair information to the proprietors, creditors, investors and others. This convention is especially significant in case of big business like Joint Stock Company where there is divorce between the owners and the managers. Therefore, The Indian companies Act 1956 not only requires that the accounts of the company, but it has also prescribed the contents and forms of profit and loss account and Balance sheet.

However, it does not mean that all information of any kind is to be included in accounting statements. The term disclosure only implies that there must be a sufficient disclosure of information's which is of material interest to proprietors, present and potential creditors and investors. Disclosure concept gives priority to substance over legal form of a transaction.

**2)** **<u>Convention of materiality</u>** – The accountant should attach importance to material details and ignore insignificant details. If this is not done accounts will be overburdened with much minute details .as per the American accounting association an item should be regarded as material, if there is a reason to believe that knowledge of it would influence the decision of informed investor. Therefore, keeping convention of materiality in view, unimportant items are either left out or merged with other items. Some items are shown as foot notes like contingent liabilities, market value of investment etc. however as item may be material for one purpose but immaterial for another or material for one year but immaterial for another year.

**a) Example**: The cost of a small calculator is accounted as an expense and not shown as an asset in a financial statement of a business entity due to Maternity concept.

**b) Example**: omission of Paise and showing the round figures in financial statements is based on materiality.

**3)** **<u>Convention of consistency</u>** – The comparison of one accounting period with the other is possible when the convention of consistency is followed. It means accounting from one accounting period to another. For example, a company may adopt straight line method, written down value method or any other method of providing depreciation on fixed assets. But it is expected that the company follows a particular method of depreciation consistently. Similarly, if stock is valued at cost or market price whichever is less, this principle should be followed every year. Any change from one method to another would lead to inconsistency. However, consistency does not mean non-flexibility. A change in accounting policy is justified to comply with accounting standard, to ensure more appropriate presentation of the financial statement of the enterprise and to comply with the law.

**a) Example**: The accounting policies once adopted are not changed unless there is an urgent need for such change is based on Consistency.

**b) Example**: Change in the method of depreciation should be done only if it is required by some statue and change would result in appropriate presentation of financial statement.

4) **Convention of conservatism**- It refers to the policy of playing safe' A per this convention all prospective losses are taken in to consideration but not all prospective profits. In other words anticipate no profits but provide for all possible losses. However this convention is being criticized on the ground that it goes not only against the convention of full disclosure but also against the concept of matching costs and revenues. It encourages creation of secret reserves by making excess provision for depreciation, bad and doubtful debts etc. the income statement shows a lower net income and the Balance sheet overstates the liabilities and understates the assets. The convention of conservatism should be applied cautiously so that the results reported are not distorted. Some degree of conservatism is inevitable where objective data is not available.

**a) Example**: A businessman purchased goods for Rs. 25,00,000 and sold 70% of such goods during the accounting year ended 31$^{st}$ March, 2005. The market value of the remaining goods was Rs. 5,00,000. He valued the closing stock at Rs. 5,00,000 and not at Rs. 7,50,000 as per concept of conservatism.

**b) Example**: A businessman purchased goods for Rs. 25,00,000 and sold 80% of such goods during the accounting year ended 31$^{st}$ March, 2005. The market value of the remaining goods was Rs. 4,00,000. He valued the closing stock at cost. He violated the concept of conservatism.

**Following are the other examples of application of conservatism**

i. Making provision for doubtful debts and discount on debtors.
ii. Not providing for discount on creditors.
iii. Valuing stock in trade at cost or market price whichever is less.
iv. Creating provision against fluctuation in the price of investments.
v. Showing joint life policy at the surrender value and not at the paid-up amount.
vi. Amortization of intangible assets like goodwill which has indefinite life.

**Fundamental accounting Assumption**

a) Going concern
b) Consistency
c) Accrual

If nothing has been written about the fundamental accounting assumption in the financial statements then it is assumed that they have already been followed in their preparation of financial statements. However if any of the above mentioned fundamental accounting assumption is not followed then this fact should be specifically disclosed.

❑ ❑ ❑

# SECTION II

## BOOK KEEPING AND ACCOUNTANCY

### 1.0 Meaning of Book Keeping:

Book- keeping means an art of keeping or maintaining or recording business transactions in a scientific and systematic manner. R.N. Carter states, “Book-keeping is a science and an art of correctly recording in the books of accounts all those business transactions that result in transfer of money or money's worth.”

Indian version of book keeping is known as “Deshi-nama” in various parts of our country.

Book keeping is a process in which various business transactions are, classified and systematically recorded in a set of books. It has basic rules, style and format for drafting, recording and maintaining the business transactions. Thus, book keeping is an art as well as science, of systematically recording business transactions on the basis of well-defined rules and principles in the books of accounts which calls for application of human skills, knowledge, training and experience.

### 1.1 Features:

Key features of Book-Keeping are :

- It is an art of recording business transactions scientifically.
- There must be a documentary support for each and every transaction.
- The system of recording should be universal.
- The recording is made of monetary transactions only. It means the transaction must involve money or money's worth. Non-monetary transactions cannot be recorded.
- Recording of transactions is made in a given set of books only.
- Recording is prepared for a specific period and presented for future references.

### 1.2 Objectives of Book Keeping:

- To maintain the permanent records of the business transactions for various purposes,
- To ascertain profit earned or loss sustained in the business,
- To know the financial position of the business, capital invested into the business, assets accumulated and acquired and liabilities owed etc.

- To know the exact amount due from debtors and the exact amount payable to creditors.
- To know the exact amount of taxes due to the Government and to do tax planning for, the business ventures.
- To detect and prevent errors and fraud committed by others in the business.
- To provide valuable business information to various groups of users.
- To take important decisions on important business matter.
- To know progress made by business and to measure efficiency of business.

### 1.3 Importance of Book-keeping:

Book-keeping is important to every business concern for the purpose of effective control over the business. The information supplied by the accounts department helps the management in decision-making. The information made available by the accounting system is of great importance not only to the owners but also to others connected directly or indirectly with the business.

Following explain the importance of Book-Keeping:

- **Facilitates Planning**: Proprietors have to plan their business operations for years to come. Book-keeping generates valuable information about production, sales, expenses and incomes which helps planning.
- **Decision-making**: Management has to take valuable decisions about business. Book-Keeping makes available necessary information which facilitates decision making.
- **Controlling**: Management can control business operations with the help of various types of budgets. Book-Keeping and Accounting helps the management in this regard also.
- **Aid to Memory**: Human memory has certain limitations. A businessman cannot remember all the business transactions. Book-Keeping helps the businessman in retrieving required information. Due to Book-Keeping. it is not necessary to remember all the transactions.
- **Comparative Study**: Proper record helps a businessman to compare one year's performance with that of the other year. Comparative study reveals the loopholes, which enables a businessman to take proper corrective action.
- **Helpful in getting discharge**: In case of insolvency, a proprietor can get discharge from the court on the basis of record of business transactions,

- **Evidence in litigation**: The court as evidence accepts Systematic record in case any dispute arises. The court can decide the matter on the basis of records only.
- **Sale of business**: In case the business is sold out, the purchase consideration can be decided on the basis of the accounts maintained.
- **Settlement of tax liability**: Business is subject to many taxes viz. Income tax, sales tax, property tax etc. Proper record of transactions would enable a businessman to fix up the amount of his tax liability and discharge it.
- **Helpful in getting loans**: A businessman may require loans from banks for financing his expansion scheme. Properly kept accounts can convince the banks about financial soundness of business.
- **Protection against theft and dishonesty**: A businessman can protect himself against theft and dishonesty of employees by keeping books of accounts in a systematic manner. He can exercise greater control on his finance through systematic recording only.

**1.4 The Utility of Book Keeping:**

Utility means usefulness. Book-keeping is most useful since it provides correct and valuable information on financial matters of the business.

- **Businessman or Owner:** The businessman or owner who invests his money and assets into his business must know profitability, financial stability and solvency of his business concern at any given point of time. This can be ascertained only from the books of accounts. It would not be possible for the owner to carry out his business without systematic records of the business transactions. He can take business decisions more realistically on the basis of information provided by the books of accounts.
- **Comparative study:** By comparing the financial statements of past years with current years and with the financial statements of similar other firms' management or owner of the business can judge whether the business is making progress or not and accordingly introduce changes in the business to increase profitability.
- **Management**: In the case of joint stock company & co-operative society there is division of ownership and management. Ownership remains with the shareholders and management looks after the business activities. It is therefore necessary for the management to provide financial information from time to time to shareholders. From the accounting records manager can provide timely information to different parties to gain their confidence.

The manager can take proper decision of various activities carried out by the business based on the information supplied by the accountants. By studying different financial statements, he can judge efficiency of the business and project the future of the business. In other words, it helps the management in planning, controlling, decision making and managing the overall business.

- **Creditors & Lenders:** Book keeping has great utility to creditors. The creditors get valuable and correct information from the different financial statements published by the business concern. On the basis of such information they can decide the credit worthiness of the concern.
- **Investors:** The investors like shareholders, debenture holders, creditors, partners or any prospective investors can take decision by studying the books of accounts whether to invest into the business concern or not.
- **Trade Union:** Accounts provide valuable information to employees, trade unions of the respective business concern about the its business dealings.
- **Government:** Government authorities collect taxes like Sales tax and Income tax and revenue collecting departments can accurately impose and collect taxes from the business on the basis of information provided by the books of accounts.

## 2.0 Meaning of Accountancy

Accounting is the broader concept than book keeping. Accountancy which includes book keeping is an entire process of classifying, summarizing and interpreting business transactions.

Kolher defines "Accountancy refers to the entire body of the theory and process of accounting"

## 2.1 Basis of Accounting:

A. **Cash Basis Accounting -** is the basis of accounting wherein only cash transactions are recorded. i.e. income is accounted when cash is actually received and expense is recorded when cash is actually paid.

B. **Accrual Basis Accounting** – is the basis of accounting wherein cash as well as credit transactions are recorded. Income is recorded when it is earned and expenses are recorded when it becomes payable. The basic difference in Accrual basis of accounting is that the income and expenses are accounted for at the point of accrual i.e. earned or incurred irrespective of whether such income or expense is received or paid.

## 2.2 Branches of Accounting

There are mainly three major branches of Accounting

- Financial Accounting
- Cost Accounting
- Management Accounting

## 2.3 Difference between Book Keeping and Accountancy

| No. | Book Keeping | Accountancy |
|---|---|---|
| 1. | It is mainly related to identifying, measuring, and recording, financial transactions | It is the process of summarizing, interpreting, and communicating financial transactions which were classified in the ledger account |
| 2. | Management can't take a decision based on the data provided by bookkeeping | Depending on the data provided by the accountants, the management can take critical business decisions |
| 3. | Its objective is to keep the records of all financial transactions proper and systematic | Its objective is to gauge the financial situation and further communicate the information to the relevant authorities |
| 4. | Financial statements are not prepared as a part of this process | Financial statements are prepared during the accounting process |
| 5. | It doesn't require any special skill sets | It requires special skills due to its analytical and complex nature |
| 6. | The process of book-keeping does not require any analysis | Accounting uses book-keeping information to analyze and interpret the data and then compiles it into reports |
| 7. | Basically there are two types of bookkeeping - Single entry and double entry bookkeeping | There are two types of accounting Cash basis accounting and Accrual basis accounting. The accounting department does preparations of a company's budgets and plans loan proposals |

## 3.0 Some Key Terms and Definitions

1. **Business:**
   Any activity carried out by a person with a motive to earn profit is called Business.

2. **Goods:**
   Goods are Commodities, which are bought or sold by a businessman for the purpose of business; or Goods are Commodities in which a trader deals. For a particular Commodity to be known as Goods it should satisfy following two conditions:
   a) It should be purchased for the purpose of selling, and
   b) It should be his regular business.

   Accounting term for goods in different situation:

   **(i) PURCHASES:**
   When goods are bought it is known as purchases

   **(ii) SALES:**
   When goods are sold it is known as sales.

   **(iii) SALES RETURN:**
   If sold goods are returned by the customer it is known as sales Return or Return Inwards.

   **(iv) PURCHASE RETURN:**
   If goods purchased are returned to supplier it is known as purchase Return or Return onwards.

3. **Transactions**:

A Transaction is an exchange of goods or things or services on cash or credit term (Basis).

For example:

i) Purchase of T.V. on Cash.
ii) Doctor's fees paid in Cash.
iii) Lawyer's fees adjusted against tuition fees.
iv) Purchase of Motor Cycle on Credit.

**Transaction can be of two types:**

1) **Barter Transaction:** When goods are exchange for goods it is called as Barter Transaction. In this type of transaction money is not used as a medium of exchange. As value of the transaction cannot be ascertained in terms of money, this type of transaction cannot be recorded in the books of accounts.

2) **Monetary Transaction**: When goods are exchanged for money or money's worth it is called as Monetary Transaction.

   Monetary Transactions are further grouped on the basis of mode of payment. They are:

   - **Cash Transaction:** Cash transaction is an immediate exchange of goods or assets or services for cash. In Cash transaction relation between parties comes to an end immediately.
   - **Credit Transaction**: Credit transaction is an exchange of goods, services or things on credit basis. In this type of transaction goods, things or services are received / given now but payment is to be made / received in future. In credit transaction, the exchange takes place at different times and relation between parties will continue in future.

4. **Assets:**

   Properties owned by a person and used in Business to earn profit is called as assets. e.g. Cash & Bank Balance, Machinery, Furniture, Motor Vehicles etc. Assets can be (a) Fixed Assets (b) Current Assets (c) Tangible Assets (d) Intangible Assets

   - **Fixed Assets** are those assets, which are held in the business for a long period of time, and they are generally used for manufacturing goods and services. For instance, Land & Building, Plant & Machineries, Motor Vehicles etc. are fixed assets of enterprise.
   - **Current Assets** are held in the business for a very short period and they are used for maintaining liquidity of business. For instance, cash in hand, bank balance, stock of goods in hand, amount receivable from debtors etc. are current assets of the business enterprises.
   - **Tangible Assets** are those, which can be seen and be touched and felt.
   - **Intangible Assets** are those assets, which cannot be seen, touched and felt, but can be sold and converted into cash. Use of tangible assets enables its owner to earn income in the form of royalty. For instance, goodwill, copyrights, patents, trademarks, etc. are called intangible assets.

5. **Liabilities:**

   It is the amount owed/payable by a Businessman to other persons like suppliers of materials, Bank or other parties from whom he has borrowed money for business purpose. Liabilities arise because the Businessman is not able to make immediate payment for goods purchased or services taken or money borrowed. Example of Liabilities is Bank Loan, Creditors, Unpaid expenses etc.

   Liabilities are classified as short-term liabilities and Long-term liabilities.

   ❖ **Short-term liabilities** are those obligations or debts, which are to be paid by business within a period of one year. For instance, Bank Overdraft, sundry creditors, bills payable etc. are called short-term liabilities as they are to be paid generally within a year.

   ❖ **Long-term liabilities** are those obligations or debts which are payable by a business after one year. For instance, capital, bank loan, debentures, loan taken financial institution like LIC, GIC, FCI, ICICI, etc. are called long term liabilities as they are to be paid by business after one year.

6. **Debtor**:
   A debtor is a person to whom another person has sold goods on credit.

**OR**

   He is a person to whom another person has given a loan.

   In other words, a debtor is a person who has to pay some amount to another person or who owes (has to pay) something to another person.

***OR***

   A debtor is a person from whom we have to receive some amount.

   For Examples:
   (a) If we sell goods to A on credit or give a loan to him, he will be our debtor, since he owes (has to pay) amount to us.
   (b) If Mr. Clinton sells goods to George Bush than George Bush is known as Debtor of Mr. Clinton.

7. **Creditor**:
   A Creditor is a person who has sold goods to another person on Credit.

***OR***

   He is a person who has given a loan to another person.

   In other words, a creditor is a person who has to receive some amount from another person

***OR***

   He is a person to whom one has to pay something.

***OR***

   A Creditor is a person to whom we have to pay some amount.

   For example:
   a) If we buy goods of Rs. 1,000 from Mr. Kapil Dev he will be called our Creditor, because we have to pay Rs. 1,000 to him.

b) If Mr. Clinton sells goods to George Bush then Mr. Clinton is known as Creditor of George Bush.

**8. Capital**:

Capital is the total amount invested in the business by the owner. It is the amount, which belongs to the owner himself. The Capital of a business is the amount receivable by the owner from the business.

**OR**

It is the amount payable by the business to the owner. Capital is a liability of the business. In the accounting Sense Capital is the Excess of Assets Over Liabilities.

The Equation will be**: Capital = Assets - Liabilities**

For example: If the assets in a business amount is Rs. 70,000 and the Liabilities amount is Rs. 20,000 then Capital of businessman will be Rs. 50,000. The owner has to receive the amount from the business. Capital may be invested in Cash or Kind.

**9. Drawings**:

It is the amount withdrawn by a proprietor from business for his personal use. It can be in cash or kind i.e. goods. Thus word ‘drawings’ is just opposite to word ‘capital’ in meaning. Drawings refer to total amount of cash and goods withdrawn by proprietor from the business from time to time for self-use or family use. Drawings are always adjusted with capital.

**10. Solvent**:

A person is said to be Solvent when he is able to pay off all his Liabilities. In other words, a person is said to be Solvent when his assets are equal to or more than his Liabilities.

**11. Insolvent**:

A person is said to be insolvent when he is unable to pay off all his Liabilities. In other words, a person is said to be insolvent when his Liabilities are more than his Assets.

**12. Revenue / Income**:

Revenue is the amount received or receivable when the firm sells its goods or products. For example: If a businessman sells goods of Rs. 5,000 on Cash and Rs. 10,000 on Credit then the total revenue of the business is Rs. 15,000.

Income: It is the amount received or receivable in return of Services rendered.

Example: Amount received by way of Rent, Commission, Interest etc.

So professionals like Doctors, Lawyers etc. earn an Income and not revenue.

**13. Expenses:**

It is the amount spent on manufacturing goods or for selling of goods and for rendering services. Therefore, expenses can be classified into:

i) Expenses on purchase of goods or manufacturing of goods.
Examples: Wages, Power & Fuel, Carriage Inward, Purchase of Raw Material.

ii) Expenses on services received by the business.
Examples: Salaries, Printing & Stationery, Advertisement etc.

**14. Profit:**

Profit is the excess of revenue or income over expenses during a particular period. In terms of equation it can be written as: Profit = Revenue or Income – Expenses

**15. Loss:**

Loss is the excess of expenses over revenue or income, during a particular period. In terms of equation: Loss = Expenses - Revenue or Income

**16. Bad Debts**:

Debts, which are not recoverable, are known as Bad Debts. Bad Debt is a loss which is incurred by the business on account of non-collection of the debt from debtors. It is treated as bad debt when all hopes or chances of recovery of debt are lost.

**17. Journal:**

It is a Book in which daily transactions of the Business are recorded in a chronological order It is also called as book of original entry.

**18. Entry:**

When the transaction is recorded in the Journal it is known as entry. It forms the basis for writing the Books of Accounts.

**19. On Account:**

When the amount is received or paid in part then it is said that payment is made or received on account.

**20. Discount:**

An allowance or benefits, which is given by the seller to buyer or by creditor to debtor, is known as discount. Thus it is the Reduction allowed by seller to buyer. Discount is of two types viz. Trade discount and cash Discount.

| TRADE DISCOUNT (T.D) | CASH DISCOUNT (C.D) |
|---|---|
| 1. T.D. is allowed at the time of purchase/sale of goods in bulk/large quantities. | 1. C.D. is allowed on prompt payment. |
| 2. T.D. is allowed for cash as well as credit of transactions buying / selling of goods. | 2. C.D. is allowed only for cash transaction . |
| 3. % of T.D. is applied on GROSS PRICE (original price of goods) (G.P.) (List price) (Catalogue price) | 3. % of C.D. is applied on NET PRICE (N.P.) |
| 4. List Price X<br>(-) T/ Discount X<br>Net Price X | 4. Net Price X<br>(-) C/Discount X<br>Cash Recd./ paid X |
| 5. T.D. is never recorded in the books of accounts | 5. C.D. is recorded in the books of accounts. |
| 6. Entry will be passed only at Net Price<br>Goods/Purchase A/c Dr. X<br>To Cash party A/c X<br>(At net price) | 6. (i) For purchase<br>Goods/Purchase A/c Dr. X<br>To Cash party A/c X<br>To Discount Received A/c X<br>(ii) For Sale<br>Cash A/c Dr. X<br>Discounts Allowed A/c Dr.<br>X<br>To Goods /Sales A/c X |

## 4.0 Double Entry System

Double Entry System of book-keeping denotes that every business transaction has two-fold effect. There cannot be a business transaction unless it has an effect on at least two accounts or two parties. Whenever a businessman gives something, he gets something else in return of that. In other words, one account receives the benefit and the other account gives the benefit.

The amount of benefit received by one account is equal to the amount of benefit given by the other party. This enables us to record the two effects of any business transaction. Thus, recording this dual aspect of business transactions in the books of accounts in known as Double Entry System of Book Keeping.

### 4.1 Key Principles of Double Entry System:

- Every business transaction has two aspects.
- These two aspects involve two accounts
- One account is the receiver of the benefit and the Other account is the giver of the benefit.
- If one account is debited the other account has to be credited with equal amount

There are three steps in recording any financial transaction:

(1) Deciding as to what accounts are affected.
(2) Deciding whether to debit or to credit the account.
(3) Deciding on the amounts to be debited or credited.

### 4.2 Advantages of Double Entry Book Keeping system:

- By recording double aspects of each transaction in the books of accounts, it ensures an arithmetical accuracy of accounts.
- This system is helpful to detect, prevent and reduce the frauds.
- If at all any mistake occurs, it can be detected and rectified.
- Exact amount due to us from customers and other parties, and exact amount payable to creditors by us can be known easily from the records maintained as per this system.
- This accounting system keeps complete, accurate and perfect records of business transactions.

- This accounting system is suitable for all types of the business organisation i.e. small scale, medium scale and large scale, public and private business organisation etc.
- This accounting system is helpful to prepare trial balance and final accounts, of the business at the end of the accounting year. .
- With the help of this system income statements of current year can be compared with the income statements of previous years and on the basis of that comparison businessman gets information about the variations in incomes and expenses. To control expenses, businessman can adopt different measures.

### 4.3 Golden Rules of Double Entry Book Keeping System

| | | |
|---|---|---|
| **Rule 1:** | **Debit what comes in.** | **Credit what goes out.** |
| **Rule 2:** | **Debit the receiver.** | **Credit the giver.** |
| **Rule 3:** | **Debit all expenses or losses.** | **Credit all income or gains.** |

### 4.4 Account:

An account is a list of business transactions falling under same description for a given period of time. A systematic and summarised record of business transactions with respect to person, property, loss, gain, income, expense is known as account. Account is generally prepared for one complete year. The word Account in abbreviation can be written as A/c. Accounts are prepared and maintained in the Ledger. Separate Ledger sheet or page is used for each account.

### 4.5 Classification of Accounts:

Accounts are classified into two main groups as (1) Personal Account and (2) Impersonal Account,

**(1) Personal Account:**

Account of person or account relating to person with which business keeps dealings is called Personal A/c. Therefore, account of an individual, partnership firm, company, club, institution, local authority, association, State Government and Central government with which business keeps dealings is called personal account.

From viewpoint of law persons are classified as (a) natural or living persons and (b) legal or artificial persons. Legal person does not have life, body and soul, but law recognizes it, as a person because all business transactions are done by it in its own name. For instance Bank of India's A/c. is a personal account as Bank of India is a financial institution, which deals in money. It is a legal person. Under the title legal person following institutions and legal bodies are included viz. partnership firm, joint stock company, association, clubs, legal, medical, financial, educational and charitable institutions, Gram Panchayat, District body, State Government, Central Government etc are included. Account of debtor, Account of creditor, Bank A/c, College's A/c, Hospital's A/c, Club's A/c, Partnership firm A/c are called Personal A/c.

**(2) Impersonal Account:**

All accounts other than personal accounts are known as impersonal accounts. In other words, all accounts, which are not personal accounts, are grouped under impersonal account. For instance, Cash A/c, Rent A/c, Wages A/c, furniture A/c are impersonal accounts. Impersonal accounts are classified as (a) Real A/c and (b) Nominal A/c.

**(a) Real Account**: An account of property, or any thing owned and possessed by business is called Real Account. In other words, Real A/c. is that account which relates to assets, objects etc. of the business. For example, Cash A/c, Furniture A/c, Land and Building A/c, Goods A/c, Goodwill A/c, Plant and Machinery A/c are called Real A/c as they relate to Property of the business.

**(b) Nominal Account**: An account relating to business expense, income, gain and loss are called Nominal account. In other words, an account of business expense, business income, business loss or business gain is called Nominal A/c. For instance, Rent A/c. is a Nominal A/c, as rent is an expense if it is paid by business and it is an Income if it is received by business.

Table showing Classification of accounts into Personal Accounts, Real Accounts and Nominal Accounts is given below:

| Personal Accounts | Real Accounts | Nominal Accounts |
|---|---|---|
| 1. Capital A/c | 1. Stock of goods A/c | 1. Bad debts A/c |
| 2. Bank of Baroda's A/c | 2. Cash A/c | 2. Interest A/c |
| 3. Mr. Kamlakar's A/c | 3. Goods A/c | 3. Discount A/c |
| 4. D.G.T. Junior college's A/c | 4. Building A/c | 4. Loss of stock by fire A/c |
| 5. X.Y.Z. Partnership Firm's A/c | 5. Goodwill A/c | 5. Printing & Stationery A/c |
| 6. Jay's A/c | 6. Investment A/c | 6. Salaries A/c |
| 7. Loan A/c | 7. Tools A/c | 7. Income Tax A/c |
| 8. Debtor's A/c | 8. Loose Tools A/c | 8. Carriage Inward A/c |
| 9. Creditor's A/c | 9. Copy right A/c | 9. Carriage Outward A/c |
| 10. Loan from Vijay's A/c | 10. Patent A/c | 10. Repairs to Machinery A/c |
| 11. M/s. Sunita Textiles A/c | 11. Shares A/c | 11. Octroi A/c |
| 12. Proprietor's Wife Loan A/c | 12. Livestock A/c | 12. Taxes A/c |
| 13. Bombay Municipalities A/c | 13. Premises A/c | 13. Audit Fee A/c |
| 14. Co-operative Stores A/c | 14. Leasehold Building A/c | 14. Interest on debentures A/c |
| 15. Cricket Club of India's A/c | 15. Freehold Property A/c | 15. Gas and Light A/c |
| 16. Mahendra & Mahendra Co.'s A/c | 16. State Govt. Security A/c | 16. Trade Expenses A/c |
| | 17. Debentures A/c | 17. Royalty A/c |
| 17. Outstanding Wages A/c | 18. Stock of Stationery A/c | 18. Bank Commission A/c |
| 18. Prepaid Insurance A/c | 19. Bills Receivable A/c | 19. Bank charges A/c |
| 19. Rent Receivable A/c | 20. Motor vehicle A/c | 20. Packing Charges A/c |
| 20. Unexpired Insurance A/c | 21. Furniture & Fixtures A/c | 21. Brokerage A/c |
| 21. Outstanding interest A/c | 22. Plant & Machinery A/c | 22. Upkeep of Machinery A/c |
| 22. Interest receivable A/c | | 23. Railway freight A/c |
| 23. Employees Provident Fund A/c | | 24. Sales Tax A/c |
| | | 25. Publicity A/c |
| | | 26. Profit on sale of furniture A/c |

**Analysis of Transactions**

| Transaction | Two A/cs Involved | Types of Accounts | How each aspect is affected | Rule Applicable | Accounts to be debited | Accounts to be credited |
|---|---|---|---|---|---|---|
| **STEP I** | **STEP II** | **STEP III** | **STEP IV** | **STEP V** | **STEP VI** | **STEP VII** |
| 1. Commenced business with Rs. 15,000/- | Cash | Real | Cash comes in | Debit What comes In | Cash A/c | |
| | Capital | Personal | Proprietor is the giver | Credit the giver | | Capital A/c |
| 2. Purchased goods for cash Rs.1,000/- | Goods | Real | Goods comes in | Debit what comes In | Goods A/c | |
| | Cash | Real | Cash goes out | Credit what goes out | | Cash A/c |
| 3. Sold goods to Pallavi Rs.1,500/- | Pallavi | Personal | Pallavi is the receiver | Debit the receiver | Pallavi's A/c | |
| | Goods | Real | Goods go out | Credit what goes out | | Goods A/c |
| 4. Sold goods for cash Rs.2.000/- | Cash | Real | Cash comes in | Debit what comes in | Cash A/c | |
| | Goods | Real | Goods go out | Credit what goes out | | Goods A/c |
| 5. Paid office rent Rs.200/- | Rent | Nominal | Rent is an expense | Debit expenses | Rent A/c | |
| | Cash | Real | Cash goes out | Credit what goes out | | Cash A/c |
| 6. Paid cash to Dhanashri Rs.500/- | Dhanashri | Personal | Dhanashri receives cash | Debit the receiver | Dhanashri's A/c | |
| | Cash | Real | Cash goes out | Credit what goes out | | Cash A/c |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7. Received Commission Rs. 100/- | Cash | Real | Cash comes in | Debit what comes In | Cash A/c | |
| | Commission | Nominal | Commission is Income | Credit income | | Commission A/c |
| 8. Returned goods by Ram | Goods | Real | Goods come in | Debit what comes In | Goods A/c | |
| | Ram | Personal | Ram is the giver | Credit the giver | | Ram A/c |
| 9. Goods withdrawn for personal use | Drawings | Personal | Proprietor receives benefit | Debit the receiver | Proprietors Drawings A/c | |
| | Goods | Real | Goods go out | Credit what goes out | | Goods A/c |
| 10. Purchased Machinery for cash Rs.10000 | Machinery | Real | Machinery comes in | Debit what comes in | Machinery A/c | |
| | Cash | Real | Cash goes out | Credit what goes out | | Cash A/c |
| 11. Paid for Stationery | Cash | Real | Cash goes out | Credit what goes out | | Cash A/c |
| | Stationery | Nominal | Stationery is an expense | Debit expenses | Stationery A/c | |
| 12. Borrowed from Bindu | Cash | Real | Cash comes in | Debit what comes In | Cash A/c | |
| | Bindu | Personal | Bindu giver of benefit | Credit the giver | | Bindu’s Loan A/c |
| 13. Paid Salary | Salary | Nominal | Salary an expense | Debit expenses | Salary A/c | |
| | Cash | Real | Cash goes out | Credit what goes out | | Cash A/c |

## 4.6 Definition of Journal

Journal means a 'daily record'. According to a Dictionary for Accountant written by Elic L. Kohler, "A 'Journal' is the book of original entry in which are recorded transactions not provided for in specialised journals". A Journal is a book of "Original entry" or "primary entry". It is a book for daily record. First of all, the business transactions are recorded in the "Journal" and subsequently they are posted in the ledger. In modern times, a journal is divided into various books known as "Subsidiary Books". To study "Book-keeping" one must learn first how to journalise the transactions. To journalise the transactions means to record the two fold effects of a transaction in terms of debit and credit. This has to be done by observing the rules of debit and credit.

## 4.7 Features of a Journal:

- Books prime original or first entry.
- Records transactions in a systematic manner.
- Analyses the transactions into their debits and credits.
- A gateway to the ledger.

## 4.8 Utility of a Journal:

A journal is needed for the following reasons:

- It contains a record of various transactions that takes place every day.
- It provides a complete record of transaction as both the aspects of the transactions are recorded at one place.
- Since narration of a transaction is written in the Journal, there is no need to give an explanation in the ledger.
- It facilitates cross checking of transactions.
- Since transactions are recorded in the Journal, there is no need to post the transactions to the ledger immediately.
- From the legal point of view also a Journal becomes necessary. Courts recognize the journal as evidence in approving or disapproving claims.
- It helps to locate and prevent errors.

**4.9 A Specimen Form of Journal:**

**In the Journal of M/s. ............**

| Date | Particulars | L.F. | Debit Rs. | Credit Rs. |
|---|---|---|---|---|
| 200___ | ____________________A/c ............Dr.<br>To ________________A/c<br><br>(Being ____________________________)<br>(Narration) | | _____ | _______ |

**Explanation of the form of Journal:**

**1. Date Column**: In this column the date of the transaction is written. Generally, this column is divided into two parts namely for writing the month and the date of the transaction.

**2. Particulars Column**: The "Particulars Column" is the most important column. Before the details are written in this column the book-keeper decides as to what accounts are affected and which account is to be debited and which account is to be credited. The account to be debited is written on the first line just near the date column. On the same line the word "Dr" is written against the account to be debited. After that, on the second line the account to be credited is written. The name of this account should be preceded by the word "To" and while writing on the second line a little space should be left from the date column. It must be noted that the word "Cr" need not be written against the account to be credited, as it is clear that if the account on the first line is shown debited the corresponding account on the next line stands credited. On the third line a brief description of the transaction is written which is known as "narration".

**3. Ledger Folio:** While recording the transactions nothing has to be written in this column. The journal entries are required to be posted to the debit and credit of accounts in the ledger. At that time the page number of the ledger on which the two accounts appear are entered in this column.

4. Debit Amount Column: In this column the amount of transaction is written against the word "Dr" in particulars column on that line.

5. Credit Amount Column: In this column the amount of transaction is written against the name of the account credited on that line.

6. In the particulars column an explanation or narration is to be given below the credit item. Such a narration should be written in between the date line and the folio line. It should not cross these two lines on either side.
7. A thin line should be drawn between each transaction across the page from the date column to the folio column immediately below the journal entry. Some space should be left after each such line so as to distinguish one entry from another.
8. At the end of each page of a journal the debit and credit amount columns are totaled up and the total of the debit and credit amount columns must be equal as the amount debited and amount credited are equal for every transaction. These totals are carried forward to the next page.
9. In case the journal runs over several pages the first page is totaled and the totals are carried over to the next page at the top as "Totals brought forward". This is repeated for subsequent pages.
10. The amount of debit column must agree with the amount of credit column.
11. Totals of amount column are never posted in the ledger.

### 5.1 Ledger:

Ledger is a book of accounts in which businessman keeps individual records of persons, properties, expenses, incomes, gains and losses. It is the end point of entries made in the journal, or subsidiary books. Ledger may be in the form of a bound register or cards or separate sheets may be attached and maintained in a loose-leaf binder. For every person with whom business keeps dealings, a separate account is prepared in the ledger; Similarly, separate account is maintained in the ledger for each kind of assets, expenses, losses and gains. As and when business transactions occur, they are first recorded in journal and subsequently those recorded entries from journal are transferred and posted to respective account in Ledger. Each ledger account is totaled at the end of the accounting period. This book contains many pages and each page is called a folio. The relationship between the business and a particular account on given date can be ascertained only from the ledger. For instance, if businessman wants to know on a particular date the amount due from a certain customer or debtor, it can be known easily only from ledger, various transactions pertaining to different dates of a particular account may be spread over in the journal on various pages but in the ledger they are found on one page.

## 5.2 A Specimen of Ledger:

Dr. NAME OF THE ACCOUNT Cr.

| Date | Particulars | J/F | Amount | Date | Particulars | J/F | Amount |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

**Explanation of the form of Journal:**

Each page of ledger is serially numbered. Each ledger account has two main side's viz. left hand side and right hand side. Left hand side of ledger account is called debit side and Right hand side of ledger account is called credit side. Each side has four sub columns viz. Date, Particulars, J.F. and Amount.

**Steps to be taken for preparation of the Ledger Account:**

(1) At the top of ledger, in the middle, name of account should be written.
(2) Date of transaction should be written in date column in the same order as we record in journal.
(3) In particulars column on debit side of ledger account name of account credited is written and in particulars column on credit side of ledger account name of account debited is written. For instance, following journal entries are posted in cash account as given below:

| | | | | |
|---|---|---|---|---|
| 1997 | | | | |
| July 1 | Cash A/c. | Dr. | 15,000 | |
| | To Sales A/c | | | 15,000 |
| July 5 | Purchase A/c. | Dr. | 10,000 | |
| | To Cash A/c | | | 10,000 |

Dr. Cash A/c Cr.

| Date | Particulars | J.F. | Amount | Date | Particulars | J.F. | Amount |
|---|---|---|---|---|---|---|---|
| 01/07/1997 | To Sales A/c | | 15,000 | 05/07/1997 | By Purchase A/c | | 10,000 |

(4) Opening balance of ledger account should be shown as balance (b/d). Real account like Cash A/c., Furniture A/c., Goods a/c. Machinery A/c. etc. always shows debit balance and liabilities like Capital A/c., Sundry Creditor's A/c. Bank Loan A/c., etc. always shows credit balance.

### 5.3 Balancing of Ledger Account:

Balancing of ledger account means finding difference between heavier total, and lighter total of ledger account and recording that difference on lighter total side. At the end of the accounting year all accounts operated in the ledger are totaled and balanced. Steps required for balancing of ledger account are given below:

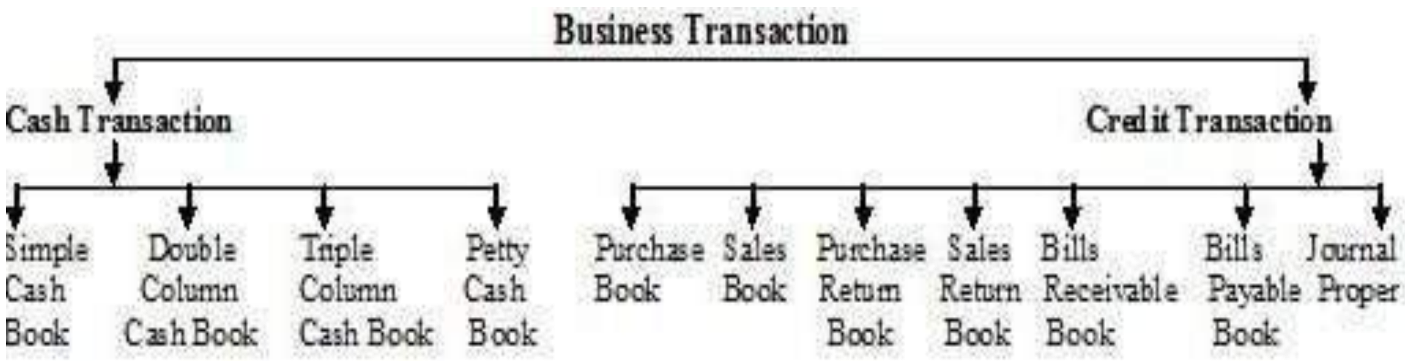
- Look at the Ledger A/c and mentally decide which side is more.
- Take total of that side first.
- Write the same total on opposite side on the same line.
- One line before total and two lines after total.
- If total of debit side of ledger account is heavier than total of credit side of that account, the balance is called debit balance and is written on credit side (i.e. on the side where total is lighter) as "By Balance (C/d.)".
- If total of credit side of ledger account is heavier than total of debit side of that account, the balance Is called credit balance and is written on debit side (i.e. on the side where total is lighter) as "To Balance (C/d)."
- Now carry forward the total to the next month on the opposite side either as “To Balance b/d “or “By Balance b/d”.

### 6.0 Subsidiary Books

Journal is a main account book in which all types of day-to-day business transactions are recorded systematically in chronological order. Journal is useful for traders whose business is small and limited in size. Journal is not useful to those traders whose business is large in size and who carries on unlimited business transactions every day. A single journal for entire large-scale business will be bulky and difficult to operate and handle. Similarly, many clerks cannot simultaneously do office work based on information written in the journal. It was felt that if all transactions are recorded in one journal, it will be time consuming to obtain necessary information. To avoid these difficulties journal is sub divided into number of parts.

Each of that sub part of journal is called subsidiary book. In other words, subsidiary book is a divided part of journal, meant for recording specific types of business transactions. These subsidiary books are: (1) Purchase Books. (2) Sales Book. (3) Purchase Return Book, (4) Sales Return Book. (5) Cash Book, (6) Bill Receivable Book, (7) Bills Payable Book, (8) Journal Proper.

**Classification of Business Transactions and Location in Book of Accounts:**




**6.1 Purchase Book:**

This is a subsidiary book in which only credit purchases of goods are recorded and is known as purchase book. It is used to record credit purchase of goods in which trader regularly deals. In this book cash purchases of goods and assets are not recorded. Similarly purchase of asset on credit is also not recorded in this book. Purchase book is written on the basis of Inward invoice i.e. a statement received from the supplier. Trade discount is never recorded. Trade discount is calculated and deducted from invoice price and net price is recorded in purchase book. If a bookseller purchases books on credit, it will be recorded in this purchase book. Purchase of furniture by bookseller on credit will not be recorded in his purchase book. At the end of each month purchase book is totaled and this total shows the total amount of goods purchased on credit.

**Specimen of Purchase book is given below:**

| Date | Name of the Suppliers | Inward Invoice | L.F. | Amount (Rs.) |
|---|---|---|---|---|
| | | | | |

**Explanation of Columns:**

(a) Date: This column is meant for recording date of credit purchase of goods.

(b) Particulars: In this column name of suppliers from whom goods are purchased on credit is recorded. Along with name of supplier his address and description of goods is also written in this column.

(c) Inward Invoice No.: Statement received from supplier along with goods purchased is called inward invoice. In this column number of inward invoice is mentioned.

(d) L.F- No.: In this column page number of ledger on which supplier's account is prepared is recorded for ready reference.

(e) Amount: This column shows net amount payable to suppliers.

**Proforma of Invoice:( for Purchase & Sales Book)**

***INVOICE***

| | |
|---|---|
| Telegrams: "Golden" | Golden Watch Makers<br>Aurangpura, |
| Telephone: 1001 | Aurangabad, |
| No. 1600 | 1st March, 2004 |
| Name: M/s. Ram Bros. Watch Co., Nagpur. | |

| Quantity | Particulars | Rate | Amount |
|---|---|---|---|
| | | | **Rs.** |
| 10 | Gents' Watches (Standard) | 500 | 5,000 |
| 10 | Ladies' Watches (Gentle) | 400 | 4,000 |
| 05 | Super Watches | 800 | 4,000 |
| | | | 13,000 |
| | **Less**: Trade Discount @ | 10% | 1,300 |
| | | | 11,700 |

E. & O.E.

For Golden Watch Makers
Sd/-
XYZ

## 6.3 Sales Book:

A subsidiary book in which only credit sales of goods are recorded, is known as sales book. This book is meant for recording credit sales of goods in which trader regularly deals. In this book sale of goods as well as assets on cash basis are not recorded. Similarly, sale of assets on credit is also not recorded in this book. This book is written on the basis of outward invoice. Trade discount never appears in this book Trade discount is simply calculated and deducted from invoice price. If a grocer sells different types of grains to its customers on credit it will be recorded in the sales book of the grocer. Cash sales made by the grocer will not be recorded in his sales book. Sales book is also known as day book. At the end of each month sales book is totaled and this total shows total amount of goods sold on credit.

**Specimen of Sales book is given below:**

| Date | Name of the Customers | Outward Invoice | L.F. | Amount (Rs.) |
|---|---|---|---|---|
| | | | | |

**Explanation of Columns:**

1. Date: The date on which the sales took place is entered.
2. Particulars: Name of the customer is written, but Address of customer need not be given.
3. Outward Invoice No.: The serial number of the invoice is entered.
4. L.F.: The page number of the ledger on which the customer's account appears is shown.
5. Amount: The net amount of the sale is recorded (amount arrived at after deducting the trade discount from the gross value of the sales.)

### 6.4 Purchase Return Book:

A subsidiary book in which, return of goods purchased on credit is recorded, is known as Purchase return book. Purchase return book is also known as return outward book or debit notebook. This book is used by trader for recording the returns of goods purchased on credit. Trader may return goods to supplier on one of the following reasons. Viz. (a) defective goods, (h) damaged goods, (c) delayed goods, (d) inferior goods, (e) goods which are not as per design, Color or sample sent (f) excess goods received etc. This book is written on the basis of debit note. Purchase return book is totaled at the end of each month. This total shows value of goods returned to suppliers.

**Specimen of Purchase Return book is given below:**

| Date | Name of the Suppliers | Debit Note No. | L.F. | Amount (Rs.) |
|---|---|---|---|---|
| | | | | |

### 6.5 Debit Note:

A Debit Note is sent to the supplier when the goods purchased from him are returned. A Debit Note is a statement sent by the buyer to the supplier stating the full details of the good returned. It is sent along with the goods. It intimates the supplier that his account has been debited by the value of the goods returned to him. Many a time goods are received correctly as per the invoice but the invoice is overcharged. Therefore, the invoice shows a larger amount than what it should be. In such a case, the buyer does not return the goods but sends a debit note to the supplier of the excess value charged. On receiving the debit note the supplier also sends a credit note to us for the excess value charged. Debit Notes and Credit Notes are in a bound book. The original copy of Debit Note is sent to the supplier to whom the goods are returned and the carbon copy is kept for reference in the office.

**Specimen of Debit Note**

**UNIVERSAL TRADING CO.**
**Marine Lines. Bombay**

Debit Note No: Dated: 10-2-2005

Swadeshi Mills. Bombay Account

We have to advise you that your account has been debited on account of.

| Invoice No. Date | Particulars | Amount Rs. |
|---|---|---|
| 21-1-2005 | Being the difference of 100 meters Terry cot Cloth at the rate of Rs. 30 but charged at the rate of Rs. 35 in the invoice. | 500.00 |
| | | 500.00 |
| | | Sd/- Purchase Manager |

### 6.6 Sales Return Book:

A subsidiary book in which transactions relating to return of goods sold on credit, are recorded, is called sales return book. This book is used by trader for recording the goods returned by customers, which were purchased by them on credit. They may return goods sold to customers on credit, on one of the following reasons, viz. (a) defective quality goods, (b) damaged goods, (c) delayed goods, (d) inferior quality goods, (e) goods not in accordance with sample, specification, color, design, (f) over supply of goods, etc.

Sales return book is written on the basis of credit note. This book is also called as credit note book or return inward book. At the end of each month sales return book is totaled.

**Specimen of Sales Return book is given below:**

| Date | Name of the Customers | Credit Note No. | L.F. No. | Amount (Rs.) |
|---|---|---|---|---|
| | | | | |

## 6.7 Credit Note:

A Credit Note is sent to the customers when we receive goods returned from them. It gives the full details of the goods returned by the customers. Credit Notes are generally printed in red ink. Transactions are recorded in this book on the basis of Credit Notes.

**Specimen of Credit Note**

<table>
<tr><td colspan="3">M/S CHOTILAL & CO.<br>Fort, Bombay - 32<br>Credit Note No. Date : 01-03-2005<br><br>M/s Ramlal Sons.<br>Pune.<br>We have to advise you that your account has been credited as under:<br>Rs.</td></tr>
<tr><td>By Return:</td><td>10 Chairs returned on account of damage in transit at Rs. 50 per chair</td><td>500</td></tr>
<tr><td colspan="3">For Chotilal & Co.<br>Rajan<br>Manager</td></tr>
</table>

## 6.8 Difference between a Debit Note and a Credit Note:

- A Debit Note is an intimation sent to the party stating that the debit is given to its account. A Credit Note is an intimation to the party to whom it is sent stating that the credit is given to it.

- A Debit Note can be sent by the seller to the buyer to adjust the under debit or under-charge in the original invoice. It can also be sent by the buyer to the seller to adjust the excess debit given in the original invoice or to evidence the purchase returns. On the other hand, a Credit Note is sent by the seller to the buyer to adjust the excess debit given in the original invoice or to evidence the sales returns. It can also be sent by the buyer to the seller to adjust the under-credit given in the original invoice.

**7.0 Cash Book:**

The Cash Book is a Book of original entry. All the cash transactions are recorded in the cash book. Even credit transactions result in cash. Cash is either received or paid. This indicates that there is a need to maintain a separate book to record all such cash transactions. When the cash transactions are recorded in the cash book, it serves both purposes of being a book of original entry as well as a ledger. Since the cash book enables the trader to find out the daily cash and bank balance, it serves the purpose of cash account. Therefore, there is no need to open a separate Cash Account in the ledger. Similarly, writing in the cash book saves a lot of time and labour by enabling recording of cash and Bank transactions without passing journal entries. In any business firm, cash and bank transactions constitute a major portion of the entries and therefore, the cash book is very useful and results in economy of time and labour.
Cash book achieves three purposes:

1. Recording all transactions pertaining to cash.
2. Ascertainment of the balance of cash on hand and bank balance.
3. Verification of correctness of cash and bank balance.

**7.1 Types of Cash Book:**

Cash Book is classified under the following heads:

(I) Simple or single column Cash Book.
(II) Cash book with cash and discount columns or double columns cash book.
(III) Cash book with Cash, Discount and Bank columns or Three columns Cash Book.
(IV) Petty Cash Book or Multi Columns Cash Book.

Above types of cash books are discussed in detail as follows:

**(I) Single Column Cash Book:**

This cashbook is also called simple cashbook. It has two sides viz. receipt side and payment side. The debit side of cashbook is meant for recording all receipts and credit side of cashbook is meant for recording all payments. This book is written on the basis of cash receipts and cash vouchers. The cashbook is balanced from time to time and balance is carried forward. The cashbook always shows a debit balance. In this book discount and bank transactions are not recorded.

**Specimen of Simple Cash Book:**

Dr. Cash Book Cr.

| Date | Receipt | R.No. | L. F. | Amount Rs. | Date | Payment | V.No. | L. F. | Amount Rs. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

**Double Columns Cash Book:**

This cashbook is also called cashbook with cash and discount columns. In this Book along with cash transactions, discount received and allowed also recorded. A businessman who receives cash discount from his suppliers or creditors and allows cash discount to his customers or debtors maintains double columns Cashbook. In this book one additional column for discount is provided on both sides of the Cashbook along with the cash column. Cash discount allowed is a loss and therefore it is to be recorded on the debit side of the Cashbook. Cash discount received is a gain and it is to be recorded on the credit side of the Cashbook.

**Specimen of Double Column Cash Book:**

Dr. Cash Book Cr.

| Date | Receipt | R.No. | L. F. | Discount Rs. | Cash Rs. | Date | Payment | V.No. | L.F. | Discount Rs. | Cash Rs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

Discount is a benefit or allowance, in money term given by seller to buyer or by creditor to debtor with a view of increasing sales or recovering the amount due. Discount is of two types viz. (a) Trade discount and (b) Cash discount. Trade discount is an allowance or concession in money term given by seller to buyer with an objective of increasing sales turnover.

Cash discount is recorded in the book of accounts. When cash is received, discount is allowed and debited in the cashbook. Similarly, when cash is paid, discount is earned and credited in the cashbook.

**(II) Three Columns Cashbook:**

This cashbook also called as cash book with cash, Bank and discount columns. Businessman, who does business transactions through Bank, records those banking transactions along with cash and discounts transactions in triple columns cashbook. Banking transactions like receipts and deposit of cheques, issue of cheques, deposit and withdrawal of cash from bank etc. are recorded in Triple columns cashbook. By maintaining triple columns cash book, businessman gets information of inflow and outflow of cash and details of banking transactions. Exact position of cash in hand and balance of cash at bank can be ascertained quickly by referring triple columns cashbook. Triple columns cashbook is useful for businessman to take quick decisions on business matters.

**Specimen of Three Columns Cashbook:**

Dr. Cash Book Cr.

| Date | Receipt | R. No. | L.F. | Disc. Rs. | Cash Rs. | Bank Rs. | Date | Payment | V. No. | L.F. | Disc. Rs. | Cash Rs. | Bank Rs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |

**7.2 Sources of Writing the Cashbook:**

**(A) RECEIPT VOUCHERS:**

It is a document showing an official and authentic acknowledgement of the fact that cash or cheque is received from the payer. Typical Contents of Receipt are -

(a) Name and address of the Concern which has received the Cash/Cheque
(b) Serial No. of receipt will be written
(c) Date of the receipt will be written
(d) The name of party from whom money is received.
(e) Amount received in words.
(f) Whether amount is received by cash/cheque/draft. Delete the word not applicable. If cheque/draft received, then write cheque no. and date.
(g) Whether amount is received in full/part/advance and write the purpose, delete the words not applicable.
(h) Write the bill no. and date.
(i) Write the amount received in figures.

(j) If amount is above Rs. 500 affix the revenue stamp and the person authorised will put his/her sign.

**Specimen**

| **RECEIPT** | |
|---|---|
| | **(a)** |
| No.: _____**(b)**_____ | SBCC ENTERPRISES<br>Mumbai – 400 004 |
| Date: ______**(c)**_____ | |
| Received with thanks from _____________________**(d)**____________________ | |
| the sum of Rupees ______________________**(e)**__________________________ | |
| | **(f)** |
| ______________________________________________ by Cash \ Cheque \ D.D. | |
| No. _____**(f)**___dated ___**(f)**_____ in part \ full \ advance payment on account of | |
| _____**(g)**______ our Bill no. _____**(h)**______ dated ___________________. | |
| Rs.________**(i)**______________ | **(j)** **Revenue Stamp** |
| Receipt subject to realisation of cheque | (Signature) |

**(B) PAYMENT VOUCHER**

It is a document giving details of cash/cheque paid to a person by a businessman. Typical contents of Payment Voucher:

(a) Write the name and address of the Company making payment.

(b) The Serial no. and date of payment voucher.

(c) The amount paid in figures

(e) The name of party to whom amount is paid.

(f) The name of a/c. to be debited.

(g) The details of transactions along with amount.

(h) The amount in words will be recorded.

(i) The person preparing and the manager authorising voucher will sign.

(j) Write the mode of payment and delete the words not applicable. Also write the name of Bank, cheque no. and date if payment is made by cheque.

(k) If payment of Rs. 500/- or above then affix revenue stamp and take signature of the persons receiving payment.

**Specimen**

| | |
|---|---|
| **DEBIT VOUCHER** <br> **(a)** SBCC ENTERPRISES Mumbai – 400 004 <br> No.: _______**(b)**_______ <br> Date: ______**(c)**________ <br> Rs.________**(d)**_______ <br> Paid to:________________________**(e)**___________________________________ <br> Debit: _________________________**(f)**___________________________________ | |
| ***Particulars*** | **Rs.** |
| **(g)** <br> Rupees **(h)** <br> Total | **(g)** |
| Authorised by ______**(i)**________ Prepared by _____**(i)**______ <br> Paid Cash / Cheque drawn on ____________**(j)**_________________ <br> Cheque No._________**(j)**__________ dated ______**(j)**___________ | **Revenue Stamp** <br> (Sign of receiver) |

## 7.3 Accounting Treatment of Banking Transactions in a Cash Book:

1. **A Cheque is received but not deposited in the Bank**: Every cheque received; so long as it is not paid into the Bank should be treated as cash and should be recorded in the cash column.

2. **A Cheque is received and deposited in the bank on the same day:** In this case, the amount of such a cheque should be entered on the receipt side of the Cash Book in the Bank column as 'To XYZ".

3. **A Cheque received on the previous day deposited into Bank:** In this respect, a contra entry should be passed on the day on which the cheque is deposited in the Bank. It will appear in the Cash Book on the Receipt Side as 'To Cash" in Bank column and on payment side as "By Bank" in Cash column.

4. **Received a Crossed Cheque:** The amount of Crossed cheque received should be entered in the Cash Book on the receipt side as 'To XYZ" in Bank column.

5. **Payment by issuing a Cheque:** Whenever payments are made by cheque they should appear in the Cash Book on the payment side as “Party's Account or Expenditure Account” in bank column".

6. **Endorsement of Cheque:** A businessman can endorse the cheque in favour of the creditor in settlement of his account. In this case, it will appear in the Cash Book on the payment side as "By XYZ" (Creditor) in cash column or Bank column.

   Whether it should be entered in the cash column or the Bank column depends upon the nature of the cheques. The simplest method is to see the original entry of that cheque. If it is originally entered in the Cash Column on the receipt side, then after endorsement it should be entered on the - payment side of Cash Book in the cash column. If it is originally entered in the "Bank Column" on endorsement, then it should be entered on the payment of the cash book in the Bank Column.

7. **Dishonour of Cheque:** A cheque received from the customer or cheque Issued to the creditors may be dishonored owing to certain reasons. Dishonour means refusal of payment by the Bank, Cheques may be dishonored on the following grounds:

   - If it is defaced.
   - If the signature on the cheque does not agree with the specimen signature.
   - If the amount in words does not agree with the amount in figure.
   - If the funds to the credit of the Drawer are insufficient.
   - If a period of six months has expired from the date of drawing the cheque.

8. **Direct Deposit by Customers**: If the amount due from customer directly deposited by him in our Bank account, on receiving the advice it will be entered in the Cash Book on the receipt side, as, ”To Customer’s Account" (the amount will be entered in the Bank Column).

9. **Collection of Interest on Investment by the Bank:** A Bank collects interest on our Investment or allows interest on our deposit. The credit the entry of such a collection is made in the passbook by the Bank. On receiving advice or the Pass Book from the bank, it will be entered on the receipt side of the Cash Book as “To interest on investment". (The amount will be entered in Bank Column).

10. **Payments made by the Bank under our Standing Instructions:** As per our standing instruction, a Bank makes payment on our behalf, on account of insurance premium, Interest on loan taken; call money on shares, etc. On making such payments, the Bank passes a debit entry in the Pass Book. After receiving the advice or Pass Book, it is entered on the payment side of the Cash Book as "By Insurance Premium or By Interest or By calls on shares" as the case may be (The amount will be entered in the bank column).

11. **Bank charges and Bank commission:** A Bank charges some amount for the services rendered to the customers. The Bank makes a debit entry in the Pass Book. On receiving the Pass Book or intimation, it is entered on the payment side of the Cash Book as "By Bank charges or by Commission” (The amount will be entered in the Bank column).

12. **Transfers:**

- **Transfer of an amount from a Savings Account in the Bank to a Current Account:** Bank columns appearing on both the sides of a Cash Book indicate a Bank Current Account. If the amount is transferred from a Savings Account to Current Account It will be entered on the receipt side of the Cash Book as “To Capital A/c" (The amount will be entered in the bank column).

- **Transfer of an amount from a Current Account to a Savings Account:** In this case, the entry will appear on the payment side of the cash book as "By Drawings A/c" (the amount will be entered in the bank column).

  **Note: Savings A/c being a personal A/c, it will be recorded either as Capital or Drawings.**

13. **Contra Entries**: Contra entries mean such entries that are made on both the sides of the cash book. When cash or a cheque is paid into the bank the cash balance in the office will be reduced and the bank balance will be increased. In such a case the Bank account is to be debited and the cash account is to be credited. Since, in three columns Cash Book, both Cash and Bank accounts are included the amount will be written in a bank column on the receipt side and also in the cash column on the payment side of the Cash Book.

    The transactions affecting the Cash Account and Bank Account (either Cash Account or Bank Account debited or credited) are recorded on both the sides of the Cash Book. As the Triple Column Cash Book consists of Cash Account and Bank Account, recording them on both the sides of the Cash Book completes Ledger posting of such transactions. Entries passed to record such transactions in the Triple Column Cash Book are regarded as contra entries. Letter "C" is written in the "L.F." column of the Cash Book in order to identify such entries.

    **Contra entries are passed in the following three cases:**

- **Cash deposited in Bank Account:** When an amount is deposited in the Bank, it is entered in the Cash Book on the receipt side as “To Cash”, (amount in bank column) on the payment side it appears as "By Bank." (Amount in cash column),

- **Cash withdrawals:** A transaction pertaining to withdrawal of cash the Bank appears on both the sides of the Cash Book. On the receipt side it appears as "To Bank" (amount in cash column) on the payment side, it is entered as "By cash " (amount in Bank column).
- **If a cheque received on the earlier day is deposited in the Bank:** Cheque may be received from the customer and entered in the cash column on the receipt side of the Cash Book. It may be deposited in the Bank after 4 or 5 days. On the date of deposit, a contra entry is passed. It is entered on the receipt side of the Cash Book as "To Cash" (amount in Bank column). It is entered on the payment side of the Cash Book as "By Bank", (amount in cash column).

## 8.0 Petty Cash Book:

With faster development in banking sectors most of the businessmen carry on their day-to-day business activities through bank. Mostly bank cheques are used for payments and receipts of higher amount. But generally cheque is not used for payments and receipts of small or minor amount, which are inevitable in the business. For instance, cheque is not used for payment of taxi fare, coolie charges, sweeping charges, postage etc and receipt of sale proceeds of old newspapers etc. In big business house or in industry to manage and pay minor expenses in cash a separate clerk or cashier is appointed. The cashier or clerk, who manages, look after and makes payment of petty i.e. minor expenses in the organisation is called petty cashier. An account book in which petty cashier records payments of petty expenses and receipts is called petty cash book. In other words, petty cash book is a separate account book in which businessman keeps records of daily transactions which are of minor in nature and payments and receipts of which are made in cash only. Head cashier gives petty cashier lump sum amount of cash in the beginning of every month and he is permitted to spend that amount on various minor expenses and also permitted to receive minor receipts in a period of a month. At the end of month petty cashier is required to return the balance amount to head cashier. This procedure is followed every month.

## 8.1 Types of Petty Cash Book:

Petty cash book is classified into the following categories viz. (a) Simple petty cash book, (b) Columnar petty cash book, (c) Petty cash book kept on imprest system.
Above types of petty cash book are discussed below in detail.

**(a) Simple Petty Cash Book:**

Simple petty cash book is just similar to simple or single column cash book. It is meant to record receipts and payments made in cash. This cash book has two main sides viz. receipts side and payments side. In this cash book columns like date and particulars are common for both receipt side and payment side. This cash book is not extensively used in business field.

**(b) Columnar Petty Cash Book:**

As name indicates, this petty cash book has many sub columns on payment side to record minor expenses individually. This cash book has two main sides viz. receipts side and payment side. In comparison to receipt side, payments side is much long. Payment side of this cash book has many sub-columns which are not fixed in number.

On payment side of this cash book one sub column is provided for one similar nature of expenditures. In short payment side has columns as many as expenditures on which business spend money. In addition to these columns, at the end two more columns are provided for L.F. No. and ledger account. In ledger account column, entries of personal account and real account are posted. This cash book is more popular and extensively used in the business field.

**Specimen of columnar petty cash book is given below:**

| Receipt | Date | Particulars | V. No. | Total | Payments | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Postage | Telephone | Advt. | Stationery | L. F. | Ledger A/c |

**(c) Petty Cash Book Kept on Imprest System:**

In many business houses Imprest system is more popular. In this system, in the beginning of every month head cashier gives to petty cashier that much amount of cash or cheque which is equivalent to amount, spent in the last month and makes opening cash in hand with petty cashier equal in the beginning of every month. In other words, in imprest system, a definite amount of cash is given to petty cashier at the beginning of a certain period. This amount is known as imprest money.

The petty cashier is then allowed to spent money on various petty expenses and when he has spent substantial amount of his imprest amount he gets reimbursement of the amount he has spent from the head cashier. Thus he again has the same amount of imprest cash. The reimbursement may be made on a weekly, fortnightly or monthly basis, depending on the frequency of small payments.

This system renders the following advantages:

(a) No excess cash is issued to petty cashier than actually required.
(b) Petty cashier will not have excess or idle cash.
(c) Misuse of cash is avoided as far as possible.
(d) Records of petty expenses can be easily checked and compared.

## 9.0 Trial Balance:

To reiterate, we have seen in the earlier sections how journal entries are passed in the journal. Similarly, the transactions can be recorded in Subsidiary Books. After recording the transactions either in the Journal or in the subsidiary Books they are posted to the Ledger and accounts are prepared and balanced. These books are written on the basis of the Double Entry System of book keeping. The fundamental principle of this system is that for every debit there is a corresponding credit. In any particular transaction, if one or more accounts are debited for some amount the other account or accounts are credited with the same amount. It follows therefore, that the amount for which one or more accounts is debited, for a similar amount the other account or accounts will be credited. As such the total of all debits and credits must be equal.

## 9.1 Key Features of a Trial Balance:

Analysis of the above definitions brings out the following features of a Trial Balance:

1. It is a list of debit and credit balances which are extracted from various ledger accounts.
2. It is a statement of debit and credit balances.
3. The purpose is to establish arithmetical accuracy of the transactions recorded in the books of accounts.
4. It does not prove accounting accuracy, which can be determined by audit.
5. It is not an account. It is only a statement of account.
6. It is not a part of the process of accounts.

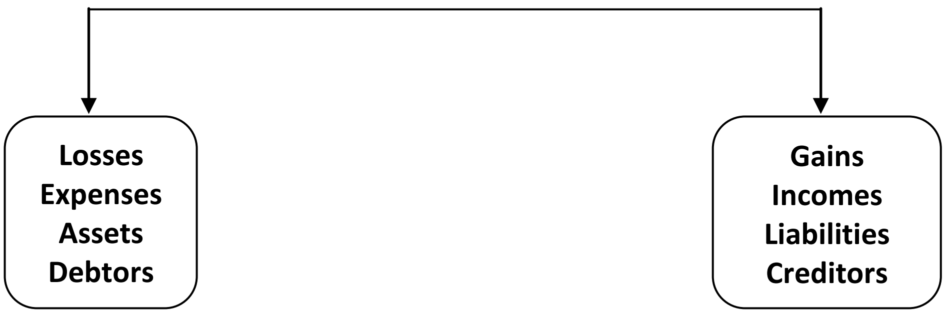
7. It is usually prepared at the end of the year but it can also be prepared any time as and when required. e.g. half yearly, quarterly or monthly.
8. It serves as a link between books of accounts and the Profit and Loss Account and Balance Sheet.

### 9.2 Preparation of a Trial Balance:

All the accounts with their debit and credit balances are listed serially. The cash and bank balances as shown by the Cash Book are also included in a Trial Balance. This becomes necessary because a separate Cash Account is not maintained in the ledger. Bank columns appearing on both the sides of Cash Book represent the Bank Account in the ledger. Closing stock of goods at the end of the year is not included in the Trial Balance. After all the accounts are included in the Trial Balance, the total of the two sides is made and it is equal.

**Forms of Trial Balance:**

**Trial Balance as on 31st March, ……..**



**9.3 Example of a Trial Balance**: From the following balances extracted from the books of accounts of ABC Traders as on 31st March, 2017:

| | Rs. | | Rs. |
|---|---|---|---|
| Capital | 1,50,000 | Goodwill | 1,00,000 |
| Sundry Debtors | 35,000 | Office Expenses | 10,000 |
| Sundry Creditors | 42,000 | Outstanding Expenses | 15,000 |
| Machinery | 21,000 | Interest Received | 3,200 |
| Furniture | 19,000 | Cash Balance | 1,800 |
| Sales | 2,00,000 | Opening Stock | 1,07,400 |

Purchases 1,16,000 (as on 1-4-2017)

**Trial Balance of ABC Traders as on 31st March, 2017**

| Sr. No. | Name of Account | L.F. | Debit Rs. | Credit Rs. |
|---|---|---|---|---|
| 1. | Capital | | | 1,50,000 |
| 2. | Purchase | | 1,16,000 | |
| 3. | Sales | | | 2,00,000 |
| 4. | Goodwill | | 1,00,000 | |
| 5. | Machinery | | 21,000 | |
| 6. | Furniture | | 19,000 | |
| 7. | Sundry Debtors | | 35,000 | |
| 8. | Sundry Creditors | | | 42,000 |
| 9. | Office Expenses | | 10,000 | |
| 10 | Interest Received | | | 3,200 |
| 11 | Outstanding Expenses | | | 15,000 |
| 12 | Opening Stock | | 1,07,400 | |
| 13 | Cash Balance | | 1,800 | |
| | | | 4,10,200 | 4,10,200 |

# SECTION III

## FINAL ACCOUNTS

**PART A – FINAL ACCOUNTS OF A SOLE PROPRIETOR**

Final accounts are the group of three different accounts viz. Trading Account, Profit and Loss Account and Balance Sheet. The group of these three accounts is called final accounts because it gives final results of the business carried out in the accounting year. Final accounts, generally, refer to two important accounting statements prepared by any business unit at the end of the financial year and those accounting statements are (i) Income statements and (ii) statement of financial position. Income statement includes trading account and profit and loss account. Whereas, statement of financial position includes Balance Sheet. Preparation of trading account and profit and loss account gives result of business operations done in the entire financial year. Balance sheet shows the financial position of assets and liabilities of the business as on particular date.

**10.1 Objectives of Final Accounts:**

(a) To ascertain gross profit or gross loss and net profit or net loss as a result of business done in the accounting year.

(b) To check arithmetical accuracy of the business and to detect fraud.

(c) To know the standing financial position of the business i.e. total assets owned by the business and total liabilities payable by the business.

(d) To know how much tax is payable to the government on the profits and assets, if taxable.

**10.2 Trading Account:**

Trading account is a part of final accounts, which is prepared on the basis of direct expenses, and direct incomes of business to ascertain gross result of the business, done in the accounting year. Preparation of trading account is the first step in preparation of final accounts. Trading account is prepared by considering only direct expenses and direct incomes of the business. Expenses and incomes which have direct connection with production are called direct expenses and direct incomes, e.g. power and fuel, cost of raw materials, wages etc. are called direct expenses, and sales proceeds are called direct incomes. Thus, trading account shows gross result of trading or business activities carried out in the particular accounting year.

The basic objective of the trading account is to ascertain the gross profit earned or the loss suffered as a result of manufacturing goods or services or buying and selling of goods.

**Specimen Form of Trading Account:**

**Name of Proprietor ..............**

**Dr. Trading Account for the year ended 31st .......20... Cr.**

| Particulars | Amount | Particulars | Amount |
|---|---|---|---|
| To Opening Stock | ---- | By Sales ---- | |
| To Purchases --- | | Less: Returns ---- | ---- |
| Less: Returns --- | ---- | By Goods lost by Fire or | |
| To Carriage Inward | ---- | Theft | ---- |
| To Wages | ---- | By Drawings (Goods | |
| To Freight | ---- | taken over) | ---- |
| To Power & Fuel | ---- | By Advertisement (goods | ---- |
| To Royalties | ---- | distributed as free sample) | |
| To Octroi | ---- | By Closing Stock | ---- |
| To Custom Duty | ---- | By Gross Loss C/d | ---- |
| To Factory Lighting | ---- | | |
| To Factory Rent | ---- | | |
| To Mfg. Expenses | ---- | | |
| To Gross Profit C/d | ---- | | |
| | ---- | | ---- |

## 10.3 Profit and Loss Account:

Profit and Loss account is a part of final accounts, which is prepared on the basis of indirect expenses, and indirect incomes of the business to ascertain net result of the business, done in the accounting year. On completion of trading account and profit & loss account are prepared by considering only indirect expenses and indirect incomes of the business. Expenses and incomes, which have no direct relation with production and whose absence do not affect production, are called indirect expenses and indirect incomes, e.g. salaries, interest, rent, cost of stationery etc. Indirect expenses are recorded on debit side of profit and loss account and indirect incomes are shown on credit side of profit and loss account. Indirect expenses of business are classified as (i) Office expenses (they are also called administrative expenses.) (ii) Selling expenses and (iii) Distribution expenses. Indirect incomes and gains include discount received; Commission earned, interest received, rent received etc

**Specimen form of Profit and loss Account**

**Dr. Profit & Loss Account for the year ended 31st …….20… Cr.**

| Particulars | | Amount Rs. | Particulars | Amount Rs. |
|---|---|---|---|---|
| To Salaries | | ---- | By Gross Profit B/d | ---- |
| To Rent | | ---- | By Rent Received | ---- |
| To Printing & Stationery | | ---- | By Interest Received | ---- |
| To General Expenses | | ---- | By Commission Earned | ---- |
| To Sundry Expenses | | ---- | By Discount Earned | ---- |
| To Depreciation | | ---- | By Miscellaneous Receipts | ---- |
| To Postage & Telegram | | ---- | By Income from Investment | ---- |
| To Telephone Expenses | | ---- | By Excess reserve for bad debt | ---- |
| To Travelling Expenses | | ---- | By Net Loss C/d | ---- |
| To Conveyance | | ---- | | |
| To Advertisement | | ---- | | |
| To Interest on loan taken | | ---- | | |
| To Interest on Capital | | | | |
| To Bad debt | ---- | | | |
| Add: Further Bad Debt | ---- | | | |
| Add: New Reserve | ---- | | | |
| | ---- | | | |
| Less: Old Reserve | ---- | ---- | | |
| To Repairs | | ---- | | |
| To Bank Charges | | ---- | | |
| To Legal Charges | | ---- | | |

| | | | |
|---|---|---|---|
| To Loss on sales of Assets<br>To Audit Fees<br>To Discount Allowed<br>To Commission Allowed<br>To Carriage Outward<br>To Insurance<br>To Net Profit C/d | ----<br>----<br>----<br>----<br>----<br>----<br>---- | | |
| | ---- | | ---- |

**10.4 Balance Sheet:**

Accounting statement, which shows financial position of all assets and liabilities of the business as on date, is called Balance Sheet. It is not an account but a positional statement showing financial position of a business concern as on date. On the left-hand side of this statement liabilities of various types are systematically recorded and on the right-hand side of this statement all types of business assets are shown systematically. Business liabilities include short liabilities like sundry creditors, bank overdraft, bills payable outstanding expenses etc. and long-term liabilities like Bank loan, capital, loan etc. Business assets are classified as fixed assets, tangible assets, intangible assets, current or circulating assets and fictitious assets.

**Specimen from of Balance sheet is shown below:**

**Balance Sheet as at 31st ........ 20....**

| Liabilities | | Amount Rs. | Assets | Amount Rs. |
|---|---|---|---|---|
| Capital | ---- | | Land & Building | ---- |
| Less: Drawings | ---- | | Plant & Machinery | ---- |
| | ---- | | Furniture & Fixture | ---- |
| Add: Interest on Capital | ---- | | Motor car | ---- |
| | ---- | | Investment | ---- |
| Less: Interest on Drawings | ---- | | Goodwill | ---- |
| | ---- | | Patents | ---- |
| Add: Net Profit | ---- | ---- | Loose Tools | ---- |
| Loan Taken | | ---- | Bills Receivable | ---- |
| Bank Loan | | ---- | Sundry Debtors | ---- |
| Sundry Creditors | | ---- | Closing Stock | ---- |
| Bank Overdraft | | ---- | Prepaid Expenses | ---- |
| Bills Payable | | ---- | Income Receivable | ---- |
| Expenses Outstanding | | ---- | Cash in Hand | ---- |
| Income received in advance | | ---- | Cash at Bank | ---- |
| | | | Loans Given | ---- |
| | | ---- | | ---- |

## 10.5 Adjustments:

Additional business information provided after completion of trial balance for preparation of final accounts are known as adjustments. To get clear view and real results of business done in the trading year, some other business information which do not find place in the trial balance are required to be considered, while preparing final accounts. These adjustment items are required to be given proper effects in the final accounts. For every adjustment Item, double effects are given in the final accounts, e.g. outstanding wages are first added to wages at debit side of trading account and secondly outstanding wages are shown separately at liability side of balance sheet.

**Final Accounts: Adjustments at a glance:**

| Adjustment | How to make it in Profit & Loss Account | How to make it in Balance Sheet |
|---|---|---|
| 1. Outstanding Expenses or Unpaid Expenses | Add to expenses concerned on debit side. | Show on liability side separately. |
| 2. Outstanding Income / Income Due but not Received / income Receivable / income Earned but not Received. | Add to income concerned on credit side. | Show on asset side separately. |
| 3. Prepaid Expenses/Expenses Paid in Advance / Unexpired Expenses. | Deduct from expenses concerned on debit side. | Show on asset side separately. |
| 4. Income Received in Advance | Deduct from Income concerned on the credit side. | Show on liability side separately. |
| 5. Depreciation. | Show on the debit side separately. | Deduct from asset concerned on asset side. |
| 6. Reserve for Doubtful Debts. | a) If New R.D.D. + Bad Debts> Old R.D.D. : Then on Debit Side: Bad Debts + New R.D.D. – Old R.D.D.<br>b) If Old R.D.D. > New R.D.D. + Bad Debts: Then on Credit Side: Old RD.D. - New RD.D. – Bad Debts. | Deduct only New RD.D. from debtors on asset side. |
| 7. Reserve for Discount on Debtors. | a) If New Reserve + Discount > Old Reserve: Then on Debit Side: New Reserve + Discount – Old Reserve.<br>b) If Old Reserve> New Reserve + Discount: Then on Credit Side: Old Reserve - New Reserve - Discount. | Deduct from debtors on asset side only the amount of New Reserve for discount. |

| | | |
|---|---|---|
| 8. Reserve for Discount on Creditors. | a) If New Reserve + Discount Received > Old Reserve: Then on Credit Side: New Reserve + Discount Received - Old Reserve.<br>b) If Old Reserve > New Reserve + Discount Received: Then on Debit Side: Old Reserve - Discount Received - New Reserve. | Deduct from creditors on liability side only the amount of New Reserve. |
| 9. Write off further Bad Debts. | Add to Bad Debts on debit side. | Deduct from debtors on asset Side. |
| 10. Goods distributed as free samples. | Show on credit side of Trading Account | Show on debit side of Profit Loss Account |
| 11. Loss of goods by fire (Goods not insured) | Show on credit side of Trading Account | Show on debit side of Profit Loss Account as loss by fire. |
| 12. Loss of goods by fire and Insurance Company admitted the claim | Show on credit side of Trading Account by full value as "goods lost by fire". Show on asset side separately as "Insurance Co. A/c" or "Insurance Claim". | Show on debit side of Profit and Loss Account only the difference below value of goods destroyed and claim admitted as '"Loss by Fire". |
| 13. Wages paid for installation of machinery debited to Wages Account. | Deduct from wages on debit side of Trading Account. | Add to Machinery on asset side. |
| 14. Goods withdrawn by proprietor for personal use. | Show on credit side of Trading Account. | Add to the drawings. |
| 15. Goods given as charity | Show on credit side of Trading Account. | Debit Profit & Loss A/c (If considered business expenses) Deduct from Capital A/c (If considered personal expenses) |
| 16. Goods used for office purposes | Show on credit side of Trading Account. | Debit to Profit & Loss A/c as office expenses. |
| 17. Goods used for making an asset | Show on credit side of Trading Account. | Add to Asset A/c |

| | | |
|---|---|---|
| 18. Goods Purchased included in closing stock but not recorded in the Purchase Book. | Add to Purchases | Add to creditors |

**10.6 Example of a Final Account:** The trial balance of M/s. ABC as on 31st December 1998 is given below:

**Trial Balance as on 31st December 1988**

| Debit Balances | Rs. | Credit Balances | Rs. |
|---|---|---|---|
| Drawings | 750 | Capitals | 25,000 |
| Building | 20,000 | Sales | 75,500 |
| Plant & Machinery | 6,000 | Purchase Returns | 1,000 |
| Cash at Bank | 550 | Sundry Creditors | 12,600 |
| Purchases | 47,500 | Discount Earned | 50 |
| Sales Return | 1,500 | Reserve for Bad Debts | 750 |
| Carriage Inward | 350 | Outstanding Salaries | 100 |
| Opening stock | 11,000 | 6 % loan Taken on 01/10/88 | 11,000 |
| Wages | 6,000 | | |
| Sundry Debtors | 17,600 | | |
| Salaries | 2,500 | | |
| Postage & Telegram | 200 | | |
| Rent & Insurance | 400 | | |
| Bad Debt | 250 | | |
| Discount | 100 | | |
| Trade Expenses | 300 | | |
| Furniture | 5,000 | | |
| Commission | 500 | | |
| Prepaid Insurance | 300 | | |
| Printing & Stationery | 700 | | |
| Cash in Hand | 2,000 | | |
| Patents | 2,500 | | |
| | 1,26,000 | | 1,26,000 |

**Adjustments:**

(I) Stock as on 31st December 1988 was valued at Rs. 15,000.

(II) Outstanding wages Rs. 600 and outstanding rent Rs. 700.

(III) Provide 10% depreciation on Plant & Machinery and 5% depreciation of Furniture.

(IV) 5% interest allowed on capital.

(V) Goods worth Rs. 250/- withdrawn by the proprietor for self-use.

(VI) Goods worth Rs. 5,000/- destroyed by fire and insurance company admitted a claim for Rs. 4,200/-

(VII) Provide 5% RD.D. at Sundry Debtors.

Preparation of a Trading Account, Profit & Loss Account for the year ended 31st December.1988 and the Balance Sheet as on that date.

**In the books of M/s. ABC Traders.**

**Dr. Trading and Profit & Loss Account for the year ended 31st December. 1978 Cr.**

| Particulars | Rs. | Rs. | Particulars | Rs. | Rs. |
|---|---|---|---|---|---|
| To Opening stock | | 11,000 | Sales | 75,500 | |
| To Purchases | 47,500 | | Less: Return Inwards | 1,500 | 74,000 |
| Less: Return Outward | 1000 | 46,500 | Goods Lost by Fire | | 5,000 |
| To Wages | 6,000 | | Goods withdrawn | | 250 |
| Add: O/s wages | 600 | 6,600 | Closing Stock | | 15,000 |
| To Carriage inwards | | 350 | | | |
| To Gross Profit C/d | | 29,800 | | | |
| | | 94,250 | | | 94,250 |
| To Salaries | | 2,500 | By Gross Profit b/d | | 29,800 |
| To Postage & Telephone | | 200 | By Discount A/c | | 50 |
| To Rent & Insurance | 400 | | | | |
| Add: Outstanding Rent | 700 | 1,100 | | | |
| To Depreciation | | | | | |
| P&M | 600 | | | | |
| Furniture | 250 | 850 | | | |
| To Bad Debt | 250 | | | | |
| Add; Further Bad debts | --- | | | | |
| Add: New Reserve | 880 | | | | |
| | 1,130 | | | | |
| Less: Old Reserve | 750 | 380 | | | |
| To Interest on Loan | | 165 | | | |
| To Interest on Capital | | 1,250 | | | |
| To Discount | | 100 | | | |
| To Trade Expenses | | 300 | | | |
| To Commission | | 500 | | | |
| To Printing & Stationery | | 700 | | | |
| To Loss by Fire | | 800 | | | |
| To Net Profit C/d | | 21,005 | | | |
| | | 29,850 | | | 29,850 |

**Balance Sheet as at 31st December. 1988**

| Liabilities | Rs. | Rs. | Assets | Rs. | Rs. |
|---|---|---|---|---|---|
| Capital | 25,000 | | Sundry Debtors | 17,600 | |
| Less: Drawing | 750 | | Less: New Reserve | 880 | 16,720 |
| | 24,250 | | Cash at bank | | 550 |
| Less: Drawings (goods) | 250 | | Plant & Machinery | 6,000 | |
| | 24,000 | | Less: Deprecation | 600 | 5,400 |
| Add: Interest (5%) | 1,250 | | Land & Building | | 20,000 |
| | 25,250 | | Furniture | 5,000 | |
| Add: Net Profit | 21,005 | 46,255 | Less: Depreciation | 250 | 4,750 |
| Sundry Creditors | | 12,600 | Closing Stock | | 15,000 |
| Outstanding Salaries | | 100 | Patents | | 2,500 |
| Outstanding Wages | | 600 | Insurance Claim Receivable | | 4,200 |
| Outstanding Rent | | 700 | Prepaid Insurance | | 300 |
| Loans | 11,000 | | Cash in Hand | | 2,000 |
| Add: Interest on Loan | 165 | 11,165 | | | |
| | | 71,420 | | | 71,420 |

**Working Notes:** (1) Interest on Loan = 11,000 * 3 / 12 * 6 / 100 = 165

(2) Interest on Capital = 25,000 * 5 / 100 = 1,250

**PART B - Capital and Revenue Expenditure**

## 12.0 Capital and Revenue Expenditure - Meaning

**12.1 Capital expenditure**: it is the expenditure resulting in:

(i) the acquisition of an asset;

(ii) an increase in the earning capacity of a business;

(iii) an advantage or a benefit of an enduring or permanent nature.

The purpose of capital expenditure is to create a new infrastructure/ asset with a view to improve future profitability. This is done either (a) positively by increasing earning capacity; or (b) negatively by some structural changes thereby decreasing working expenditure.

It is not absolutely essential that some new asset must come into existence as a result of capital expenditure. If a cinema theatre is renovated to provide additional seating capacity, then expenditure on such renovation is a capital expenditure, because, it increases the earning capacity of the business. Similarly, if a petrol engine of a motorcar were converted into diesel engine, the expenditure involved would be of capital nature, as it would result in a decrease in working expenditure of the business in future.

**Following are examples of capital expenditure:**

(1) Expenditure for purchase or acquisition of fixed assets like land, buildings, plant, machinery, furniture, fixtures, goodwill, patent, trademarks, copyrights, leasehold rights, vehicles, etc.

(2) Expenditure incurred in connection with or incidental to the purchase or installation of a fixed asset e.g., legal charges, stamp duty for the purchase of land and building or copyrights, expenses incurred for installation of plant and machinery, expenses incurred for bringing the fixed asset into the factory like freight, customs duty, or octroi duty on purchase of machinery, furniture and building materials.

(3) Expenditure for extending or improving a fixed asset e.g., amount spent on increasing the seating capacity of a hotel, cinema auditorium or amount spent in converting petrol engine into diesel engine or amount spent in converting coal-fired furnace into electric furnace, etc.

Thus, a capital expenditure is that expenditure, which results to a benefit not only in the current accounting year, but also the future years. It is therefore necessary to carry forward such expenditure for allocation / amortization over all those years in which benefits are expected to accrue. Thus, the cost of fixed asset is written off by way of depreciation over the period of its use.

**12.2 Revenue Expenditure:** It is the expenditure incurred

- (i) for the actual running of business;
- (ii) in maintaining adequately all the fixed assets;
- (iii) in an accounting period and is:
  - (a) matched against the income of that accounting period and
  - (b) not carried forward to the subsequent accounting year.

Revenue expenditure is necessary for the maintenance of the earning capacity (including the upkeep of fixed assets), and all other normal expenses incurred in sale and purchase of goods and services, office administration, etc.

**Examples of revenue expenditure:**

(1) All items of expenditure whose benefit expires within the same year of expenditure e.g., printing and stationery, travelling expenses, rent, salaries and wages. These are the administration and such other expenses incurred in the normal course of the business like office expenses, sales expenses, interest, audit fees etc.

(2) Cost of purchase of goods for conversion into final product for resale e.g., purchase of raw materials, packing materials and also such conversion charges as are necessary to produce the saleable product.

(3) Expenditure incurred in maintaining the fixed assets of the business, e.g., repairs and maintenance of machinery, furniture, building.

(4) Depreciation on fixed assets.

### 12.3 Deferred Revenue Expenditure:

There are certain expenses, which are primarily revenue in nature but the benefit from which is not exhausted during the year in which it is incurred. Such expenses are called "Deferred Revenue Expenditures." The term refers to those revenue expenses the writing off, of which is deferred to more than one year. Such expenses are carried forward and written off over the period during which the business is likely to benefit from the same.

Revenue expenditure written off over more than one year can be of two different categories:

(1) (a) Those expenses which are wholly paid in advance and for which the services/benefits are to be received in future. e.g., prepaid insurance, prepaid rent, advance salaries.

(b) Those expenses the benefit of which is partly received during the year under consideration and partly in subsequent year(s) e.g., expenditure incurred in an advertising campaign for introducing a new product. A part of this expenditure will be charged against profit of the year and the balance will be carried forward (and shown in the balance sheet), for write off in subsequent years.

(2) Expenses, which are incurred very rarely. Such expenses are not incurred in the normal routine carrying on of the business. Illustrations of such expenses are developmental expenditure like market survey, expenses on experiments, expenses on issue of shares and debentures, discount on issue of shares or debentures. Proper accounting necessitates that; these are not treated as expenses for the year in which they are incurred, but spread over a number of years. Such expenses are the real "deferred revenue expenses." These expenses do not create any asset or infrastructure. Hence they are not "capital expenditure." Simultaneously they are not normal day-to-day expenses of the year, which can be absorbed against the revenue of one year.

Revenue expenditure constitutes a charge against profits; it is therefore debited to Trading and Profit and Loss account. On the other hand, capital expenditure is not a charge against profits. It is an asset not meant for resale. It is shown on the assets side of the balance sheet.

**12.4 Capital and Revenue Receipts:**

Any receipt on capital account is a capital receipt and any receipt on revenue account is a revenue receipt. A capital receipt is disclosed in the balance sheet while a revenue receipt appears in the trading and profit and loss account.

Thus, any receipt in the ordinary course of the business, which is a regular source of income of the company, is a revenue receipt. Sale of goods, receipt of interest and dividend income, rents received, commission and discounts earned are all examples of revenue receipts. Receipts like loans from banks and friends, capital contributed by a partner, a lottery prize, and sale of old assets are the examples of capital receipts.

However, here also, at times the distinction is very thin. Facts and circumstances of each case will decide the issue. A sale of machinery will be a capital receipt for a manufacturing company using that machine as a fixed asset, but, will be a revenue receipt for a machinery dealer.

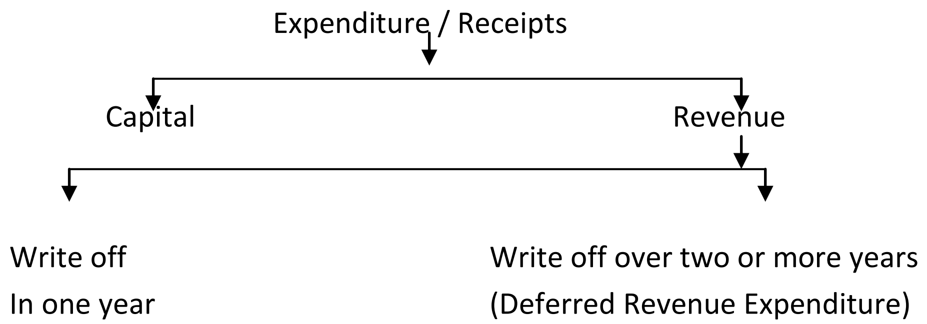
## 12.5 Distinction between "Capital" and "Revenue"

The distinction between "Capital" and "Revenue" is of vital importance in accounting. It directly affects the correctness of the amount of profit or loss made by the firm during a given period. It also affects the truthfulness of the financial position of the firm on any given date. The distinction between Capital and Revenue is connected with the matching of costs with revenues. This concept requires matching the expenses incurred for a period, with revenue earned for the same period. The process involves two steps: (1) Ascertain the revenue earned for a given accounting period and (2) Determine expenses incurred to earn that revenue.

The distinction between Capital and Revenue is relevant for both the steps. Certain receipts are not income. For example, sale proceeds of obsolete plant and machinery, or capital received from the partner. These are receipts but not income for a given period. Hence such receipts are not credited to profit and loss account. They are capital receipts.

Similarly, there are certain payments, which do not represent expense for the year e.g., purchase of land and building or repayment of loan taken from the bank. Hence such payments are not to be debited to profit and loss account. They are capital expenditures.

The distinction between capital and revenue becomes relevant in the preparation of final accounts viz. profit and loss account and balance sheet. All items appearing in the trial balance are taken either to trading and profit and loss account or balance sheet. All revenue expenditures and receipts are taken to the trading and profit and loss account, while all capital expenditures and receipts are taken to the balance sheet. Each item of expenditure and receipt must therefore, be placed in the appropriate financial statement. The distinction can be depicted with the help of a chart:



**12.6 A Specimen bifurcating following items as Capital, revenue or deferred revenue with reasons:**

(1) Cost incurred in replacing worn out but costly spare parts of a machine.
(2) Cost of acquisition of copyrights.
(3) Cost of designing a new product, which ultimately could not come up for commercial production,
(4) Heavy current repairs to the roof of the factory building.
(5) Cost of alteration to a cinema theatre in accordance with municipal law,
(6) Replacement of a wooden roof with a guarantee of 20 years.
(7) Replacement of worn out tyre of delivery van.
(8) Repainting of the building.
(9) Replacement of wooden platform for machinery with a concrete one,
(10) Replacement of an open truck body with a closed refrigerated body,
(11) Replacement of petrol engine of the car with the diesel engine.
(12) Planting of rose bushes outside the managing director's office.
(13) Amount received from insurance company for loss of stock.
(14) Loss due to change in exchange rate for purchase of materials.
(15) Additions to factory building.
(16) Repairs to plant.
(17) Heavy advertising expenses.
(18) Renewal of factory licenses.
(19) Premium given for lease.
(20) Costs in relation to mortgage.
(21) Commission on issue of debentures.
(22) Cost of pulling down an old factory preparatory to constructing a new one
(23) Amount received as claim from insurance company, on a fire destroying one machine.
(24) Profit on sale of investments.
(25) Contribution paid to state government/municipal corporation / gram panchayat for road development in surrounding area.
(26) Rs.10,000 spent on renovation and overhauling machinery, which resulted in extension of the life of the plant.
(27) Carriage inwards and freight for bringing the furniture from the dealer.
(28) White washing of factory building.
(29) Heavy legal expenses incurred by a publisher in a defamation suit.
(30) Cost of market research of a new product.
(31) Interest paid on money borrowed for purchasing plant and machinery.

(32) A sum of Rs. 2,500 previously written off as bad debts now recovered; this year.

(33) Legal expenses incurred in an action for infringement of trademark.

(34) Expenditure incurred for an additional exit to the theatre under the order of a local authority.

(35) Purchased a second-hand typewriter for Rs. 5,000 and spent Rs. 3,000 on repairs to make it ready for use.

(36) Compensation received from local authority for compulsory acquisition of land.

(37) Expenditure incurred for equipping the theatre with sitting accommodation and electrical fittings.

(38) Expenditure on uniforms for the staff.

(39) Cost of stores consumed in manufacturing machinery for installation in own factory.

(40) Rs.25,000 spent for replacing the electric motor of machinery. The motor was destroyed by fire.

(41) Claim received from an insurance company for suspension of business activity due to fire.

(42) Compensation of Rs. 95,000 paid for termination of services of three workers who were disturbing the industrial peace in the factory.

(43) Rs.1,00,000 received by tenant for surrendering his tenancy right in favour of the builder who has purchased the premises.

(44) Amount of Rs. 25,000 spent for dismantling (at old factory), removing and reinstallation (at new factory).

(45) Purchase of loose tools costing Rs. 1,500 expected to last only for eight months approximately.

(46) Cost of raincoats and umbrellas for employees who are given the same every two years.

(47) Expenditure incurred on two engineers for training on a new machine in Japan. Expenditure includes their lodging, boarding, travelling, and training expenses.

(48) Wage paid for construction of building extension.

(49) Import duty on raw materials purchased and imported from Germany.

(50) Cost of replacement of defective part of the machinery.

(51) Expenditure incurred in preparing a project report.

(52) Expenditure for training employees for better running of machinery.

(53) Expenditure incurred for repairing cinema screen.

(54) Legal and other expenses incurred in connection with the issue of share capital.

(55) Amount paid for purchase of goodwill of a similar business.

(56) Amount received from a relative staying abroad.

(57) Old items of machinery disposed off at a loss.

(58) Travelling expenses of a director for going to USA to find possibilities of export of company's products.

(59) Stock transferred from one factory to another one where there is shortage.

(60) Travelling expenses of a director for going to Germany to purchase a new machine.

**Solution:**

| Sr. No. | Item | Nature of Expenditure / Receipt | Reason |
|---|---|---|---|
| 1. | Cost of replacing costly spare parts of a machine | Revenue | For maintenance of an asset |
| 2. | Cost of acquisition of copyrights | Capital | New asset acquired |
| 3. | Cost of designing a new product which did not come up for production | Deferred revenue | Amount spent on developing a product. (Basically, it is a capital loss/expenditure) |
| 4. | Heavy current repairs to roof of factory building | Revenue | For maintenance of an asset |
| 5. | Cost of alteration of cinema theatre in accordance with municipal law | Revenue | Normal day-to-day business expenditure |
| 6. | Replacement of wooden roof with 20 years guarantee | Revenue | Maintenance expenditure |
| 7. | Replacement of worn out tyre of delivery van | Revenue | Maintenance expenditure |
| 8. | Repainting of building | Revenue | Normal recurring expenditure |
| 9. | Replacement of wooden platform for machinery with concrete | Capital | Increases life of the asset |
| 10. | Replacement of open truck body with a closed refrigerated body | Capital | Increases earning capacity of the asset |
| 11. | Replacement of petrol engine of the car with diesel engine | Capital | Increases earning capacity of the car by reducing cost of operation |
| 12. | Planting rose bushes outside director's office | Revenue | Normal business |
| 13. | Amount received from insurance company for loss of stock | Revenue | Proceeds on compensation for loss of stock is revenue receipt |
| 14. | Loss due to change in exchange rate for purchase of materials | Revenue | Normal business expenditure |
| 15. | Additions to factory building | Capital | Purchase of an asset |
| 16. | Repairs to plant | Revenue | For maintenance of an asset |
| 17. | Heavy advertising expenses | Deferred revenue | Spent for a new product and the benefit will last over some years |

| | | | |
|---|---|---|---|
| 18. | Renewal of factory licenses | Revenue | Recurring expenditure |
| 19. | Premium given for lease | Capital | Expenditure incidental to purchase of an asset |
| 20. | Costs in relation to mortgage | Revenue | Normal business expenditure |
| 21. | Commission on issue of debentures | Deferred Revenue | Benefit will last over some years |
| 22. | Cost of pulling down an old factory for building a new one. | Revenue | Does not result in any new asset |
| 23. | Claim received from insurance co. on fire destroying one machine | Capital | It is in connection with destruction of a capital asset |
| 24. | Profit on sale of investments | Revenue | Sales realisation over and above the cost is revenue receipt |
| 25. | Contribution for road development | Revenue | Does not result in any asset for the company and is social responsibility of the company |
| 26. | Amount spent on renovation and overhauling a machinery which resulted in extension of the life of the plant | Capital | Increases life of the asset |
| 27. | Carriage inwards/ freight for brining furniture | Capital | Expenditure in connection with purchase of an asset |
| 28. | White washing of factory building | Revenue | Normal business expenditure |
| 29. | Heavy legal expenses incurred by publisher in a defamation suit | Revenue | Normal business expenditure for a publisher |
| 30. | Cost of market research of a new product | Deferred revenue | Benefit will last for a number of years |
| 31. | Interest paid on money borrowed for purchase of machinery | Capital up to the date of installation of machinery and thereafter revenue | Expenditure incidental to purchase of asset |

| | | | |
|---|---|---|---|
| 32. | Amount previously written off as bad | Revenue | Normal business receipts |
| 33. | Legal expenses for infringement of trademark | Revenue | Expenditure for maintenance of an asset |
| 34. | Amount for additional exit to the theatre | Revenue | Normal business expenditure |
| 35. | (a) Purchase of second- hand typewriter<br>(b) Amount spent on repairs of typewriters | Capital<br>Capital | Purchase of an asset<br>Expenditure incidental to purchase of asset to bring it in running condition |
| 36. | Compensation from local authority for acquisition of land | Capital | Receipt in connection with sale of a fixed asset |
| 37. | Expenditure for equipping a theatre with sitting accommodation and electrical fittings | Capital | Increases earning capacity of the asset i.e. theatre |
| 38. | Amount spent on uniforms | Revenue | Recurring expenditure for the staff |
| 39. | Cost of stores consumed in manufacturing machinery for installation in own factory | Capital | Expenditure incidental to acquisition of an asset |
| 40. | Amount spent on replacing electric motor of machinery destroyed by fire | Revenue | For maintenance of an asset |
| 41. | Claim received from an insurance company for suspension of business activity due to fire | Revenue | Receipt for suspension of revenue activities |
| 42. | Compensation paid for termination of services of workers disturbing peace in the factory | Revenue | Normal business expenditure |
| 43. | Amount received by tenant for surrendering tenancy right | Capital | Receipt for sale of capital asset |
| 44. | Amount spent for removing and reinstallation of machinery | Revenue | Expenditure does not increase life of asset |
| 45. | Purchase of loose tools expected to last 8 months | Revenue | Normal running expenditure |
| 46. | Cost of raincoats and umbrellas for employees | Revenue | Recurring business expenditure |
| 47. | Training of two engineers on a new machine in Japan | Capital | Expenditure incidental to acquisition of an asset |
| 48. | Wages for building extension | Capital | Expenditure incidental to acquisition of an asset |
| 49. | Import duty on raw materials imported from Germany | Revenue | Normal business expenditure |
| 50. | Cost of replacement of defective part of machinery | Revenue | For maintenance of an asset |

| | | | |
|---|---|---|---|
| 51. | Expenditure in preparing project report | Capital / Deferred Revenue | Capital if project is ultimately implemented otherwise deferred revenue |
| 52. | Training expenses for employees for better running of machinery | Revenue | Normal business expenditure |
| 53. | Expenses for repair of cinema screen | Revenue | For maintenance of an asset |
| 54. | Legal and other expenses in connection with issue of share capital | (Deferred) Revenue expenditure | Benefit of expenditure to last for a few years |
| 55. | Goodwill of another business acquired | Capital | Brings into existence a new asset |
| 56. | Gift received from a relative | Capital | It is not a normal receipt |
| 57. | Loss on sale of machinery | Capital | Loss is because of sale of a fixed asset |
| 58. | Travelling expenses of director abroad for exploring export possibilities | Revenue expenditure | Normal business (even if export ultimately does not take place) |
| 59. | Cost of transferring stock from one factory to another | Revenue | Normal business expenditure |
| 60. | Travelling expenses of director abroad for purchase of machinery | Capital | Expenditure incidental to purchase of an asset. |

**PART C –NPO**

**FINAL ACCOUNTS AND BALANCE SHEET OF NON-PROFIT SEEKING CONCERNS**

Certain concerns like Clubs, Charitable Institutions, Medical Association, Societies, etc. do not intend to earn profit. They render service to the society or to their members. Their members do not get any share of profit or dividend. These concerns are known as non-profit concerns as their transactions are service-based but not profit-based.

Their annual accounts are regularly prepared to convey their financial affairs to their members or others like (govt. etc.) for seeking financial grants. If the size of the concern is small, the accounting records are usually kept under single entry system. Complete double entry system is followed only in big concerns. In any case they all prepare — (A) Receipts & Payments Account for a financial period; (B) Income & Expenditure Account for a financial period and (C) Balance Sheet at the end of the financial period.

## A. Receipts & Payments Account

1. It is an Account which contains all Cash and Bank transactions made by a non-profit organization during a particular financial period.
2. It starts with the opening balances of Cash and Bank. All Cash Receipts both capital & revenue during the period are debited to it.
3. AH Cash Payments both capital & revenue during the period are credited to this Account. It ends with the closing Cash and Bank Balances.
4. While recording the Cash and Bank transactions all entries are made on Cash Basis.
5. It is a summary of Cash Book.
6. It follows Real Account

**PERFORMA RECEIPTS & PAYMENT ACCOUNT**
**In the books of …………….**
**Receipts & Payments Account For the year ended**

| Receipts | Amount Rs. | Amount Rs | Payments | Amount Rs. | Amount Rs. |
|---|---|---|---|---|---|
| To balance b/d | | | By Sundry Payments | | |
| Cash in hand<br>Cash at bank<br>To sundry Receipts<br>(Both Capital and Revenue) | | XXX<br>XXX<br><br>XXX | (Both Capital and Revenue)<br>By Balance C/d<br>Cash in hand<br>Cash at bank | | XXX<br><br>XXX<br>XXX |
| | | XXX | | | XXX |

**B. Income & Expenditure Account**

1. It follows Nominal Account.
2. All expenses of revenue nature for the particular period are debited to this Ace accrual basis.
3. Similarly all revenue incomes related to the particular period are credited to thi on accrual basis.
4. All Capital incomes and Expenditures are excluded.
5. Only current year's incomes and expenses are recorded. Amounts related to other periods are deducted. Amounts outstanding for the current year are added.
6. Profit on Sale of Asset is credited. Loss on Sale of Asset is debited. Annual Depreciation on Assets is also debited.
7. If income is more than expenditure, it is called a Surplus, and is added with C General Fund etc. in the Balance Sheet.
8. If expenditure is more than income, it is a deficit, and is deducted from Capital or Fund etc. in the Balance Sheet.

**PROFORMA INCOME & EXPENDITURE ACCOUNT**
**In the books of …….**
**Income & expenditure Account for the year ended,,.,,,,.**

**Dr.**
**Cr.**

| Expenditure | Amount Rs. | Amount Rs | Income | Amount Rs. | Amount Rs. |
|---|---|---|---|---|---|
| To Revenue Expenditure | | XXX | By Revenue Income | | XXX |
| To Surplus (Excess of Income over Expenditure) | | | By Deficit (Excess of Expenditure over Income) | | |
| | | XXX | | | XXX |

**C. Balance Sheet**

The Balance Sheet is prepared in the similar way as followed in a Trading concern shalling of the assets and liabilities may be made in order of liquidity or in order of nence.

Calculation of opening capital Fund: (If not mentioned)
Opening Capital Fund = Opening Assets - Opening Liabilities,

Distinction between Receipts and Payment Account and Income & Expenditure Account

| | Receipts & Payment Account | | Income & Expenditure Account |
|---|---|---|---|
| 1 | It is a summarized Cash Book | | It closely resembles the Profit & Loss Account of a Trading Concern |
| 2 | Receipts are debited, and Payment are Credited | | Incomes are credited, and Expenditures are debited |
| 3 | Transactions are recorded on cash basis | | Transactions are recorded on Accrual basis. |
| 4 | Amounts related to previous period or future period may remain included. Outstanding amount for included. Outstanding amount for current year is excluded | | Transactions are recorded on accrual basis. All amounts not related to the current period are excluded. Outstanding amounts of current period are added. |
| 5 | It records both Capital and Revenue transactions. | | It records of Revenue transactions only. |
| 6 | It serves the purpose of a Real Account | | It serves the purpose of a Nominal Account |

| | | | |
|---|---|---|---|
| 7 | It starts with opening Cash and Bank Balances and ends with closing Cash rind Bank Balances. | | 1 It does not record such balances, rather its final balance shows a surplus or a deficit for the period |
| 8 | It does not record notional loss or non-cash expenses like bad debts, depreciation etc. | | It considers all such expenses for matching against revenues |
| 9 | Its closing balance is carried forward to the same account of the next accounting period. | | Its closing balance is transferred to Capital Fund, or General Fund or Accumulated Fund in the same period's Balance Sheet. |
| 10 | It helps to prepare an income & ire A/c. | | It helps to prepare a Balance Sheet |

**Some Important Considerations**

1. **Capital Fund:**
   It is also called "General Fund" or "Accumulated Fund," It is actually the Capital of a non-profit concern. It may be found out as the excess of assets over liabilities. Usually "Surplus" or "Deficit" during a period is added with or deducted from it. A portion of Capitalized incomes like donations may be added with it.
2. **Special Fund:**
   It may be created out of special donation or subscription or out of a proportion of the "Surplus". For example club may have "Building Fund". It may be used meeting some specific expenses or for acquiring an assets. It any income is derived out of investment made against this fund or if any profit or loss occurs due to sale of such investment, such income or profit or loss is transferred to this fund.

**Other Treatments:**

**(a) If the Special Fund is used to meet an expense**

Special Fund A/c Dr.
To Bank A/c (amt. of expense)

The balance of the Fund is shown as a liability. If the balance is transferred to Capital Fund, the entry will be—

Special Fund A/c Dr.
To Capital Fund A/c (Balance of Special Fund)

**(b) If the Special Fund is used to purchase an asset**

Asset A/c Dr.
To Bank A/c (Cost of the asset) Special Fund A/c Dr.
To Capital Fund A/c (Special Fund closed)

3. **Donations**

(a) Donation received for a particular purpose should be credited to Special Fund. For example, Donation received for Building should be credited to Building Fund A/c.

(b) For other donations received the by-laws or rules of the concern should be followed.

(c) If there is no such rule, donations received of non-recurring nature should be credited to Capital Fund. Recurring donations received should be credited to Income & Expenditure Account.

(d) Donation paid by the concern should be debited to Income & Expenditure Account.

4. **Legacy received:** It is to be directly added with Capital Fund after deduction of tax, (if any). It is a kind of donation received according to the will made by a deceased person.

5. **Entrance Fees or Admission Fees**

(a) The rules or by-laws of the concern should be followed.

(b) If there is no such rule, Admission or Entrance Fees paid once by members for acquiring membership should be added with Capital Fund.

(c) If such fees are of small amounts covering the expenses of admission only, the fees may be credited to Income & Expenditure Account.

6. **Subscriptions**

(a) Annual subscriptions are credited to Income & Expenditure Account on accrual basis.

(b) Life membership subscription is usually credited to a separate account shown as a liability. Annual Subscription apportioned out of that is credited to Income & Expenditure Account and deducted from the liability. Thus the balance is carried forward till the contribution by a member is fully exhausted. If any member dies before hand, the balance of his life Membership contribution is transferred to Capital Fund or General Fund.

**Illustration:**

**Special Points: (a) Preparation of Income & Expenditure Account and calculation of Closing Capital Fund; (b) Loss on Sale of Asset; (c) Donation to a Specific Fund.**

The following is the Receipts and Payments Account of a Club for the year ended 31st December, 2007

**Receipts:** Cash in hand (1.1.07) Rs. 1,000; Cash at Bank (1.1.07) Rs. 4,000; Donation for Building Rs. 10,000; Sale of Furniture (Balance on 1.1.07 Rs. 100) Rs. 80; Sale of Newspapers Rs. 200; Subscriptions Rs. 20,000.

**Payments:** Sports Materials Rs. 2,500; Salaries Rs. 3,250; Furniture Rs.1,600; Newspapers Rs.500; Building Fund Investment Rs. 10,000; Tournament Expenses Rs. 11,000; Postage Rs. 200; Cash in hand (closing balance) Rs. 1,030;Cash at Bank (Closing Balance) Rs. 5,200.

The following adjustments are to be made

(i) Of the Subscriptions collected Rs. 2,000 was outstanding for 2006;

(ii) on 1.1.07 Stock of Raw Materials was Rs. 500 and 31.12.07 it was Rs.700.

**Prepare the Income and Expenditure Account for the year ended 31st December, 2007 and show the Capital Fund of the Club as on that date.**

## PART D - COMPANY FINAL ACCOUNTS

### (i) Schedule VI of Companies Act :

Schedule VI to the Companies Act, 1956 provides the manner in which every company registered under the Act shall prepare its Balance Sheet, Statement of Profit and Loss and notes thereto. The Revised Schedule VI is applicable for the financial year commencing on or after April 1, 2011.

The Revised Schedule VI prescribes only the vertical format for presentation of Financial Statements. Thus, a company does not have an option to use horizontal format for the presentation of Financial Statements.

The Structure of Revised Schedule VI is as under:

I. General Instructions

II. Part I - Form of Balance Sheet

III. General Instructions for Preparation of Balance Sheet

IV. Part II - Form of Statement of Profit and Loss

V. General Instructions for Preparation of Statement of Profit and Loss.

### (ii) Shareholder's Funds

Shareholder's Funds consists of;

**A. Share Capital: It should include**

a. The Authorized Capital with the number and amount of shares;

b. The number of shares issued and subscribed and whether they are fully paid or not fully paid;

c. Face value per share;

d. The different classes of shares and their rights and restrictions.

e. A reconciliation of the number of shares outstanding at the beginning and at the end of the period;

f. Separate particulars for a period of five years following the year in which the shares have been allotted/bought back, in respect of:

- Aggregate number and class of shares allotted as fully paid up pursuant to contract(s) without payment being received in cash.
- Aggregate number and class of shares allotted as fully paid up by way of bonus shares.
- Aggregate number and class of shares bought back.

**B. Reserves and Surplus:** It shall be classified as:

a. Capital Reserves;
b. Capital Redemption Reserves;
c. Securities Premium Reserve;
d. Debenture Redemption Reserve;
e. Revaluation Reserve;
f. Other Reserves;
g. Surplus i.e. balance in Statement of Profit & Loss disclosing allocations and appropriations such as dividend paid, bonus shares and transfer to/from reserves.
h. Debit balance of Statement of Profit and Loss shall be shown as a negative figure under the head 'Surplus' Similarly, the balance of' Reserves and Surplus', after adjusting negative balance of surplus, if any, shall be shown under the head 'Reserves and Surplus' even if the resulting figure is in the negative.

**(iii) Non Current Liabilities :**

**Ans.** Non current Liabilities includes:

**A. Long-term Borrowings :**

a. Bonds/debentures.
b. Term loans
from banks
from other parties.
c. Deposits.
e. Loans and advances from related parties.
f. Long-term maturities of finance lease obligations
g. Other loans and advances (specify nature).

Borrowings shall be classified as secured and unsecured. The type and nature of security shall be specified. If the loans have been guaranteed by directors, it should be mentioned against the loan. Also the terms of repayment of loans should be mentioned. If the company is in default about repayment of loan then the period and amount of default, with break-up of principal and interest shall be specified separately.

**B. Deferred Tax Liabilities:** If the company has to pay either the Central Govt. or the State Govt for any taxes in the future the details of the liabilities along with the period should be mentioned.

**C. Other Long-term Liabilities :** Other Long-term Liabilities shall be classified as:

a. Trade payables

b. Others.

**D. Long-term Provisions**: The amounts shall be classified as:

a. Provision for employee benefits.

b. Others.

**(iv) Current Liabilities:**

Current Liabilities consists of,

**A. Short-term Borrowings:**

a. Loans repayable on demand
- from banks.
- from other parties.

b. Loans and advances from subsidiaries/holding company/associates/business ventures.

c. Deposits.

d. Other loans and advances.

Borrowings shall be classified as secured and unsecured. The type and nature of security shall be specified. If the loans have been guaranteed by directors, it should be mentioned against the loan. Also the terms of repayment of loans should be mentioned. If the company is in default about repayment of loan then the period and amount of default, with break-up of principal and interest shall be specified separately.

**B. Trade Payables :**They consist of Creditors, Bills Payable and outstanding expenses

**C. Other Current Liabilities :**The amounts shall be classified as:

a. Current maturities of long-term debt;

b. Current maturities of finance lease obligations;

c. Income received in Advance;

d. Interest accrued but not due on borrowings;

e. Interest accrued and due on borrowings;

f. Unpaid Dividends;

g. Other payables.

**D. Short-term Provisions : The amounts shall be classified as:**

a. Provision for employee benefits.

b. Others.

**(v) Non Current Assets :**

It includes

**A. Tangible Assets:**

a. Land.
b. Buildings.
c. Plant and Equipment.
d. Furniture and Fixtures.
e. Vehicles.
f. Office equipment.
g. Others .

**B. Intangible Assets:**

a. Goodwill.
b. Brands/trademarks.
c. Computer software.
d. Copyrights, and patents and other intellectual property rights, services and operating rights.
e. License and franchise.
f. Others

Details for both Tangible and Intangible Assets should be given, the Gross as well as Net Amount of the Assets , additions and Deductions during the year. The amount of depreciation charged in the current year and the amount of depreciation adjusted on sale of assets.

**C. Non-current Investments:** These are Long Term Investments

a. Investments in Equity Instruments;
b. Investments in Preference shares;
c. Investments in Government or trust securities;
d. Investments in units, debentures or bonds;
e. Investments in Mutual Funds;
f. Investments in partnership firm;

The following information should be given

a. The amount of quoted investments and market value;
b. The amount of unquoted investments;
c. The provision for decrease in value of investments;
d. The amount of partly paid-up investments.

**D. Long-term Loans and Advances:**

Long-term loans and advances shall be classified as:

a. Capital Advances;
b. Security Deposits;
c. Loans and Advances to related parties ;
d. Other Loans and Advances.

The above shall also be separately sub-classified as:

a. Secured, considered good;
b. Unsecured, considered good;
c. Doubtful.

**E. Other Non-current Assets :**Other non-current assets shall be classified as:

(i) Long-term Trade Receivables;
(ii) Others .

**(vi) Current Assets:**

Current Assets consists of

**A. Current Investments:** These are called as short term investments

a. Investments in Equity Instruments;
b. Investments in Preference shares;
c. Investments in Government or trust securities;
d. Investments in units, debentures or bonds;
e. Investments in Mutual Funds;
f. Investments in partnership firm;

The following information should be given

a. The amount of quoted investments and market value;
b. The amount of unquoted investments;
c. The provision for decrease in value of investments;
d. The amount of partly paid-up investments.
e. The basis of valuation of individual investments.

B. **Inventories:**

a. Raw material;
b. Work-in-progress;
c. Finished goods;
d. Stock-in-trade;
e. Stores and spares;
f. Loose tools;
g. Goods In Transit

Mode of valuation should be stated.

**C. Trade Receivables:**

Under this heading we record entries for debtors and bills receivable. If the amount of Trade Receivables is outstanding for a period exceeding six months they should be separately stated. Trade receivables should also be segregated as

a. Secured, considered good;
b. Unsecured, considered good;
c. Doubtful.

If the Debts are due by directors or other officers of the company or debts due by firms or private companies respectively in which any director is a partner or a director or a member should be separately stated.

**D. Cash and Cash Equivalents:**

a. Balances with banks;
b. Cheques, drafts on hand;
c. Cash on hand;

If the company has Bank Fixed Deposits having a maturity of more than 12 months it should be disclosed separately.

**E. Short-term Loans and Advances:**

a. Loans and Advances to related parties (giving details thereof);
b. Others .

**F. Other Current Assets :**This is an all-inclusive heading, which incorporates current assets that do not fit into any other assets categories.

**(vii) Contingencies and Commitments:**

Contingencies and Commitments consists of

(i) **Contingent liabilities:**

a. Claims against the company not acknowledged as debt;
b. Guarantees;
c. Other money for which the company is contingently liable

(ii) **Commitments :**

a. Estimated amount of contracts remaining to be executed on capital account and not provided for;
b. Uncalled liability on shares and other investments partly paid;
c. Other commitments .

(iii) Arrears of fixed cumulative dividends on Preference Shares shall also be disclosed separately.

**(viii) Accounting Standard 1:**

1) Accounting policies refers to specific accounting principles and the method of applying those principles adopted by the enterprises in preparation and presentation of the financial statements.
2) At the time of preparation of financial statements i.e. Balance sheet, profit and loss account, there are many areas, which have more than one method of accounting treatment such as:
   **Methods of depreciation, conversion or translation of foreign currency item, valuation of inventories, valuation of investments, treatment of retirement benefits etc.**

   There are many other areas where more than one method can be followed in preparation of Balance sheet and profit and loss account. What methods have been followed must be disclosed as accounting policies. Hence, accounting policies contain the information about the method adopted in preparation of financial statements. Statement of accounting policies are a part of financial statements.
3) For proper and better understanding of financial statement it is required that all the significant accounting policies followed in preparation of financial statements should be disclosed because assets and liabilities in the balance sheet and profit and loss account are significantly affected by the accounting policies followed. All significant accounting policies should be disclosed at one place because it would be helpful to the reader of financial statement.

4) **Selection of accounting policies**

The basic objective of selection of accounting policies is that the financial statements should be prepared on the basis of such accounting policies, which exhibits true and fair view of the state of affairs of the Balance sheet and profit and loss account.

Major points which are considered for the purpose of selection and application of accounting policies are:

a) **Prudence** – Generally maker of financial statement has to face uncertainties at the time of preparation of financial statement. These uncertainties may be regarding collection of receivables, number of warranty claims that may occur. Prudence means making of estimates, which are required under conditions of uncertainty.

b) **Substance over form** – It means that transaction should be accounted for in accordance with the actual happening and economic reality of the transaction and not by its legal form. Like in hire purchase if the assets are purchased on hire purchase by hire purchaser, the assets and are shown in the books of hire purchaser inspite of the fact that the hire purchaser is not the legal owner of the assets purchased. Under the hire purchase agreement, the purchaser becomes the owner only on the payment of last installment. Therefore, the legal form of the transaction is ignored and the transaction is accounted as per its substance.

c) **Materiality** – Financial statement should disclose all the items and facts which are sufficient enough to influence the decisions of the reader/user of financial statements.

5) **Changes in accounting policies**

A change in accounting policies should be made in the following conditions:

a) When it is required for compliance of statute.
b) For compliance of accounting standard and
c) For better presentation of financial statements.

If there is any change in accounting policies in preparation of financial statement from one period to subsequent period and such change affects the state of affairs of the balance sheet and profit and loss account of current period or the financial statement of later period, then such change must be disclosed in financial statement. The amount, by which the financial statement is affected should be disclosed to the extent ascertainable.

6) **Fundamental accounting assumption**

The institute of chartered accountants of India issued accounting standard (AS1) disclosure of accounting policies which states that there are three fundamental accounting assumptions:-

i. Going concern
ii. Consistency
iii. Accrual

The institute issued the frame work for the preparation and presentation of financial statements in year 2000 which defines the underlying assumptions as follows:-

**Going concern –**

The financial statements are normally prepared on the assumption that an enterprise is a going concern and will continue in operation for the near future. Hence it is assumed that the enterprise has neither the intention nor the need to liquidate or curtail materially the scale of its operations, if such an intention or need exists, the financial statements may have to be prepared on a different basis and if so the basis used is disclosed.

**Consistency -**

In order to achieve comparability of the financial statements of an enterprise through time, the accounting policies are followed consistently from one period to another; a change in an accounting policy is made only in certain exceptional circumstances.

**Accrual**

In order to meet their objectives, financial statements are prepared on the accrual basis of accounting. Under this basis the effects of transactions and other events are recognized when they occur (and not as cash or cash equivalent is received or paid) and they are recorded in accounting records and reported in financial statements of the periods to which they relate. Financial statements prepared on the accrual basis inform users not only of the past events involving the payment and receipt of cash but also of obligation to pay cash in the future and of resources that represent cash to be received in the future. Hence, they provide the type of information about past transactions and other events that is most useful to users in making economic decisions.

If nothing has been written about the fundamental accounting assumptions in financial statements, it is assumed that fundamental accounting assumption has been followed in preparation of financial statement.

If any fundamental accounting assumption is not followed in the financial statements, then this fact should be disclosed in the financial statement.

7) **Notes to accounts -** Notes to accounts are integral part of financial statement. Notes to accounts are the explanation of the management about the items in the financial statements (profit and loss account and the balance sheet). The management gives more explanation and information about the items profit and loss account and balance sheet and any other items by way of notes to accounts.

**Balance Sheet as on ........**

**Final Accounts Format**

| Particular | Sch. No. | Current Year | Previous Year |
|---|---|---|---|
| **I] EQUITY AND LIABILITIES** | | | |
| A. SHAREHOLDERS FUND | | | |
| 1. Share Capital | 1 | xx | |
| 2. Reserves & surplus | 2 | xx | |
| 3. Money received against share warrant | | xx | |
| B. Application of Money received, pending allotment | | xx | |
| **C. NON CURRENT LIABILITIES** | | | |
| 1. Long term borrowings | 3 | xx | |
| 2. Deferred Tax Liability (Net) | | xx | |
| 3. Other long term Liabilities | 4 | xx | |
| 4. Long term provision | 5 | xx | |
| **D. CURRENT LIABILITIES** | | | |
| 1. Short term borrowings | 6 | xx | |
| 2. Trade payable | 7 | xx | |
| 3. Other current liabilities | 8 | xx | |
| 4. Short term provision | 9 | xx | |
| **TOTAL** | | **xxx** | |
| **II] ASSETS** | | | |
| **A. NON CURRENT ASSETS** | | | |
| 1. Fixed Assets | | | |
| a. Tangible Assets | 10 | xx | |
| b. Intangible Assets | 11 | xx | |
| c. Capital WIP | | xx | |
| d. Intangible assets under development | | xx | |
| **2. NON CURRENT INVESTMENT** | **12** | **xx** | |
| 3. Deferred Tax assets (Net) | | xx | |
| 4. Long term loans & advances | 13 | xx | |
| 5. Other non current assets | 14 | xx | |
| **B. CURRENT ASSETS** | | | |
| 1. Current Investment | 15 | xx | |
| 2. inventories | 16 | xx | |
| 3. Trade Receivable | 17 | xx | |
| 4. Short term loans & advances | 18 | xx | |
| 5. Cash & Bank Equivalent | 19 | xx | |

| | | | |
|---|---|---|---|
| 6. Other current Assets | 20 | xx | |
| **TOTAL** | | **xxx** | |
| * Contingent Liabilities | 21 | xx | |

| | |
|---|---|
| SCH. 1 | |
| Authorised Share Capital | xx |
| Issued, subscribed, paid up_______ equity shares of Rs. ____ each, Rs. ______ called up | xx |
| _______ % of preference shares of Rs. _____ each, Rs. ______ called up | xx |
| **Less:** calls in arrears | (xx) |
| **Add:** share forfeiture | xx |
| | xx |
| **NOTE: 1** | |
| Out of the above state how many shares were issued for consideration other than cash. | |
| **NOTE: 2** | |
| State out of the above how many shares were issued as bonus shares | |
| **SCH. 2** | |
| **Reserves and Surplus** | |
| Capital Reserves | xx |
| Capital Redemption Reserves | xx |
| Security premium | xx |
| Reserve Fund | xx |
| General Reserve | xx |
| Revaluation Reserve | xx |
| Profit and Loss A/c 'Cr' balance | xx |
| | xxx |
| **SCH. 3** | |
| **Long Term Borrowings** | |
| Debentures / Bonds, | xx |
| Loan taken from financial institutions | xx |
| Mortage Loan | xx |
| Loan from commercial Banks | xx |
| In accrued and due on the above | xx |
| **NOTE: 1** | |
| State what kind of an assets has been given as security. Also state the period of redemption And rate of redemption. | |
| **SCH. 4** | |
| **Other Long Term Liabilities** | |
| Public deposits | xx |
| Fixed deposits accepted from people | xx |
| Loan from directors | xx |
| Intercompany Loans | xx |
| | xx |

| | |
|---|---|
| **SCH. 5** | |
| **Long Term Provisions** | |
| Employee Benefits | xx |
| Staff Provided Fund | xx |
| | xx |
| **SCH. 6** | |
| **Short Term Borrowings** | |
| Bank Overdrafts | xx |
| Cash / Credit | xx |
| Short term loans | xx |
| Treasury Bills | xx |
| | xx |
| **SCH. 7** | |
| **Trade Payable** | |
| Trade Creditors | xx |
| Bills Payable | xx |
| | xx |
| **SCH. 8** | |
| **Other Current Liabilities** | |
| Outstanding Expenses | xx |
| Income received in advance | xx |
| Any short term liability | xx |
| Interest accrued but not due | xx |
| | xx |
| **SCH. 9** | |
| **Short Term Provisions** | |
| Proposed dividend | xx |
| Provision for tax | xx |
| Workmen compensation fund | xx |
| | xx |
| **SCH. 11** | |
| **Intangible Assets** | |
| Goodwill | xx |
| Copyrights | xx |
| Patents | xx |
| Trademarks | xx |
| | xx |
| **SCH. 12** | |
| **Non Current Investment** | |
| Trade Investment | xx |
| Long term investment | xx |
| Investments in Govt. Securities | xx |
| Investment in Subsidiary | xx |
| | xx |
| **NOTE: 3** | |
| Investment will always be valued at cost price, if market price or face value are given there are to be shown as Information. | |

| | |
|---|---|
| **SCH. 13** | |
| **Long Term Loans and Advances** | |
| Security Deposits | XX |
| Loan given to subsidiary company | XX |
| | XX |
| **SCH. 14** | |
| **Other Non Current Assets** | |
| Preliminary Expenses | XX |
| Underwriting commission | XX |
| Formation Expenses | XX |
| Share issue Expenses | XX |
| Discount on issue of shares & debentures | XX |
| | XX |
| **NOTE:** | |
| The above amount are to the extend not written off | |
| **SCH. 15** | |
| **Current Investment** | |
| Short term investment | XX |
| Marketable investment | XX |
| | XX |
| **SCH. 16** | |
| **Inventories** | |
| Stock of Raw Material | XX |
| Stock of WIP | XX |
| Stock of Finished Goods | XX |
| Stock of loose tools | XX |
| | XX |
| **SCH. 17** | |
| **Trade Receivable** | |
| Debtors | XX |
| | XX |
| **NOTE:** | |
| State out of the above debtors how many are due for a period exceeding 6 months and how many are doubtful | |
| **SCH. 18** | |
| **Short Term Loans and Advances** | |
| Prepaid Expenses | XX |
| Bills Receivable | XX |
| Advance Tax | XX |
| Advance to Suppliers | XX |
| | XX |
| **NOTE:** | |
| According to the disclosure between advance tax and provisions for tax any one is to be shown. Hence we will let of whichever is greater. | |

| | |
|---|---|
| **SCH. 19** | |
| **Cash Bank Equivalents** | |
| Cash in Hand | xx |
| Cash at Bank | xx |
| | xx |
| **SCH. 20** | |
| **Other Current Assets** | |
| Income Receivable | xx |
| Stock of stationary | xx |
| Other Assets | xx |
| | xx |
| **SCH. 21** | |
| **Contingent Liabilities** | |
| Court case pending | xx |
| Arrears of preference dividend | xx |
| Any amount payable on occurring of an event | xx |
| Any amount payable on party paid up invt. | xx |
| | xx |

**SCH. 10. Tangible Assets**

| Particular | Gross Block | | Prov. For Dep$^{n}$. | | | | Net Block | |
|---|---|---|---|---|---|---|---|---|
| | Op. Bal. | C/S Bal. | Op. Bal. | On Sale | C. yr. Dep. | Closing Bal. | Op. WDV | Cl. WDV |
| | (1) | (2) | (3) | (4) | (5) | 6=(3-4+5) | (7)=(1)-(3) | (8)=(2)-6 |
| Land & Bldg.<br>Furn. & Fixt.<br>Plt & Mach.<br>Com & Equip. | | | | | | | | |
| | **xxx** | **Xxx** | **xxx** | **xxx** | **xxx** | **xxx** | **xxx** | **xxx** |
| | | | | | This will be shown in income statement | | | This will be in balance sheet |

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# SECTION IV

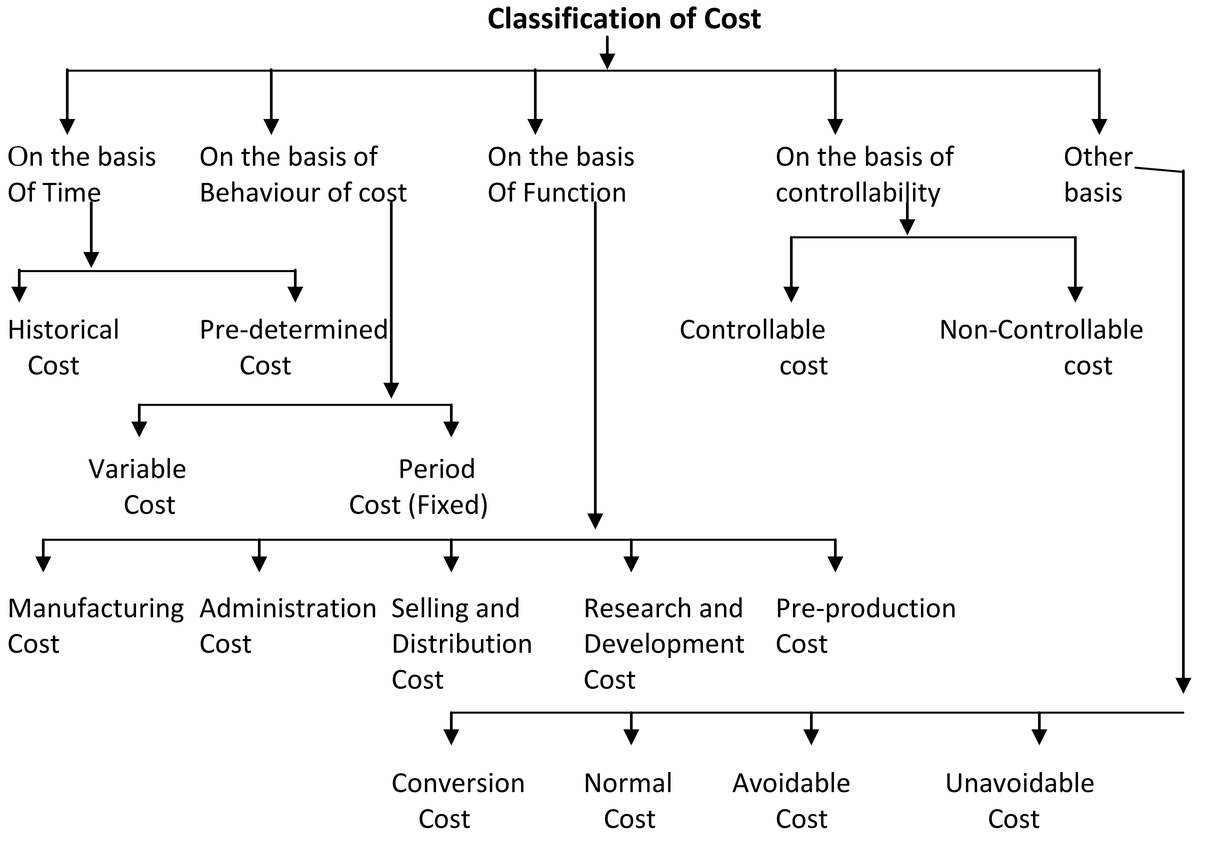
## COSTING

### 16.0 Meaning of Cost

'Cost' is the amount of expenditure incurred on a given thing. Cost has been defined as the amount measured in money or cash expended or other property transferred, capital stock issued, services performed or a liability incurred in consideration of goods or services received or to be received. By cost, we mean the actual cost i.e. historical cost. ICWA (UK) defines cost as the amount of expenditure (actual or notional) incurred on, or attributable to a specified thing or activity.

### 16.1 Classification of Cost

Cost classification is the process of grouping costs according to their common features. Costs are to be classified in such a manner that they are identified with cost center or cost unit. The following chart shows the classification of cost:

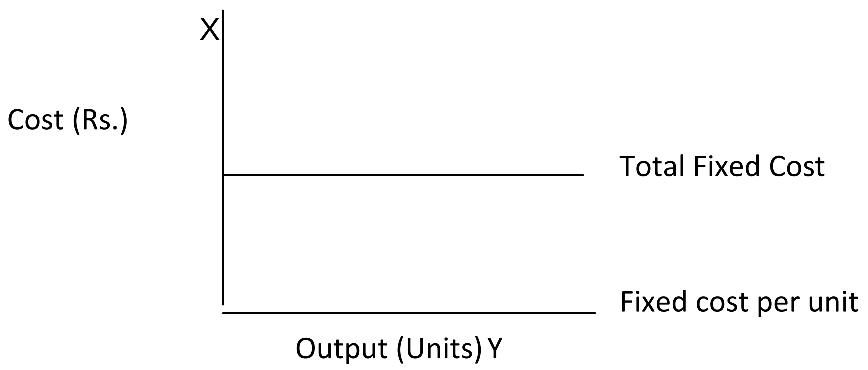


## 16.2 On the basis of behaviour of cost:

Behavior means change in cost due to change in output. On the basis of behavior cost is classified into the following categories:

## 16.3 Fixed Cost

It is that portion of the total cost, which remains constant irrespective of output up to the capacity limit. It is called as a period cost as it is concerned with period. It depends upon the passage of time. It is also referred to as non-variable cost or stand by cost or capacity cost or "period" cost. It tends to be unaffected by variations in output. These costs provide conditions for production rather than costs of production. They are created by contractual obligations and managerial decisions. Rent of premises, taxes and insurance, staff salaries constitute fixed cost. It is shown in the diagram given below:

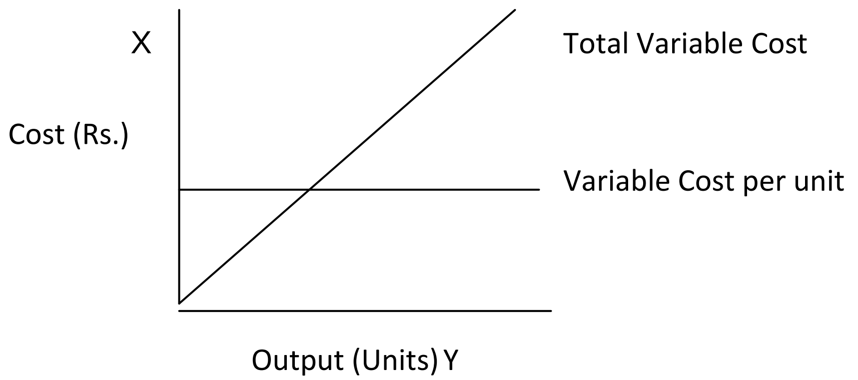



Key characteristics of fixed cost are as follows:

1. Large in value.
2. Indivisible cannot be broken in small penny pocket.
3. Irreversible, fixed cost decisions require greater thought.
4. Influence variable costs and working capital.
5. Higher Break-Even point if fixed cost is larger.
6. Image value, large fixed cost has high image value.
7. Indirect cost.
8. Lesser degree of controllability.

## 16.4 Variable Cost

This cost varies according to the output. In other words, it is a cost, which changes according to the changes in output. It tends to vary in direct proportion to output. If the output is decreased, variable cost also will decrease. It is concerned with output or product. Therefore, it is called as a "product" cost. If the output is doubled, variable cost will also be doubled. For example, Variable Cost, direct material, direct labour, direct expenses and variable overheads. It is shown in the diagram below:

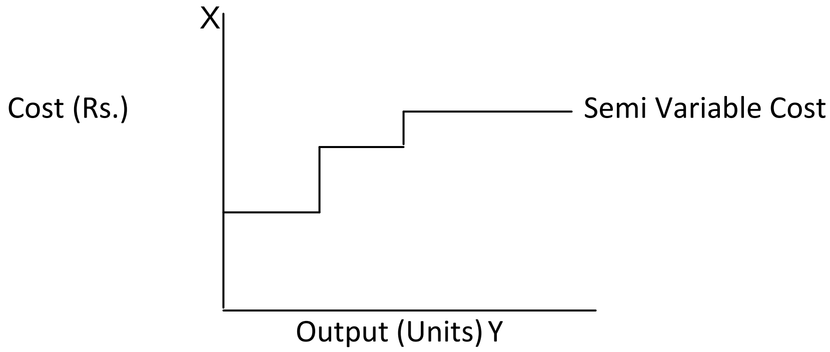



**Characteristics of Variable Cost**:

1. Total cost changes in direct proportion to change in total output.
2. Variable cost per unit remains constant.
3. It is quite divisible.
4. Per unit variable cost is smaller value.
5. It is identifiable with the individual cost unit.
6. Functional managers can exercise control over variable cost.

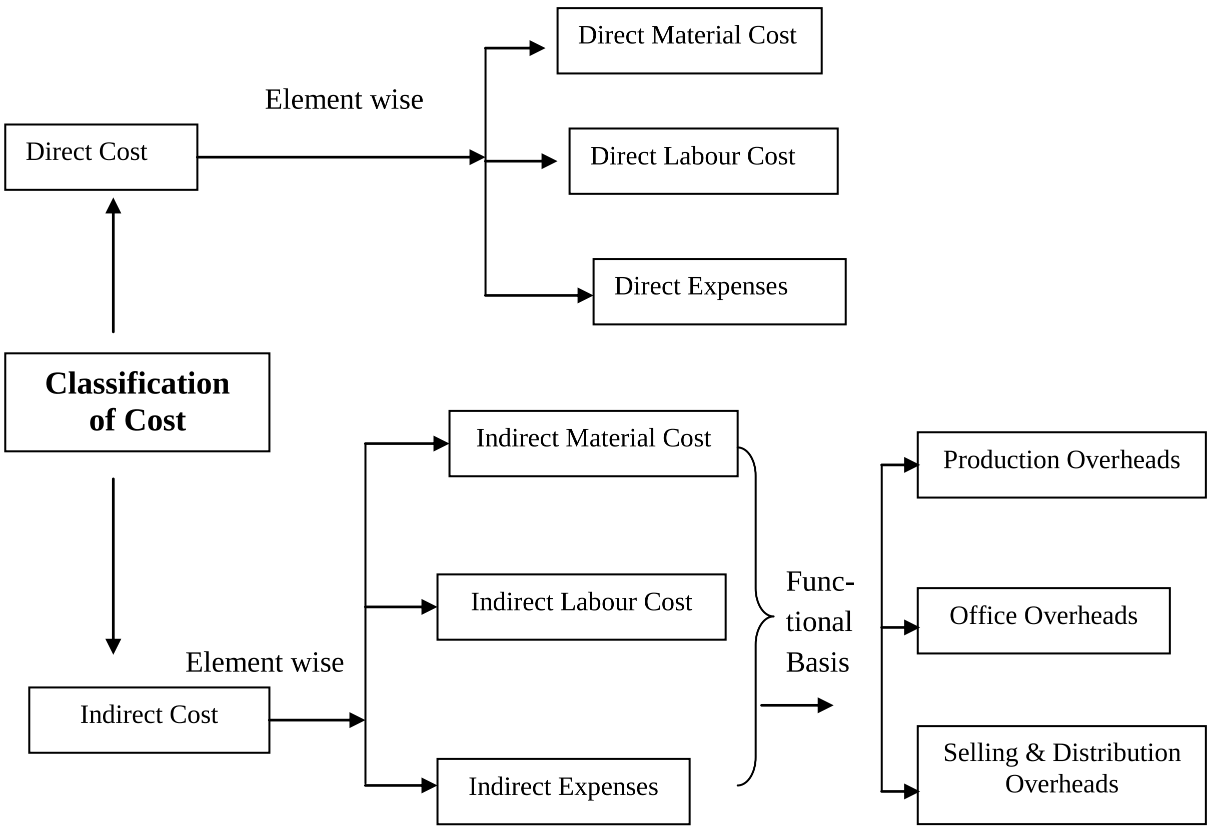
## 16.5 Semi-variable Cost

This is also referred to as semi-fixed or partly variable cost. It remains constant up to a certain level and registers change afterwards. These costs vary in some degree with volume but not in direct or same proportion. Such costs are fixed only in relation to specified constant conditions. For example, repairs and maintenance of machinery, telephone charges, maintenance of building, supervision, professional tax etc. It is shown in the diagram given below:




## 16.6 On the basis of elements of cost

Elements means nature of Items. A cost is composed of three elements: material, labour and expenses. Each of these three elements can be direct and indirect.



## 16.7 Direct cost

It is the cost, which is directly chargeable to the product manufactured. It is easily identifiable. Direct cost consists of three elements, which are as follows:

**Direct Material**

It is the cost of basic raw material used for manufacturing a product. It becomes a part of the product. No finished product can be manufactured without basic raw materials. It is easily identifiable and chargeable to the product. For example, leather in leather wares, pulp in paper, steel in steel furniture, sugarcane for sugar etc. What is raw material for one manufacturer might be finished product for another. Direct material includes the following:

1. All materials specially purchased for production or the process.
2. All components purchased for production or the process.
3. Material transferred from one cost center to another or one process to another.
4. Primary packing materials, wrappings, cardboard boxes etc. necessary for preservation or protection of product.

Some of the Items like nails or thread in the store are part of finished product. They are not treated as direct materials in view of negligible cost.

**Direct Labour or Direct Wages**

It is the amount of wages paid to those workers who are engaged on the manufacturing line for conversion of raw materials into finished goods. The amount of wages can be easily identified and directly charged to the product. These workers directly handle raw materials, wipe and finished goods on the production line. Wages paid to workers operating lathes, drilling, cutting machines etc. are direct wages. Direct wages are also known as productive labour, process labour or prime cost labour.

Direct wages include the payment made to the following group of workers:

1. Labour engaged on the actual production of the product.
2. Labour engaged in aiding the operations viz. Supervisor, Foreman, Shop clerks and worker on internal transport.
3. Inspectors, Analysts needed for such production.

**Direct Expenses or Chargeable Expenses**

It is the amount of expenses, which is directly chargeable to the product manufactured, or which may be allocated to product directly. It can be easily identified with the product. For example, hire charges of a special machine used for manufacturing a product, cost of designing the product, cost of patterns, architects fees/surveyors fees, or job cost of experimental work carried out specially for a job etc, cost of special drawings, cost of special layout designs, patents, patterns, cost of models, surveyors fees, Excise duty. Royalty on production cost of rectifying defective work, license fees for a product. Utility of such expenses is exhausted on completion of the job.

## 16.8 Indirect Cost

It is that portion of the total cost, which cannot be identified and charged direct to the product. It has to be allocated, apportioned and absorbed over the units manufactured on a suitable basis. It consists of the following three elements:

***Indirect Material***

It is the cost of material other than direct material, which cannot be charged to the product directly. It cannot be treated as part of the product. It is also known as expenses materials. It is the material which cannot be allocated to the product but which can be apportioned to the cost units. Examples are as follows:

1. Lubricants, cotton waste, Grease, Oil, stationery etc.
2. Small tools for general use.
3. Some minor Items such as thread in dressmaking, cost of nails in shoe making etc.

***Indirect Labour***

It is the amount of wages paid to those workers who are not engaged on the manufacturing line, for example, wages of workers in administration department, watch and ward department, sales department, general supervision.

***Indirect Expenses***

It is the amount of expenses, which is not chargeable to the product directly. It is the cost of giving service to the production department. It includes factory expenses, administrative expenses, selling and distribution expenses etc.

Internet based firms need to treat customer as a primary cost objective in differentiating between direct and indirect costs. In other words, in accumulating and allocating costs, Internet based firms need to adopt a customer focus.

### *16.9 Overheads or On Cost or Burden or Supplementary Cost*

Aggregate of indirect cost is referred to as overheads. It arises as a result of overall operation of a business. According to Weldon overhead means "the cost of indirect material, indirect labour and such other expenses including services as cannot conveniently be charged direct to specific cost units. It includes all manufacturing and non-manufacturing supplies and services. These costs cannot be associated with a particular product. The principal feature of overheads is the lack of direct traceability to individual product. It remains relatively constant from period to period. The amount of overheads is not directly chargeable i.e. it has to be properly allocated, apportioned and absorbed on some equitable basis.

### 16.10 Classification of Overheads:

1. **Factory Overheads:** It is the aggregate of all the factory expenses incurred in connection with manufacture of a product. These are incurred in connection with running of factory. It includes the items of expenses viz., factory salary, work manager's salary, factory repairs, rent of factory premises, factory lighting, lubricants, factory power, drawing office salary, haulage (cost of internal transport), depreciation of plant and machinery, unproductive wages, estimation expenses, royalties, loose tools w/off, material handling charges, time office salaries, counting house salaries, etc.
2. **Administrative Overheads or Office Overheads:** It is the aggregate of all the expenses as regards administration. It is the cost of office service or decision-making. It consists of the following expenses: staff salaries, Printing and stationery, postage and telegram, telephone charges, rent of office premises, office Conveyance, printing and stationery and repairs and depreciation of office premises and furniture etc.

    2. **Selling and Distribution Overheads:** It is the aggregate of all the expenses Incurred in connection with sales and distribution of finished product and services. It is the cost of sales and distribution services. Selling expenses are such expenses, which are incurred in, acquiring and retaining customers.

It includes the following expenses: (a) Advertisement (b) Show room expenses (c) Travelling expenses (d) Commission to agents. (e) Salaries of Sales office (f) Cost of catalogues (g) Discount allowed (h) Bad debts written off (i) Commission on sales (j) Rent of Sales Room (k) Samples and Free gifts (1) After sales service expenses (m) Expenses on demonstration and technical advice to prospective customers (n) Free repairs and servicing expenses (o) Expenses on market research (p) fancy packing and demonstration. Distribution expenses include all those expenses, which are incurred in connection with making the goods available to customers. These expenses include the following: (a) Packing charges (b) Loading charges (c) Carriage on sales (d) Rent of warehouse (e) Insurance and lighting of warehouse (I) Insurance of delivery van (g) Expenses on delivery van (h) Salaries of Godown keeper, drivers and packing staff.

## 17.0 Marginal Costing:

We have studied in the earlier unit that cost can be classified into two groups viz. fixed cost and variable cost. Variable cost varies with the changes in the volume of output or level of activity. As against this, fixed cost relates to time and does not vary with the changes in the level of activity. Because of inclusion of fixed cost in determination of total cost of a product, the cost per unit or process varies from period to period according to the volume. This has given rise to the concept of marginal costing. Marginal costing is concerned with determination of product cost which consists of direct material, direct labour, direct expenses and variable overheads. It should be kept in mind that variable costs per unit are fixed and fixed costs per unit are variable with changes in the level of output. In United Kingdom, variable costing is generally known as marginal costing. Marginal costing is also known as direct costing, contributory costing and incremental costing.

The ICMA has defined marginal cost "as the amount at any given volume of output by which aggregate costs are changed if the volume of output is increased or decreased by one unit." From the analysis of this definition it is clear that increase / decrease in one unit of output increases / reduces the total cost from the existing level to the new level. This increase / decrease in variable cost from existing level to the new level is called as marginal cost.

Suppose the cost of producing 100 units is Rs. 200. If 101 units are manufactured the cost goes up by Rs. 2 and becomes Rs. 202. If 99 units are manufactured, the cost is reduced by Rs. 2 i.e. to Rs. 198. With the increase or decrease in the volume the cost is increased or decreased by Rs. 2 respectively. Thus Rs. 2 will be called as the marginal cost.

Marginal costing means "the ascertainment of marginal costs and of the effect on profit of changes in volume or type of output by differentiating between fixed and variable costs".

Marginal costing is not a method of costing. It is a technique of controlling by bringing out relationship between profit and volume.

**17.1 Key Features of Marginal Costing:**

- The elements of cost are differentiated between fixed costs and variable costs.
- Only the variable or marginal cost is considered while calculating product costs.
- Stock of finished products and work-in-progress are valued at variable cost.
- Contribution is the difference between sales and marginal cost.
- Fixed costs do not find place in the product cost.
- Prices are based on marginal cost plus contribution.
- It is a technique of cost recording and cost reporting.
- Profitability of various products is determined in terms of marginal contribution.
- Presentation of data is oriented to highlight the total contribution and contribution from each product.

**17.2 Advantages of Marginal Costing:**

- **Constant in Nature**: Marginal cost remains the same per unit of output whether there is increase or decrease in production.
- **Realistic:** It is realistic as fixed cost is eliminated. Inventory is valued at marginal cost. Therefore, it is more realistic and uniform. No fictitious profit arises.
- **Simplified Overhead Treatment:** There is no complication of over-absorption and under-absorption of overheads.
- **Facilitates Control:** Classification of cost as fixed and variable helps to have greater control over costs.
- **Meaningful Reporting:** The reporting made on management is more meaningful as the reports are based on sales figures rather than production. Comparison of efficiency can be done in a better way.

- **Relative Profitability:** In case a number of products are manufactured, marginal costing helps management in the determination of relative profitability of each product.
- **Aid to Profit Planning:** The technique of marginal costing helps management in profit planning. The management can plan the volume of sales for earning a required profit.
- **Break-even Point:** It can be determined only on the basis of marginal costing.
- **Pricing Decisions:** These decisions can be based on contribution levels of individual products.
- **Responsibility Accounting:** It becomes more effective when based on marginal costing. Managers can identify their responsibilities clearly.

**17.3 Limitations of Marginal Costing:**

- **Analysis of Overheads:** In marginal costing, costs are to be classified into fixed and variable costs. Considerable difficulties are experienced in analyzing overheads into fixed and variable categories. Therefore, segregation of costs into fixes and variable is rather difficult and cannot be done with precision.
- **Greater emphasis on Sales:** Marginal costing technique lays greater emphasis on sales rather than production. In fact, efficiency of business is to be judged by considering both sales and production.
- **Difficulty in Application:** Marginal costing is not applicable in those concerns where large stocks have to be carried by way of work-in-progress.
- **Improper basis for fixation of selling price:** In marginal costing selling price is fixed on the basis of contribution alone which is not proper.
- **Less effective in Capital Intensive Industry**: Marginal costing technique is less effective in capital intensive industry where fixes costs are more.
- **Lack of standard for control:** Marginal costing does not provide any standard for control purpose. In fact, budgetary control and standard costing are more effective tools in controlling costs.
- **Elimination of Fixed Cost:** In marginal costing technique fixed costs are not included in the value of finished goods and work-in-progress. Since fixed costs are incurred, these should also form part of the costs of the product. Elimination of fixed costs from finished stock and work-in-progress results into the understanding of the stocks. The understating of the stocks affects the profit and loss account and the balance sheet, which leads to deflation of profit.

* **Incomplete Information:** Marginal cost does not give complete information. For example, increase in production and sales may be due to so many factors such as extensive use of machinery, expansion of resources and by automation. The exact cause is not disclosed by marginal costing.
* **Useful only for short term assessment:** Marginal costing is useful for short-term assessment of profitability. However, long-term assessment of profit can be correctly determined on full costs basis only.
* **Not acceptable for tax:** Income tax authorities do not recognize marginal costing for inventory valuation.

## 17.4 Contribution:

Contribution is the excess of selling price over variable costs. It is known as contribution because it contributes towards recovery of the fixed costs and profits. Contribution is a pool of amount from which total fixed costs will be deducted to arrive at the profit or loss. By equation the concept of contribution can be stated as follows:

$$\boxed{C = S - V}$$

C = Contribution

S = Sales

V = Variable Cost

## 17.5 Profit / Volume Ratio:

This is popularly known as P/V Ratio. It expenses the relationship between contribution and sales. It is expressed in percentage. P/V ratio is given by the formula:

$$\text{P/V ratio} = \frac{S - V}{S} \times 100 = \frac{C}{S} \times 100$$

Where C = Contribution, (being the difference between sales and variable costs)
S = Sales
V = Variable Costs

P/V ratio can be determined by expressing change in profit or loss in relation to change in sales. P/V ratio indicates the relative profitability of different products, processes and departments.

If information about two periods is given, P/V ratio is calculated as follows:

$$\text{P/V Ratio} = \frac{\text{Change in Profit}}{\text{Change in Sales}} \times 100$$

### 17.6 Break Even Point [BEP]:

Break-even point means the point of no profit and loss. BEP is the volume of output or sales at which the total cost is exactly equal to the revenue. Below the BEP, the concerns make losses, at the BEP, the concern makes neither profit nor loss, above the BEP, the concerns earns profits. BEP is calculated in terms of either units or value. Thus,

$$\text{BEP (in Units)} = \frac{\text{Fixed Cost}}{\text{Contribution per unit}}$$

$$\text{BEP (in Rs.)} = \frac{\text{Fixed cost}}{\text{PV Ratio}} = \frac{F}{PVR}$$

### 17.7 Margin of Safety [MS]:

Margin of Safety is the difference between the Actual Sales and the Sales at the Break-even Point. Thus,

**Margin of Safety (Rs.)** = Actual sales – BEP (Rs.)
**Margin of Safety (Units)** = Actual sales (units) – BEP (units)

Larger MS indicates stronger business. Such business can continue to earn profits, even if the sales decrease (i.e. in recession).

### 17.8 Marginal Cost Statement

There is no fixed format for marginal cost statement. However, the information will be recorded as follows.

| | | | |
|---|---|---|---|
| Sales | | XX | |
| (-) | <u>Variable Cost</u> | <u>XX</u> | |
| | Contribution | | XX |
| (-) | <u>Fixed Cost</u> | <u>XX</u> | |
| Profit / Loss | | XX | |

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# SECTION V
## DEPRECIATION

Fixed assets like machines, vehicles, furniture etc. can be used in the business for many years. However, as time goes by these assets lose their value due to constant use, wear and tear etc. When an asset becomes totally useless after some years, its value will be nil. Depreciation means the decrease in value of a fixed asset over the years. The reduction in the value of assets is a loss for the business. Such loss must be recorded in the books by passing an entry for depreciation at the year-end. Depreciation is debited to the profit and loss account every year so as to show the correct profits. Depreciation is also deducted from the book value of the assets so that the balance sheet shows the correct value of the assets. Depreciation is charged in such a way that by the time the asset becomes useless, its total cost is written off in the books.

### 15.1 Key Features of Depreciation:

The above discussion brings out the following features of depreciation:

- Decrease in Value: Depreciation is a decrease in the value of a fixed asset. A fixed asset is an asset (a) which is expected to be used during more than one accounting period; (b) which has a limited useful life; and (c) which is held by a concern as a source of earning income and not for the purpose of sale.
- Permanent Decrease: Such decrease in value is not temporary; it is permanent in nature. Once the value of an asset decreases, it will not go up in future.
- Gradual Decease: The decrease is gradual; it is not sudden. The value decreases slowly over a long period of time. The value falls step by step over many years of the useful life of the asset.
- Reasons of Decrease: The decrease in value is caused mainly by the use of the asset. But there may be other reasons such as passing of time, new inventions etc., which reduce the value of the asset.

### 15.2 Causes of Depreciation:

- **Wear and Tear due to Use**: The value of asset falls due to use. When a machine is used, there is wear and tear of its parts. An old machine gives less output.

- **Efflux of Time:** Even if an asset is not used, its value falls over a period of time. So, depreciation is charged even on an idle machine. Some assets like lease, patents have a fixed life. A lease for 6 years has nil value at the end of the 6th year. The total cost of such lease is written off over 6 years (i.e. 1/6 every year). Such writing off is known as amortization.
- **Obsolescence:** As asset may become outdated (obsolete) due to new inventions or new technology (e.g. computers). The old asset is scrapped and written off as depreciation.
- **Damage:** An asset, which is damaged by accident, fire, flood etc., loses its value and it will be scrapped. The loss of value is written off as depreciation.
- **Exhaustion**: A mine contains a limited quantity of minerals. The value of a mine as the minerals is taken out over a period of time. When all the minerals are taken out of the mine the value of mine will be zero. In this case the depreciation arises due to exhaustion or depletion.

## 15.3 Why to Account for Depreciation:

- **Correct Amount of Profits:** Let us take an example to see why depreciation must be charged every year to arrive at the correct amount of profits. Suppose, Mr. A purchases a machine worth Rs. 20,000 having a useful life of 10 years. His total profits for next 10 years come to Rs.50, 000 at the rate of Rs. 5,000 per year. It is clear that his net profits for 10 years are Rs. 50,000 - Rs. 20,000 = Rs. 30,000 after deducting cost of the machine. Mr. A should write off the cost of machine over 10 years. He can charge proportionate cost of machine Rs. 2,000 (Rs.20, 000 / 10) as depreciation every year. Thus, his profit and loss A/c will show a net profit of Rs. 3,000 (5,000 - 2,000) every year. If he does not charge depreciation every year, he will show profits of Rs. 5,000 every year for 10 years. In the last year the machine will become useless. Mr. A will have to write off the entire cost of Rs. 20,000 and show it as a loss in the profit and loss A/c of the last year. Instead of showing a big loss in the last year, it is better to charge depreciation and show smaller profits every year.

- **Match Revenue with Cost:** If a machine is used to earn income for 10 years, the cost of machine must also be written off over its useful life of 10 years. Depreciation is the proportionate cost of using the machine during a year for earning income in that year.

- **Replacement of Assets:** In the above example, Mr. A will have to buy a new machine at the end of the 10th year. If he has charged depreciation of say Rs. 2,000 every year, he will have Rs. 20,000 after 10 years to buy a new machine. This is because depreciation is a non-cash expense. When depreciation of Rs. 2,000 is debited to the profit & loss A/c, it does not mean that cash of Rs. 2,000 is actually spent. The cash remains in the business and is accumulated over the years. The accumulated cash can be used to buy a new asset.

- **Correct Value of Asset:** In the above example, if depreciation is not recorded, Mr. A's Balance Sheet will show the value of the machine at Rs. 20,000 for all 10 years. This is not correct. As time goes by, the machine must be shown at a lower and lower value in the balance sheet. The book value of the machine must be reduced every year by charging depreciation, so that in the last year the book value becomes zero.

- **Comply with Law**: Under the Companies Act, 1956 a limited company must charge depreciation before it can declare dividends.

### 15.5 Methods of Depreciation:

There are two main methods, of charging depreciation: (1) Straight Line Method and (2) Written Down Value Method. The yearly amount of depreciation may be different under each method. But finally, under both methods, the total net cost will be written off over the useful life of the asset. Computation of the yearly depreciation is known as the 'allocation of depreciation'.

**Straight Line Method (SLM) :**

Straight Line method is also known as Fixed Installment method. In this method, the yearly depreciation is equal to the Net Cost of asset divided by the No. of Years of its useful life. The amount of depreciation remains the same every year. Thus, if the net cost of the assets is Rs. 48,000 and the useful life is 10 years. The yearly depreciation will be Rs.48,000 / 10 = Rs.4,800. Rs.4,800 will be charged as depreciation to the profit and loss account every year for 10 years. Since the amount of depreciation is like a fixed installment, this is known as fixed installment method.
Under this method, depreciation is charged as a fixed percentage on the original cost every year. Thus, in the above example, we can charge depreciation @ 10% of the original cost of Rs. 48,000 every year.

Depreciation is computed under the straight-line method by the following formula:

Total Cost - Scrap Value / No. of Years of Useful life OR [C – S] / [Y]

Thus, if an asset is purchased for Rs. 50,000; installation expenses of Rs. 10,000 are incurred; its expected life is 5 years; and its expected scrap value in the end is Rs. 5,000, depreciation under this method is 50,000 + 10,000 - 5,000 = 55,000 + 5 years = Rs. 11,000. Thus, depreciation can be charged @ 20% per year (p.a.) on the cost of Rs. 55,000. This fixed percentage is equal to 100+ No. of Years (100 + 5 = 20%).

Total Cost (C) means invoice cost of asset plus incidental expenses such as freight, cartage, installation expenses, wages paid for erection etc. till the asset is actually put to use for the first time.

Scrap Value (S) means the money expected or actually received at the end of the useful life of the asset on sale as scrap etc.

No. of Years of Useful Life (Y) means the number of years the asset is expected to be used in the business. Technical experts such as engineers fix this period.

**Written Down Value (WDV) Method**

Written Down Value method is also known as Reducing Balance Method or Diminishing Balance method. In this method, the yearly depreciation is not a fixed amount. The rate of depreciation is fixed in the beginning. In the Straight Line method, this rate is applied to the original cost in all years. However, under the Written Down method, the rate is applied to the written down value. Thus suppose the net cost of a new asset is Rs. 48,000 and depreciation is charged @ 10% on the written down value. In the first year, the depreciation is Rs. 48,000 x 10% = Rs. 4,800. The written down value is Rs. 48,000 - Rs. 4,800 = Rs. 43,200. Next year, depreciation will be Rs. 43,200 x 10 % = Rs. 4,320. The yearly depreciation will thus go on decreasing. This is because the depreciation is charged not on original cost, but on the written down value. Under this method, depreciation is charged as a fixed percentage on the written down value every year.
Depreciation is computed under the written down value (wdv) method by the following formula:

% of Depreciation x Opening WDV

Thus, if an asset is purchased on 1-1-2000 for Rs. 50,000; installation expenses of Rs. 10,000 are incurred; and the rate of depreciation is 10%, yearly depreciation under this method is:

Depreciation for 2000:
= % of Depreciation x Opening WDV
= 10% x Rs. 60,000 = Rs. 6,000.

Written Down Value On 31-12-2000/1-1-2001:
= Opening WDV - Depreciation
= Rs. 60,000 - Rs. 6,000 = Rs. 54,000.
Depreciation for 2001:
= % of Depreciation x Opening WDV
= 10 % x Rs. 54,000 = Rs. 5,400.

Written Down Value On 31-12-2001/1-1-2002:
= Opening WDV - Depreciation
= Rs. 54,000 - Rs. 5,400 = Rs. 48,600.

Depreciation For 2002:
= % of Depreciation x Opening WDV
= 10 % x Rs. 48,600 = Rs. 4,860:

Written Down Value On 31-12-2002/1-1-2003:
= Opening WDV - Depreciation
= Rs. 48,600 - Rs. 4,860 = Rs. 43,740.

Thus, depreciation is charged @ 10 % per year on the opening written down value of the asset. The above details can be better understood in the form of a table:

| Year | Opening Cost \ WDV | Depreciation for the year | | Closing WDV |
|---|---|---|---|---|
| | | Formula | Amount | |
| (A) | (B) | (C) | (D) | (E) = (B – D) |
| 2000 | 60,000 | 10 % * 60,000 | 6,000 | 54,000 |
| 2001 | 54,000 | 10 % * 54,000 | 5,400 | 48,600 |
| 2002 | 48,600 | 10 % * 48,600 | 4,860 | 43,740 |

**Difference between SLM and WDV methods of Depreciation**

| Factors | SLM | WDV |
|---|---|---|
| 1. Formula | Calculated as % of Original Cost. | Calculated as % of Written Down Value. |
| 2. Yearly Charge | Yearly depreciation is constant. | Yearly depreciation decreases. |
| 3. Total Charge | Total charge (repairs + depreciation) increases. | Total charge remains constant. |
| 4. Nil Book Value | Book value at the end of life becomes zero. | Book value at the end of life does not become zero. |
| 5. Suitable | Suitable for assets with fixed life e.g. lease. | Suitable for assets whose life reduces due to use, e.g. Plant. |
| 6. Income-tax Act | Not allowed under the Income- tax Act | Only method allowed under, Income tax Act. |

### 15.6 Performa Journal Entries:

**Entries for purchase of assets:**

(1) Purchase of Asset By Cash/Cheque:

Asset A/c Dr.

To Cash/Bank A/c

(Being the purchase of ….. asset)

(2) Purchase of Asset On Credit:

Asset A/c Dr.,

To Party's A/c

(Being the purchase of ……… asset)

(3) Incidental Expenses on New Asset:

Asset A/c Dr.

To Cash/Bank A/c

(Being the freight/installation/legal expenses on new asset)

**Entries for depreciation:**

(4) Record Depreciation at Year End:

Depreciation A/c Dr.

To Asset A/c

(Being the depreciation @ ... % on Rs…. for the period from …..to the year end)

(5) Transfer Depreciation to P & L A/c:

Profit & Loss A/c Dr.

To Depreciation A/c

(Being the amount of depreciation transferred to P & LAIc)

**Note: Depreciation is a 'charge' against the profits. Hence depreciation is debited to the P & L A/c even if there is loss.**

**Entries on Sale of Asset:**

(6) Depreciation till Date of Sale:

Depreciation A/c Dr.

To Asset A/c

(Being the depreciation @ … % on Rs. …. for the period from ... to the date of sale)

(7) Sale of Asset:

Cash/Bank/Party A/c Dr.

To Asset A/c

(Being the sale price of asset)

(8) Profit on Sale of Asset:

Asset A/c Dr.

To Profit & Loss A/c

(Being the profit on sale of asset: Sale Price - WD.V.)

**OR**

Loss on Sale of Asset:

Profit & Loss A/c Dr.

To Asset A/c

(Being the loss on sale of asset: WD.V. - Sale Price)

(9) Transfer Depreciation to P & L A/c:

Profit & Loss A/c Dr.

To Depreciation A/c

(Being the amount of depreciation till date of sale, transferred)

### 15.7 Recording Depreciation – Provision Method

In the afore-mentioned entries, the direct method has been used i.e. depreciation has been recorded directly in the concerned Asset A/c. However, Depreciation can also be recorded by another i.e. maintaining a separate account known as Provision for depreciation account. The entries under the 'provision method' for depreciation on purchase or sale of asset are passed as shown below:

***Purchase of Assets***

The entries for purchase of asset etc. are same in both the methods; only the method for depreciation (entry no. 4 shown under 'Purchase of Assets' above) is different. The entry is

(4) Record Depreciation at Year End:

Depreciation A/c Dr.

To Provision for Depreciation A/c

(Being the depreciation @ ..% on Rs. ……… for the period from …… to the year end)

Depreciation is, thus, credited to the Provision for Depreciation A/c (instead of Asset A/c). In this method, the Asset A/c shows the gross (original) cost, the Provision for Depreciation A/c shows the accumulated depreciation till date, and their difference (Asset less Provision for Depreciation) shows the written down value (WDV) of the asset. In the balance sheet, the amounts are shown on the asset side as follows:

| | |
|---|---|
| Asset (gross cost) | xxx |
| Less: Provision for Depreciation | xxx |
| Net Block (or written down value) | xxx |

The entries for purchase of new assets, incidental expenses, depreciation etc. are the same under both the methods, i.e. SLM as well as WDV. Under WDV method also, the amount of deprecation depends upon the number of days the asset is used during the year. If the asset is purchased at the beginning of the year, full depreciation is charged on the total cost of the asset. However, if the asset is purchased in the middle of the year, amount of depreciation will depend upon the details available.

***Sale of Asset***

When a Provision for Depreciation A/c is maintained, an Asset Disposal A/c is opened to ascertain the profit/loss on sale. The entries are passed as shown below:

**Entries for on sale of asset:**

(1) Depreciation till Date of Sale:

Depreciation A/c Dr.

To Prov. for Depreciation A/c

(Being the depreciation @ … % on Rs... for the period from ... to the date of sale).

(2) Transfer Asset A/c Balance:

Asset Disposal A/c Dr.

To Asset A/c

(Being the transfer of gross cost of asset sold)

(3) Transfer Prov. for Depreciation A/e Balance:

Prov. for Depreciation A/c Dr.

To Asset Disposal A/c

(Being the transfer of accumulated depreciation on the asset sold)

[Note: At this stage the balance of Asset Disposal A/c indicates the WDV of the asset on the date of sale i.e. Gross cost less Accumulated depreciation].

(4) Sale of Asset:

Cash/Bank/Party A/c Dr.

To Asset Disposal A/c

(Being the sale price of asset)

(5) Profit on Sale of Asset:

Asset Disposal A/c Dr.

To Profit & Loss A/c

(Being the profit on sale of asset: Sale Price - W.D.V.)

**OR**

Loss on Sale of Asset:

Profit & Loss A/c Dr.

To Asset Disposal A/c

(Being the loss on sale of asset: W.D.V. - Sale Price)

[Note: After this entry Asset Disposal A/c gets closed].

The entries for sale of assets, profit or loss on sale etc. are same under both methods, i.e. SLM as well as WDV. If the asset is sold at the beginning of the year, no depreciation is charged, because the asset was not used at all during the entire year. Thus, if an asset is sold on 1st January 2003, no depreciation is charged for the accounting year ending on 31 st December 2003.

However, if the asset is sold in the middle of the year, say on 1st July, 2003, proportionate (1/2) depreciation will be charged, because the asset was used for 6 months from 1-1.2003 to 30-6-2003 till the date of sale. The depreciation will be charged on the opening written down value of the asset. Under straight-line method, depreciation would be charged on the original cost. The profit or loss is computed in the same way under both methods by comparing the sale price and the WDV on the date of sale.

### *15.8 Change in Method:*

(1) A business concern may change the method of charging depreciation from the straight line to written down value method or vice versa.

(2) When a method is changed, there is a change in the amount of yearly depreciation. The new amount of yearly depreciation may be more or less than the old amount.

(3) Further, such a change may be effective for future (prospective) or also for the past (retrospective).

(4) In prospective change, the new method will be used only in future. The new rate will be applied to the existing balance in the asset account.

(5) In a retrospective change, the depreciation is recalculated by applying the new rate right from the beginning. The difference between the new amount and the amount already charged as depreciation is adjusted in the profit & loss account. If the new amount of depreciation is more, the extra amount is debited to the profit and loss account. If the new amount is less, the difference is credited to the profit & loss account. The asset account is adjusted as if the new rate is in use from the date of original purchase of the asset. A new WDV is calculated for the asset, which is equal to Original Cost - New depreciation till Date of Change, the new rate will then be applied to such new WDV in future.

(6) According to Accounting Standard AS 6 issued by the Institute of Chartered Accountants of India, the change in method should have only retrospective effect. Thus, AS 6 does not approve of giving prospective effect to a change in the method of depreciation. Hence only retrospective change in method has been explained and illustrated below.

(7) Suppose a concern, which started business from 1-4-1997, changes its method of depreciation from 1-4-2003, with retrospective effect. The following Table sums up the steps for recording this in the book:

## 15.9 Change in Method with Retrospective Effect:

**Step What is to be done:**

A. Calculate depreciation on assets existing as on 1-4-2003 debited to the profit and loss A/c from 1-4-1997 to 31-3-2003 under the old method.

[Ignore assets sold etc. between 1-4-1997 and 1-4-2003]

B. Calculate depreciation on such assets by using the new method right from 1-4-1997.

C. Calculate the difference between (A) and (B).

D. There is surplus [A is more than B], pass a Journal entry on 1-4-2003 crediting such surplus to profit & loss A/c and debiting the Asset A/c.

OR

If there is deficit [A is less than B], pass a Journal entry on 1-4-2003 debiting such deficit to profit & loss A/c and crediting the Asset A/c.

E. Calculate and charge depreciation for the year beginning on 1-4-2003 and new method, on the new value of the Asset.

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# LAW – GENERAL


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# INDEX

# LAW GENERAL

## UNIT - I

### Indian Legal System -
### Salient features of the Indian Constitution, fundamental rights, directive principles of the state policy

Government : Executive, Legislature and Judiciary

**INTRODUCTION**

While studying any laws of any Country, it important to know the legal frame work and nature of legal system prevailing and applicable in the Country. In India we have written constitution, which provides for legal system in country.

**STRUCTURE OF THE UNIT**

## 1.1 OBJECTIVES

By the end of this Unit it is intended that the student will learn about-

- Nature and objects of the constitution of India
- Salient features of the Constitution of the India
- What are the fundamental rights guaranteed under the constitution of India
- What are the Directive principals of State policies
- Relation between Central and state governments

## 1.2 THE PREAMBLE OF THE CONSTITUTION

The Preamble to our constitution indicates the source from which the Constitution derives its authority; and objects which it seeks to established and promote.

It is as given under -

“We, the people of India, having solemnly resolved to constitute India into a sovereign, socialist, secular, democratic republic and to secure to all its citizens –

| | | |
|---|---|---|
| **Justice** | - | social, economic and political |
| **Liberty** | - | of thought, expression, belief, faith and worship |
| **Equality** | - | of status and of opportunity and to promote among them all |
| **Fraternity** | - | assuring the dignity of the individual and the unity and integrity of the Nation |

In our constitution Assembly this 26th day of November, 1949 do hereby ADOPT, ENACT and GIVE TO OURSELVES THIS CONSTITUTION.”

The Constitution of India is ordained by the people of India through their representatives assembled in a sovereign Constituent Assembly which was competent to determine the political future of the country in any manner it liked.

It declares India as sovereign, socialist, secular and democratic Republic State. Sovereign means the independent authority of a State. It means that it has the power to legislate on any subject; and that it is not subject to the control of any other State or external power. Democratic denotes a Government in which the mass of the adult population has a direct or indirect say in the governance of the state. The constitution holds out equality to all citizens in the matters of choice of their representatives, who are to run the governmental machinery. Republic means a government by the people and for the people. Socialist state means that the principal means of production are under social ownership and not concentrated in few hands and there is equitable distribution of the national wealth. The insertion of the word 'socialist' would enable the courts "to lean more and more in favour of nationalization and state ownership of industry." A secular State, guaranteeing freedom of religion to all it means that the state protects all religions equally and does not itself uphold any religion as the state religion.

### 1.3 SALIENT FEATURES OF CONSTITUTION OF INDIA

Constitution of India is perhaps the best Constitution in the world. Our constitution makers, gathered the best features of each of the existing constitution and adapted them to the existing conditions and needs of India. Hence this feature is the first Salient Feature of the Constitution of India. The chapter on the Fundamental Rights was based on the American Constitution, Parliamentary System of Government on the British System, while the concept of the Directive Principles of State Policy was borrowed from Irish Constitution. The elaborate provisions relating to Emergencies are based on the Constitution of the German Republic and the Government of India Act, 1935. Our Constitution also embodies the modified results of judicial decisions delivered elsewhere-interpreting comparable provisions in order to minimize uncertainty and litigation.

The next important feature is that our Constitution reproduced the Government of India Act, 1935 in providing matters of administrative details, going one step ahead of the American constitution, which only laid down the fundamental principles of Governance. This step was taken to prevent perversion of the Constitution by changing the form of Administration which will be now impossible unless the Constitution is changed.

The Constitution of India contains detailed provisions about the Organization of the Judiciary, the Services, the Public Service Commission and the like.

The Constitution of India has taken into account the vastness of the country and the peculiar problems to be solved, by devoting one entire part (Part XVI) relating to the Scheduled Castes & Tribes and other backward classes, one part (Part XVII) relating to

Official language and another (Part XVIII) relating to Emergency Provisions.

The Constitution of India provides for the Constitution of both the Union and the State with the same fullness and precisions with the exception of the State of Jammu & Kashmir which was allowed to make it's own Constitution.

The Constitution of Indian provides details about the relations between the Federation and the Units and among the Units inter se, whether Legislative or Administrative. This has given the Constitution of India a unitary bias. In another manner also it confers upon a federal system the strength of a unitary government by assuming powers of States by imposing emergencies (Part XVIII).

The Constitution of India also contains Directive Principles (Part V) which do not confer any justiciable rights upon the individuals but are regarded as Fundamental in the governance of the country being in the nature of "Principles of Social Policy" as contained in the Constitution of Eire, to serve as moral constraints upon future governments.

Through the 42nd amendments, one new chapter of Fundamental duties of citizens to be read along with Fundamental Rights was added.

One more salient feature is that the Constitution of India seeks to impart a flexibility to a written Federal Constitution. The amendment of only a few of the provisions of the Constitution require ratification by half of the State Legislatures. The rest of the Constitution, can be amended by a special majority of the Union Parliament i.e. a majority of not less than two-third of the members of each House present and voting which again must be a majority of the House.

The Constitution of India is unique in the sense that it wonderfully adopts the via-media between the American System of Judicial Supremacy and the English Principle of Parliamentary Supremacy by conferring upon the judiciary the power of declaring a law as unconstitutional if it is beyond the competence of the legislature according to the distribution of powers provided by the Constitution or if it contravenes the Fundamental Rights guaranteed by the Constitution or any other mandatory provision of the Constitution. At the same time, the judiciary has no power of judicial review of the wisdom of the Legislative Policy.

The balancing between the supremacy of the Constitution & Sovereignty of the

Legislature is illustrated by the novel declaration of Fundamental Rights in the Constitution of India. This guarantee of individual Rights has been carefully balanced with the need for security of the State itself.

The adoption of Universal Adult Suffrage (Article 326) without any qualification of sex, property, taxation or the like is a bold experiment in India considering the large population including many illiterates and the vast size of the country. This embodiment of popular Sovereignty is the basic' feature of our Constitution has made our country the largest democracy in the world.

The last but not the least an important and outstanding feature of our Constitution is the integration or Union of 552 then Indian States with the rest of India. Elaborate provisions were made in our Constitution by making 216 States merge as Part - B States, 61 States as centrally administered areas and also constituting Union of States with Raj Pramukhs as their heads.

The Basic Elements / Structure of Constitution of India may briefly be stated as under-

1. The supremacy of the constitution.
2. Republic and democratic forms of government and the sovereignty of the country.
3. Secular and federal structure of the constitution.
4. Demarcation of powers between the executive, legislature and judiciary.
5. The dignity of the individual.
6. The unity and integrity of the nation.

## 1.4 NATURE OF CONSTITUTION OF INDIA

The constitution of India is basically federal in nature with unitary features.

Let us first understand the federal system of governance. Federalism is a form of government where two sets of government operate and function simultaneously. Each state has its own government, which functions independently in the local matters like education, health, police etc.. But matters of national importance, e.g., defence, coins and currency, foreign affairs, are not left in the hands of the State Government.

Federalism is a principle by means of which there is co-ordinate division of powers between the Central Government and the State Government and whereby each of such governments exercise direct and simultaneous authority in their limited sphere over the same territory.

### 1.4.1 Main Characteristics of a Federal Constitution

Dual Government

In a federal state, there are two governments – the national or federal government and the government of each state.

Distribution of Powers

There is a distribution of legislative and executive powers between the federal government and the state government.

Supremacy of the Constitution

As there is division of power, such division must be evidenced in a written document. The constitution, which provides for such division of power is a document of fundamental importance, and it is from such constitution that a federal polity drives its existence.

Authority of Courts

The interpretation of the constitution assumes great importance in the successful working of a federal constitution. This power of interpretation is vested in the courts. The courts are empowered to declare any action on the part of the government to be ultra virus; if such action violets the provisions of the constitution. Therefore, the judiciary acting as the constitution and guardian of the constitution assumes immense importance in a federal state.

### 1.4.2 Constitution of India is Federal but with Unitary Bias

It may appear that the Constitution of India has all characteristics of a federal polity. However, this is not so and there is departure from the federal principle in various respects.

Prof. Wheare has observed that - "The Constitution of India provides a unitary state with subsidiary federal features, rather than federal state with subsidiary unitary features"

**Characteristics of the Constitution of India-**

Formation of the Constitution

Federations elsewhere have been the result of a voluntary agreement between number of sovereign and independent states coming under a common administration of certain specific purposes. But in India, federation was not a process of integration, but a process of decentralization. The former imperialistic unitary state was converted into a democratic union by the constitution.

Distribution of Powers

It provides for the distribution of power on various matters through Union list, State list and Concurrent list and also provides for residuary power on the matters not covered in the above lists. The constitution of India provides for clear and definite distribution of administrative power between centre and state.

No double Citizenship

There is singe citizenship for the whole union and there is no citizenship for the state.

No dual system of Judiciary

There is no bifurcation of the judiciary between the federal (Union) and state government. The same systems of courts, headed by the Supreme Court, administer both the union laws and the state laws as per applicable to the cases coming up for adjudication. This is again in contrast to the American System, where there are Federal Courts and State Courts. There are equal laws for whole country.

Election, Accounts and Audit

The machinery for election, accounts and audits is also similarly integrated as single judiciary.

Power of Union during the failure of Constitutional Machinery in the State

Where there is a failure to the constitutional machinery in a state, the president can suspend the constitution of the state and assume responsibility for administration of the state. In such circumstances, the parliament may legislate for such a state.

Formation of New States

The Union Legislative has the power to form new states, to increase or diminish the area of existing states and to alter their boundaries or names.

## 1.5 FUNDAMENTAL RIGHTS

In every democratic system of Government, there are some rights which are regarded as 'fundamental'. They are also regarded because they are 'vitally' necessary for the attainment by the individual of his moral and spiritual status. Without these rights, the individuals' moral and spiritual life would remain stunted, and he would not be able to develop his potential. Such rights are embodied in Part-III of the Constitution of India. The Constitution itself classifies the Fundamental Rights under seven groups as under-

**Right to Equality (Article 14 to 18)**

1. Equality before law

   It means 'any person shall not be given any specific rights and common law will be applied to all individuals.'
   Each state has to recognize certain exception of principle of principle of equality before law due to political and international reasons.

2. Equal protection of law

   The law will treat uniformly to all individuals in equal circumstances. All individuals are equal in the eyes of law and therefore, there shall not be any kinds. There should be no discrimination between one person and another if, as regards the subject matter of the legislation, their position is same.

3. Prohibition of discrimination on ground only of religion, race, caste, sex or place of birth (Article 15).

4. Equality of opportunity in matters of public employment (Article 16).

5. Abolition of untouchability (Article 17).

6. Abolition of titles (Article 18).

**Right to Freedom**

1. Freedom of speech and expression (Articles 19 (1)(a) and (2))
2. Freedom of assembly (Article 19 (1)(b) and (3))
3. Freedom to form associations or unions.
4. Freedom to move freely throughout India.
5. Freedom to reside and settle in any part of India.
6. Freedom to acquire, hold and dispose of properties (omitted).
7. Freedom to practice any profession

**Protection in respect of Conviction for Offences (Article 20)**

1. Protection against ex-post facto laws (Article 20(1))
2. Protection against double jeopardy (Article 20(2))
3. Protection against self-incriminations (Article 20(3))

**Protection of life and Personal Liberty (Article 21)**

**Protection against Arrest and Detention in certain cases**

**Right against exploitation (Article 23 – 24)**

1. Prohibition of traffic in human beings and forced labor [Art. 23].
2. Prohibition of employment of children in hazardous employment [Art. 24].

**Right to Freedom of Religion (Article 25 – 28)**

1. Freedom of conscience and free profession of religion (Article 25)
2. Freedom to manage religious affairs (Article 26)
3. Freedom from payment of taxes for promotion of any particular religion (Article 27)

4. Freedom to attend religious instructions in certain educational institutions (Article 28)

**Cultural and Educational Rights**

1. Protection of language, script or culture of minorities.(Article 29)
2. Right of minorities to establish and administer educational institutions (Article 30)

**Right to Property**

It is omitted by the Constitution (44th Amendment) Act, 1978

**Right to Constitutional Remedies**

Remedies for enforcement of the fundamental rights conferred by this Part - writs of habeas corpus, mandamus, prohi¬bition, certiorari and quo warranto [Art. 32).

## 1.6 DIRECTIVE PRINCIPLES OF SATE POLICY

Part IV of the Constitution (Atr. 36-51) contains the Directive Principles of state Policy. They are directions to the state to meet those social, economic and cultural reforms which the framers of the constitution looked upon as the ideas of the new order, but to which they did not give legal effect in the framework of the organic low itself.

They are like the instruments of instructions which shall be followed by the state both in the matter of administration as well as in the making of laws.

They can be used for the purpose of private and political criticism, but they confer no legal rights and create no legal remedies. They are good guides, but they cannot be enforced. They are not enforceable in a Court of Law does not, however mean that no judicial notice is taken of such principles. The state, while it implements these principles, should take care to see that the fundamental rights are also protected at the same time.

They may be under several groups as under-

**(i)** Directives in the Nature of Ideals of the state that it should strive for
**(ii)** Directives shaping the policy of the state (legislative and executive)
**(iii)** Non-justiciable Rights of Citizens

Scope

It shall be the duty of state to follow these principles. They embody the object of the state under the republic constitution i.e. 'Welfare State' and not a 'Police State'. Aim at the establishment of the economic and social democracy which is pledge for in the preamble.

## 1.7 DISTRIBUTION OF POWERS

The relation between the Union and the State is according to the constitution of three kinds:

(i) Legislative

(ii) Administrative

(iii) Financial

**(A) The Scheme of Distribution of legislative powers – based on –**

(i) The Territory, and

(ii) The Subject

(i) The Territory - Extent of Union and State legislation

The Union

The Parliament has the power to legislate for 'the whole or any part of the territory of India.' It also possesses the power of 'Extra territorial legislation'.

There are certain limitations to the territorial jurisdiction of the Parliament with respect to Union Territory and Scheduled Areas

The State

A state legislature makes a law relating to a subject within its competence, it must be read as referring to persons or subjects situated within the territory of the state concerned. It can make laws for the whole or any part of the state to which it belongs.

It is not possible for a state legislature to enlarge its territorial jurisdiction under any circumstances except when the boundary of the state itself is winded by an Act of Parliament.

Distribution of Legislative Subject

The constitution adopts this scheme from the Government of India Act, 1935 by enumerating possible subjects to legislate under three legislative lists in Schedule VII of the constitution.

**List – I - (Union List)**

It includes subjects or entries over which the union shall have exclusive power of legislation.

**List – II - (State List)**

It comprises such subject or entries over which the state legislature shall have exclusive power of legislation.

**List – III – (Concurrent List)**

It gives concurrent powers both to the Union and State Legislatures.such subject or entries.

In case of overlapping of a matter as between the three lists, predominance has been given to the Union legislature.

In the concurrent sphere, in case of repugnancy between a Union and a State law relating to the same subject, the former prevails.

Residuary Power

The power to legislate, with respect to any matter not enumerated in any one of the three lists, vests in the Union legislature and the final determination as to whether a particular matter fall under the residuary power or not is that of the Courts.

Expansion of the legislative powers of the Union under different circumstances.

In the National Interest

The Parliament shall have the power to make law with respect to any matter included in the state list for a temporary period, if the council of states, declares by a resolution of 2/3 of its members present and voting that it is necessary in the National Interest that Parliament shall have power to legislate over such matters.

Under a Proclamation of Emergency

While a proclamation of Emergency made by the President is in operation, Parliament shall have similar power to legislate with respect to State subjects.

By agreement between States

If the legislatures of two or more States resolve that it shall be lawful for Parliament to make laws with respect to any matters includes in state list relating to those States, Parliament shall have such power as regards such States.

To implement Treaties

Parliament shall have the power to legislate with respect to any subject for the purpose of implementing treaties or international agreements and conventions.

Under a proclamation of failure of constitution of machinery in the states.

When such a Proclamation is made by the President, the President may declare that the powers of the Legislature of the state shall be exercisable by or under the authority of Parliament.

**(B) Distribution of Executive Powers**

The distribution of executive powers between the Union and States is somewhat more complicated than that of the legislative powers. In general, it follows the scheme of distribution of the legislative powers. In the result, the executive power of a state is, in the main, coextensive with its legislative powers,- which means that the executive power of state shall extend only to its own territory and with respect to those subjects over which it has legislative competence. Conversely, the Union shall have executive power over (a) the matters with respect to which Parliament has exclusive power to make laws, and (b) the exercise of its powers conferred by any treaty or agreement. On other hand, a State shall have exclusive executive power over matters included in List II. The Union may, whenever it thinks fit, itself take up the administration of Union laws relating to any Concurrent subject.

**(C) Distribution of Financial Powers**

The Constitution has made elaborate provisions, for both the Union and States to have at their disposal adequate financial resources to enable them to discharge their respective responsibilities under the Constitution.

The constitution has made provides relating to the distribution of the taxes as well as non-tax revenue and the power of borrowing, supplemented by provisions for grants-in-aid by the Union to the States.

# UNIT – II

## THE INDIAN CONTRACT ACT

(Act IX of 1872)

**INTRODUCTION :**

Laws were made to govern every walk of life, including Trade and Commerce. One of them so far as India is concerned took the form of "The Indian Contract Act, 1872". It is not complete code dealing with the law relating to all kinds of contracts. There are separate Acts relating to contracts like the Sale of Goods Act, 1930, the Partnership Act, 1932, the Transfer of Property Act governing contracts of Sale of immovable property, mortgage, lease, etc. which therefore are not dealt with in The Indian Contract Act, 1972.

In this section, the emphasis is made to analyze, discuss and understand Contracts, the law relating to Contracts with an eye on the Indian Contract Act, 1872. It is understanding of this Section where we would be able to understand:

- What is a contract?
- How it can be formed?
- What are the different types of contracts?
- How a contract is discharged? and
- Special form of contracts.

The Indian Contract Act came in force from 1st Sep.1872. It is applicable to the whole of Indian except the state of Jammu and Kashmir. The Act can be divided into two heads viz. General Principles of Contacts and specific kinds of contracts.

# Part - 1

**STRUCTURE OF Part - 1 :**

## 1.1 OBJECTIVES:

By the end of this Unit, it is intended that the students will learn about –

- What is Contract?
- What is an Agreement? Does it differ from Contract?
- What are the essential elements for formation of a contract?
- Definitions : a promise, consideration and agreement, a contract
- Classification of contracts

## 1.2 SCOPE

When two parties enter into an agreement with an intention to hold the other party liable in case of non-performance, It is Law of Contracts which governs these contracts. It provides a framework of rules and regulation which governs formation and performance of contract by the parties. The court of law act as an enforcing body which intervenes in case of non-performance of contract.

Most interesting aspect is that rules of contract law govern only the making of contract and abiding the contract so made by the parties. As far as the mutual rights and duties of the contracting parties are concerned they are decided by the parties themselves. The law will not itself come to intervene. It is only when one of the parties does not meet his part of obligations and the other party who is aggrieved, calls judiciary to intervene and take care of his interest, the law comes into picture.

But, there is legislative interference with the right of the parties to make any contract they like.

## 1.3 WHAT IS CONTRACT

As per s. 2(h), 'Contract' is an 'agreement' enforceable by law. Thus, for the formation of a contract, there must be an agreement and something in addition to that, i.e. an agreement and its enforceability at law. Therefore it is all the more essential to understand what is meant by an Agreement?

### 1.3.1 Definition of Agreement

An agreement, therefore to submit minimum, is a reasonable and definite understanding between two or more persons as to what each party is to do.

Mr. A agrees to sell his Maruti 800 car to Mr. Y for Rs. 70,000/-, this an agreement. But while Mr. Y agrees to purchase thinking that he is purchasing Maruti 1000, then no agreement is made.

Let's see, how the Indian Contract Act looks at the agreement. It defines Agreement thus :-

Every promise and every set of promises, forming the consideration for each other is an agreement. [s.2 (e)].

When the person to whom the proposal is made signifies his assent there to, the proposal is said to be accepted, A proposal when accepted becomes a promise. [s.2 (b)].

An agreement is a promise or a set of reciprocal promises. A promise comes into existence when a proposal is made by one and accepted by the other. These mutual promises must form consideration, i.e. something in return to each other.

An agreement and its enforceability at law since is of almost importance for formation of any contract since an agreement must be enforceable at law to become a contract.

As seen earlier, An agreement is a set of promises whereby all the parties to an agreement promise to perform something in return to the performance of the others. If a party does not perform, what he has promised, then, what to do? Although it is moral duty of a person to do as he promised, but moral duties cannot be enforced in the court of law unless they are supported by legal recognition. But if it becomes legal duty of a person to perform as he promised and he fails to do so, law has a power to intervene and enforce the performance. As given in earlier example if R does not turn up for dinner, A cannot ask R for payment he made for table booking in the absence of any specific understanding. But payment he made for table booking to V, if A does not pay, V can go to court and recover table booking charges from A.

Power of the law to enforce the performance of an agreement is termed as its legal enforceability.

Whether an agreement is legally enforceable or not would depend upon two factors-

1. Intention of parties to enforce it legally
2. Presence of all essentials elements of a contract as per s.10.

What does one mean by 'intention of the parties to enforce and agreement legally'? A legal obligation will arise only when the parties to an agreement want to make themselves legally bound to perform the duties assigned in the agreement. For example when we agree to meet a friend for dinner or we agree with an electrician, that he will install new switch for fan next day, we may not have any intention to legally bind the other person who is accepting it, but when we agree 10. a.m. delivery of urgent letter with a courier service and pay extra charges for the same, the intention here is to make the things legally binding as non-delivery of such letter in time may lead one to suffer losses.

It is difficult to ascertain what was in the minds of the persons at the time of making an agreement. However, it may be inferred from the circumstances and type of contracts whether the contracting parties intended to be legally bound. As general rule it is presumed that the agreement of social nature are not made with an intention to create legal relations while the trade agreements are made with an intention to create legal obligations.

## 1.4 PRESENCE OF ALL ESSENTIAL ELEMENTS OF CONTRACT :

### 1.4.1 Presence of all essential elements of contract

When the parties to an agreement intend to make it legally enforceable, the agreement should be so made as to satisfy the criteria provided by section 10 of the Indian Contract Act, 1872. Law will recognise an agreement as a contract only when the agreement is so made that all the essential elements of a contract as prescribed by section 10 of the Indian Contract Act are present in it. If any of these elements lacks, an agreement shall not be enforceable at law. These elements are discussed under next heading.

### 1.4.2 All agreements are not contracts

From the above discussion, we can conclude that all agreements are not contracts but all contracts are agreements.

Agreement is a wider term. It may be legally enforceable. It may not be legally enforceable. A contract is a legally enforceable agreement. In other words, to constitute a contract, we need an agreement + legal enforceability. Legal enforceability further depends upon two factors:

1. Intention of the parties making an agreement.
2. Presence of all the essential elements of a contract as per section 10 of the Indian Contract Act.

Thus an agreement acquires the form of a contract if certain 'ifs' and 'buts' are complied with. But in any case contract is made out of an agreement only.

## 1.5 ESSENTIAL ELEMENTS OF A VALID CONTRACT

Section 10 of the Indian Contract Act, 1872 provides that, "All agreements are contracts if they are made by the free consent of the parties competent to contract, for a lawful consideration and with a lawful object, and are not hereby expressly declared to be void."

Thus to form a contract, there must be-

***(1)*** *an agreement*
***(2)*** *which is legally enforceable*
***(3)*** *where the concerned parties are competent to contract*
***(4)*** *their consent is free*
***(5)*** *lawful consideration is present*
***(6)*** *its object is lawful*
***(7)*** *Contract Act has not expressly declared it void.*
***(8)*** *certainty of the terms*
***(9)*** *Possibility of performance*

**(i) and (ii)** First two elements are already discussed above. Rest is discussed in detail in the following chapters. For the purpose of having a broad idea of the subject, here we will briefly discuss them:

***(3) Competency of parties*** - When we say that the parties must be competent to contract, first question arises as to who can be considered as competent to contract. Section 11 of the Indian Contract Act provides that the law recognize a person as con1petent to contract, provided:

1. He is of the age of majority, like when a person attains the age of 18 years; he is considered as major by the Indian Law,
2. He is of sound mind, i.e., he should not be insane, and
3. He is not specifically disqualified by any law to enter into a contract. Like when a person's estate is under court's custody for decree, he is disqualified from entering into a contract to sell it.

Thus, if any of the parties to the agreement suffers from minority, lunacy, or disqualification under any law, the agreement is not enforceable at law. There are certain exceptions to this rule as per section 68 of the Indian Contract Act, which we will discuss in detail in forthcoming chapters.

***(4) Free Consent -*** The concept of free consent has two aspects, one, a consent should be made; second, it should be free from any pressure or misunderstanding.

The parties entering in an agreement must have a mutual consent on it. Two or more parties are said to consent when they agree upon the same *thing* in the same sense. Like when A agrees to sell his 'Maruti' car to B, where B is ready to pay Rs. 1 lakh for the same, there is a consensus ad idem, i.e., identity of minds. But when A agrees to buy a car from B thinking that the B is talking about his 'Maruti' while B in fact was talking about his 'Fiat', there is no identity of minds and no consent is said to be made.

The consent should be genuine i.e., the person concerned should make the consent out of his free will. It should not be affected by any kind of influence or misunderstandings. Law recognize a consent to be free when it is not caused by :

- ***Coercion*** - using physical force such as obtaining consent on gun point.
- ***Undue influence*** - using psychological pressure.
- ***Fraud*** - deceiving or misleading the other person by intentionally providing wrong in formation.
- ***Misrepresentation*** - providing wrong information without having knowledge that it is wrong.
- ***Mistake*** - misconception as to a matter of fact, or as to a matter of law.

**(5) Lawful consideration -** Consideration means something in exchange. If a person makes an agreement, to do something for the other without expecting anything in return (i.e., consideration); it does not constitute a valid contract. Presence of consideration is a must to form a contract.

Moreover this consideration should be lawful. It should not be fraudulent, or immoral, or opposed to the public policy, or forbidden by any law.

**(6) Lawful Object -** Object means the purpose or design of the contract. The object of an agreement must be lawful. The object is said to be unlawful if :

***(a)*** *it is of such a nature that if permitted it would defeat the provisions of any law;*
***(b)*** *it is fraudulent;*
***(c)*** *it involves an injury to the person or property of the another;*
***(d)*** *the court regards it as immoral or opposed to public policy.*

**(7) Contracts expressly declared void -** A void contract is one which does not give rise to any legal consequence. Despite having all other essential elements of a contract, a contract may be treated as void because the Indian Contract Act has declared it to be void. The contracts which are specifically declared as void by the Act are as follows:

***(a)*** *Agreements where both parties are under mistake as to the matter of fact [Section 20]-explained through example*
***(b)*** *Agreements with unlawful object or consideration [Section 24]- already dealt above*
***(c)*** *Agreements without consideration [Section 25] - already dealt above*
***(d)*** *Agreement in restraint of marriage [Section 26] - explained through example*
***(e)*** *Agreement in restraint of trade [Section 27] - explained through example*
***(f)*** *Agreement in restraint of legal proceedings [Section 28] - explained through example*
***(g)*** *Agreement having uncertain meaning [Section 29] - dealt below separately*
***(h)*** *Wagering agreement [Section 30] - explained through example*
***(i)*** *Agreement to do an impossible act [Section 56] - dealt below separately*

To become legally enforceable a contract should not have been expressly declared void by law.

**(8) Certainty of the terms -** The terms of an agreement must be clear, complete and certain. If an agreement is vague, or illusory, or its meaning is not clear, it cannot be enforced by a court of law. It does not give rise to any legal binding and cannot be termed as a contract.

***(9) Possibility of performance -*** An agreement must be capable of being performed. An agreement to do an impossible act in itself is void.

The above elements must be present to convert an agreement into a contract.

## 1.6 CLASSIFICATION OF CONTRACTS :

For the purpose of our discussion we may classify the contracts according to their:

| ***Validity*** | ***Formation*** | ***Performance*** |
|---|---|---|
| *(a)* Valid contract | *(a)* Express contract | (a)Executed contract |
| *(b)* Void contract | *(b)* Implied contract | (b)Executory contract |
| *(c)* Voidable contract | *(c)* Quassi contract | (c) Bilateral contract |
| *(d)* Illegal or unlawful contract | | (d)Unilateral contract |
| *(e)* Unenforceable contract | | |

### 1.6.1 Classification on the Basis of Validity

An agreement is enforceable at law when certain essentials stipulated in section 10 of the Indian Contract Act are complied with. It forms a valid contract. If anyone of the element is missing, then the agreement may either be void, voidable, illegal or unenforceable. These terms have been elaborated below for better understanding.

***(a) Valid contract -*** Contracts which have all essential elements as laid down by section 10 of the Indian Contract Act, are enforceable at law. Such contracts are called valid contracts.

*Note: A contract to enter into a contract is, however, not a valid contract.*

***(b) Void contract -*** Legal meaning of the term 'void' is - null and ineffectual having no legal force or binding effect, and unable in law to support the purpose for which it was intended.

A void agreement or a void contract is a total nullity and has no legal effect in the eyes of law. It creates no rights or obligations. None of the parties can enforce it in the court of law.

*Void agreement* - An agreement not enforceable by law is said to be void [Section 2(g)].

If an agreement fails to meet the basic criteria to become a contract as per section 10 of the Act, it is termed as void ab initio. The literal meaning of the term void ab initio is void since beginning. It may be noted here that a void agreement never attains the form of a contract. To quote a few examples, agreements made by a minor or lunatic, agreements made with unlawful object, agreements made without consideration are void agreements.

*Void contract* **-** It may happen that a valid contract is formed initially which subsequently becomes void. The Indian Contract Act provides that A contract which ceases to be enforceable by law becomes void when it ceases to be enforceable [Section 2(j)].

A valid contract may become void subsequently due to supervening impossibility or illegality etc.

*The term void contract is little confusing because an agreement is called contract when it is legally enforceable, and a void contract is a contract which is not enforceable at law. Although the terminology is faulty but it is capable of depicting the actual meaning of the expression.*

An act or contract neither wrong in itself nor against public policy may be declared void by statute for the protection or benefit of a certain party or class of party. Indian Contract Act has expressly declared certain contracts as void. Such contracts are already discussed under the heading 'contracts expressly declared void'.

***(c) Voidable contract -*** A contract which can be put to an end at the option of some of the parties to the contract, is a voidable contract. The party(s) entitled to avoid the contract may or may not do so. If the parties decide to avoid it, it no longer can be enforced in the court of law. If the parties opt not to avoid the contract, it is as good as any other valid contract.

An agreement which is enforceable by law at the option of one or more of the parties thereto, but not at the option of other or others, is a voidable contract [Section 2(i)].

*When a contract becomes voidable* - When the consent of one or more of the parties to a contract is obtained by coercion, or undue influence, or misrepresentation, or fraud, the contract becomes voidable at the option of the party(s) whose consent was so obtained. Such party is termed as aggrieved party. [Sections 15 to 18].

When a contract contains reciprocal promises, and one party to the contract prevents the other from performing his promise, the contract becomes voidable at the option of the party so prevented [Section 53]. The idea is that no man can complain of another's failure to do something which he has himself prevented the other from doing or performing.

When time is the essence of a contract and it is required to be performed by a specified time, and a party fails to perform it within this time, the contract becomes voidable at the option of the other party [Section 55].

***(d) Illegal or unlawful contract [Section 23] -*** A contract is considered as illegal or unlawful, if its consideration, or its object is :

**1.** Forbidden by law- All states have criminal statutes; these not only prohibit certain acts but provides for the imposition of fine, or imprisonment on persons who violate the relevant laws. Any contract for commission of a crime is clearly unlawful. Some other statutes simply prohibit the performance of the certain acts without imposing a penalty. Contracts for the performance of these acts are also unlawful.

**2.** Of such nature, that if permitted would defeat the provisions of any law - The term 'law' include any enactment or rule of law for the time being in force in India. Any agreement defying the provisions of law is unlawful. For example, as per the Indian Companies Act, 1956, A trading partnership of more than 20 persons is illegal unless registered as a company. If 21 persons make an agreement to form a trading partnership, the agreement is unlawful as it would defeat the provisions of the Companies Act.

3. Fraudulent - Where the parties agree to impose a fraud on third person, their agreement is unlawful.

4. Injurious to the person or property of another - An agreement between two persons to injure the person or property of another is unlawful.

5. Immoral - What is 'immoral' depends on the standards of morality prevailing in the society. From time to time courts establish what is immoral through the cases presented before them. Certain kinds of acts have been regarded as immoral by the courts like prostitution, interference with the marital relations, etc. An immoral agreement is considered as unlawful.

Against public policy - Where the court or the state feels that the performance of certain acts will have an adverse effect on the society, contracts for performance of such acts are unlawful.

A contract may be illegal since its formation, or it may become illegal subsequently after the formation.

*Effect of illegal contract* - An illegal contract is not enforceable at the court of law, i.e., the court will not assist a party to such an agreement either directly or indirectly. As a consequence of this rule, money or property transferred under an illegal contract cannot be recovered by a legal action. Thus when A agrees with B that they will share the dacoity money fifty-fifty, and later on refuses to do so, B cannot have any claim in the court of law for his share, because this is illegal contract which is a nullity in the eyes of law.

*Effect on collateral transactions* - Where an agreement is illegal, other agreements which are incidental or collateral to it are also illegal, and hence not enforceable at law. The underlying reason for this rule is that the courts will not assist or enforce any agreement entered into with the object of assisting or encouraging an illegal transaction.

*All illegal contracts are void but all void contracts are not illegal.*

We have discussed above that illegality makes a contract void, i.e., ineffective in the eyes of law. When a contract is void because of illegality of purpose, consideration or performance; it is termed as illegal contract.

Void contract is a wider term which encompasses all the contracts which are not enforceable at law for whatever reason. It may be a defect in the formation of contract, or it may be impossibility of performance, or it may be express declaration by the contract law, or it may be illegality of purpose, consideration or performance - which makes a contract void.

It may be inferred from the above that an illegal contract is necessarily void, while a void contract may be void because of a reason other than illegality.

***(e) Unenforceable contracts*** - A contract which cannot be enforced in a court of law because of some technical defect is known as unenforceable contract. In certain cases there are special provisions of law which require certain formalities to be fulfilled for formation of a contract like the contract must be registered, or it must be attested by notary, or it must be stamped, etc. If such formalities are not observed, the contract cannot be enforced by law. Some of such contracts can be enforced, if the technical defect can be removed.

### 1.6.2 Classification on the Basis of Formation

A contract may be either expressed or implied or may be inferred from the circumstances. It may also be of mixed character that is partly expressed or partly implied. Contract whether implied or express or constituted by circumstances gives an equal cause of action.

***(a) Express contract*** - Section 9 of the Indian Contract Act provides that, in so far as the proposal or acceptance of any promise is made in words, the promise is said to be express'. In other words, a promise made in words is called an express promise. The express promises results in express contracts. Express contracts can be made by words spoken or written.

***(b) Implied contract -*** Section 9 of the Indian Contract Act provides that, "in so far as such proposal or acceptance is made otherwise than in words, the promise is said to be implied." An implied promise results in implied contract. An implied contract is one which is not expressly agreed upon between the parties. It is inferred from the acts or conduct of the parties or course of dealings between them or from the surrounding circumstances.

***(c) Quasi-contract -*** In a quasi-contract rights and obligation arise not by any agreement between the parties but by operation of law. These obligations are imposed by law because of existence of some special circumstances between the parties. For example, the finder of a lost article is under an obligation to find the owner and return it. Such contracts are based on the principle that "none should be allowed to enrich himself unjustly at the expense of another. There is no consensus, no offer and no acceptance; still the law implies a contract. As a matter of fact, these are not contracts, instead these are relations resembling contract. But Contract Law views such relations as contracts.

**1.6.3 Classification on the Basis of Performance**

Contracts can be classified depending upon the extent to which they have been performed. They may be executed, or executory, or bilateral, or unilateral.

***(a) Executed contract -*** Where all the parties to a contract have performed their obligations under the contract, it is known as executed contract.

***(b) Executory contract -*** Where all the parties to a contract have still to perform their respective obligations in a contract, the contract is known as executory contract.

**Note:** It may happen that some of the parties have performed their part of obligations while the others are yet to perform.

*An executory contract may be bilateral or unilateral*

***(c) Bilateral contracts -*** These are contracts where as soon as the contract is made, both parties are bound by it. A typical example of bilateral contract is where A promises to sell goods to B in return for B promising to pay the purchase price. In relation to services, the same applies, so that an agreement between A and B that B will dig A's garden for Rs. 500 next Sunday is a bilateral agreement.

***(d) Unilateral contracts -*** In a unilateral contract only one party makes a commitment. If we make a slight change in the above example, and A says to B, 'If you dig my garden next Sunday, I will pay you Rs. 500.' B makes no commitment, but says, 'I am not sure that I shall be able to, but if I do, I shall be happy to take Rs. 500.' This arrangement is not bilateral-A has committed himself to pay Rs. 500 in certain circumstances, but B has made no commitment at all. He is totally free to decide whether he wants to dig A's garden or not. If B does not turn up on Sunday to dig the garden, A cannot do anything about it. If, however, B reaches to A's place on Sunday to do the work, it will amount to his acceptance and a contract will be formed where both parties will be bound by their performance.

# Part - 2

## AGREEMENT – OFFER AND ACCEPTANCE

**STRUCTURE OF PART - 2**

## 2.1 OBJECTIVES

After reading this Unit, you should be able to understand:

- What is an offer and how it can be identified amongst different statements.
- What constitutes a valid acceptance.
- When and how offer and acceptance can be revoked.
- When the communication of a proposal, acceptance and revocation is complete.

## 2.2 PROPOSAL/OFFER :

S. 2 (a) of the Act defines the term 'proposal' as under :

'When one person signifies to another his willingness to do or abstain from doing anything, with a view to obtaining the assent of that other to such act or abstinence, he is said to make a proposal.'

Offers are not mere requests or information, nor statements of fact, nor statements as to person's intention. An offer must be distinguished as more than all these. An offer is a statement of terms which it appears you are willing to standby.

The person, who makes an offer, promise to perform certain act on the condition that the other person accepts his offer. Thus an offer is a conditional promise. When I offer anything to a person, what I mean is "I will do that if you choose to assent to it."

For example, if buyer and seller are negotiating the sale of rice, seller may at some point say, "I promise to deliver 200 rice bags to you on January 31, if you promise to pay me Rs. 40,000 Seller's statement is an offer and seller is an offeror because he is making a promise ("I promise to deliver….") which is conditional upon the acceptance of the given terms ("….If you promise to pay me Rs. 40,000") by the buyer, the offeree. If the offeree does not choose to accept it, no agreement will come into existence. But if he says I promise to pay you Rs. 40,000 for the rice bags," he has accepted the offer, and the seller's promise is transformed into a contract.

### 2.2.1 Essential elements of offer-

The elements of offer are as under :

(i) Offer must be communicated to the offeree.

(ii) Offer constitutes willingness to do or abstinence to do some act.
(iii) Offer must be made to other person.
(iv) Offer must be made with a view of obtaining the assent of the other.
(v) Offer may be express or implied.
(vi) Offer may be conditional.
(vii) Offer must be capable of creating legal relationship.
(viii) The terms of offer must be certain.
(ix) Offer must not thrust the burden of acceptance on the offeree.

***(i) Offer must be communicated to the offeree*** - The definition of proposal contains the words. "when one person signifies to another his willingness". It infers that the offer must be conveyed to the offeree.

Section 4 of the Contract Act lays down that, "the communication of a proposal is complete when it comes to the knowledge of the person to whom it is made."

Thus the law recognizes a proposal when it is communicated. Communication is complete only when it comes to the knowledge of the person to whom it is made. As a corollary, there can be no acceptance of a proposal which is not communicated because a person cannot assent to something which he is not aware of.

**Example:** A proposes, by letter, to sell a cow to B at price of Rs. 6000/-. The communication of the proposal is complete when B receives the letter.

The communication of a proposal is complete when it comes to the knowledge of the person to whom it is made [s.4]

***(ii) Offer constitutes a willingness to do some act or abstinence*** - An offer is a promise to do or not to do something which an offeror purports to perform provided the offeree gives his consent to it.

***Examples:***

1. A says to B, "I will paint a picture for you if you are ready to pay Rs. 10,000 for it." This is an offer where A is willing to perform certain act for certain price.

2. X says to Y, "If you will pay me Rs. 500 per month, I will not play tabla every night." This is an offer where X is willing to abstain from something for a consideration.

**(*iii) The offer must be made to other person -*** An offer cannot be made by a person to himself. On the basis of the fact to whom an offer is made, it can be categorized as follows:

Offer made to -

(a) one particular person is a specific offer

(b) a particular group of persons is specific offer

(c) the whole world, i.e. anyone having knowledge of its existence is general offer

Offer to one particular person - Where an offer is made to one particular person, it can only be accepted by that person.

*Offer to a group of persons -* Where an offer is made to a particular group of persons, it may be accepted by any member of that group.

*Offer to the whole world -* Where an offer is made to the whole world, it can be accepted by anyone having knowledge of its existence.

*Certain points are to be kept in mind while dealing the cases of the offer made to public at large which are -*

a. Giving an offer only does not constitute a contract with the public at large. The contract comes into existence only when the offer is accepted by some ascertained person.

b. If the offer at large is of continuing nature, it may be accepted by a number of persons. If a large number of persons accepts such offer. There would be equal number of contracts.

c. If the offer at large is an offer of reward for some information or restoration of a missing article. The offer is open for acceptance by only one individual who performs the required condition first of all, and as soon as the condition is first performed, the offer is closed. For example when a person offers a reward to anybody who will find his lost dog, the moment an individual finds the dog, the offer is closed for rest of the world.

***(iv) Offer must be made with a view of obtaining the assent of the other-*** An offer must be addressed to another person in order to obtain his assent to the proposal. It must be distinguished from an expression of intention or enquiry.

Thus a casual enquiry- "Do you intend to sell your car?" - is not a proposal. Similarly a mere statement of intention - "I may sell my car if I can get Rs. 50,000 for it" - is not a proposal. But if X says to Y, "Will you buy my car for Rs. 50,000", we have a proposal as it has been made with the object of obtaining the assent of Y.

***Examples:***

1. A says to B, "I will sell you my house if you are ready to pay Rs. 1 Lakh for it". B says, "I accept your offer." Here what A said to B was with a view to obtain his assent. A contract is formed.

2. A, jokingly said that he was willing to sell his horse for Rs. 2,000. B knowing that A was not seriously making the offer, said that he has accepted the offer. In this case A's offer is not the real offer as he did not make it with the view to obtain the consent of B.

***(v) An offer may be express or implied -*** An offer may be expressed by words or may be inferred from conduct. Section 3 of the Indian Contract Act provides two modes of communication - (i) an act or (ii) omission.

*Act includes:*

1. express words spoken which includes telephone messages - it is also known an express oral offer.

2. written words which includes letters, telegrams, telex, advertisements etc. - it is also known as an express written offer.

3. conduct would include positive acts or signs so that the other person understands what the person acting or making signs mean to say or convey - it is an implied offer.

**Examples:**

1. A says to B, "will you buy this car for Rs. 80,000?" This is an express oral proposal.

2. A writes a letter to B stating the above offer. It is an express written proposal.

3. The BEST runs buses on different routes to carry passengers at the scheduled fares. This is an implied offer by the BEST.

*Omission* would not mean silence but would include such conduct or forbearance on one's part that the other person takes it as his willingness or assent. For example A says to B, "I will leave 80 % of my property for you if you will not drink alcohol till I am alive." B who was very fond of alcohol does not say anything but abstain from drinking alcohol. B's acceptance is conveyed.

***(vi) An offer may be conditional-*** An offeror may attach any terms and conditions to the offer he makes. In such case it can be accepted only when that condition is fulfilled. It is immaterial if the terms are hard and ridiculous. If one chooses to stipulate some eccentric act as the only manner in which the offer may be accepted like place your letter of acceptance in the hollow tree before midnight - it is effective. It is open to a person to whom a conditional offer is addressed to accept or not to accept the offer.

**Example -** A gave an offer to B to sell his car for Rs. 50,000 if he sends his acceptance by telegram immediately on receiving the offer. B, sends a letter of acceptance instead of a telegram. No contract is made.

However, in such cases, offeror's status can be viewed as follows - The offeror may opt to treat the acceptance valid even if the offeree does not comply with the condition stipulated by him. Thus in the above example, if A choose to consider the letter of acceptance as valid, a contract will come into existence.

If the offeror does not opt to treat the acceptance valid, it is a duty on his part to make it very clear to the offeree that he will not accept the acceptance because of non-performance of the condition by him. In case, the offeror does not communicate to this effect to the offeree, he becomes bound by the acceptance.

[Section 7(2)]

*Considering the above example,* it is duty of A to convey B that his acceptance will not hold good because he has not sent his acceptance by telegram. If A does not make this clear to B, he will be bound by the acceptance made by B, and a contract will be made.

***(vii) Offer must be capable of creating legal relationship* -** A valid offer must intend to create legal relations. If the parties to the agreement have no intention to create legal relationships, it is not an offer in the eyes of law.

*It may be noted here that the basic testing criteria is "intention of the party"* - Even in a business transaction the party can specifically rule out the legal enforceability, and even in domestic transactions things can be made legally enforceable if the parties decides so.

**Examples:**

1. X makes a promise with his wife Y that he will pay her Rs. 1000 per month if she will leave her job, in writing with the specific mention that they want to be legally bound by it, it is enforceable in the court of law.

2. X and Y agree to contribute Rs. 1 Lakh each and start a partnership business with a specific clause in their partnership deed that any partnership dispute is not to be taken in the court of law, the agreement lacks legal enforceability.

***(viii) The terms of offer must be certain*** - A contract may fail to come into existence, even though there is an offer and an acceptance, because of uncertainty as to what has been agreed. A vague offer does not convey what it exactly means. In particular this will be the case where the parties have left essential terms to be settled between them. Thus where parties enter into an agreement for sale of goods but fail to state the price at which the goods are to be sold, the courts are not able to enforce such promise.

**Examples:**

1. Where a person states that he is prepared to purchase the property for a reasonable sum, the proposal cannot be construed as an offer to purchase for any definite amount.

2. A promised to buy the horse from B if it proved lucky. This is a vague and loose offer. Thus it cannot give rise to any contract.

***Limitations to the rule*** - The rule that an offer is not valid if its terms are not certain, can be ignored in the following cases:

1. If only a minor term is meaningless, it may simply be ignored and the rest of the contract may be treated as binding.

2. If the parties have had previous dealings similar to the present transaction, the courts can use these matters to ascertain the terms of the contract.

It is worth noting that simply absence of few terms does not render uncertainty to the contract. If the missing terms make an essential part of the contract without which the responsibility of the parties cannot be fixed, then only a contract can be held void because of uncertainty.

***(ix) An offer must not thrust the burden of acceptance on the offeree -*** The offeror cannot say that if the acceptance is not communicated within a fixed period of time, the offer would be considered as accepted. The offer should not impose on the offeree, an obligation to reply.

**Example-** A writes to B "I will sell you my horse for Rs. 500. If I do not receive a reply by Sunday next, I shall assume you have accepted the offer." B does not reply. There is no contract.

### 2.2.2 Offer Should be Distinguished From :

***(i) Cross offers -*** Two offers meeting cross purposes, made by two parties to each other, in ignorance of each other's, offer are termed as 'cross offers'. Cross offers do not amount to acceptance of one's offer by the other and do not constitute a completed agreement.

**Example -** A wrote a letter to B, a firm of furniture dealers to supply him 5,000 chairs of a particular type and at a certain price. The same firm on *the* same day posted a letter to A offering to sell 5,000 chairs of the same quality at the same price. The letters crossed each other in the post. Here, the letters are cross offers, and neither is acceptance of the other because each side was ignorant of the proposal other party at the time of writing the letter.

*<u>Comment: </u>It may be noted here that the offer made by A and the offer made by B are good offers in their individual capacity. If B gives an acceptance to the offer given by A or vice versa, an agreement will be formed. The idea is that the two similar offers cannot be treated as offer and acceptance.*

***(ii) <u>Counter offers. -</u>*** Acceptance to an offer with a variation is no acceptance. It is simply a counter offer. A contract can be concluded only when the exact terms of the offer are accepted by the offeree. A counter offer amounts to the rejection of the original offer and has the effect of canceling the original offer. An offer once rejected is dead and cannot be accepted unless renewed.

**Example:** A offered B to sell his horse at Rs. 1000. B replied that he can pay Rs. 800 for the horse. B's reply is a counter offer.

When a counter offer is made by an offeree, following situations may occur :

(i) The offeror refuse to accept the counter offer, original offer comes to an end. Result - No contract.

(ii) The offeror choose to accept the counter offer, original offer comes to an end, counter offer amounts to new offer; acceptance of counter offer by the original offeror amounts to acceptance, a contract is formed.

(iii) The offeror refuse to accept the counter offer, original offer comes to an end. The offeror renews the offer and the offeree now accepts it. A new contract is formed.

***(iii) <u>Invitation to offer -</u>*** When a person makes an invitation to offer, the purpose is not to obtain the assent of the other person but merely to circulate the information that he is willing to deal with anybody, who on such information is willing to open the negotiations with him.

If I park my car on the driveway of my house with a 'For Sale' notice on the windscreen, it is an example of an invitation to offer, not an offer. The idea behind this invitation is that anybody who is interested in buying the car can come and talk to me.

An invitation to offer is not the same thing as offer. An offer is a final expression of willingness of the offeror. If the offeree accepts it, a contract will be made and both the parties will be bound by it. Invitation to offer is an invitation to open negotiations. Acceptance to an invitation to offer cannot give rise to a contract.

We shall discuss below some of the possible forms an 'invitation to offer' may take:

**(1)** **Displaying goods for sale -** Displaying goods that are for sale does not amount to making an offer to sell. It is something you do to encourage the people who come forward and negotiate.

Where goods with a price tag attached are displayed in a shop window, this does not amount to an offer by the shop to sell the goods, but it is merely an invitation by the shop to the members of the public to make an offer for the goods in question. Although from a social standpoint a person may feel offended why the shopkeeper rejected to sell the goods at the price quoted by him only, but the legal situation remains the same.

A natural consequence is of course that a customer cannot demand the sale of goods to him, at the price indicated, for he is the person making the offer, which the shopkeeper must then decide whether to accept or reject.

**(2)** **Price lists, catalogues -** The issue of a tradesman's circular or catalogue advertising goods for sale is usually regarded as a mere attempt to induce offers, and is not an offer in itself.

**(3)** **Advertisement -** Generally speaking, an advertisement on a hoarding, a newspaper 'display', or a television commercial, etc. is not regarded as an offer. These are simply attempts to make the public aware of what is available, and will in any case not be specific enough to amount to an offer.

**(4)** **Declaration of intention -** A declaration of intention, such as an advertisement to hold an auction, does not amount to an offer.

**(5)** **Auctions -** At an auction sale, the auctioneer's request for bids is not an offer, instead, it is a bid that constitutes an offer. The general proposition is that the bidder is the offeror; his bid (which may be by words or by conduct, such as waving a catalogue) is the offer, and this auctioneer may accept or reject. If the auctioneer chooses to accept the offer, it is by striking the table with his hammer. It follows that the auctioneer can withdraw any item before the fall of hammer.

**(6)** **Share offers -** A company which in commercial language makes an offer to the public of new shares does not in law "offer" to allot the shares. It invites members of the public to apply for them. It reserves right to accept or reject the application.

**(7)** **Tenders -** If A asks a number of tradesmen to put in tenders for supplying him with some particular goods or services, in doing so, he is not making an offer. Consequently he is not bound to accept the lowest or any other tender. The position is similar where A asks one tradesman to put in an estimate for supplying particular goods or services. It is not A, who makes the offer; the offer comes from the tradesman in the form of the tender or estimate.

A tender merely indicates a readiness to receive offers. The offer in all such cases comes from the person who receives the tender. The person inviting the tender mayor may not accept it.

Acceptance of tender- It is essential to understand what is precisely meant by accepting a tender, since different legal results are obtained according to the wordings of the invitation to tender. Consider the following two cases:

**(a)** Tenders are invited for the supply of 10,000 tons of coal to B & Co., delivery to take place as demanded between January and December 1998.

**(*b)*** Tenders are invited for the supply of coal not exceeding 10,000 tons to B & Co., if and when demanded between January and December 1998.

Acceptance to tender replies in the case (a) - will result into binding contract.

Acceptance to tender replies in the case (b) - will result into standing offer.

***(iv) Standing offer -*** Sometimes a proposal may take the form of a continuous offer. Such offers are called 'standing offers'. It is an offer to supply certain commodity for a certain price up to a certain period. The quantity to be supplied may or may not be specified. It usually takes the form of a tender.

## 2.3 TERMINATION OF OFFER

An offer remains capable of acceptance until it is terminated (i.e. stop existing). An offer may terminate by the operation of law or by the act of the parties. Section 6 of the Indian Contract Act enumerates the circumstances when an offer comes to an end. But these are not exhaustive. Following discussion covers the provisions of section 6 as well as other circumstances when an offer is said to become non-existent.

### 2.3.1 Instances of termination of offer as per section 6 of the Act

***(1) Revocation -*** Two relevant provisions of the Indian Contract Act dealing with revocation are as follows:

A proposal may be revoked at any time before the communication of its acceptance is complete against the proposer, but not afterwards [Section 5].

A proposal is revoked by the communication of notice of revocation by the proposer to the other party [Section 6(1)].

It follows from the above that, the offeror may revoke (i.e. withdraw) his offer at any time before the offeree has communicated his acceptance. And that, to be effective, such revocation must be communicated to (i.e. actually brought to the attention of) the offeree, by the offeror himself or by his duly authorised agent.

**Example:** At an auction sale A makes the highest bid but withdraws it before the fall of the hammer, no contract is concluded because the offer has been revoked before acceptance.

*How the cases are dealt when offer is kept open for a specified period of time* - The above example shows that even if the offer is kept open for a specified period of time, the offeror can revoke it. The rationale is that when offeree is not bound in any way to accept the offer, why the offeror should be bound to keep it open.

But there is an exception to it. If the offeror has promised to keep the offer open for a consideration (i.e. something in return), a separate contract is formed which is technically known as 'option'. In such a case the offeror cannot revoke the contract before the expiry of agreed period.

**Example -** O in consideration of the payment of Rs.1, granted in writing an option to A to purchase O's house for Rs.10000 exercisable within six months. O purported to withdraw his offer before the expiry of six months. A went to the court. It was held that the offer continued in existence and O's withdrawal of offer has no effect.

***(2) Lapse of time -*** A proposal is revoked by the lapse of time prescribed in such proposal for its acceptance, or, if no time is prescribed, by the lapse of reasonable time, without communication of acceptance [Section 6(2)].

An offer continues in existence for so long as the offeror intends it to continue. If he states, "This offer is to remain open until noon on April 1," it remains open until that moment and then ceases to exist. It may happen that the offeror does not specify anytime for the termination of the offer but that does not mean that it is intended to last forever. The offer, therefore, comes to an end after the lapse of reasonable time.

What is reasonable time is a question of fact depending upon the circumstances of each case. For example, an offer made by telegram suggests that a reply is required urgently and if the offeree delays the communication of his acceptance even by a day or two, the offer will be considered to have lapsed.

***(3) Failure of acceptor to fulfil the condition precedent to acceptance -*** A proposal is revoked when the acceptor fails to fulfil a condition precedent to the acceptance of the proposal [Section 6(3)].

If there is a *condition* therein the proposal, without fulfilling which, the acceptor cannot accept the proposal; the proposal will naturally be revoked if the acceptor fails to fulfill that precedent condition.

**Example -** A, a seller agrees to sell his house subject to the condition that B, a buyer, pays the agreed price before a certain date. B fails to fulfill that condition. Hence the offer stands revoked.

***(4) Death or insanity of the proposer*** - A proposal is revoked by the death or insanity of the proposer, if the fact of his death or insanity comes to the knowledge of the acceptor before acceptance [Section 6(4)].

If the offeree does not know that the offeror has died or gone insane and gives his acceptance, it is a good acceptance in the eyes of law. This will result in a valid contract and legal representatives of the deceased offeror shall be bound by the contract. But where the offeree has knowledge of the offeror's death or insanity, he cannot make an effective acceptance.

***Example*** - X had written Z, requesting him to give credit to Y and guarantying payment up to Rs. 1 lakh. The Z gave credit to Y, X, then died, and the Z, in ignorance of this fact continued credit to Y. Y failed to repay this amount. The Z now sued X's executors for guarantee amount. Here, the guarantee was to be performed out of the estate of X.

However, if the offer is of personal nature, i. e. involves personalised services like painting of picture by the offeror, in such cases, the offer stands lapsed when the offeror dies or goes insane, even if the offeree gives acceptance without the knowledge of this fact.

It is interesting to know that there is no provision in the Indian Contract Law about the effect of death of the offeree. But it may be construed that since an offer can be accepted only by an offeree and not by any other person, it cannot be accepted by his executor on his death.

***(5) Other instances when an offer gets terminated -*** In addition to the modes mentioned in section 6 of the Indian Contract Act, an offer comes to an end in the following cases:

*(a) Rejection -* An offer comes to an end when the offeree rejects it. Once an offer has been refused, it ceases to exist, and no longer remains capable of acceptance.

**Example** - A offers to sell his 10 acre of land to B for Rs. 1 lakh, B refuses. Offer no longer exists.

The rejection of a proposal is wholly distinct from revocation as it is a deliberate act on the part of offeree while revocation is an act on the part of the offeror.

*(b) Counter offer -* A counter offer proposing different terms has the same effect as

refusal. It is no, less a rejection of the original offer. A party, who having made a counter offer, changes his mind and want to accept the original offer, cannot treat the first offer as still open.

**Example -** A offers to sell his 10 acre of land to B for Rs. 1 lakh, B offers to pay Rs. 90,000 for the same. Original offer stops existing. Now even if B is ready to pay Rs. 1 lakh for the land, the original offer is not open to him.

*(c) Failure to accept according to the mode prescribed -* Offer is revoked if the offeree fails to accept it according to the mode prescribed by the offeror.

**Example -** A offered to buy flour from B requesting that the 'acceptance should be sent by the messenger who brought the order. B sent his acceptance by post thinking that it would reach A earlier than the messenger. In this case A was not bound by the acceptance.

It may be noted that according to section 7, if the offeree does not accept the offer according to the mode prescribed, the offer does not lapse automatically. It is duty of the offeror to reject such acceptance within reasonable time. Thus, if the acceptance is not in the mode prescribed, and the offeror does not reject acceptance or gives no answer, he is deemed to have accepted the acceptance.

*(d) Subsequent illegality or destruction of the subject matter -* An offer lapses if it subsequently becomes illegal.

**Example -** An offer is made for the sale of 100 bags of cement at the rate of Rs. 100 per bag, and subsequently a law passed prohibiting the sale of cement by the private individuals, the offer becomes illegal and stands lapsed.

When the subject matter of an offer gets destroyed, the offer lapses automatically.

**Example -** A offers to B that he will supply him 10 cans of groundnut oil if his ship will reach safely to the shore. B accepts the offer. The ship wrecks on the way, the offer stands lapsed irrespective of the fact whether B has knowledge of this event or not.

## 2.4 ACCEPTANCE OF AN OFFER

Once the existence of an offer has been proved, a valid acceptance is required to form a contract. An acceptance is an expression, by words or conduct, which clearly indicates that the person making it agrees to be bound by the terms of the offer. The acceptance must be unqualified and must correspond to all the terms of the offer.

Whether there has been an acceptance by one party to an offer made to him by the other may be collected from the words or documents that have passed between them or may be inferred from their conduct.

### 2.4.1 Acceptance :

Section 2(b) of the Indian Contract Act provides that, "When the person to whom the proposal is made signifies his assent thereto, the proposal is said to be accepted. A proposal when accepted becomes a promise." Thus, acceptance is the act of giving consent to the proposal. A proposal when accepted becomes a contract.

This definition can be broken into the following elements:

1. When the person to whom the proposal is made
2. Signifies his assent thereto
3. The proposal is said to be accepted.

The word "thereto" in the above definition emphasizes that the acceptance should be made exactly to whatever has been offered.

### 2.4.2 The elements of acceptance

The elements of acceptance are discussed below along with the other legal rules which are applied to see when and how an acceptance comes into existence.

The elements of acceptance are as under :

***(1)*** *Acceptance must be made by the party to whom the offer is made*
***(2)*** *Acceptance must be absolute and unqualified*
***(3)*** *The acceptance must be expressed in some usual or reasonable manner*
***(4)*** *Acceptance must be given within reasonable time*

*(5)* *Acceptance cannot be made in ignorance of offer*
*(6)* *Acceptance must be given before the offer lapses or revoked*
*(7)* *An acceptance must be communicated to the offeror*
*(8)* *Mere mental acceptance is no acceptance*

***(1) Acceptance must be made by the party to whom the offer is made -*** When an offer is made to a particular person, it can be accepted only by that person, when an offer is made to a class of persons, it can be accepted only by a member of that class, and when an offer is made to the public at large, it can be accepted by any member of the public.

**Examples:**

1. X offered to sell his house to Y for Rs. 1 lakh. Z, who was overhearing, came forward and said that he is ready to buy X's house on X's terms. Result is ‘no contract’.

2. X gave advertisement in the paper that whoever will bring his lost cat will get a reward of Rs. 500. Any member of the public can accept this offer.

***(2) Acceptance must be absolute and unqualified [Section 7(1)] -*** An acceptance should be unconditional assent by the offeree to all the terms of the offer. A conditional or qualified acceptance is no acceptance at all. If there is any variation, even of unimportant point, there is no contract. An acceptance with a variation is a counter proposal which mayor may not be accepted by the person (i.e. the original offeror) to whom it is made.

**Examples:**

1. R offered to purchase D's house with vacant possession from 25th July. D sent an acceptance letter suggesting acceptance from 1st August. Here, it was no acceptance of R's offer.

2. A offers to sell his house to B for Rs. 1,00,000. B replies, "I am willing to buy your house for Rs. 1,00,000 if you buy my 1960 model Fiat for Rs. 50,000." There is no acceptance on the part of B.

(3) ***The acceptance must be expressed in some usual or reasonable manner [Section 7(2)] -*** Where the offeror prescribed a particular mode of acceptance - The acceptance must be made in the prescribed manner. Thus when an offer was made on the following terms - the seller wrote to the purchaser, "I intend to sell my house for Rs. 1000. If you are willing to have it, write to F at his address." Instead of writing to F, the purchaser sent an agent to F and agreed to purchase. Here, It is an invalid acceptance.

A departure from the prescribed manner does not of itself invalidate the acceptance. Law imposes a duty on the offeror to reject such acceptance within reasonable time of receipt of acceptance. If he fails to do so, he becomes bound by the acceptance. Thus in the above case, if the seller does not deny the sale of the house within the reasonable time insisting upon the deviated manner of acceptance of by the purchaser, a valid contract will be formed.

Where the offer does not prescribe any mode of acceptance - The acceptance must be made in a reasonable manner. This expression includes what must have been done according to the ordinary practice followed in a particular trade or business or place. However, what is reasonable depends on the facts and circumstances of each case.

Thus a contract of insurance will be concluded only when a party to whom an offer has been made accepts it unconditionally and communicates his acceptance to the person making the offer - because this is the normal mode of acceptance of an insurance proposal.

(4) ***Acceptance must be given within reasonable time-*** If the offeror specifies time limit within which the offer can be accepted and the acceptance is not made within such time, the offer automatically lapses. If any time limit is not specified in the offer, it can be accepted within reasonable time. What is reasonable will depend on the facts and circumstances of each case. Thus an offer to sell perishable goods should be replied quickly.

(5) ***Acceptance cannot be made in ignorance of offer –*** The rule is that the acceptance follows the offer. If the offer is not communicated to the other person, he cannot accept it.

**Example -** B found A's lost dog, and not having seen the advertisement given by A offering a reward for his return, returned it out of goodness of heart. Here B will not be able to claim the reward because he has acted in ignorance of the offer.

***(6) Acceptance must be given before the offer lapses or revoked -*** Acceptance can be given only to an existing offer. When an offer terminates, it stops existing and hence cannot be accepted. How and when an offer terminates has already been discussed.

***Example -*** O offered to sell A his farm for Rs. 10,000. A, replied that he could buy the farm for Rs. 9,500. O refused this counter offer. A then accepted the offer to buy the farm for Rs. 10,000. He was too late. That offer terminated when O received the counter offer. A’s acceptance was a nullity.

***(7) An acceptance must be communicated to the offeror-*** As per the definition of acceptance, when a person signifies his assent to a proposal, it is said to be accepted. The offeree should do something to signify his assent, Le. to communicate his acceptance. An acceptance can be communicated in any of the following modes:

1. By words spoken
2. By words written
3. By conduct - (i) By performance of conditions
   (ii) By acceptance of consideration

**Examples:**

1. P offers to buy Q's bicycle at Rs. 2500. Q may accept this offer by stating so orally or through the telephone - oral acceptance.

2. P offers to buy bicycle at Rs. 50. Q accepts the offer by writing a letter or by sending a telegram to that effect - written acceptance.

3. A widow promised to settle some immovable property on her niece if the niece stayed with her at her residence. The niece stayed at her residence till her death. Here, the niece was entitled to the property because she has accepted the aunt's offer by going to her residence and staying with her as desired - acceptance by performance of condition.

4. T offers to pay S Rs. 50 if he would jump from the first floor of a house to the ground floor. S jumps down from the first floor to the ground floor - the offer has been accepted by conduct of jumping from first floor.

It may be understood from the above illustrations that in any case, the offeree has to perform certain act to convey his acceptance. If the offeree does not react in any way to signify his assent, the acceptance is not said to have occurred. Mere mental acceptance is no acceptance. It has to be accompanied by some external indication.

**Example:** A person received an offer by letter. In reply he wrote a letter of acceptance, put the letter in his drawer and forgot all about it. In this case, there was no contract because the other party was not informed.

***(8) Mere mental acceptance is no acceptance*** - A mere mental acceptance, not evidenced by words or conduct is, in the eyes of law, no acceptance.

**Example -** A draft agreement relating to the supply of coal was sent to the manager of a Railway company for his approval. The manager put the words 'approved' on the agreement but by an oversight the draft remained in his drawer. In this case, there was no contract because of no communication

A contract will thus be binding only when the acceptor has done something to signify his intention to accept and not when he has only made up his mind to do so. A natural corollary to this rule is that the Silence cannot be construed as acceptance.

As a general rule, silence on the part of the offeree does not constitute an acceptance. This is true even when the offeror states, "If you do not reply within 10 days, I shall conclude that you have accepted." In such a case, even if the offeree does not reply within 10 days, his acceptance cannot be presumed.

*Possible cases where acceptance by silence can be construed as acceptance* - There may be exceptional circumstances, where silence on the part of the offeree does constitute an acceptance. While it is difficult to generalize about these exceptional situations, following types of cases present little controversy:

1. When an offeree initially indicates that silence on his/her part can be taken as acceptance, his silence will infer his acceptance. Thus if A says to B, "If you do not hear from me by March 1, you can conclude that we have a contract," and maintains silence till March 1, the contract will be formed.

   *Note: It may be noted here that it is offeree who is ready to construe silence as a mode of acceptance. An offeror cannot decide by himself to construe silence as a mode of acceptance.*

2. When a series of past dealings exist between the parties. For example, A retail jewelry store has over the years, received periodic shipments from a big supplier and has always paid for any unordered goods not returned within two weeks. A failure by the retail dealer to reject a particular shipment within two weeks will amount to acceptance.

3. Where the offeree having reasonable opportunity to reject the offered goods or services takes the benefit of them. It will amount to acceptance.

**Example -** A landlord served a notice on the tenant demanding enhancement of rent. The tenant did not protest against it and continued to occupy the premises. The conduct of the tenant amounts to acceptance of the offer to pay the rent at the higher rate.

### 2.5 COMMUNICATION OF OFFER, ACCEPTANCE AND REVOCATION

When people talk face to face, the message is communicated then and there. Thus where A and B are sitting across and A says to B, "I am ready to sell my house to you for Rs. 1 lakh." And B replies, "I agree to buy your house for Rs. 1 lakh." the communication of offer and acceptance is complete instantaneously and contract is formed.

But when parties are at a distance to each other, different modes of communication like letter, telegram, telephone, telex, fax, E-mail, etc., may be used to communicate.

In case of telephone/fax/telex etc., it is presumed that there is instantaneous communication. But while communicating, if the equipment which is being used goes out of order or some other disturbance occurs due to which the message is not conveyed properly, the communication is not treated as complete. Thus where a contract is affected by telephonic conversation, the contract is not complete till acceptance of the offer by the offeree is clearly heard and understood by the offeror.

The *spirit of the law* is that the message reaches to the party concerned - The words of Justice Denning are worth mentioning here - "Let me first consider a case where two people make a contract by words of mouth in the presence of each other. Suppose for instance, that I shout an offer to a man across a river or a courtyard, but I do not hear his reply because it is drowned by an aircraft flying overhead. There is no contract at the moment. If he wishes to make a contract, he must wait till the aircraft is gone and then shout back his acceptance so that I can hear what he says. Now take a case where two people make a contract by telephone. Suppose for instance, that I make an offer to a man by telephone and in the middle of his reply, the line goes 'dead', so that I do not hear his words of acceptance. There is no contract at that moment.

When the parties negotiate a contract through the mail or by telegram, there is a considerable time lag between putting the message in the course of transmission by one party and its receipt by the other party. In such cases, it is very important to decide the precise moment when communication is said to be complete. Section 4 of the Indian Contract Act explains when a communication will be treated as complete in the eyes of law. The language of section 4 depicts that it is applicable in the cases where contract is made through correspondence.

*Note: Indian Contract Law does not deal precisely with the contracts made in the presence of both the parties or over the telephone.*

### 2.5.1 Communication of offer-When complete

Section 4 provides that "the communication of proposal is complete when it comes to the knowledge of the person to whom it is made." The definition provides two stages. The communication of the proposal is the first stage. Receipt of the communication by the acceptor is the second stage. When offer is given by posting a letter or telegram, it is complete when it is received by the offeree.

**Examples:**

1. A proposes, by a letter to sell his house to B at certain price. The letter is posted on 1st June at 10.00 a.m. It reaches to B on 3rd June at 3.00 p.m. The

communication of the offer is complete when B receives the letter, i.e. at 3.00 p.m. on 3rd June.

2. A sends a letter to B offering to sell his house for Rs. 10 lakh. The letter never reaches B. The offer is not complete.

*Note: Offer by letter must be deemed to have reached to the addressee, when the letter ordinarily would be delivered at the addressee's residence. Any delay in addressee actually receiving it in his hands, caused owing to his failure to make proper arrangements to receive the communication will not be considered.*

**2.5.2 Communication of acceptance - When complete**

Section 4 provides that "The communication of an acceptance is complete-

*as against the proposer :*
When it is put in a course of transmission to him, so as to be out of power of the acceptor

*as against the acceptor :*
When it comes to the knowledge of the proposer."

It is to be noted here that the communication of an acceptance is complete at different times for the offeror and the acceptor. Thus, the offeror becomes bound by the acceptance as soon as the letter of acceptance is posted by the acceptor. And for the acceptor, the communication of acceptance is complete, i.e., he is bound by the acceptance when it comes to the knowledge of the offeror.

**Examples**:

1. Continuing with the first illustration given above, on 5th June at 2.00 p.m., B hands over the letter of acceptance to his peon for posting. Peon actually posted the letter at 2.30 p.m. The letter reaches A on 8th June, 11.00 a.m. Communication of acceptance is complete:

   *As against A,* the offeror- when letter is actually posted at 2.30 p.m. on 5th June (not at 2.00 p.m. when it was handed over to the peon, since the letter is said to be out of the power of the acceptor only when the letter is actually posted).

*As against B*, the acceptor - On 8th June at 11.00 a.m. when letter is received by A.

2. A offers to sell his car to B by a letter dated 1st January. B receives the letter on 2nd January at 1 p.m. B posts the letter of acceptance on 3rd January at 11 a.m. The letter reaches A on 4th January at 4 p.m. In this case:

(i) Communication of offer is complete on 2nd January at 1 p.m., when the offeree receives letter containing the offer.

(ii) Communication of acceptance is complete,

*As against A,* the offeror - On 3rd January at 11 a.m., when the letter of acceptance is posted by B, so as to be out of his power.

*As against B*, the acceptor - On 4th January at 4 p.m., when the letter of acceptance is received by A.

**2.5.3 Effect of delay or loss of letter of acceptance in postal transit**

Where there is an offer by mail and acceptance by mail, the acceptance is effective the moment it is deposited in the mail box in a properly addressed and stamped envelope. Even if the letter is lost on the way and never reaches to offeror, the contract is formed.

If the letter of acceptance is misdirected because it has not been addressed correctly, no acceptance will take place. But if the wrong address is furnished by the offeror, and the letter is addressed accordingly, the offeror will be bound by such acceptance.

In such cases, the acceptor is at an advantageous position. The moment letter is posted by the acceptor; the communication of acceptance is complete as against the offeror. The acceptor is in a position to bind the offeror by the contract. When letter is lost on the way, it does not reach the offeror. The communication of acceptance is not complete as against the acceptor till the time letter of acceptance reaches the offeror. The acceptor has an option to withdraw his acceptance if he chooses to do so.

**Example** - G made an offer by the post to purchase shares of Company H. The offer was accepted by the company. The letter of allotment duly posted by the company never reached the offeror. Here, that the acceptance was complete as against G as soon as the letter of acceptance was posted.

### 2.5.4 Communication of revocation - When complete

Section 4 of the Indian Contract Act provides. "The communication of revocation is complete -

as against the person who makes it:
*when it is put into a course of transmission to the person to whom it is made so as to be out of the power of the person who makes it;*

as against the person to whom it is made,
*when it comes to his knowledge."*

The rules regarding communication of revocation are on the same line as the rules regarding the communication of acceptance.

**Examples:**

A offers to sell his house to B by a letter dated 3rd March.
B receives the letter on 5th March.
A posts letter of revocation on 4th March.
B receives letter of revocation on 6th March.

The revocation of offer is complete as against A, on 4th March, when the letter is posted. It is complete as against B on 6th March when the letter of revocation is received by him.

What is important to decide here as a first step is that when an offer or an acceptance can be revoked.

***(1) When an offer may be revoked -*** A proposal may be revoked at any time before the communication of its acceptance is complete as against the proposer, but not afterwards. [Sec. 5]

In simple words it can be said that an offer can be revoked before its acceptance. But the communication of revocation of offer should reach offeree before he posts the letter of acceptance.

*To illustrate:*

| | | |
|---|---|---|
| Case | June 2 - X | mails offer to Y. |
| | June 3 - Y | receives offer at noon. |
| | June 3 - X | mails letter of revocation at 2 p.m. |
| | June 3 - Y | mails acceptance at 5 p.m. |
| | June 4 - Y | receives the revocation. |
| | June 5 - X | receives Y's acceptance. |

*Result*- A contract was formed at 5 p.m. on June 3, when Y mailed his acceptance (since a revocation is not effective until it is received, the letter that X mailed on June 3 could have no effect until June 4, by which time the contract had already been formed).

***(2) When an acceptance may be revoked -*** An acceptance may be revoked at any time before the communication of acceptance is complete as against the acceptor, but not afterwards. [Sec. 5]

Thus an acceptance can be revoked any time before the letter of acceptance reaches to the offeror. Once the acceptance comes to the knowledge of the offeror, it cannot be revoked.

| | | |
|---|---|---|
| *Case 1* : | July 2 – X | mails offer to Y. |
| | July 3 – Y | receives offer at noon. |
| | July 3 – X | mails letter of rejection at 5 p.m. |
| | July 4 – Y | changes his mind and at 10 a.m. mails a letter of acceptance which X receives on July 6. |
| | July 5 - X | receives letter of rejection. |

Result - No contract. The rejection has reached the offeror before the acceptance.

| | | |
|---|---|---|
| *Case 2*: | July 2 -X | mails offer to Y. |
| | July 3 -Y | receives offer at noon. |
| | July 3 -Y | mails letter of rejection at 5 p.m. |
| | July 4 -Y | changes his mind and at 10 a.m. calls X on the telephone accepts the offer, telling X to disregard his letter of rejection. |
| | July 5 – X | receives letter of rejection. |

*Result* - A contract was formed at 10 a.m. June 4, when Y gave X actual notice of his acceptance. Y's letter of rejection could have had no effect until June 5 by which time, the contract was already formed.

An interesting situation may occur when the letter of acceptance and the letter of revocation of acceptance, both reach offeror at the same time. At that time the formation of contract depends on the fact that which letter was opened first by the offeror. If he first opens the letter of acceptance, a contract is formed which cannot be revoked. And if he opens the letter of revocation first, the acceptance stands revoked and no contract comes into being.

# Part - 3

## Consideration

**STRUCTURE OF PART - 3:**

## 3.1 OBJECTIVES

After reading this Unit you should be able to understand:

- The concept of consideration, and its importance for a contract.
- The circumstances when a contract is valid even without consideration.
- Concept of "stranger to a contract" vis-a-vis "stranger to consideration
- When the object and consideration of a contract can be considered as lawful.
- What is the effect of an unlawful contract?

## 3.2 WHAT IS CONSIDERATION

Consideration to say least means something in exchange. It is an essential element ordinarily required in a contract. One of the basic ideas underlying the present day requirement of consideration is that one party to an agreement should not be bound by it if the other party is not similarly bound. Generally, if an agreement lacks consideration, neither party can enforce it, even if it is in writing.

Stating it positively, the concept of consideration requires that both parties to a contract shall have given and have received something as the "price" of their respective promises. For example: X promise to install a home-air conditioning unit for Y, and Y promises to pay X Rs. 1,100 for the job. Here the price X has received (in return for his obligation to install the unit) is the right to a payment of Rs. 1,100 from Y when the job is done; similarly, the price Y has received (for her promise to pay the Rs. 1,100) is her right to have the unit installed.

Section 2( d) of the Indian Contract Act defines consideration as: 'When, at the desire of the promisor, the promisee or any other person has done or abstained, from doing or does or abstains from doing, or promises to do or to abstain from doing something, such act or abstinence or promise is called a consideration for the promise.

As per this definition, consideration is something in return of a promise which consists of:

1. an act, abstinence or forbearance,
2. done at the desire of the promisor,
3. by the promisee or any other person,

4. which can be either already executed or is in the process of execution or may still be executory.

Thus if at the desire of A, B agrees to paint a picture for him at an agreed remuneration, the painting of the picture would be regarded as consideration moving from B and the remuneration as consideration moving from A.

### 3.2.1 Essential Elements of Consideration

The above elements of consideration can be elaborated as follows:

***(1) Consideration must move at the desire of the promisor -*** An act or abstinence without any request from the promisor is a voluntary act and does not come within the definition of consideration. Similarly an act or abstinence done at the request of any person other than the promisor does not constitute consideration. In other words an act shall not be a good consideration unless it is done at the desire of the promisor.

**Example -** A sees B drowning and saves his life. A cannot demand payment for his services as it is a voluntary act on his part and B never asked him to do so.

***(2) Consideration may move from the promisee or any other person -*** It means that so long as there is consideration for promise, it is immaterial who has furnished it. It may move from the promisee or from any other person if the promisor has no objection.

**Examples -**

1. In marine insurance, broker's undertaking to pay premium is consideration though it moves from a third person.

2. An old lady, by a deed of gift made over certain property to her daughter D under the direction that she should pay her aunt, P (sister of the old lady), a certain sum of money annually. The same day D entered into an agreement with P to pay her the agreed amount. Later, D refused to pay the amount on the plea that no consideration had moved from P to D. Here, P was entitled to maintain the suit as consideration had moved from old lady, sister of P, to the daughter D.

*Note: A consideration moving from third party who is a minor is no consideration*

***(3) Consideration is an act, abstinence, forbearance or detriment -*** At times consideration is taken as misnomer of money form of exchange. The legal term consideration does not mean payment of money only. The Contract Act says that the consideration can be in the form of an act, abstinence, forbearance or detriment.

*(a) Consideration as an act -* An act done by a person can constitute consideration. Where a person executes an undertaking in favour of a bank on the basis of which he receives a substantial benefit of having a current overdraft account with a bank, the facility of overdraft account cannot be said to be without consideration.

*(b) Consideration as an abstinence* - To constitute abstinence as consideration, one must refrain or promise to refrain from doing something that he or she is privileged to do.

**Example** - X promised to pay his nephew Y, a sum of Rs. 50,000 if he would refrain from drinking, using tobacco, swearing and playing cards for money until he becomes 21 years of age. The nephew refrained from all the specified activities as he was requested to do but his uncle died without making the payment. He claimed the money out of the uncle's estate as his legal right. Here, he abandoned his legal right and restricted his lawful freedom of action upon the faith of his uncle's agreement although it may seem that such performance actually did not prove to be a benefit to the promisor. Such detriment however amounted to consideration and he can be granted the promised sum of Rs. 50,000.

*(c) Consideration as forbearance -* Forbearance means foregoing one's legal right or claim. Creditor forbearing to enforce execution and allowing time to pay at the request of the debtor is a good consideration.

**Example-** An agreement to accept a decree and not to appeal against it when parties to it would have appealed is one which is supported by good consideration.

*(d) Consideration as detriment -* A detriment suffered by the promisee or any other person, whether actual or prospective, can constitute a good consideration. The ordinary contract of guarantee is good example of detriment form of

consideration. In consideration of A's lending B Rs.1000, C promises to repay the loan if B does not. Here C derives no benefit, but A suffers detriment by parting with his money, and this is enough consideration to support C's promise provided A lends the money at C's request.

**Example-** X, a publisher, promises Y "If you will loan Rs. 5,000 to my nephew for one year, I will run all your advertisements during that time at half the regular rate." Y makes the loan, but X refuses to provide advertising space at the reduced rate. If Y sues X to recover damages for breach of contract - that is, Y seeks to enforce X's promise - X is liable. Y's act of making the loan to the nephew constituted not only an acceptance of X's offer but a detriment to Y - the parting with something of value where he was not otherwise legally obligated to do so. Thus X's promise, supported by consideration, is enforceable against him.

*Note: That it is not necessary for the promisor to receive any benefit as long as the promisee or someone else suffers a detriment.*

***(4) Consideration can be past, present or future***

*(a) Past consideration -* A past consideration consists in an act already done by one as consideration for a promise of the other. Thus when a person promises to compensate another in return for what the latter had done for the promisor in the past or before making of the promise, such promise is said to be for past consideration, i.e. consideration which took place in the past. Past consideration is as good as present or future consideration. For example A does some work for B in the month of April without expecting any return from B. Later on, in June, B promises to pay him some money for the work done in April. This constitutes a valid contract as the work done by A is of the nature of past consideration.

**Example -** "A" provided extra services to B (his master), after which B promised him a bonus for the same. Later on B refused to pay the bonus. Here, if the servants put forth extra work in consideration whereof a bonus is subsequently promised to them by the masters, it is in law a promise for past services which is good under Indian Law.

*(b) Present (Executed) Consideration-* The consideration which moves simultaneously with the promise is present consideration. It consists in "doing" or "abstaining from doing something". The best example of present consideration is cash sale where

performance by both the parties (seller and buyer) is simultaneous. Another example is a contract of marriage where there is simultaneous performance by both the parties.

The present consideration is also known as executed consideration because it emphasizes on the execution part of performance.

(c) Future (Executory) Consideration - A promise to do something in future is legal consideration. When the consideration from one party to another is to move at some future date, it is called future consideration. The consideration for A's promise to B may be a promise by B to A. The consideration is then said to be executory. If A promises to marry B in consideration of B promising to marry A, the promise made by each is the consideration for the promise made by the other.

**Example-** M and B enter into a contract in April under the terms of which M agrees to build a swimming pool for B in June, B promising to pay Rs. 2,500 in return. M later refuses to perform, and B sues him to recover damages for breach of contract. M is liable; that is, his promise is enforceable.

### 3.2.2 Rules Regarding Consideration

In addition to the elements of consideration, the other general rules regarding consideration are as follows:

***(1) Adequacy of consideration -*** Consideration, means .something in return". This something in return" need not necessarily be equal in value to "something given". The law simply provides that a contract should be supported by consideration. So long as consideration exists, the Courts are not concerned as to its adequacy, provided it is of some value. The adequacy of the consideration is for the parties to consider at the time of making the agreement, not for the Court when it is sought to be enforced.

Consideration must, however, be something to which the law attaches value though it need not be equal in value to the promise made. The Courts do not exist for concerned to repair bad bargains.

*Explanation 2 to section 25 of the A*ct says that an agreement to which the consent of the promisor is freely given is not void merely because the consideration is inadequate; but the inadequacy of consideration may be taken into account by the court in determining the question whether the consent of the promisor was freely given.

***(2) It must have some value in the eyes of law -*** A valuable consideration may consist either in some right, interest or property accruing to one party or some loss or responsibility suffered or undertaken by the other. Moreover, consideration must be certain. A promise to give a reasonable sum in return for a service cannot be enforced on the grounds of uncertainty.

Although the court will not inquire into the adequacy of the consideration, there are certain acts and promises which, for reasons of policy, are deemed to be of no value in the eye of law and which are, therefore, an insufficient consideration. A promise to do any act, or forbearance from doing any act, which the promisor might lawfully do, is generally a sufficient consideration; but the law regards some promises as void and, if a promise is void, it is a nullity, it is not a sufficient consideration for a counter promise.

***(3) It must be real not illusory-*** The consideration should be real, i.e. it must not consist of impossible act or promise. It must not be illusory or sham, e.g. to discover a treasure by magic. The impossibilities can be categorized as:

- *Physical impossibility -* A promises to pay B Rs. 1,00,000 in consideration of B bringing a star from the sky to the earth. This is unreal because B's promise is absurd and physically impossible.

- *Legal impossibility -* A owes Rs. 1,000 to B. He promises to pay Rs. 200 to C, the servant of B who in return promises to discharge A from the debt. This is legally impossible because C cannot give discharge for a debt due to B, his master.

- *Illusory consideration -* Illusory consideration gives impression of consideration which is not actually there. These agreements lack mutuality.

**Example-**

Two seamen deserted the ship, their Captain promised to divide their wages among the rest of the crew if they helped him take the ship home. The consideration was illusory as the crew was already duty bound to take the ship home.

***(4) It must be something which a promisor is not already bound to do -*** Where one is doing, or promising to do something which one is already under an obligation to do will not form a good consideration. One can already be bound:

*(a) Under a duty imposed by law:* Where a person is responsible to perform certain duty under laws of land, performance of such duties cannot form a consideration to constitute a valid contract. Thus, where A promise to pay B, who had received summons to appear at a trial in a civil suit, a certain sum being a compensation for the loss of time during his attendance. Here, the promise was without consideration as B was already under a duty imposed by law to appear and give evidence –

*(b) Under a duty emanating from an existing contract:* If a person is bound to perform certain act under an existing contract, the same performance cannot form a good consideration for any other contract. There was a promise to pay the advocate an additional sum if the suit was successful. Here, the promise was void for want of consideration. The advocate was under a pre-existing contractual obligation to render the best of his services under the original contract.

However, where a person being already under a legal contractual duty to do something undertakes to do something more than what he is bound to do under the original contract, this will be a good consideration for the promise, e.g., where a police constable who sued for reward offered for the supply of the information, leading to a conviction, had rendered services outside the scope of his ordinary duties, he may be held entitled to recover.

***(5) Consideration must be lawful-*** According to section 10 of the Act, "All agreements are contracts if they are made for a lawful consideration". So a consideration must be lawful without which an agreement is void. Section 23 states that consideration is unlawful if –

(a) it is forbidden by law; or
(b) is of such a nature that if allowed it would defeat some law of the country;
(c) it is fraudulent;
(d) it involves injury to the property or person of the other;
(e) court regards it as immoral or opposed to the public policy.

There may be cases where one part of consideration is unlawful but the other is not. In such cases the whole agreement is void if the unlawful part cannot be separated from the lawful part.

**Example -** A promises to work for B who runs both illegal and legal business for a sum of Rs. 4,000 per month and B agrees to pay this amount to A. The legal business can be separated from illegal business; the part of salary pertaining to legal business is lawful consideration.
In the above case, if legal and illegal businesses cannot be separated, whole salary of A will constitute unlawful consideration.

Lawfulness of consideration is discussed in detail in this Chapter under the heading 'Legality of Object and Consideration'.

## 3.3 EXCEPTIONS TO THE DOCTRINE OF CONSIDERATION

So far, we have seen that an agreement has to be supported by consideration to be enforceable at law. But there may be certain circumstances where it will not be reasonable to apply the doctrine of consideration to meet the basic motives of the law. Section 25 of the Indian Contract Act, 1872 takes care of such circumstances. It says that, "An agreement without consideration is void unless it is in writing and registered or is a promise to compensate for something done, or is a promise to pay a debt barred by limitation law."

Such circumstances are elaborated below:

***(1) Love and affection*** [Sec. 25(1)] - An agreement is enforceable even if there is no consideration, if it is -

(i) expressed in writing,
(ii) registered under the law for the time being in force for the registration of documents,
(iii) is made on account of natural love and affection, and
(iv) between parties standing in a near relation to each other.

In simple words, a written and registered agreement based on natural love and affection between near relatives is enforceable even if it is without consideration –

**Examples:**

1. F, for natural love and affection, promises to give his son, S, Rs. 1,000. F puts his promise to S in writing and registers it. This is a contract.

2. A Hindu, husband, after referring to quarrels and disagreement between him and his wife executed a registered document in favour of his wife agreeing to pay her for maintenance, but no consideration moved from the wife. Here, the agreement was void for want of consideration. as the essential requirement that the agreement is made on account of natural love and affection between the parties was missing.

***(2) Compensation for past voluntary services [Sec. 25 (2)]*** - A promise to compensate, wholly or in part, a person who has already voluntarily done something for the promisor, is enforceable, even though without consideration. In simple words, a promise to pay for a past voluntary service is binding.

**Examples:**

1. A finds B's purse and gives it to him. B promises to give A Rs. 50. This is a contract.

2. A supports B's infant son. B promises to pay A's expenses in so doing. This is a contract.

3. A says to B, "At the risk of your life you saved me from a serious accident. I promise to pay you Rs. 1,000: There is a contract between A and B.

***(3) Promise to pay a time-barred debt [Sec. 25(3)] -*** A time barred debt is a debt which is not recoverable because of lapse of specified time (presently 3 years) under the Limitation Act. In the normal course, once a debt becomes time barred, the lender is left with no remedy to get his money back. Therefore a debtor is not legally bound to pay the debt if it becomes time-barred.

In such a case, if the debtor subsequently promises to pay the time barred debt, apparently there is no consideration moving from the other party but the contract is still enforceable. This is because, under section 25(3) of the Act, a promise by a debtor to pay a time-barred debt is enforceable provided:

*(i)* it is made in writing,

*(ii)* is signed by the debtor or by his agent generally or specially authorized in that behalf, and

*(iii)* the debt must be such "of which the creditor might have enforced payment but for the Law of the limitation of suits."

The promise may be to pay the whole or any part of the debt.

**Example** - D owes C Rs. 1,000 but the debt is barred by the Limitation Act. D signs a written promise to pay C Rs. 1,000 on account of the debt. This is a contract.

*Note: Section 25(3) applies only:*

*(a) When a promisor himself was liable for the time barred debt. This means sub-section 25(3) would not apply to a case of a promise to pay a time* barred *debt payable by a third party.*

*If however, a Hindu promises to pay a time barred debt due by his father, he can be held liable, because the Hindu law* makes *the son responsible for his father's debts to the extent to which he has received property from his deceased father or to the extent of his ancestral estate.*

*(b) Where the promise is to pay an ascertained amount. A promise to pay what is due after taking accounts is not a promise within* the *meaning of section 25(3).*

***(4) Completed gift [Explanation 1 to Sec. 25]*** - The rule "No consideration, no contract" does not apply to completed gifts. According to Explanation 1 section 25, nothing in section 25 shall affect the validity, as between the donor and the donee, of any gift actually made.

Thus transfer of properties by one person to the other as a gift according to the provisions of the Transfer of Property Act (i.e. by a written and registered document) is valid and a person transferring the property cannot subsequently demand the property back on the ground that there was no consideration.

*Note: In earlier paras we have discussed that gratuitous promises/ gifts are not enforceable at the court of law because in such cases there is no consideration for the donor. This is to be distinguished from the Explanation 1 to section 25 because as per the latter once a gift has actually been made, the donor cannot demand it back on the ground that there was no consideration.*

***(5) Agency [Sec. 185]*** - Under section 185 of the Indian Contract Act, no consideration is necessary to create an agency, i.e. a transaction of agency. For giving a person authority to act as agent, consideration is not necessary. Thus if A authorises B to act on his behalf (act as an agent) before C, and B agrees to do so, the contract is enforceable at the court of law although no consideration is moving from A to B. A will be bound by the acts done by B on his behalf as against C. Even a gratuitous agent can be held liable for negligence. The principle of Promissory Estoppel emanates from this provision.

***(6) Remission*** - Under section 63 of the Act, no consideration is necessary for an agreement to receive less than what is due, known as remission in the law.

**Example** - Creditor A agrees to accept Rs. 500 from B in full satisfaction of the debt of Rs. 1000. A subsequently cannot claim the amount of Rs. 500 which he has rescind.

***(7) Guarantee [Sec. 127J*** - A contract of guarantee is made without consideration.

## 3.4 STRANGER TO CONTRACT VIS-A- VIS STRANGER TO CONSIDERATION

A stranger to the contract, not being a party to the contract, can neither sue nor be sued upon under it. However, if a party to contract is a stranger to consideration, it does not affect his legal rights under the contract.

### 3.4.1 Stranger to the contract

A person who is not a party (i.e. neither a promisor nor a promisee) to the contract is a stranger to the contract. Under the law of contract, an agreement can be binding on and can only be enforced against the parties to it. Since a contract is a private relationship between the parties who make it, the rights and obligations under such a contract are strictly confined to them. This is known as the doctrine of privity of contract. From this follows a general rule of law that only parties to a contract may sue and be sued on a contract. Privity of contract means relationship subsisting between the parties who have entered into contractual obligations. The consequences of the doctrine of privity of contract are:

(1) a person who is not a party to a contract cannot sue upon it even though he has provided the consideration.

(2) a contract cannot confer rights or impose obligations arising under it on any person other than the parties to it. Thus if there is a contract between X and Y, Z cannot enforce it.

**Example -** A clause in a Motor Insurance Policy providing that the Insurance Company shall indemnify the insured against his legal liability in respect of death of or accident of other passengers cannot give a right of suit against the insurance company for the money due under the policy to a passenger who is a mere stranger to the contract of insurance.

The principle that a person who is not a party to the contract cannot take advantage of its provisions is subject to certain recognized exceptions discussed under the heading 'exceptions to the doctrine of privity of contract'.

### 3.4.2 Stranger to Consideration

In the Indian Contract Act, in order to constitute a valid contract, the consideration may move from the promisee or any other person. In case, the consideration moves from a person other than the promisee, the promisee can be categorized as a stranger to the consideration. For example, if A promises to B that he will pay Rs. 1000 to B, if B can get a picture painted from C for A. Here consideration is moving from C to A (painting of picture by C for A) and from A to B (Rs. 1000) and there is no consideration from B to either party, i.e. B is stranger to the consideration, but the relationship of promisor and promisee subsists between A and B only. The relationship between A and C is that of the privity of consideration. But the privity of consideration does not confer any right to the party providing consideration to enforce the contract at the court of law, unless he is a party to the contract. This is known as the doctrine of privity of consideration. In the given example if A does not perform his part of the contract, C cannot sue upon A in the court for its enforcement, only B is entitled to do so. Conversely it can be said that a stranger to the consideration has a right to enforce a contract, provided he is party to the contract.

**Example** - Where a person transfers property to another and stipulates that money be paid to a third person, a suit to enforce that stipulation by that third party will not stand.

### 3.4.3 Exceptions to the Doctrine of Privity to Contract

Following are the exceptions to the rule that a stranger to a contract cannot sue:

***(1) Beneficiary under trust or a charge -*** When a trust is created, the beneficiary can enforce the rights given to him under the trust, even though he was not a party to the contract between the settler and the trustees.

**Example -** A transfers some property in favour of B to be held by him in trust for the benefit of X. X can enforce the agreement even though he is a stranger to the contract.

***(2) Doctrine of promissory estoppel-*** Courts have at times been confronted by the cases involving gratuitous promises and unaccepted offers, which are without consideration and hence not enforceable at law. Under certain circumstances, the courts will enforce gratuitous promises and unaccepted offers.

If a person makes a promise to the other, and that other person incurs a detriment relying upon the promise, in such a case, the promiser is estopped from going back from his promise to the extent the promisee has incurred a detriment on the basis of such promise. This is known as the doctrine of promissory estoppel.

For example, A promises to make a gift of Rs. 3,000 towards the repairs of temple. The trustee of the temple on the faith of his promise incurs liability worth Rs. 2,500. A does not pay. Can the trustee recover the promised amount from A ? Yes, because the trustee has taken action (i.e. spent amount on repair of the temple) on the basis of the promise made by B to the extent of amount spent by him, i.e. Rs. 2,500.

The basic idea underlying this doctrine is that if the promisor makes a promise under circumstances in which he or she should realise that the promisee is almost certainly going to react to the promise in a particular way, and if the promisee does so react, thereby causing a substantial change in his or her position, the promisor is bound by the promise even though the consideration is lacking.

**Example -** A tenant takes a building on lease from the landlord from January 1, 1967 to December 31, 1968. In early December 1968, the tenant indicated his intention of renovating the premises and asked for renewal of lease for two years.

The landlord replied to him that, we will get to work on a new lease soon. I don't know about two years, but you can count on one year for sure. The tenant then spent Rs. 5000 over the next few weeks on renovating the house but the parties never executed a new lease. The landlord sought to evict the tenant in March 1969 on the ground that no renewal contract had been formed, he was held unsuccessful and was held to fulfil his promise regarding the year 1969. In this case, the landlord should have realised the likelihood of the tenant's conduct in consequence of his promise, he is said to be "stopped by his promises"; he cannot contend that the lack of consideration on the tenant's part caused his promise to be unenforceable.

***(3) Family Settlements -*** Family arrangements or compromises made among male members for the benefit of female members of the family can be enforced by the female members, although the female members are not a party to those arrangements. Thus where an agreement is made in connection with marriage, partition or other family arrangement and a provision is made for the benefit of a person, that person may take advantage of that agreement although he is not a party to it.

**Example** - On the partition of a joint Hindu family property, an agreement was entered among its male members to make provision for the marriage expenses of a female member. Here, the female member was entitled to sue the parties to the partition deed to enforce the provision in her favour.

***(4) Marriage Settlement of Minor -*** In case of provisions of marriage settlement of minors, the minor is entitled to sue to enforce his claim. This is because in India, marriages are contracted for minors by their parents and guardians and therefore the *Doctrine of Privity of Contract* does not apply in this case.

**Example-** R's father entered into an agreement for her marriage with J. Subsequently, J refused to marry. Here' R after attaining majority could sue J for damages of breach of the promise and J could not take the plea that R was not a party to the agreement.

***(5) Agency -*** Contracts entered into by an agent can be enforced by the principal.

**Example-** A appoints B as his agent for selling the goods. B sold the goods to a buyer C. C sued A for defective goods. In this, though there is no direct contract between A and C, yet A is liable because B has sold the goods to C as A's agent. When an agent sent the goods to a foreign buyer, not as his own, but as agent of principal, there is privity of contract between the principal and the foreign buyer, even in cases when the agent has not disclosed the name of the principal.

***(6) Covenants running with the land -*** In cases of transfer of immovable property, the purchaser of land is bound by certain conditions or covenants created by an agreement between the original buyer and the concerned authority effecting the land although he was not a party to the original agreement which contained those conditions or covenants.

**3.5 LEGALITY OF OBJECT AND CONSIDERATION**

According to section 10 of the Indian Contract Act, 1872, lawful consideration and object is one of the essential ingredients to constitute a valid contract. Section 23 lays down the cases where the *consideration* and object (purpose or design) of an agreement can be deemed to be unlawful. It can, therefore, safely be inferred that every consideration is lawful unless deemed to be unlawful in the Act.

Anything which is not lawful within section 23 is unlawful for the purpose of an agreement or compromise, and a decree incorporating such an agreement or compromise is a nullity. The section declares following *agreements to be void for unlawfulness:*

***(1) Where the consideration or object is forbidden by law -*** A contract which is expressly forbidden and made criminal by statute can give no cause of action to a party who seeks to enforce it.

**Examples -**

1. A promises to obtain for B an employment in the public service, and B promises to pay Rs. 1,000 to A. The agreement is void as the consideration for it is unlawful.

2. Oral sale of any immovable property under the J&K Transfer of Property Act is forbidden and thus such oral contract would be void under section 23 of the Contract Act.

3. An agreement to sell paddy above the maximum price fixed under Maximum Price Control Order - it is unlawful or void.

***(2) Where the consideration or object defeats the provisions of any law -*** Where a contract is to do a thing which cannot be performed without an infringement of law, it is void whether parties knew the law or not.

**Examples -**

1. A promises B to drop a prosecution which he has instituted against B for robbery, and B promises to restore the value of the things taken. The agreement is void as its purpose is to defeat provisions of law.

2. A's estate is sold for arrears of revenue under the provisions of an Act of the Legislature, by which the defaulter is prohibited from purchasing the estate. B, upon an understanding with A, becomes the purchaser, and agrees to convey the estate to A upon receiving from him the price which B has paid. The agreement is void as it renders the transaction, in effect, a purchase by the defaulter, and would so defeat the object of the law.

3. Where the consideration or object is of such nature that it is fraudulent- Where agreement involves the commission of a wrong, or commission of a fraud against a third person or the commission of fraud against the public, they are unlawful and unenforceable.

**Examples -**

1. A, B and C enter into an agreement for the division among them, of gains acquired, or to be acquired, by them by fraud. The agreement is void.

2. A, being agent for a landed proprietor, agrees for money, without the knowledge of his principal, to obtain for B a lease of land belonging to his principal. The agreement between A and B is void, as it implies a fraud by concealment by A on his principal.

***(4) Where the consideration or object of the agreement involves or implies injury to other's person or property -*** The word 'injury' means criminal or wrongful harm. An agreement to cause injury to the person or property of another is void.

**Example-** A promised to pay B, an editor of the newspaper, Rs. 500 in consideration of his publishing a defamatory article against C. The agreement between A and B is void as it involves injury to the person of C.

***(5) Where the consideration or object is regarded by the court as immoral -*** Word 'immoral' means inconsistent with what is right. The only aspect of immorality which the law courts have dealt with is sexual immorality. Certain kinds of acts have been regarded as immoral, e.g. illicit cohabitation, prostitution, interference with the marital relations, etc. Any contract which involves, or assists or promotes sexual immorality is void.

**Examples -**

1. A man who knowingly lets out quarters to a prostitute to carry out prostitution cannot recover the rent in a court of law.

2. A agrees to let her daughter hire to B for concubinage. The agreement is void because it is immoral, though the letting may not be punishable under the Indian Penal Code.

3. A, a bachelor gave money to B, a married woman, to obtain a divorce from her husband. A agreed to marry him as soon as she obtained a divorce. The contract is void. A will not be able to recover the amount from B, if she does not take the divorce.

***(6) Where the consideration or object is regarded by the court as opposed to public policy -*** The phrase 'public policy' denotes 'public good'. An agreement which is injurious to the public or against the interests of the society is said to be opposed to public policy. A contract may be against public policy either from the nature of the acts to be performed or from the nature of the consideration. Certain kinds of contracts are regarded as being 'opposed to public policy'. These are discussed in detail under a separate heading.

**Examples:**

1. An agreement between two firms according to which firm A is to submit tender for Government contract for higher amount and firm B is to pay certain amount

to A if B's tender is accepted, is an agreement opposed to public policy as it involves unfair trade practice.

2. An agreement to acknowledge a forged signature in consideration of the other party forbearing to prosecute the actual forgerer is against the public policy and void.

### 3.6 AGREEMENTS OPPOSED TO PUBLIC POLICY

Public policy is not the policy of a particular Government. It is a policy which should be followed by people so that they do not cause any harm to the society. The law seeks to prevent any transaction which is opposed to public policy.

The Indian Contract Act does not specifically identify the instances which are to be considered against the public policy. But it very clearly states its intention that any contract opposed to public policy is unlawful. The courts try to determine what public policy is by considering the Constitution, Statutes, Executive orders, previous decisions of courts, and the customs and opinions of society.

Since the courts have wide discretionary powers to decide whether an agreement is opposed to public policy or not, these are to be used very carefully and scarcely. However, some well-established instances of the agreements opposed to public policy are discussed below:

***(1) Trading with an enemy -*** The State can declare any country as enemy country according to its political status, such as on declaration of war. The contract entered into with an enemy is considered as opposed to public policy. Sometimes it may happen that a contract is entered during peace times and a war breaks out later. In such cases either the contract has to be suspended till the restoration of peace, or has to be dissolved by the parties.

***(2) Agreements interfering with the administration of justice***

*(i)* *Agreements interfering with the course of justice -* An agreement which obstructs the ordinary process of justice is unlawful, and is void. It may take the form of making an improper influence over the judiciary or giving false evidence, or stopping a person from giving evidence which he is required to give under law, etc.

**Example -** A promise to give money to induce a person to give false evidence is void.

*(ii) Stifling (confining) prosecution -* The public interest requires that the criminals should be prosecuted and punished. An agreement to stifle a prosecution, i.e. to prevent a prosecution, or to compromise a prosecution is illegal and void. The principal is that - "if you are aware that a crime has been committed, you shall not convert that crime into a source of profit or benefit to yourself."

**Examples -**

1. A settlement made by a father with certain bankers in order to shield his son from a criminal prosecution on the charge of forgery is void.

2. A instituted a prosecution against B for robbery. A promised to drop the prosecution, and B promised to restore the value of the robbed articles. Object of the agreement is to stifle prosecution. It is a void agreement.

The reason is that the effect of such an agreement is to take the administration of the law out of the hands of the judges and put it in the hands of a private individual and so has a tendency to overthrow public justice.

***(3) Maintenance and Champerty -*** When a person agrees to help the other by money or otherwise in litigation in which he is not himself interested, it is called 'Maintenance'. When a person helps the other in litigation in exchange of a promise to hand over a portion of the fruits of the litigation, if any, it is called 'Champerty'.

**Examples -**

1. A files a suit against B for the recovery of a house. A did not have money to pay the advocate. X, a well-wisher lends the required money to A. This is a 'Maintenance' agreement.

2. A files a suit against B for the recovery of a house. X promises to advance Rs. 1,000 to A for the costs of the litigation and A promises X a portion of his house if he is successful in the suit. This is a champertous agreement. Indian Law considers these agreements as void only when they are made against public interest. Otherwise these contracts are as good as any other valid contract.

Thus an agreement made for improper object, e.g. gambling in litigation, or for injuring others, etc., is contrary to public policy and void. When object of such a contract is not to stir up litigation but to assist the other in making a reasonable claim arising out of a contract, it is perfectly valid.

It may be inferred that a 'Maintenance' or 'Champerty' contract is valid if the motive of the contract is *bona fide.*

**Example** - An advocate entered into an agreement to provide his professional services to his client and take the remuneration whenever it is convenient to the client, in order to assist him to fight his claim. It is a valid contract of *'maintenance'.*

However, if payment of remuneration of the advocate is dependent upon winning of the case like if he will win the case, he will get this much and if the case is lost no payment will be made, the agreement is void. It will amount to gambling in litigation.

Whether an agreement is fair and made with a bona fide motive is to be decided on case to case basis. In the cases of Champerty, the quantum of share in the fruits of litigation which a person agrees to pay as a price for the assistance provided to him may provide a good basis to adjudge its fairness.

**Example** - An advocate entered into an agreement with his client by which the latter promised to pay to the former 50% whatever is recovered from the decree of the court. The agreement is void.

However the agreement to pay the 1/6th, or 1/8th of the proceeds are held valid in different cases. Again the final discretion is in the hands of the court of law.

***(4) Traffic in public offices -*** 'Traffic' or sale in public offices means trading in public offices to obtain some gain which otherwise cannot be obtained in the normal course of governmental working. It may take the form of giving bribe for appointments in public offices, or procurement of public recognition by payment of some consideration (money or some other value), etc. This is based on the principle that an agreement which is intended to induce a Government servant to act corruptly is contrary to public policy.

**Examples -**

1. A promises to obtain for B an employment in the public service, and B promises to pay Rs. 10,000 to A. The agreement is void.

2. A paid B, a public servant, a certain amount inducing him to retire from service, so that A can be appointed in his place. The agreement is void.

3. The secretary of certain college promised P that if he donates 3,000 pounds to the college, he would use his influence to secure a knighthood for him. P made the donation but did not get a knighthood and sued for the recovery of the money. The action failed because the agreement was against the public policy.

***(5) Agreements creating an interest opposed to duty -*** The public policy requires that a person must perform his duties honestly. If a person agrees to do something which is against his public or professional duty, the agreement is void.

**Examples-**

1. An agreement by a contractor with a public officer whereby the contractor agrees to give bribe if the officer accepts a particular tender in his favour is illegal and void. It tends to create a conflict between interest and duty.

2. A, an editor of a newspaper agreed not to publish reports about B for Rs. 50,000 is void.

(***6) Agreements unduly restraining personal liberty -*** An agreement which restricts the personal liberty of an individual is void.

**Example -** An agreement by a debtor to work as a bonded labor for creditor is void.

***(7) Agreements interfering with parental duties -*** The father and the mother are the natural guardians of a minor child. This right of guardianship cannot be taken away by any agreement.

**Example -** The father of two minor sons agreed to transfer their guardianship to Mrs. A permanently. Subsequently he wanted to set aside the agreement and take back the custody of his children. Here, the guardianship of A cannot be permanently alienated. The agreement was void and he got back the custody of boys.

***(8) Marriage Brokerage agreements -*** In India the marriages are generally arranged by the parents or guardians of the parties. Obtaining or not obtaining the consent of persons who are going to get married does not make any difference to the contract of marriage.

But any contract through which a third person charge brokerage for fixing the marriage of two persons is void, and is not enforceable.

**Example -** J promised to pay Rs. 20000 to P, for procuring a wife for him. P procured a wife for J, but J refused to pay the money. P could not recover the money in the court of law because the agreement was void being opposed to public policy.

Further, agreements to pay money to the parents or guardian of minor or their agreeing to give minor in marriage is void.

**Example -** A promise to pay Rs. 50,000 to B if he will marry his minor daughter C to him. The agreement is void, and not enforceable.

An agreement of dowry cannot be enforced.

**Example -** A promised Rs. 1 lakh to B if he will marry his daughter C. After marriage A refuses to give the agreed money. B cannot recover the money from A. If the dowry has been paid, and the marriage is solemnized, it cannot be recovered back.

**Example -** In the above example, if A pays the money before marriage, he cannot claim to recover the same after the marriage.
If dowry has been paid, but the marriage has not been solemnized, it can be recovered. In case, the cloths or ornaments, etc. are given, they can be recovered either in specific or in terms of their value.

**Example -** In the above example, alternatively if A pay Rs. 1 lakh to B, but somehow the marriage does not take place, A may claim his money back from B. It may be noted that such agreements are not enforceable in terms of payment only; the validity of marriage is not affected.

***(9) Miscellaneous cases -*** The following agreements have also been held to be opposed to public policy from time to time:

1. Agreements creating monopolies
2. Agreement to defraud creditors
3. Agreements not to bid against each other in an auction in order to defraud some third person.
4. Agreements to defraud revenue authorities. For example, an agreement by which an employee was to get, in addition to his salary an expense allowance grossly in excess of the expenditure actually incurred by him is unlawful because it is a device to defraud the Income-tax Authorities.

The above list is not exhaustive. Landmark decisions made by the courts from time to time may consider the different situations and stipulate the events and circumstances when an agreement can be considered as opposed to public policy, and hence unlawful.

## 3.7 EFFECT OF UNLAWFUL OBJECT AND CONSIDERATION

There are two possibilities - either the whole contract is unlawful because of unlawful object and consideration or partly the contract is unlawful and partly it is lawful.

### 3.7.1 Object and consideration wholly unlawful

The effect of unlawfulness is to render a contract void, i.e. the court will not assist a party to such an agreement either directly or indirectly. As a consequence of this rule, money or property transferred under an illegal contract cannot be recovered by a legal action. Thus if A and B agree that A will pay Rs. 10,000, in consideration of B murdering C; Rs. 5,000 to be paid at the time of the agreement and the remaining Rs. 5,000 when the deed has been carried out, and A pays the initial Rs. 5,000 but B fails to carry out the murder as agreed, any action by A to recover Rs. 5,000 will fail.

Agreement collateral to unlawful agreement- Any agreement which is collateral to an unlawful agreement is also void. In the above example if A borrows money from D to give it to B for murdering C, and D knew this at the time of lending, D would not be able to recover the money from A through the court of law. The reason is, that the agreement between D and A is collateral to the unlawful agreement between A and B.

We have seen that the agreements having wholly unlawful object and consideration and their collateral agreements are void. But there are certain exceptions to this rule.

***<u>EXCEPTIONS TO THE RULE - "ILLEGALITY MAKES A CONTRACT VOID"</u>***

1. ***Where one party repented illegal purpose prior to the date of performance-*** In the example given above, had A have informed B that he has changed his mind, and did not want C killed, he would be able to recover Rs. 5,000 given to B. It should be noted, however, that repentance must be genuine, in that it must result from a change of heart, and not as a result of some extraneous cause over which the parties had no control. If therefore, in our example C was killed in a motor accident before B had an opportunity of carrying out the agreement, A would not be able to recover the, money from B, as there would have been no genuine repentance from heart.

2. ***Where the parties are not equally at fault-*** In most unlawful contracts parties are considered equally at fault - that is, each should have known that the contract was unlawful. If, however, one party can show that he or she is innocent of wrong doing, the fault lying essentially with the other party, the innocent party may be entitled to judicial assistance. For example, X forges a warehouse receipt which makes it appear that he is owner of the ***warehouse***. He shows the receipt to Y, a transport agent, and seek his services to deliver the goods from warehouse to his place of business. Y does so. Here Y is entitled to recover his transportation charges from X although it was an unlawful transaction.

3. ***Where recovery possible without relying on illegal contract -*** Where a person is lawful owner of some property and transfers it to somebody under an unlawful contract, he retains the right to recover back the same. For example, where a person passed over his property and business to his brother-in-law in order to evade taxes, he was allowed to recover the possession of the same by the court.

### 3.7.2 Objects and Consideration Unlawful in Part

Till now we have discussed the cases in which object or consideration of a contract is wholly unlawful. At times it may happen that some of the terms of a contract are lawful while others are unlawful. *The general rule is that where you cannot severe the illegal from the legal part of the contract, the contracts altogether void; but where you can severe them, you may reject the bad part and retain the good.*

Section 24, section 57 and section 58 of the Indian Contract Act dealing with the status of 'contracts which are not wholly unlawful' with regard to their enforceability are discussed below:

***(1) Part of single consideration or object is unlawful [Section 24] -*** "If any part of a single consideration for one or more objects, or anyone or any part of anyone of several conditions of a single object, is unlawful, the agreement is void."

Where a single consideration supports several promises; some of which are illegal and the rest legal, in such a case if the legal part can be severed from the rest of the contract, it can be enforced. Where the legal and illegal objects cannot be separated, the whole transaction is void.

**Examples-**

1. A promised to pay Rs. 50 per month to B, in consideration of B living in adultery with A, and also for acting as his housekeeper. Here consideration for housekeeping is inseparable from the consideration for adultery. The whole agreement was void and B could not recover anything for services rendered to A.

2. A promised to pay Rs. 1,500 on account of old debt and Rs. 500 on account of gambling loss and executed a promissory note for Rs. 2,000 in favour of B. Here one part of the consideration (i.e. Rs. 1,500 for old debt) is lawful while the other part of consideration (i.e. Rs. 500 for gambling loss) is unlawful. These two are separable. Therefore, the lawful part can be enforced.

***(2) Reciprocal promises [Section 57]*** - "Where persons reciprocally promise, firstly, to do certain things which are legal, secondly, under specified circumstances, to do certain other things which are illegal, the first set of promises is a contract; but the second is void agreement."

**Example -** A and B agrees that A shall sell B a house for Rs. 10,000, but that, if B uses it as a gambling house, he shall pay A Rs. 50,000 for it.

The first set of reciprocal promises, namely, to sell the house and to pay Rs. 10,000 for it, it is a contract.
The second set is for an unlawful object, namely that B may use the house as a gambling house, and is a void agreement.

***(3) Alternative promises [Section 58 J]* -** "In the case of an alternative promise, one branch of which is legal and the other illegal, the legal branch alone can be enforced."

**Example -** A and B enters into an agreement where A promises to give Rs. 10,000 to B, and B promises to deliver either rice, or opium for the money, this is a valid contract to deliver rice. The alternative agreement to deliver opium is void.

# Part - 4

## Capacity Of Parties

**STRUCTURE OF PART - 4**

## 4.1 OBJECTIVES

After reading this Unit, you should be able to understand:

- who are the persons competent to contract.
- what is the effect of can tracts entered in to by the persons not competent to can tract.
- whom the law regards as a minor.
- whom the law regards as a person of unsound mind.
- what is the position of a minor with respect to the contracts entered into by him.

## 4.2 MINORS

Contracts entered into by minors do not have any value in the eyes of law. To understand the practical impact of minor's agreements, we need to know certain rules regarding them.

### 4.2.1 Who is a Minor?

A minor is a person who has not attained the age of majority. The age of majority is determined by the law to which he is subject. In India, the term 'minor' is understood as explained in section 3 of the Indian Majority Act, 1875, which reads as - . A minor is a person who has not completed eighteen years of age".

However, in the following two cases, a person becomes major on completing the age of 21 years:

1. Where a guardian of a minor's person or property has been appointed under the Guardians and Wards Act, 1890.
2. Where the superintendence of minor's property is assumed by a Court of Wards.

It may happen that the law of land where a person belongs to, and the law of land where a contract is entered into prescribe different age limits to recognise a person as 'major'. For example the age of majority in India is 18 years. While in Sri Lanka it is 21 years. This kind of situation may create a legal problem like when a 20 year old Sri Lanka national enters into a contract in India, whether he should be considered as a minor or not? To deal with such cases, the courts of law follow the following approach:

1. In case of contracts relating to ordinary mercantile transactions, the age of majority is to be determined by the law of the place where the contract is made.

2. In the case of contracts relating to land, the age of majority is to be determined by the law of the place where the land is situated.

### 4.2.2 Status of the Contracts Entered into by a Minor

Section 10 of the Indian Contract Act provides that an agreement can become a contract when the parties to it are competent to contract. Minor is a person who is not competent to contract.

Although it is not clearly stated in the Contract Act that the agreements entered into by a minor are void, it can be clearly inferred from the above that an agreement entered into by a minor does not qualify to become a contract, and hence is void ab initio.

Still the controversy existed till 1903 as to whether a contract entered into by a minor is void or voidable. Maybe because India was ruled by the British and the English Law treats the contracts entered into by minors as voidable.

### 4.2.3 The status of a minor with respect to the agreements entered into by him

Following are the rules which determine status of a minor with respect to the agreements entered into by him:

***(1) No ratification on attaining the age of majority -*** The term 'ratification' means 'confirmation of some previous act'. Thus when a party accepts obligation acquired under some previous contract, ratification is said to be made. Ratification relates back to the date of making of the contract, and therefore, a contract which was once void cannot be made valid by subsequent ratification.

As a consequence, once a minor reaches the age of majority, he or she cannot ratify any contract made during his minority.

**Example -** A, a minor, borrowed Rs. 10,000 from B. After attaining majority, A requested B for another loan of Rs. 15,000 which B gave to A. Now A gave a combined promissory note for Rs. 25,000 to B with a promise to repay the whole amount. It is a fresh contract based on a fresh consideration where A is liable to pay Rs. 25,000 to B. There is no question of ratification in such case. A person can always make a fresh promise after attaining majority in terms of the promise made during the minority. All that is necessary is that there should be some fresh consideration for it.

*Note: Where, a person after attaining majority has not only ratified but also paid the debt incurred by him during the minority, he cannot afterward recover it back. The reason being, such a debt is only void and not unlawful.*

(***2) No Specific Performance except in certain cases -*** Specific Performance means actual carrying out of the contract as agreed. A minor's agreement being void cannot be specifically enforced. Similarly minor also cannot claim specific performance from the other party. 'Specific performance' is an equitable remedy. It can be granted only when there is mutuality.

**Example -** A, a minor agrees to sell his car to B for Rs. 50,000. Later on, A refuses to give the car. B cannot enforce specific performance by A. The agreement is void.

However, a contract entered into by the guardian or manager of a minor on his behalf can be specifically enforced if :

1. the contract is such that the guardian or manager is competent to enter into on behalf of the minor; and

2. the contract is for the benefit of the minor.

***(3) The doctrine of estoppel does not apply to a minor -*** The doctrine of estoppel is that - when a person makes a false representation, and the other person believes it to be true and acts accordingly, later on the person who has made false representation is estopped from denying the truth of that presentation.

**Example -** A told B that C wants to buy 100 kg. of rice from B for his daughter's marriage. B said he will be sending the rice to C's place in a day's time. C, who was also present at that time, did not utter a single word. Next day, B sent 100 kg. rice at C's place. Now C said that he did not want to take the rice and that he did not make any contract with B.

In this case the legal position is that that C has to accept the rice and pay the respective price because by keeping mum at the time when A was telling B to deliver the rice at C's place, he lead B to believe that he wanted to make the said transaction. Now he is 'estopped' from denying that he did not intend to make the said transaction.

This doctrine is applicable to the contracts which are entered in to by the parties competent to contract. But this is not applicable to a minor. When a minor misrepresents his age and leads the other party to believe that he is major, and on such belief the other party enters into a contract with him, the minor is not estopped from denying his majority. He can still plead that in fact he is a minor, and not a major.

**Example -** A, a minor borrowed Rs. 5,000 from B by fraudulently representing himself to be a major. A refused to repay the money. B sued him for the money. A pleaded that he is a minor and the agreement between B and himself is void. Here B cannot recover his money.

However, a minor should not be left to enjoy the fruits of fraud committed upon others. Law has provided a little protection to the persons dealing with a minor when minor plays a fraud with them. This protection takes the form of 'restitution'. This topic is dealt below in detail.

***(4) No Restitution except in certain cases -*** The term 'restitution' may be defined as an act of restoring back to the rightful owner that which has been taken away or lost.

*'Restitution'* explained when applied to minor - If a minor obtains goods on credit, its payment cannot be enforced but the goods can be recovered if they are still in his possession. For instance, if a minor misrepresents his age, and gets a car on credit, the car can be recovered if it is still in his possession. If he has sold the car but has the money received from its sale, he can be restrained from parting with money and the same can be recovered. If he has purchased any other thing with that money, the car dealer can still follow the thing. But if he has spent the amount, nothing can be recovered from him. In any case there is no personal liability of the minor.

In the light of the provision of the Specific Relief Act, 1963, and the Indian Contract Act, 1872, the position of minor with respect to restitution is as follows:

1. *When a minor is a defendant-* When the party other than the minor, files a suit on minor upon the transaction in which the minor has played a fraud on him or her, at the best the court may require a minor to restore the benefits obtained by him under the contract. Thus the only remedy available is restitution. Here restitution is feasible only when the advantage received by minor is traceable in his possession.

   **Example -** A minor mortgaged his two houses and spent the money taken by him on such mortgage. The other contracting party sued him to set aside the mortgage and to recover money from him. The money could not be recovered.

2. *When a minor sues as a plaintiff -* When a minor brings upon a suit on the other party after inducing him or her, by fraud to enter into a transaction, which is otherwise legal and validly enforceable, the minor can be compelled to restore the benefit received and make any compensation required. Here the remedy is restitution and compensation.

   **Example -** A minor sells a house for Rs. 50,000 posing that he is an adult. Later on files a suit to set aside the sale on the ground of minority, he may be directed by the court to refund the purchase money received by him before he can recover the possession of the property sold by him.

   In this case even if the minor has already spent the money in specific (i.e., Rupee notes of 50,000 received from the purchaser of house), the repayment has to be made.

   *(Plaintiff* is *the person who brings out a suit in the court of law, and the person who has to defend his stand against the person who has filed a suit against him* is *termed as defendant.)*

***(5) Agreements where minor is a beneficiary are enforceable -*** Judicial decisions given from time to time establish that an agreement can be enforced for the benefit of a minor. However the Indian Contract Act, 1872, does not contain any provision to this effect.

**Example** - A, a minor advanced certain sum of money to B for which B executed a mortgage of his immovable property in favour of A. In this case, the mortgage can be enforced by A if B does not repay the money.

*Note: It may be noted in the above case that the contracts where a minor execute a mortgage, the other party is not able to enforce it against him. But if the party other than minor has executed a mortgage in favour of a minor, he is able to enforce it because it is for his benefit. Thus law does not regard a minor as incapable of accepting benefit. A minor is capable of purchasing an immovable property and can enforce the other party to hand over its possession after making payment for it, or he can enforce promissory note executed in his favour, and the like. A few examples are quoted below:*

**Examples-**

1. A, a minor agreed to deliver some goods to B at some price. He delivered the goods but B refused to make payment. Here, the minor was entitled to maintain a suit for recovery for the price of the goods delivered by A.

2. A minor purchased certain property and sued the vendor for possession. If the minor has performed his obligations, he is allowed to enforce the obligations against the other party.

***(6) Minor's liability in case of tort -*** The term 'tort' may be defined as any wrong for which a civil suit can be brought. Like, if a person injures the other, he is liable to pay the damages for the same under the law of 'torts'.

Generally minors are fully liable for any torts or crime they commit. Thus, if a minor drives a car negligently, anyone injured thereby can recover damages from him or her. But in case of contract he is not liable when the 'tort' is directly connected to a contract. The logic given by the courts is that 'when a tort arises out of a contract and the contract is not enforceable against the minor, he cannot be made liable for 'tort' committed under the contract unless it can be severed from the contract'.

**Examples-**

1. A minor hired a horse for riding. He injured it by overriding. The court held that he is not liable to pay the damages for injuring the horse. He was guilty of

negligence in performing his part of contract. He cannot be made liable in 'tort' if he is not liable on contract.

2. A, a minor hired a horse for riding under express instructions 'not to jump'. He lent the horse to his friend who killed the horse by making it to jump. Here A's wrongful act of unauthorised lending the horse to a friend is independent of contract. Thus A was liable to pay the damages.

***(7) Minor's liability for necessary. -*** Section 68 of the Indian Contract Act, 1872 reads as "If a person is incapable of entering into a contract or anyone whom he is legally bound to support, is supplied by another person with necessaries suited to his condition in life, the person who has furnished such supplies is entitled to be reimbursed from the property of such incapable person."

The above provision is applicable to all persons who are not competent to contract. Talking in the context of minor, if a person supplies goods or services:

- to a minor or anyone whom he is legally bound to support,
- which are necessaries suited to his condition of life,
- he is entitled to payment for the same out of minor's property.

<u>*What Constitutes a necessity -*</u> The term 'necessaries' is not defined in the Indian Contract Act, 1872. Courts have given rulings from time to time to determine the meaning and scope of this term. The term 'necessaries' is elaborated as follows:

*"Things necessary are those without which an individual cannot reasonably exist. In the first place, food, cloths, lodging, and the like. About these there is no doubt. Again, for proper cultivation of mind, instruction in art, or trade, or intellectual, moral, or religious education may also be necessary. Then there are different classes in a society. One's cloths may be fine or coarse according to his rank; his education may vary according to his future plans; and the medicines will depend on the illness with which he is afflicted, etc."*

But in all these cases it must first be made out that the class itself is one in which the things furnished are essential to the existence and of reasonable advantage and comfort. Thus articles of mere luxury are always excluded.

**Example -** A, a minor was amply supplied with proper cloths according to his position. He bought a number of new dresses, including eleven fancy waist- coats from B. Here, these were not necessaries. Thus B could not recover the price.

*Note: Although things may suit to life style of a particular person, it also matters that such things were actually required by the minor at the time of supply. Like in this example, the minor was already having ample cloths, his need for more cloths cannot be considered a necessity.*

*Payment can be made out of the property of minor -* Once it is established that a person has supplied goods or services necessary for him, that person can claim his dues for the same from the property of minor. However, it may be noted that the liability of minor is not personal. It is only property of minor which is liable for the liabilities towards the necessaries supplied to him. If a minor does not own any property at all, no recovery can be made from him.

Moreover, liability for necessaries is not a contractual liability because the minor lacks capacity to contract. Instead recovery from the minor must be based on what is called a quasi-contract remedy. Because of this, the person providing the necessaries is not entitled to the contract price agreed by the minor. The minor is liable only for the fair value of the necessaries provided.

### 4.2.4 MINOR AND SPECIAL CONTRACTS/AGREEMENTS

***(1) Contracts of apprenticeship by minor-*** Contracts of apprenticeship are governed by the Apprenticeship Act. The Act was passed with a view to enabling the children to learn trade, crafts, and employment, by which when they come to full age, they may gain a livelihood.

To fall within the purview of this Act, the contract must satisfy following two criteria:

1. The minor must not be less than fourteen years of age, and
2. The contract must be entered into on behalf of the minor by his guardian.

Thus the restraints imposed upon a minor, by an agreement, granting him an article of apprenticeship shall be valid and binding on him, as it is considered beneficial to him. But if a contract does not fall within the terms of the Apprenticeship Act, it is void.

**(2) *Service contracts -*** A contract for personal service by minor is void under the Indian Law and the mere fact that it is for his benefit would not entitle the minor to sue under the contract.

**Example -** A, a minor was allowed the role of an actress in a particular 'film' by B, the producer. This agreement was made with A's father. Subsequently B allotted the role to another artist and terminated the agreement with A's father. A went to the, court. The court held that the agreement was not enforceable being the contract of personal service. And that the contracts of personal service do not stand on the same footing as the contract of apprenticeship, or a contract of marriage of a minor.

It may be noted that when a minor has already served under a contract of service, he is entitled to enforce such contract, not for the reason that the contract is enforceable but for the reason that it is a quasi-contract where a person is supposed to get the benefit of the lawful services which he or she has already provided.

**(3) *Marriage contracts -*** A contract for the marriage of a minor is presumed to be a contract for his benefit. Thus the minor can enforce the contract of marriage against the other contracting party, but the other party cannot enforce such contract against minor.

**Example -** A, the father of a minor girl B, entered into a contract with C that he would marry B. Subsequently C refused to marry B. B brought a suit against C for breach of contract. Here, the contract was for the benefit of B, the minor, and she was able to recover the damages from C.

**(4) *Minor Partner-*** A partnership is created by an agreement. Since minor is incompetent to enter into a contract, he cannot be a partner of a partnership firm. However, he can be admitted to the benefits of partnership, like right to property of partnership, or right to profits, or right to have access copy of accounts of the firm etc.

**(5) *Minor Agent [Section 184] -*** A minor can become an agent but he is not personally liable for his acts towards third party. However, the principal will be liable to the third party for the acts of minor agent which he does in the ordinary course of dealings.

***(6) Position of minor's parents -*** The minor's contracts do not impose any liability on his parents, or guardians even if the contracts are for necessaries. However, when a minor incurs an obligation as an agent to his parents or guardian, they are bound by the same.

***(7) Surety for minor -*** When an adult stands as a surety for minor in a contract of guarantee, he is liable towards third party although the minor does not incur any liability in the contract. In such case, the position of the adult is that of a person who has directly entered into the contract.

***(8) Minor and Insolvency -*** A minor cannot be declared insolvent because he is incapable of contracting debts. Moreover, he is not personally liable for any obligation including payment for necessaries; it is only his property which is liable in such a case.

***(9) Joint contract by minor and adult -*** Where a minor and an adult jointly enter into an agreement with another person, the minor has no liability but the contract as a whole can be enforced against the adult.

**Example -** A minor and an adult jointly agreed to pay a certain sum of money and executed a bond also for the amount promised. Here, the bond was not enforceable against the minor but the adult executant was liable for the full amount.

(***10) Minor can execute a negotiable instrument -*** A negotiable instrument means and includes a promissory note, a bill of exchange, and a cheque. Thus it is a piece of paper which entitles a person to a sum of money. The minor is competent to draw, negotiate or endorse the negotiable instruments. However, the minor will not incur any personal liability under such instruments. But the negotiable instruments executed in the favour of a minor are enforceable by him.

## 4.3 PERSONS OF UNSOUND MIND

Persons of unsound minds are not competent to enter into a contract. However, we need to understand who is considered by law as a person of unsound mind. Note that in real life this is the most abused provision of the law of contract.

### 4.3.1 Who is a person of unsound mind?

A person who does not have a sound mind is considered as a person of unsound mind.

Section 12 of the Indian Contract Act, 1872 provides that, a person is said to be of 'sound mind' for the purpose of making a contract if, at the time when he makes it, he is capable of-

- understanding it, and
- of forming a rational judgment as to its effect upon his interests.

What is important here is that a person should be able to understand the nature and consequences of his or her act at the time of entering into the contract. If such understanding was not present, the person did not have contractual capacity. The agreements made by such persons are absolutely void.

To make this situation clearer, section 12 further adds two clauses -

1. A person, who is usually of unsound mind, but occasionally of sound mind, may make a contract when he is of sound mind.

   **Example-** A, a patient, was in lunatic asylum. It was noticed that at intervals, he was of sound mind. During such an interval, A borrowed Rs. 5,000 from B and executed a promissory note in his favour for repayment of the loan. This promissory note is valid and A is liable to repay the loan taken from B.

2. A person who is usually of sound mind, but occasionally of unsound mind, may not make a contract when he is of unsound mind.

   **Example -** A sane man, who was delirious from fever and was not in a position to make a rational judgment, sold his scooter while in that state. The transaction of sale is void.

### 4.3.2 Unsoundness of Mind may Take Various Forms

***Idioticity -*** An idiot is a person who doesn't have mental faculties of thinking. His incapacity is permanent and at no time he is of sound mind.

***Lunacy or insanity -*** A lunatic is a person whose mental faculties of thinking are deranged (disordered) due to some mental strain or disease. Ho wever, the mental capacity of such persons may not be completely lost. He may have intermittent inter-vals of sanity and insanity.

When the property of a lunatic is under a committee or court of wards (i.e., some caretaker is appointed by the court), he is not entitled to enter into any contract at all, not even during lucid intervals.

***Drunkenness or intoxication -*** A drunkard or intoxicated person loses his contractual capacity when he is intoxicated so excessively as to suspend his reasoning power for the time being and create impotence of mind. Drunkenness is treated on same footing as insanity.

**Example -** A, a sane man, who when excessively drunk, sold his car worth Rs. 1 lakh for Rs. 20,000. The contract of sale is void.

However, the contract is void, only when a person can establish that he or she was so intoxicated as not to understand the nature of the purported agreement. Thus a lesser degree of intoxication is no grounds as to make a contract void.

In addition to above discussed forms, mental incapacity may be caused by hypnotism, or mental decay because of old age, etc.

#### 4.3.3 Effect of the agreement entered into by the persons of unsound mind

1. A contract entered into by a person of unsound mind is absolutely void.
2. A contract for his benefit is valid and enforceable.
3. His property is, however, always liable for the necessaries supplied to him or to anyone he is legally bound to support like that of the minor.

#### 4.3.4 Burden of proof

In the court of law burden of proving that a person was mentally incapable of contracting, lies on the party who seeks to cancel the contract on this ground. However, once it is established that a person is insane, the burden to prove that he was sane at the time of making contract is on the party who wants to establish that the contract is good.

## 4.4 DISQUALIFIED PERSONS

Law specifically disqualifies some persons to enter into a contract in order to protect the public from the possible consequences of being cheated or being left with no remedy to enforce such contracts. A person can be disqualified by the specific legislation to which he is subject.

***(1) Alien enemies -*** An alien is a person who is a foreigner to the land. If the State of the alien is at peace with country, he is an alien friend. And if a war is declared between two countries, he is termed as an alien enemy. An alien friend is competent to contract, and an alien enemy is not competent to contract.

If, an alien enemy enters into a contract during the war, it is void, and not enforceable. But if a contract is entered into by him before the declaration of war, it stands suspended, and can be revived after the war.

***(2) Foreign Sovereigns and Ambassadors -*** These persons are at liberty to enter into a contract and sue upon it. But they cannot be sued against in our courts except with the prior sanction of the Central Government. Thus anybody contracting with such persons is left without a remedy in case of non-performance by them.

**Example -** The staff of a foreign mission, being a tenant owed arrears of rent. No action can lay against him since he was protected by diplomatic privilege.

***(3) Convict -*** While undergoing an imprisonment, a convict cannot enter into a contract, or sue upon any contract made by him before imprisonment. However, he can enter into a contract while 'on Parole', and after the sentence of imprisonment expires, he becomes capable of entering into a contract.

***(4) Insolvent -*** Under the Insolvency Act, on adjudication, insolvent's property vests in the 'Official Receiver', and he has no power to deal with that property. Thus he cannot enter into any contract regarding the same. An insolvent also suffers from certain disqualifications under different legislations, like he cannot become director of a company, or a member of a local body, or a magistrate. However, an insolvent can enter into certain types of contracts, i.e., he can incur debts, purchase property, or be an employee, etc.

After an insolvent is 'discharged' from insolvency, he is like an ordinary person and is competent to make contracts.

(5) ***Corporations -*** Corporations are the artificial persons who come into existence by virtue of their incorporation (i.e., registration) under certain legislation, like a company incorporated under the Companies Act, 1956, or L.I.C. incorporated under the LIC Act of India, etc. Their charter of incorporation contains their powers, objects and limitations. These corporations are not entitled to enter into any contract which is beyond the power conferred to them by their respective charter of incorporation. If they enter into such a contract, it is void and hence not enforceable.

Moreover, these corporations cannot enter into personal contracts like contracts of marriage.

# Part - 5

## Free Consent

**STRUCTURE OF PART - 5**

## 5.1 OBJECTIVES

After reading this Unit, you should be able to understand:

- The concept of consensus ad idem
- The factors which vitiate free consent of the parties
- Legal significance of these factors

In this Unit, we will be studying the elements vitiating free consent of the parties to contract, their effect upon validity of contract and the remedies available to the party whose consent is so caused.

## 5.2 COERCION

The term 'coercion' means forcibly compelling a person to enter into a contract.

Section 15 of the Indian Contract Act defines it as follows - '''coercion' is the committing or threatening to commit, any act forbidden by the Indian Penal Code or the unlawful detaining or threatening to detain, any property, to the prejudice of any person whatever, with the intention of causing any person to enter into an agreement."

### 5.2.1 Acts amounting to coercion

The definition of coercion says that when one party acts in a certain way to make the other party enters into contract the contract is said to be caused by coercion. Following is the list of those acts which amounts to coercion –

***(1) 'Committing of any act forbidden by the Indian Penal Code'.***

**Examples-**

1. A took B into unlawful confinement and asked B that he would not be released until he executed a gift deed of his property in A's favour. Unlawful confinement is forbidden by the Indian Penal Code. The gift deed is voidable as it is caused by coercion.

2. A died leaving a young widow. The relative of the deceased threatened the widow to adopt a boy otherwise they would not allow her to remove the dead

body of her husband. The widow adopted the boy and subsequently, applied for cancellation of the adoption. An act of restraining a dead body from being removed for cremation is forbidden by the IPC. Here, the adoption was not valid being caused by coercion.

***(2) 'Threatening to commit' any act forbidden by the Indian Penal Code***

**Example -** A threatens to kill B if he does not lend him Rs. 2,000. B lends the amount. This threat amounts to coercion. Under IPC threat to commit suicide is not punishable. However, an abetment of suicide is punishable under section 306 and an attempt to commit suicide is punishable under section 309 of IPC. Thus, threat to commit suicide amounts to coercion as it is forbidden by law.

*Note: Students are not supposed to know the exhaustive list of what all is forbidden by the IPC. It can be seen from case to case basis whether a particular act is forbidden by IPC or not.*

***(3) The unlawful detaining of property***

**Example -** An agent refused to hand over the account books of the business to the new agent sent in his place, unless the principal released him from all the liabilities. The principal had to give release deed as demanded. In this case, the consent was obtained by unlawfully detaining the property (i.e., account books) of the principal. Here, the release deed was voidable at the option of the principal as he was made to execute the release deed under coercion.

***(4) Threatening to detain any property***

**Example –** A bank gave a threat of attachment against the property of P for the recovery of fine due from T, the son of P. P paid the fine. It was induced by coercion.

### 5.2.2 Features of Coercion

Now we understand that certain acts committed would amount to coercion. However, a doubt may arise whether such an act committed in given circumstances would amount to coercion. Law has given some clarifications on that.

***(1) It is immaterial whether Indian Penal Code (IPC) is or is not in force in the place where the coercion is employed [Explanation to section 15]***

**Example -** A, on board an English ship on the high seas causes B to enter into an agreement by committing an act forbidden by the IPC. B does not perform the contract so entered. A sues him for breach of contract in Mumbai. Here A's act would amount to coercion although it may not be considered as an offence by the law of England. A will not succeed.

***(2) It is not required that coercion must proceed from the party to the contract. It may proceed from a third person also.***

**Example -** A, threatens to kill B if he will not sell his house to C at the terms decided by C. The contract of sale of house by B to C is induced by coercion.

***(3) It is not necessary that coercion be directed against the party whom it is intended to induce to enter into a contract, it may be directed against any third person whatever'***

**Example -** A threatens to shoot R, son of B, if he does not let out his house to C. B agrees to let out his house to C. B's consent is caused by coercion.

***(4) Coercion must be done to induce the other party to enter into a contract***

**Example -** A gave a threat to B that he would take possession of all the land belonging to B, and will not vacate it at any cost. B may do whatever he wants. Here A's threat to unlawfully detain B's property is not coercion as it is not done with an intention of inducing B to enter into a contract.

### 5.2.3 Special Points to be noted

Coercion considered in context of specific acts.

***(A) Threat to commit suicide -*** The law point involved here is that whether 'a threat to commit suicide' is to be considered as an act forbidden by the Indian Penal Code. The controversy occurs because it is not punishable under the Indian Penal Code. Majority of judges have viewed that although 'threat to commit suicide' is not punishable under the Indian Penal Code, it must be deemed to be forbidden by that code. And hence, should amount to coercion.

Following observation of the Calcutta High Court is worth noting in this regard:

"One committing suicide places himself or herself beyond the reach of the law, and necessarily beyond the reach of any punishment too. But it does not follow that suicide is not forbidden by the Indian Penal Code. Section 306 of the IPC punishes abetment of suicide. Section 309 punishes an attempt to commit suicide. Thus, suicide as such is no crime, as indeed it cannot be. But its attempt is; its abetment too is. So, it may very well be said that the Indian Penal Code does forbid suicide"

**Example -** A person held out a threat to commit suicide to his son and wife if they refuse to execute a release deed in his favour. The son and the wife executed the release deed in consequence of the threat. The release deed was obtained by coercion.

***(B) Threat to prosecution -*** A threat to file a civil or criminal suit is not forbidden by the Indian Penal Code. Therefore, it does not amount to coercion. However, threat to file a suit on false charge is forbidden by the Indian Penal Code, and hence, amount to coercion.

**Example -** A, a landlord gave a threat to B, his tenant, to file a suit against him to get his premises vacated. B vacated the house. The threat by A is not coercive.

**5.2.4 Effect of coercion**

The effect of coercion is emphasised in sections 19, 72, and section 64 of the Indian Contract Act, 1872. It can be summarised as follows:

1. The contract is voidable at the option of the party whose consent was obtained by coercion.

2. When the aggrieved party decides to set aside the contract, it must give back any benefit received from the other party under the contract. Moreover, the other party need not perform his part of the promise.
   Also, the other party to whom money has been paid or anything delivered under coercion, must repay or return it.

**Example -** A transport company refused to deliver certain goods to the consignee unless he paid some illegal charges. The consignee paid illegal charges in order to obtain the. goods. He is entitled to recover the charges which were illegal.

3. If the aggrieved party does not opt to set aside the contract, it works as a valid contract. '.

### 5.2.5 Burden of proof – consent

In a court of law, the burden of proving that the consent was obtained by coercion shall lie upon the aggrieved party who wants to set aside the contract. Moreover, such a party has to prove that he would not have entered into a contract, had the coercion not been employed.

## 5.3 UNDUE INFLUENCE

When a party exercises undue influence over the other party to induce him to enter into a contract, the consent of such other person is not free.

### 5.3.1 What is undue influence?

Undue influence is an influence by which the exercise of free will and judgment of the other is prevented. The strong mind overpower the weak mind of a person and induces him to do which he would not have done if left to his own judgment. It is a kind of mental coercion.

Section 16(1) of the Indian Contract Act, 1872, defines the term 'undue influence' as follows:

> “A contract is said to be induced by 'undue influence', where the relations subsisting between the parties are such that one of the parties is in a position to dominate the will of the other and uses that position to obtain an unfair advantage over the other".

Thus, the *'undue influence'* is said to have been made when,

1. The relations between the parties are such that one of the parties is in a position to dominate the will of the other, and

2. The dominant party uses his position to obtain an unfair advantage over the other.

Generally, the test employed to see whether the consent was affected by undue influence is that 'would any reasonable man in full possession of his senses and not under unusual influence of some kind or the other do such a thing?'

**Examples:**

1. A, an illiterate elderly woman was possessing certain property. B, her nephew was managing her affairs. A gifted whole of her property to B. The court held that B, who managed the affairs of his aunt was in a position to dominate his aunt's will. Therefore, the gift deed was set aside on the grounds of undue influence.

2. A, a spiritual adviser (guru), induced B, his devotee, to gift him the whole of his property to secure benefit to his (devotee's) soul in the next world. Here, the gift was obtained by undue influence.

***(1) When a person is in a position to dominate the will of the other***

A person is deemed to be in position to dominate the will of another in the following cases:

1. where he holds a real or apparent authority over the other, or
2. where he stands in a fiduciary relation to the other, or
3. where he makes a contract with a person whose mental capacity is temporarily or permanently affected by reason of age, illness, or mental or bodily distress. [Section 16(2)]

*(a) <u>Real or apparent authority -</u>* A person in real authority is able to dominate the will of the person over whom the authority is held. The expression 'apparent authority' would include cases in which a person has no real authority, but is able to approach the person with a color that he really has such authority. Some examples are income-tax officer in relation to an assessee; a magistrate or police officer in

relation to an accused person, and the like.

**Example -** A, a police officer purchased a property worth Rs. 1 lakh .for Rs. 5,000 from B, an accused under his custody. Later on, B sought to cancel the sale on the ground of undue influence. Here, A, the police officer is in a position to dominate the will of B, the accused; therefore, undue influence can be presumed to be exerted.

*(b) Fiduciary relation -* It is a relationship of trust and confidence. This relationship provides a very good opportunity to the person in whom the confidence is reposed to exploit it to one's own use. There is no exhaustive list of such relationships. It has to be seen from case to case whether the parties to a contract were in a fiduciary relationship. However by common sense and on the basis of past decisions, some relationships are considered as fiduciary, like, the relationship of parent or guardian of a child, solicitor and client, trustee and beneficiary, spiritual adviser and his devotee, doctor and patient, woman and her confidential managing agent, and the like.

**Example** - A, a solicitor, sold certain properties to one of his clients B. B filed a suit upon A claiming that the property was considerably over-valued and that his consent was caused by undue influence. The court held that since the relationship of solicitor and client is a fiduciary, the existence of undue influence can be presumed.

*(c) Persons with affected mental capacity-* A person's mental capacity may be affected by extreme old age, or mental or bodily illness or any other cause. Such a person may easily be persuaded to give consent to a contract which may be un favourable to him.

***(2) When a party is presumed to have used his position to dominate the will of the other***

When a contract is made where one party is in a position to dominate the will of the other, and the transaction appears (whether on the face of it or by presenting an evidence) to be unconscionable, it is presumed that the stronger party has exercised undue influence over the weaker party.

*What is an unconscionable transaction* - It is a transaction with unfair terms which no man in his senses would make on the one hand and no honest and fair man would accept on the other.

**Example** - A, heir of an estate borrowed Rs. 3,700 to enable him to prosecute his claim when he was without even with the means of subsistence, and gave the lender a bond for Rs. 25,000 to be paid after receiving possession of the property. The court held that the transaction was unconscionable and awarded a decree of only Rs. 3,700 plus interest to the lender.

### 5.3.2 Features of Undue Influence

Some points to be considered while ascertaining whether undue influence was exercised or not -

(1) *Undue influence may be exerted by a person who is not a party to the contract*- It is not necessary that the person in a position to dominate the will of the other must himself benefited. It is sufficient that the third person in whom he is interested is benefited.

(2) *Lack of foresight is not a ground for establishing a case of undue influence* - If a transaction is unconscionable because the concerned party did not make a good judgment, the existence of undue influence cannot be presumed.

### 5.3.3 Effect of undue influence

Section 19A of the Indian Contract Act deals with the effect of undue influence, provisions of which are summarized as follows:

1. The agreement is voidable at the option of the party whose consent was caused by undue influence.

2. The court may direct the aggrieved party to refund the benefit whether in whole or in part or set aside the contract without any direction for refund of benefit.

   **Example -** A, a money lender advanced Rs. 100 to B, an agriculturist. A induced B by undue influence, to execute a bond for Rs. 200 with an interest at the rate of 6% per month. The bond is voidable at the option of B. The court may set the bond aside ordering B to repay Rs. 100 with such interest as may seem just.

3. If the aggrieved party does not opt to set aside the contract, it works as any other valid contract.

Note: In case of rescission of contract caused by coercion, any benefit received by the aggrieved party has to be restored to the other party from whom he has received such benefit. But in the case of rescission of contract caused by undue influence, the court has discretion to direct the aggrieved party to restore the benefit received by him in full or in part, or not to restore at all.

### 5.3.4 When existence of undue influence is presumed by court

The burden of proof is on stronger party (i.e., the party is in a position to dominate the will of the other) that he has not exercised undue influence.

Court presumes the existence of undue influence when,

1. the contracting parties are not on equal footing when one party is in a position to dominate the will of the other, and

2. the transaction is unconscionable.

*As between the parties on equal footing, mere unconscionable bargain does not create the presumption of undue influence. And merely because* the *parties are closely related to each other, no presumption of undue influence can arise.*

*When existence of undue influence is not presumed by the court -* the weaker party who is seeking relief has to prove that his consent was obtained by undue influence.

## 5.4 FRAUD

Fraud can be defined as the intentional misleading of one person by another. When one party induces the other party to enter into a contract by fraud, the consent of such other party is not free. The most common type of fraud occurs when one person lies to another about a material fact, as a result of which a contract is made.

### 5.4.1 Definition of fraud

Section 17 of the Indian Contract Act, 1872 defines the term 'fraud' as follows:

*'Fraud'* means and includes any of the following acts committed by a party to a contract, or with his connivance, or by his agent, with intent to deceive another party thereto or his agent, or to induce him to enter into the contract:

**1.** the suggestion, as a fact, of that which is not true, by one who does not believe it to be true;
**2.** the active concealment of a fact by one having knowledge or belief of the fact;
**3.** a promise made without any intention of performing it;
**4.** any other act fitted to deceive; and
**5.** any such act or omission as the law specifically declares to be fraudulent

<u>The above definition has three aspects:</u>

***A. That the fraud cannot be committed by a stranger to the contract -*** The act constituting fraud must have been committed by a party to the contract, or by his agent, or by a person in collusion with him. If the person by whose fraudulent misrepresentation, a transaction has been induced is not himself a party to the transaction, the transaction is not said to be effected by fraud.

**Examples-**

1. The directors of a company issued a misleading prospectus. A purchased some shares of the company on the faith of such prospectus. Here, fraud is committed by the contracting party itself. A can set aside the contract on the ground of fraud.

2. A was induced to buy shares of a company relying upon a false statement made by B. B was neither a 'Director' nor a 'representative' of the company. A is not in a position to set aside the 'purchase of shares' on account of fraud because it is committed by a stranger to the contract.

***B. That fraud must have been committed upon the other party to the contractor his agent -*** If a fraud is committed on a stranger, it will not amount to fraud in context of the contract.

**Example -** A fraudulently informed B that he had a new 'YCR' in excellent condition and wanted to sell it. B passed on this information to C, who was in no way connected to A or B. Upon this information, C bought the 'YCR' from A. Later on, he discovered that 'VCR' was very old and in bad condition. C wanted to set aside the sale on the ground of fraud. Here, C could not do so because A defrauded B, who was a stranger to the contract between Band C.

***C. Certain acts enumerated in section 17 constitute fraud which are discussed below.***

**5.4.2 Acts which constitute fraud**

Definition of *'Fraud'* lists certain acts which are considered as fraud. Following is a discussion on these acts-

***(1) A suggestion that a fact is true, by one, who does not believe it to be true -*** A statement which is made with knowledge of its falsehood or without belief in its truth by the person making it, is considered as an act to defraud the other. A false statement made recklessly without enquiring whether it is true or false would also amount to fraud.

**Examples:**

1. Where for securing the insurance policy, the insured gives willfully untrue answers, he commits a fraud.

2. When the seller of a used car has no idea about its mileage but nevertheless states that "it has not been driven more than 50,000 miles", his statement constitutes fraud, if later it is proven that the true mileage materially exceeded that figure. .

*Note: A mere opinion, commendatory expression, or exaggerated statement does not amount to a statement of fact. Thus in a case, where a representation was made that the land was very fertile and improvable, such expression was considered as mere exaggerated or puffery statement regarding the property to be sold.*

***(2) An active concealment of fact, by one, having knowledge of the act -*** Concealment is as bad as a direct lie. If a person conceals a fact which is material to the contract and it is his duty to disclose it, it is considered as an act to defraud the other.

**Example** - A, a horse dealer sold a mare to B. A knew that the mare had a cracked hoof, which he filled up in such a way as to defy detection. After the sale, the defect was discovered by B. Here, that B's consent was obtained by fraud.

*Mere silence where there is no duty to speak is not active concealment of fraud-* It is worth noting here that in the transactions of sale of goods the principle of *'Caveat Emptor '* is employed. Its literal meaning is 'let the buyer beware'. Under this principle, the seller is under no duty to disclose 6rery defect in the goods, it is duty of the buyer to be diligent while purchasing.

**Example -** A sold to B some pigs which were, to his knowledge, suffering from fever. The pigs were sold .with all faults, but A never disclosed the fever to B. The court held there was no fraud on the part of A.

***(3) A promise made without any intention of performing it -*** When a person while making a contract has no intention to perform his part of promise, it is considered as an act to defraud the other. However, it is difficult to prove what the state of a person's mind was at a particular time.

**Example -** A man and woman went through a ceremony of marriage, the husband having no intention to regard it as his real marriage. The court held that the consent of the wife was obtained by fraud and that the marriage was just pretense.

*Note: The fraud that is contemplated by the sub-section is a fraud which is at the very inception a fraud vitiating the transaction itself and not any subsequent conduct or representation by the party or his representative.*

***(4) Any other act fitted to deceive-*** The expression 'act fitted to deceive' means any act which is done with an obvious intention of committing fraud. Man has got a very fertile mind. He may invent any kind of trick to cheat others. Since an exhaustive list of the acts which can be employed to deceive a person cannot be made, this clause seems to have been inserted for the sake of caution.

**Example -** Fictitious issue of huge quantities of food grains by quoting release orders meant for other storing agents can be considered fraud under section 17(4).

***(5) Any such act or omission which law specifically declares to be fraudulent-*** In some cases, the disclosure of certain kinds of facts is expressly required by the law and non-compliance with the law is expressly declared to be fraudulent. For example, the Insolvency Act, and the Companies Act, declares certain transfers to be fraudulent. Thus, where section 55 of the Transfer of Property Act requires seller of an immovable property to disclose to the buyer any material defect in the property, which the buyer could not discover by ordinary care; an omission to make such disclosure amounts to fraud.

### 5.4.3 Mere Silence is not Fraud

The essence of fraud is an affirmative misleading of one person by another. Thus, mere silence does not constitute fraud. As regards nondisclosure of material facts, the general rule is Caveat Emptor, i.e., let the buyer beware. This implies that a person before entering into an agreement need not disclose to the other party all material facts which he knows.

**Examples -**

1. A sells by auction, to B a horse, which he knows to be unsound. A says nothing to B about the horse's unsoundness. This is not 'fraud'. Here A is under no duty to disclose the fact to be under the principle of 'Caveat Emptor'.

2. A candidate, who had full knowledge of the fact that he was short of attendance, did not mention this fact in his examination form. The court held that it was not a fraud. It was duty of the University to scrutinize forms or to call for verification or information in case of doubts. The University, having failed to do so, was stopped from canceling the examination of the candidate.

*Instances where silence amounts to fraud*

*Explanation to section 17* reads as, "Mere silence is not fraud, unless the circumstances of the case are such that, regard being had to them, it is the duty of the person keeping silence to speak, unless his silence, is in itself, equivalent to speech".

The above explanation talks about some exceptional situations in which law imposes a duty to speak, here silence would amount to fraud:

***(1) When silence in itself is equivalent to speech -*** A person who keeps silent, knowing that his silence is going to be deceptive is guilty of fraud.

**Example -** A says to B, "If you don't deny it, I shall assume the horse to be sound." B says nothing. Here, B's silence is equivalent to speech.

***(2) When it is duty of the person keeping silence to speak-*** Since the courts decide cases involving a wide variety of fact patterns, they often do not agree completely on the precise circumstances in which, silence constitutes fraud. However, for certain situations of special importance, they usually do hold that a legal duty to speak exists.

For instance, where one of the parties occupies a position of trust and confidence in relation to the other, or where one of the parties is utterly without any means of discovering the truth and has to depend on the good sense of the other party, a duty to speak arises on the part of the party on whom such confidence is reposed. These are known as contracts *uberrimae fidei,* i.e., contracts of utmost good faith. Some examples of such contracts are as follows:

1. *Contract between the parties having fiduciary relationship -* Fiduciary relationship is a relationship of trust and confidence. Law imposes a duty of disclosure to the parties to such contracts.

   **Example -** A sold a car to B, his son, knowing that the engine of the car was defective. A said nothing to B regarding engine. B purchased the car. This amounts to fraud on A's part. Here A was under a legal duty to divulge all material facts about the car because of his fiduciary relationship with his son.

2. *Contracts of insurance -* A person wishing to take out a policy of insurance is usually required to complete a proposal form and a duty is imposed to answer each question with the utmost good faith. Like in the case of life insurance, the assured must divulge all material facts regarding his or her past and present physical condition.

   *Note: The question in each case is not that whether the assured believed any particular circumstance to be material but whether it was in fact material.*

3. *Contracts of sale of immovable property -* The Transfer of Properties Act requires the defects in the title of the property (i.e., free from encumbrance etc.) to be disclosed by the seller.

4. *Contracts of Share allotment -* When a company registered under the Companies Act, 1956, invites the public to subscribe to its shares by issuing a prospectus, it is under a statutory obligation to disclose all information regarding the company with accuracy. Any non-disclosure would amount to fraud.

5. *Contracts of Partnership -* Contracts of partnership are not contracts *uberrimae fidie* at the time of formation of partnership but during subsistence of partnership utmost good faith is required amongst all the partners.

   **Example -** When a partnership firm is considering a land purchase, a partner who is a part owner of the land in consideration must divulge his interest to the other partners before the purchase is made.

6. *Contracts of family arrangements -* Contracts relating to the arrangement or settlement of the family property also require full disclosure of all material facts within the knowledge of the parties to each other.

In addition to the abovementioned circumstances, there may be some other situations. When silence is considered as fraud:

***(3) When it is duty of the seller to disclose latent or hidden defect in a contract of sale*** **-** A latent defect which cannot be disclosed by a simple and casual inspection by purchaser should be disclosed by the seller. If he does not do so, it may amount to fraud.

***(4) When change in circumstances requires disclosure-*** Sometimes a statement is true when made. But the facts change before the contract is entered into. In such a case, the one who made the representation has a duty to notify the other of the changed condition before contracting. If he does not do so, it may amount to fraud.

### 5.4.4 Effect of fraud

Section 19 of the Indian Contract Act, 1872 deals with the remedies available to the party defrauded. Its provisions can be summarized as under:

1. The contract is voidable at the option of the defrauded party.

2. When a party opts to rescind (i.e., set aside) the contract, it may claim restitution in its entirety, i.e., to be placed in the same position as if there was no contract at all.

   He is entitled to compensation for any damage he has sustained through the non-fulfillment of the contract; further the person rescinding a voidable contract shall restore to the other party any benefit received from him under the contract.

   **Example -** Where A fraudulently induced B to buy his house, B was allowed to recover the expense involved in moving into house as 'damages'.

3. The defrauded party may affirm the contract, i.e., may insist that the contract shall be performed and that he should be put in the position in which he would have been if the representation made was true.

   **Example -** A fraudulently informs B that A's estate is free from encumbrance. B, thereupon, buys the estate. The estate turned out to be subject to a mortgage. B may avoid the contract or may insist on its being carried out and the mortgage debt repaid by A.

*Notes:*

1. *The defrauded party can exercise his option either to rescind the contract or to affirm it, only once. Once this option is exercised, both the parties are bound by it. Later on, he has no option to change his stand for the same fraud.*
2. *In certain circumstances right to recession is lost by the aggrieved party. These are discussed later in the Unit.*

Section 19, further mentions the circumstances when the remedy to avoid the contract is not available to the defrauded party:

1. When the consent is caused by fraudulent silence where the defrauded party could have discovered the truth by ordinary diligence.

2. The party defrauded did not rely upon the fraudulent statement of the other party for entering into the contract.

### 5.4.5 Burden of proof - In the cases of fraud

Burden of proving the fraud lies upon the party who seek relief in the court of law.

## 5.5 MISREPRESENTATION

When a party to contract misrepresents a fact to the other party, based on which, other party enters into a contract, consent of such other party is not free.

### 5.5.1 What is misrepresentation?

'Misrepresentation' is a false representation of a statement of fact made innocently, i.e., without any intention to deceive the other party. The term is broadly interpreted to include any word or conduct that causes an innocent person to reach an erroneous conclusion of fact.

Section 18 of the Indian Contract Act, 1872 defines misrepresentation as follows:

*"Misrepresentation"* means and includes-

1. the positive assertion in a manner not warranted by the information of the person making it, of that which is not true, though he believes it to be true;

2. any breach of duty which without an intent to deceive, gains an advantage to the person committing it, or anyone claiming under him, by misleading another to his prejudice or to the prejudice of anyone claiming under him;

3. causing, however, innocently a party to an agreement to make a mistake as to the substance of the thing which is the subject of the agreement."

Note that the above definition simply lists certain acts which amount to misrepresentation. These are discussed below:

***(1) Positive assertion of the statements not warranted by the information -***

A statement is said to be warranted by information of the person making it when he receives the information from a trustworthy source. An innocent false statement of material fact not warranted by information is considered as misrepresentation.

**Example-** A on the strength of hearsay information (without having reasonable grounds to believe it) positively asserted to B that certain third party is going to be Director of the company to be incorporated. B bought the shares on faith of such a statement. This is a case of misrepresentation by A.

***(2) Breach of duty resulting in advantage to the representor and prejudice to the representee -*** Any breach of duty which brings an advantage to the person committing it by misleading the other to his prejudice is a misrepresentation.

In such a case, may be the intention of the party is not to deceive but the fact he or she has derived benefits from the transaction makes him equally answerable in effect as if he had been actuated by motives of fraud or deceit.

The expression *'breach of duty'* carries within it contracts involving a duty on the part of the contracting party to disclose all material facts. Thus, all cases where silence becomes fraudulent will fall under this category.

*Note: The legal effect of 'fraudulent silence' and 'misrepresentation' is same. Therefore, there is no contradiction if contracts of uberrimae fidei fall under both the categories.*

***(3) Inducing mistake about subject matter -*** The subject matter of every agreement forms the very basis of it and possess certain value and quality. When one party misleads the other, however innocently, as to the nature and quality of the subject matter, a misrepresentation is said to be made.

**Example -** The Government auctioned certain 'Forest coups'. A part of the land was occupied by tenants. The Forest Department knew this fact but did not disclosed it to the purchaser. Here, the contract was caused by misrepresentation. The purchaser was allowed to recover the damages for loss.

Misrepresentation may also arise from suppression of vital facts. Cases of concealment or suppression will fall either under *sub-section (2)*, when it amounts to breach of duty, or under *sub-section (3)* when it leads the other party to make a mistake about the subject matter of the agreement.

**Example -** A spent a sum of money to mark the engagement of his son. He then discovered that the girl suffered from the epileptic fits and so broke off the engagement. He sued the other party to recover from them compensation for the loss which he has suffered on account of their deliberate suppression of a vital fact which amounted to fraud. Here, non-disclosure of the facts about the girl amounted to misrepresentation.

### 5.5.2 When a consent is said to be caused by misrepresentation

The definition of 'misrepresentation' gives a list of the acts which are capable of causing misrepresentation. But it may happen at times that despite of misrepresentation made by one party to the other, law refuses to recognize the fact that the contract is caused by misrepresentation. There are certain essentials required to establish that a consent was caused by misrepresentation:

1. *There was a misrepresentation of fact -* Misrepresentation must relate to a fact and not to mere opinion. There is a lot of difference when a seller states that his property is, Worth Rs. 1 lakh, and when he states that he paid Rs. 1 lakh for the property. The first is the opinion which the buyer may accept if he wishes, but the second is a statement of fact, which if false, makes the contract voidable.

2. *The fact was material -* A misrepresented fact is considered material when it would be likely to affect the conduct of a reasonable person. In other words, would a reasonable person who knew the truth have entered into the contract under the same terms? If the answer is 'no', there is good reason to believe that the fact is material.

3. *There was justifiable reliance on misrepresentation -* If someone agrees to contract, based on his own investigation and knowledge of the facts rather than on a misrepresentation of the facts by the other party, there has been no reliance on it and the contract cannot be avoided.

**Example -** A, by misrepresentation, leads B to believe that 500 kg of indigo were made annually at A's factory. B examines the accounts of the factory, which show that only 400 kg of indigo have been made. After this, B buys the factory. The contract is not said to be caused by misrepresentation.

*Note: A false statement whether innocent or fraudulent, does not in itself gives rise to a cause of action. It must have produced misunderstanding and that misunderstanding must have caused the party to enter into the contract.*

### 5.5.3 Effect of misrepresentation

When the consent of a party is caused by misrepresentation-

1. The agreement is voidable by the party whose consent is obtained by misrepresentation.

2. The aggrieved party may affirm the contract, i.e., may insist that the contract shall be performed and that he should be put in the position in which he would have been if the representation made was true. However, misrepresentation does not entitle the aggrieved party to claim damages by way of interest or otherwise for expenses incurred.

Further, law does not provide a remedy to the aggrieved party when the reality of misrepresented fact could have been discovered by ordinary diligence.

### 5.5.4 Burden of proof - In the case of misrepresentation

Burden of proving the fact of misrepresentation lies upon the party who seek relief in the court of law.

### 5.6 Limitations to the Right of Rescission

When a party enters into a contract because of exercise of coercion, undue influence or fraud, or misrepresentation made by the other party, it has a right to rescind (set aside) the contract. However, this right can be exercised with certain limitations discussed below -

***(1) By lapse of time -*** When a party comes to know about the wrong done to him, rescission must be claimed within reasonable time of such knowledge, otherwise the party is supposed to have affirmed the contract.

**Example -** A person purchased certain shares in a company on the basis of misleading prospectus. The shares were allotted in July. In December, he wanted to set aside the sale. The court held that the unexplained delay of five months was unreasonable for obtaining the relief.

***(2) By affirmation -*** When a party comes to know about the wrong done to him, and thereafter, affirms the contract expressly or by some conduct, the party loses its right to rescind the contract.

**Example -** A person purchased certain shares in a Company on the basis of misleading prospectus. The shares were allotted in July. In August, the company declared some dividend which he accepted. It is affirmation of contract by conduct.

***(3) Restitution not possible -*** Rescission is always subject to the condition that the party seeking recession must be in a position to restore the benefits he may have obtained under the contract. When the party seeking rescission is not in a position to restore the benefits, the right to rescind the contract cannot be exercised.

**Example -** A sold a painting to B misrepresenting that it is'antique' while it was an ordinary painting. B came to know about it but it slipped from his hand and got smashed. Now, B is not in a position to restore the 'painting' to A. He cannot exercise his right of rescission.

***(4) Right of third parties -*** As soon as, a third party acting in good faith, acquires rights in the subject matter of the contract, the right to rescind the contract is lost by the aggrieved party.

**Example -** A, by misrepresentation, obtained a watch from B and sold the same to C. C paid due consideration to A, and purchased it in good faith. In this case, B's right to rescind the contract with A is lost since a third party (i.e. C) has acquired interest in the subject matter in good faith.

### 5.7 MISTAKE

Mistake may be defined as *'an erroneous belief about something'*. Two parties cannot believe same thing in the same sense when they are under a mistake. A mistake by one or both of the parties assume significance because it may make the contract void (i.e., prevent its formation) or voidable (i.e., allow it to be avoided by one of the parties). Mistake in contract transactions occur in various ways. It can be discussed under following heads:

*<u>1. Mistake of law</u>* - Indian law
- Foreign law

*<u>2. Mistake of fact</u>* - Bilateral mistake
- Unilateral mistake

### 5.7.1 Mistake of law

No man can excuse himself from doing his duty by saying that he did not know the law on the matter. A person is presumed to know the ordinary law of the land and he cannot plead its ignorance. But he is not supposed to have knowledge of the laws applicable in the whole world. If he commits a mistake because of ignorance of foreign law, it is treated as a mistake of fact.

Section 21 of the Indian Contract Act, 1872 provides that, "A contract is not voidable because it was caused by a mistake as to any law in force in India; but a mistake as to a law not in force in India has the same effect as a mistake of fact.

1. *<u>Mistake of Indian law -</u>* A mistake of Indian law does not affect validity of a contract.

   **Example -** A, a widow was entitled to certain occupancy rights. She remarried and believed that she had lost her occupancy rights by reason of her second marriage. Under this mistake, she agreed to take the lease of the same land from Z, the Zamindar. Later on, she came to know that legally she had not lost her occupancy rights. Now, A wanted to revoke the lease agreement with Z. Here, A could not revoke the lease agreement because there was a mistake of law.

2. *<u>Mistake of foreign law</u>* - A mistake of foreign law is treated as a mistake of fact which is discussed below in detail.

### 5.7.2 Mistake of fact

A mistake of fact occurs when a party believes something to be true, but his or her belief is not in accord with the real facts. If both parties are mistaken in their beliefs, there is a mutual mistake. If only one of the parties is mistaken in his or her belief, there is a unilateral mistake.

***A. Bilateral mistake -*** It is a mistake committed by both the parties. When both parties are confused about some fundamental fact, no contract can be presumed to exist.

**Example -** A agreed with B to sell his 'Tata Sierra' while B thought that he is agreeing to buy his 'Tata Estate'. Here both the parties are under a mistake of fact. No contract has concluded.

Section 20 of the Indian Contract Act, 1872 provides that, *"Where both the parties to an agreement are under a mistake as to a matter of fact essential to the agreement, the agreement is void."*

*Explanation -* An erroneous opinion as to the value of the thing which forms the subject matter of the agreement is not to be deemed a mistake as to a matter of fact.

In order to bring this section into ***operation***, it is essential that a bilateral mistake:

- must relate to a fact, not a judgment or opinion.
- the fact must be essential to the agreement.
- the fact must be existing at the time of making contract.

***(1) Mistake must relate to a fact, not opinion -*** When parties make a mistake about a fact relating to contract, it is void. But when mistake is in making an opinion only, it does not affect validity of the Contract.

**Example-** A buys a house from B for Rs. 2 lakh. Later on, he discovers that its actual worth was Rs. 50,000 only. It is a mistake of opinion for which he has to blame his ignorance only. The contract cannot be avoided on this ground.

***(2) Fact must be essential to the agreement -*** Mistake regarding a fact essential to agreement makes it void. Mistake relating to a minor aspect of agreement does not affect its validity. What facts are essential to an agreement depend upon the nature of promise in each case. Generally, it can be said that a fact pertaining to a minor aspect of the agreement is not considered as essential.

**Examples -**

1. A was wholesale dealer under a Rationing order. He was paid transport charges from Government godowns to his shop for a distance less than 25 km. Both the

parties were unaware that the distance exceeded 25 km. When it was discovered, future payments were made accordingly. A filed a suit to recover past arrears. The court dismissed the suit saying that the mistake did not relate to an essential fact.

2. A agreed to sell a piece of land to B. Neither of the parties were aware that this land was already acquired by the Government. In this case, the fact that the Government has already acquired the land is material to the agreement. The agreement is void.

***(3) The fact must exist at the time of contract -*** A mistake as to existing fact will render the contract void ab initio. If the mistake is as to some future event, a binding contract is entered into between the parties. The contract may be avoided at some future date if the expected event does or does not happen.

**Example -** Considering the above example, suppose that the Government acquire the land subsequent to the agreement between A and B. In such a case, the agreement is not void on the ground of mistake. Initially, it will be a valid agreement which will become void, subsequently, on the ground of 'impossibility of performance.'

**Some Instances of bilateral mistakes -** The mistakes which can be covered under section 20 are discussed below:

1. *Mistake as to the existence of subject matter -* Here, both parties enter into an agreement under a mistaken belief that there is something to agree about whereas in fact there is not, i.e., where the subject matter of the agreement has ceased to exist.

2. *Mistake as to identity of subject matter-* Where one party has one thing in the mind and the other party has some other thing while making an agreement about it, a mistake as to the identity of subject matter occurs.

3. *Mistake as to title or rights -* When a person, in ignorance to his right to a property, enters into an agreement for its purchase, rental. or lease, etc:, it is considered as a mistake of fact and the contract is void.

4. *Mistake as to the quantity of subject matter -* When both the parties are under a mistake as to the quantity of subject matter, the contract is void.

5. *Mistake as to the price of the subject matter -* When both the parties are under a mistake as to the price of the subject matter, the agreement is void.

6. *Mistake as to the quality of subject matter -* A mistake as to the quality of subject matter as distinguished from its substance may not render the agreement void. But if the mistake as to quality is such which makes the subject matter different from what it was believed to be, the contract is void.

7. *Mistake as to the substance of subject matter -* The term 'substance of subject matter means an integral and essential element of the subject matter. A mistake as to 'substance of subject matter' render an agreement void.

8. *Mistake as to assumption -* When a mistake is committed as to fundamental assumption to an agreement, it is void.

***B. Unilateral mistake -*** When only one party to an agreement is mistaken as to contents of the agreement, it is termed as unilateral mistake. Generally, a unilateral mistake does not affect the validity of an agreement. However, in case of unilateral mistake a contract can be avoided, if it can be proved that it was caused by fraud or misrepresentation on the part of the other party.

Section 22 of the Indian Contract Act, 1872 provides that, *"A contract is not voidable merely because it was caused by one of the parties to it being under a mistake as to a matter of fact."*

It may be noted that there are certain cases in which a unilateral mistake has the effect of defeating the true consent of the parties. Such unilateral mistake renders an agreement void.

**Example -** A lady named A, was convicted for allowing disorderly conduct in her restaurant. Subsequently, she assumed a false name B, and hired a house of C. On becoming aware of the true identity of B, C wanted to set aside the lease of the house. Here, the true consent of C was defeated. Here, the agreement was void

**Some instances of unilateral mistake**

Unilateral mistakes which can render a contract void are discussed below:

1. *Mistake as to the identity of person-* A mistake of identity of contracting party occurs where a party enters into an agreement with some person believing him to be some other person. This mistake will render the agreement void only when, the identity of the party is of material importance to the agreement, and the fraudulent party knows that he is not intended to be a party to the agreement. A mistake about the identity of contracting party will render the contract void where the identity of the party is of vital importance.

   **Example -** B the owner of a theatre gave strict instructions that no ticket for first performance should be issued to A, a critic of some members of theatre. However, A obtained the ticket through some friend. But at the gate, A was refused admission. A filed a suit on B for breach of contract (i.e. by selling ticket B is bound to give entry to the ticket holder). Here, the identity of A was material element in formation of contract. Hence, the contract was void.

   When the parties are present face to face, the presumption is that the contract is made with the person actually present, even though there is a fraudulent impersonation by the buyer as a different man than he is.

   *Note: Where a contract is rendered void for mistake as to identity, no title in any property transferred will pass under the original contract, therefore no title can pass to a third party. However, where the contract is merely voidable for fraud, a valid contract exists until avoided. Therefore, if a third party acquires an interest in the property transferred before such time as the contract is avoided, his title will defeat that of the original owner.*

2. *Mistake as to the character of document -* Sometimes a deed of one nature is executed under the mistaken expression that it is of different nature. In such cases it is wholly void.

   **Example -** An illiterate lady, on finding that some strangers were occupying her lands approached her brother for advice. He advised that a complaint should be made to the 'Collector', and took her to the Collector's office. There he obtained her thumb impressions on some blank papers; these were, subsequently, registered as sales deed in the name of certain persons. She challenged the transaction in the court of law. Transaction to be void.

*Note: Although generally the fraud renders a transaction voidable, but where the fraudulent misrepresentation is as to the character of document, the transaction is wholly void.*

**5.7.3 Effect of mistake**

A mistake of Indian Law does not affect the validity of a contract, and a mistake of foreign law is treated as a mistake of fact.

When there is a bilateral mistake of fact, no contract exists at all, i.e., the contract is void. In case of unilateral mistake the validity of the contract is not affected generally. However, if the mistake was caused by fraud or misrepresentation, the party who was induced to make such a mistake can treat the contract voidable at his option.

**Part - 6**

# Void Agreements

**STRUCTURE OF PART - 6**

## 6.1 OBJECTIVES

After reading this Chapter, you should be able to understand:

- Why the Indian Contract Act, 1872 has declared certain agreements void.
- Which agreements have been declared void by the Act?
- How to distinguish these agreements from the valid agreements of similar nature.

## 6.2 AGREEMENTS IN RESTRAINT OF MARRIAGE

Law regards marriage and married status as the right of every individual. Section 26 of the Indian Contract Act, 1872, provides that, "Every agreement in restraint of marriage of any person, other than a minor, is void."

Thus an agreement, which prevents a major person from marrying (i.e. complete restraint), is void. Also, an agreement which puts any restrictions on the freedom of marriage (i.e., partial restraint), like preventing somebody from marrying a particular person, or a particular class of persons, or during a fixed period, etc., is void.

**Examples-**

1. A promised his religious guru G that he will not marry throughout his life if G would teach him art of reading the other's mind. The agreement is in complete restraint of marriage. It is void.

2. A agreed with B that he will not marry until he repay the loan of Rs. 10,000 taken by his father from B. The agreement is in partial restraint of marriage. It is void.

3. S promised his father F, in consideration of the latter bestowing his entire property to him, not to marry R. The agreement is in restraint of marriage and cannot be enforced.

*A promise to marry a particular person does not imply any restraint of marriage, and therefore is a valid contract.*

**Example -** S agreed with his father F that he will marry G if F would give him his entire property. Though, by implication S cannot marry any other person, but the agreement does not contain such a clause and hence the agreement is not in restraint of marriage and is a valid agreement.

*A penalty upon remarriage may not be construed as restraint of marriage.*

**Example -** Two co-widows made an agreement that if any of them remarried, she should forfeit her right to her share in the deceased husband's property. Here, in this agreement no restraint was imposed upon either of the two widows for remarriage. All was that, if a widow elected to remarry, she would be deprived of her rights. The agreement is valid.

## 6.3 AGREEMENTS IN RESTRAINT OF TRADE

Section 27 of the Indian Contract Act, 1872, provides that, "Every agreement by which anyone is restrained from exercising a lawful profession, trade or business of any kind, is to that extent void:

### 6.3.1 What is an agreement in restraint of trade?

An agreement in restraint of trade is one whereby one party seeks to prevent the other from carrying out a particular trade, business, or profession. In other words it interferes with the liberty of a person to engage himself in any lawful trade, occupation or profession of any kind.

***The restraint may be complete or partial -*** A complete restraint is one which prevents any person from carrying on any kind of business at all. The partial restraint prevents a person from carrying on a particular kind of business within a particular locality, or for a particular time, etc. But whether restraint is complete or partial, whether it is qualified or unqualified, it renders an agreement void.

**Examples:**

1. A purchased the business of B with the condition that B will not carryon any business activity throughout his life. This is a complete restraint on trade. The agreement is void.

2. M and R were carrying on the business of similar goods in Calcutta. R suffered a loss from M's competition. R entered into an agreement with M that if M would

close his business in a particular quarter, he would pay him all the advances M had made to his workmen. M closed his business for that quarter but R did not pay anything to him. M sued R to recover advances. Here, the agreement was in partial restraint (i.e. for a quarter only) of trade, and hence void. M could not recover anything from R.

### 6.3.2 Only void portion of an agreement is unenforceable

The words 'to the extent void' in section 27 means that only void portion of an agreement is unenforceable. Where the agreement in restraint of trade is divisible, the valid portion is enforceable. However, where it is not divisible, the whole agreement is void.

**Example -** A, a businessman sold the 'goodwill' of his business to B. Both of them agreed that A will not practice the same trade for 3 years, and also that A will not carry any business competing in anyway with the business of B. Here the agreement being divisible, the first part is valid because it is necessary to protect the interest of the purchaser of goodwill. The second part is void because it prevents A from carrying on any business which is unreasonable restraint upon him.

## 6.4 UNCERTAIN AGREEMENTS

Section 29 of the Indian Contract Act, 1872 provides that "agreements, the meaning of which is not certain, or capable of being made certain, are void."

The terms of an agreement must be clear, complete and certain. If an agreement is vague, or illusory, or its meaning is not clear, it cannot be enforced by a court of law. In other words, to constitute a valid agreement, it is essential that the proposal must be so certain, that the rights and obligations of the parties arising out of the contract can be exactly fixed.

**Examples-**

1. A agreed to sell 100 tons of oil to B. Here it is not clear what kind of oil they are talking about. It is not complete agreement and hence void.

2. A agreed to sell his house to B for Rs. 90,000 or Rs. 1,00,000. There is nothing to show which of the two prices are final. This is an uncertain agreement and hence void.

3. A promised to buy the horse from B if it proved lucky. This is a vague and loose agreement. Thus it cannot give rise to any contract.

4. An option to renew a lease at 'such rental as may be agreed upon between the parties' was held void (i.e. not enforceable at law)

5. An agreement to acquire goods on 'hire-purchase' was too vague since there were many kinds of hire purchase agreements having widely different terms, so it was impossible to specify the terms on which the parties had agreed.

## 6.5 AGREEMENTS IN RESTRAINT OF LEGAL PROCEEDINGS

Every person has freedom to enforce his legal rights. An agreement which interferes with the course of justice is void. It follows that the individuals by agreement cannot alter the provisions of any law.

Section 28 of the Indian Contract Act, 1872, provides that, “Every agreement, by which any party thereto is restricted absolutely from enforcing his rights under or in respect of any contract, by the usual legal proceedings in the ordinary tribunals, or which limits the time within which he may enforce his rights, is void to that extent.”

### 6.5.1 Restrictions must be absolute

Partial restriction does not render an agreement void.

**Examples:**

1. A agrees to sell 200 kilo of sugar to B for Rs. 500 and the parties further agree that in case of a breach by any party, none of them would have recourse to a court of law. The agreement is void.

2. K and S entered into an agreement whereby they agreed that neither of them would appeal against the trial court's decision. Here the restriction is partial as the parties can go to the court of law at the first instance. The only restriction is

that that the losing party cannot file an appeal. Here, this agreement valid as section 28 applies only to absolute restrictions on recourse to legal proceedings

### 6.5.2 Curtailing the period of limitation

The Indian Limitation Act provides that an action for the breach of contract may be brought within three years from the date of breach. Such period of limitation cannot be curtailed by the parties to the contract.

**Examples:**

1. A sold his car to B. B agreed to pay the price within 6 months of the sale. It was further agreed that if B failed to pay the price, A must take action for the recovery of the price within two years from the expiry of six months afth the date of sale (i.e. the date of breach), otherwise B would not be liable. This agreement is cutting short the period of limitation provided by the Limitation Act (i.e., 3 years). Thus it is a void agreement.

2. In a case of fire insurance policy there was a clause 'if the claim is made and rejected and the action or suit is not commenced within three months after such rejection, all the benefits under this policy shall be forfeited: Here, in this case, this clause was valid and did not reduce the period of limitation.

*Note: A clause providing for the forfeiture of rights if no suit is brought within a stipulated period should be distinguished from the limiting of time within which a party may bring upon a suit to enforce his rights.*

### 6.5.3 Exceptions in the agreements against legal proceedings

In the following cases, even absolute restraint to legal proceedings does not render the agreement void:

***1. Referring disputes to arbitration -*** Sometimes the concerned parties agree that any existing or future dispute which may arise between them shall be referred to arbitration. Such an agreement is not void.

**Example -** A trader entered into an agreement with B, a manufacturer of clocks, to purchase 500 clocks at the rate of Rs. 150 each. The parties also agreed that any dispute which may arise about the payment of the price or quantity of clocks shall be referred to arbitration and not to the *court* of law. This is a valid agreement.

*Note: It may be noted that if parties are not satisfied with the arbitration award, they cannot be restricted to go to the court against it. This right cannot be excluded by the agreement.*

***2. Exclusion of jurisdiction of a particular court-*** At times, it may happen that a particular transaction falls under the jurisdiction of more than one court. In such cases, the parties have an option to select the court where they would refer their dispute.

**Example -** A was a tradesman in Calcutta. B carried on a business in Delhi. They entered into a business transaction. In the normal course, they have an option to file a suit in the Court of Delhi or the Court of Calcutta in case of any dispute. However, they entered into an agreement that they can enforce their respective rights in Delhi only, and not in Calcutta. The agreement is valid.

## 6.6 WAGERING AGREEMENTS

Section 30 of the Indian Contract Act, 1872 says that 'an agreement by way of wager is void.'

### 6.6.1 What is a wager?

A wager occurs when the parties agree that a payment will take place between them depending upon the outcome of an uncertain event in which they have no interest other than their agreement. For instance, a bet on a sporting event would be a wager.

A wagering contract is one by which two persons professing to hold opposite views touching the issue of a future uncertain event, mutually agree that, dependent on the determination of that event, one shall pay or hand over to him, a sum of money, or other stake; neither of the contracting parties having any other interest in that contract than the consideration for the making of such contract by either of the parties. It is essential to a wagering contract that each party may win or lose, whether he will win or lose being dependent on the issue of the event, and, therefore remaining uncertain until that issue is known. If either of the party may win but cannot lose, it is not a wagering contract.

### 6.6.2 Essentials of a wager

To constitute a wager, following elements must be present in the contract:

***(1) Uncertain event -*** It is either a future event the outcome of which is uncertain, or it may be a past event with an ascertained outcome about which the parties to the agreement have no knowledge.

**Example -** A cricket match between India and Pakistan is scheduled to start next month. A and B enter into an agreement that if India wins, A will pay Rs. 5000 to B, and if Pakistan wins, B will pay Rs. 5000 to A. This is a wagering agreement. Alternatively it may happen that the match has already been concluded but A and B are not aware of the result of the match. They enter into an agreement that A will pay Rs. 5000 to B if India had won the match and B will pay Rs. 5000 to A if Pakistan had won the match. It is also a wagering agreement.

***(2) Win or lose situation -*** Each party must be in a situation where it may win or lose depending upon the issue of the event. If either of the parties may win but cannot lose, or may lose but cannot win, it is not a wagering agreement.

**Examples:**

1. S and R deposited 200 pounds to abide the results of a tennis match and the loser was to forfeit this amount and the gainer was to recover it. In this case each party has the chances to win or lose. And the gain of one party will be the loss of the other. This is a wagering agreement.

2. Two wrestlers R and B agreed to play a wrestling match on the condition that if any of them would fail to appear for the match, he would have to pay Rs. 500 to the other party. The winner was to receive Rs. 1000 out of the gate money (i.e., sale proceeds of the tickets). R failed to appear in the match and B sued him for Rs. 500. Here, was not a wagering agreement, and was enforceable

   *Note: In this case, Rand B were not going to win or lose in terms of money as a result of wrestling match (i.e., uncertain event). The winning amount had not to be given out of their pockets, but had to be paid from the gate money which was provided by the public. As for the condition of payment for non-appearance, no uncertain event provided the equal chances of winning or losing.*

(3) No other interest - Neither party should have any interest in the happening of the event other than the sum or stake he will win or lose. That is what marks the difference between a wagering agreement and a contract of insurance.

**Example -** A takes a fire insurance policy for his house. It is not a wagering contract as he has an insurable interest in the house property. Alternatively if A takes a life insurance policy for the wife of his clerk, it will amount to a wagering agreement as he does not have any interest in-the life of the insured.

(4) No control over the event- Neither party should have any control over the event in one way or the other.

**Example -** A and B agree with each other that if it rains tomorrow, A will pay Rs. 100 to B and if does not rain tomorrow, B will pay Rs. 100 to A. Here 'raining' or 'not raining' is the event over which neither party has any control. This is a wagering agreement.

(5) To constitute a wager, there should be a promise to pay money or money's worth only - There must be a proof that the agreement was entered into upon the terms that the performance of the agreement should not be demanded; but only difference in prices should be paid.

(6) The stake money should come out of the pockets of the parties themselves and not outsiders otherwise the agreement does not constitute a wager.

(7) Finally, to make a wagering agreement there must be a common intention to bet. The essence of wager is that only one party stands to win or lose to the other party according to an uncertain event or to the fluctuation of the price.

### 6.6.3 Effect of wagering agreements

The effect of wagering agreement can be viewed in context of the main transaction and collateral transaction.

***(1) Main transaction -*** Section 30 of the Indian Contract Act, 1872 provides that, "Agreements by way of wager are void, and no suit shall be brought for recovering anything alleged to be won on any wager, or entrusted to any person to abide by the results of any game or other uncertain event on which any wager is made."

Thus the agreements by way of wager are void. The winner in wager cannot recover the stake money from the other party. .

**Example -** A agreed to pay Rs. 1,000 to B if 'X' won the election. B agreed to pay Rs. 1,000 to A if 'X' did not won the election. Subsequently 'X' won the election but A refused to pay Rs. 1,000 to B. B cannot recover this money from A.

Even if the stake money is deposited with a third person, it cannot be recovered by, the winner from him.

**Example -** Considering above example, say A and B both deposit their respective stake of Rs. 1,000 with C, to enable him to pay the winner. 'X' won the election but C refused to pay money to B. B cannot recover the winning money from C. However, both A and B can recover their respective money from C which they had deposited with him.

*Note: It may be noted that, though wagering agreements are void, they are not illegal. However, in Gujarat and* Maharashtra*, the wagering agreements have been declared illegal by the respective States.*

***(2) Collateral transaction -*** It is a transaction which is incidental or parallel to the main transaction. For example, A bets with B and loses; and obtains a loan from C in order to pay B. Here the transaction between A and B is main transaction, and the transaction between Band C is a collateral transaction. Since the wagering agreement are void, but not unlawful (except in the States of Gujarat and Maharashtra), the transactions collateral to them are valid and enforceable.

**Example** - Considering the above referred example, B borrowed Rs. 1,000 from C to pay his bet money to A. Later on he refused to pay back the money to C. Here C can go to the court of law to recover his money from B, as his contract with B was a valid and enforceable contract.

### 6.6.4 Exception in the Wagering Agreements

Horse racing competition - Section 30 of the Indian Contract Act, 1872, provides that, "a subscription or contribution, or agreement to subscribe or contribute, made or entered into for or towards any plate, prize or sum of money, of the value or amount of five hundred rupees or upwards, to be awarded to the winner or winners of any horse race, shall not render an agreement void."

Thus a bet on the horse race carrying a prize of Rs. 500 or more will not constitute a wagering contract, and is enforceable. However, a bet on a horse race carrying a prize of less than Rs. 500 remains a wager. Here the intention of the Law is to protect the poor people from gambling.

### 6.6.5 Special Transactions Resembling To Wagering

***(1) Commercial transactions -*** Sometimes it is difficult to find it out whether an agreement is by way of wager or a genuine commercial transaction. It has now been settled that where delivery of the goods is intended to be given and taken, it is a valid contract but where only the difference in prices is intended to be paid, it is a wagering transaction.

**Example -** A agrees to buy 100 grams of gold from B at Rs. 300 per gram after two months. On the due date the price of gold is Rs. 290 per gram. This transaction may be settled in two ways:

(i) A may purchase 100 grams of gold at Rs. 300 per gram, or
(ii) he may give Rs. 1,000 to B, being the difference between the contract price and the market price on the date of performance.

In the first case, it is a valid contract of sale and purchase. In the second case there was no intention of sale or purchase of gold. Both the parties were interested in gambling on the fluctuations of gold prices. It is a wagering transaction.

***(2) Lotteries -*** A lottery is a game of chance, in which the event, either of gain or loss giving the absolute right to prize, is wholly dependent on the drawing of lots. It is a wagering agreement. Thus the winning in the lottery is not possible to be recoverable through court of law. Moreover an agreement to buy a lottery ticket is also a wagering agreement, and is void.

**Example -** A bought a lottery ticket. According to the draw, he won the prize of Rs. 50,000, but the organizers of the lottery refused to pay him this money. He cannot recover this money through the court of law as lottery is considered as a wagering contract.

*Note: It may be noted that the Government may give sanction for conducting lotteries. But the sanction of the Government does not change the nature of the lotteries, i.e., it will remain a wager. The only effect of the sanction is that the persons conducting the lotteries will not be liable to the punishment by law.*

***(3) Chit fund -*** A chit fund transaction is simply a loan of the common fund to each subscriber in turn. In such cases, the transaction is not a lottery though there is an element of chance in it.

**Example -** Twenty-two persons were conducting a transaction. Each person was to contribute Rs. 10 for the first week. At the end of the week, the prizes were drawn and the winner gets gramophone and drops out of transaction. The remaining members contribute for the next week. Again the prizes were drawn at the weekend. The new winner gets the gramophone and drops out of transaction. The similar contributions and drawings continued for next 20 weeks (22 weeks in total).

In this case, each person got his money's worth though some got less and some more by lot. Moreover the transaction was conducted between definite number of persons and there was no invitation to public to join. The transaction not a lottery and did not amount to wager.

***(4) Crossword puzzles -*** Crossword Puzzles are of two types:

(i) One in which any person solving the puzzle would be awarded, therefore it is a game of skill and not of chance and is not a wagering agreement. Even in such competitions the amount of prize should not exceed Rs. 1,000. If the prize money exceeds Rs. 1,000, then it amounts to wager and void according to the Prize Competition Act, 1955.

(ii) The other type of crossword puzzle is one in which the prize would be awarded to that competitor whose solution corresponds to the solution kept with the editor of the newspaper. It is a game of chance and not of skill and hence is a wagering agreement.

***(5) Insurance contracts -*** It is a contract where a person in consideration of certain sum of money agrees to bear the risk regarding the property or life of another person in which such other person has insurable interest. The main object is mitigation of losses.

*'Insurable interest'* is an interest in the subject matter of insurance which the insured person wants to protect against some uncertain event.

Certain points regarding insurance contracts:

(i) It is only the person possessing an insurable interest who is allowed to insure life or property, and not any other person.

(ii) In the insurance contracts, with the exception of the Life Insurance, the insured does not stand to gain. He is only compensated against the loss if some uncertain event happens. Like in the case of fire insurance, only the actual loss suffered by the insured is paid by the insurance company, and not the full amount for which the property is ensured.

(iii) Insurance contracts are regarded beneficial to the public whereas wagering agreements do not serve any such purpose.

**Example -** A insured the life of M, the wife of a clerk in his employment, for a term of 10 years for Rs. 25,000. The policy was assigned to A. M died a year later. A sued the insurance company to recover Rs. 25,000. Here A had no insurable interest in the life of M. Thus it is a wagering agreement. Hence A could not recover anything from the insurance company.

## 6.7 AGREEMENTS CONTINGENT ON IMPOSSIBLE EVENTS

Section 36 of the Indian Contract Act, 1872 provides that, "contingent agreements to do or not to do anything if an impossible event happens, are void, whether the impossibility of the event is known or not to the parties to the agreement at the time when it is made:

**Examples:**

1. A agrees to pay B Rs. 1,000 if two straight lines should enclose a space. The agreement is void.

2. A agrees to pay B Rs. 1,000 if B will marry A's daughter C. C was dead at the time of the agreement. The agreement is void.

### 6.8 AGREEMENTS TO DO IMPOSSIBLE ACTS

Section 56 of the Indian Contract Act, 1872 provides that "an agreement to do an act impossible in itself is void."

**Example -** A agrees with B to discover treasure by magic. The agreement is void.

It may happen that an event becomes impossible after the contract is made. In such a case, the contract becomes void from such time when the event on which the contract is based becomes impossible.

**Example -** A and B contract to marry each other. Before the time fixed for the marriage, A goes mad. The contract becomes void.

Part - 7

# Contingent Contracts

**STRUCTURE OF PART - 7**

## 7.1 OBJECTIVE

After reading this Unit, you should be able to understand:

- What is a contingent contract?
- How it is different from an ordinary contract?
- What are the rules as to its enforceability?

## 7.2 WHAT IS A CONTINGENT CONTRACT?

The word 'contingent' is used in the Indian Contract Act, 1872, to mean 'conditional' as we use ordinarily. Thus a contingent contract is a conditional contract.

Section 31 of the Indian Contract Act, 1872, provides that, *"A contingent contract is a contract to do or not to do something, if some event, collateral to such contract, does or does not happen."*

It may be inferred from the above that the performance of a contingent contract is dependent on a future uncertain event, and such event should be collateral to the contract.

*Performance dependent on a future uncertain event* - In an ordinary contract, as soon as the contract is made, its performance becomes due by the respective parties. When a contract is contingent, i.e. dependent upon the happening or non-happening of a future event, its performance will become due only on the happening or non-happening of such event.

**Examples:**

1. A promise to sell his house to B for Rs. 1 Lac. Here A owes an obligation to transfer the possession of his house to B, and B owes an obligation to pay Rs. 1 Lac to A. It is an absolute contract.

2. A agrees to sell his house to B provided C, to whom he offered in the first instance does not purchase it; here A's promise to sell his house to B is conditional depending upon C's refusal to purchase it. If C refuses, both A and B will become bound to perform their respective obligations, but if C accepts to

purchase A's house, no contract will exist between A and B. This is a contingent contract.

The future uncertain event must be collateral to contract - The collateral event on which the performance of a contract is dependent must be independent or ancillary to the contract. It should not be a part of contract itself. i.e. *"a collateral event is an event which is neither a performance directly promised as part of the contract, nor the whole of the consideration for promise."*

**Examples:**

1. A enters into a contract to pay B for a piece of work on the terms that he will be paid only when the work is done. Here the 'completion of the work', being the very thing contracted for, is not collateral to the contract. This contract is not a contingent contract though the performance of the work may be a condition precedent to the payment of wages.

2. A offer a reward for the recovery of lost goods. There is no contract at all unless someone find the goods and bring them to A. Here 'finding the goods' is constituting whole of the consideration for promise, it cannot be considered a collateral event. Thus it is not a contingent contract.

3. A, an insurance company promise to pay B Rs. 50,000, in case his house is burnt. Here 'burning of the house' is an independent event which is neither a performance required from B under the contract, nor it is forming consideration of the contract. This is a contingent contract.

## 7.3 RULES REGARDING A CONTINGENT CONTRACT

Above discussion makes it clear that the performance of a contingent contract is dependent upon a contingency which is uncertain. This contingency may take different forms and different effects. Legal rules regarding the same are discussed below:

***(1) Act of a party -*** The word event include 'act of the party', the 'act' may be either of a party to the contract, or a third party.

**Examples:**

1. A agreed to pay Rs. 1 Lakh to B, if B marries C. In this case B's act of marrying C is an uncertain collateral event because he may or may not marry C. This is a contingent contract.

2. A agreed with B that he will get his house constructed by B provided C, an architect certifies the layout plan of the house made by B. Here the contract is contingent upon the 'certification by C, an act of third party. This is a contingent contract.

*It may be noted that contingency in a contract cannot be 'mere will' of a party.*

Thus a promise by A to sell his house to B for Rs. 1 Lac if he will consider it proper after a month is no promise. Here contingency is mere will of A, hence the contract is not valid.

***(2) Happening of an event -*** Section 32 of the Indian Contract Act, 1872, provides that, "Contingent contracts to do or not to do anything if an uncertain future event happens cannot be enforced by law unless and until that event has happened:

Thus when the contingency in a contract is 'happening of certain event', it can be enforced only when that event happens. If such event becomes impossible, it renders the contract void.

**Examples:**

1. A contracts to pay B a sum of money if B marries C. A will become liable to pay the money to B only when he marries C.

2. A contracts to pay B a sum of money if B marries C. C dies without being married to B. Now the event on which the contract was contingent has become impossible. The contract is void.

3. Non-happening of an event - Section 33 of the Indian Contract Act, 1872, provides that, "Contingent contracts to do or not to do anything if an uncertain future event does not happen can be enforced when the happening of the event becomes impossible, and not before".

Thus when the contingency in a contract is 'non-happening of certain event', it can be enforced only when such event becomes impossible. However, the happening of such event renders the agreement void.

**Examples:**

1. A agrees to pay a sum of money to B if a certain ship does not return. The ship sinks. Now there is no possibility that ship will ever return. The contract can be enforced.

2. A agrees to pay a sum of money to B if a certain ship does not return. The ship returns back. The contract has become void.

*When future conduct of a person is considered impossible* - Section 34 of the Indian Contract Act, 1872, lays down that, "If the future event on which a contract is contingent is the way in which a person will act at an unspecified time, the event shall be considered to become impossible when such person does anything which renders it impossible that he should so act within any definite time, or otherwise than under future contingencies:

Thus the future conduct of any person is considered impossible, if it becomes impossible to perform it in the given circumstances.

**Example -** A agrees to pay a sum of money if he marries C. C marries D. Here the possibility that D may die and C may marry B at some future date cannot be denied. But in the given circumstances, the marriage of B and C would be considered impossible.

***(3) Happening of an event within a fixed time -*** Section 35 of the Indian Contract Act, 1872, provides that, "Contingent contracts to do or not to do anything if a specified uncertain event happens within a fixed time become void if, at the expiration of the time fixed, such event has not happened, or if, before the time fixed, such event becomes impossible."

Thus when the contingency is happening of certain event within a fixed time, the contract can be enforced only when such event happens within the time fixed.

**Example -** A promise to pay a sum of money to B if a certain ship returns within a year.

The ship returns within a year. The contract is enforceable.

*Such contract will become void in the following circumstances:*

1. *Fixed time expires without happening of such event.*

   **Example -** " A promise to pay a sum of money to B if a certain ship returns within a year. One year expires and ship does not return. The contract has become void.

2. *Before the expiry of fixed time, such event becomes impossible.*

   **Example -** A promise to pay a sum of money to B if a certain ship returns within a year. The ship sinks after 6 months. Returning of ship is impossible. The contract has become void.

***(5) Non-happening of an event within a fixed time -*** Section 35 of the Indian Contract Act, 1872, provides that, "Contingent contracts to do or not to do anything if a specified uncertain event does not happen within a fixed time may be enforced by law when the time fixed has expired and such event has not happened, or before the time fixed has expired, if it becomes certain that such event will not happen."

Thus when the contingency is non-happening of certain event within a fixed time, the contract can be enforced in the following two circumstances:

1. *When fixed time expires without happening of such event.*

   **Example -** A promises to pay a sum of money to B if a certain ship does not return within a year. One year expires and ship does not return. The contract becomes enforceable.

2. *Before the expiry of fixed time, such event becomes impossible.*

   **Example** - A promise to pay a sum of money to B if a certain ship does not return within a year. The ship sinks after 6 months. Returning of ship is impossible. The contract becomes enforceable.

***(6) Happening of an impossible event -*** Section 36 of the Indian Contract Act, 1872, provides that, "Contingent agreements to do or not to do anything if an impossible event happens, are void, whether the impossibility of the event is known or not to the parties to the agreement at the time when it is made."

Thus, if the contingency relates to the happening of an impossible event, it will render an agreement void. It does not make a difference whether the fact of impossibility was known to the parties or not.

**Examples:**

1. A agrees with B to discover treasure by magic. The agreement is void.

2. A agree to sell 1,000 Kg. of sugar to B, which was to reach A through a certain ship. The ship sunk on the way. The performance of the contract is impossible. The agreement is void.

## 7.4 EFFECT OF CONTINGENT CONTRACTS

The contingent contracts are perfectly valid, though they can be enforced in a court of law only upon the happening or non-happening of a future uncertain event. When the event has occurred, the contract for all purposes rests on the same footing as if it had been made positively and without reference to any contingency.

## 7.5 AN IMPORTANT COMPARISON

Wagering agreement and Contingent contract

| ***Wagering agreement*** | ***Contingent contract*** |
|---|---|
| ***Similarities*** | |
| Performance of the agreement depends on the happening or non-happening of some event. | Performance of the contract depends on the happening or non-happening of some event. |
| ***Differences*** | |
| In a wagering contract, the uncertain event is the sole determining factor.<br><br>The parties have no interest in the subject matter of the agreement other than their betting take. | In a contingent contract, the uncertain event is collateral to the main contract.<br><br>The parties have interest in the subject matter of the contract. |

| | |
|---|---|
| A wagering agreement is void. | A contingent contract is valid. |

**Part - 8**

## Quasi Contracts

**STRUCTURE OF PART - 8**

## 8.1 OBJECTIVES

After reading this Unit, you should be able to understand:

- What is a Quasi Contract
- What are various kinds of quasi contracts
- How law treats such contracts

## 8.2 VARIOUS FORMS OF QUASI CONTRACTS

Sections 68 to 72 of the Indian Contract Act provides for five kinds of quasi contractual obligations. These are discussed below.

### 8.2.1 Supply of necessaries

Section 68 of the Indian Contract Act, 1872, provides that, "If a person incapable of entering into a contract, or anyone whom he is legally bound to support, is supplied by another person with necessaries suited to his condition in life, the person who has furnished such supplies is entitled to be reimbursed from the property of such incapable person."

The above provision applies when:

1. The person to whom the necessaries are supplied is incapable of entering into a contract, i.e., he may be a minor, or a person of unsound mind.

2. The other person has supplied him or anyone whom he is legally bound to support with the necessaries suited to his condition of life.

The effect of the provision is that:

1. The price of the goods or services so supplied can be recovered only out of property of the incompetent person, if he has any. In any case, personal liability is not created.

   **Examples:**

   (i) A supplied B, a lunatic, with necessaries suitable to his condition in life.

A is entitled to be reimbursed from B's property.

(ii) A supplies the wife and children of B, a lunatic, with necessaries suitable to their condition in life. A is entitled to be reimbursed from B's property.

2. Incompetent person's property is liable to pay only a reasonable price for such goods or services supplied and not the price which the incompetent person might have agreed to (legally speaking an incompetent person cannot agree to anything).

**Example -** A supplied a jacket to the minor for which he agreed to pay Rs. 1,000 although its reasonable market price was Rs. 500 only. A can recover only Rs. 500 out of minor's property.

*Note: This topic has been dealt with in detail in the Unit 'Capacity of Parties'.*

### 8.2.2 Payment of lawful dues by interested person

Section 69 of the Indian Contract Act, 1872, provides that, "A person who is interested in the payment of money which another is bound by law to pay, and who therefore pays it, is entitled to be reimbursed by the other."

The above provision applies when:

***(1) The person who made the payment had an interest in such payment.***

**Examples:**

1. A pays arrears of rent of his neighbor B, just to avoid a struggle between B and his landlord. Here A cannot recover this rent from B as he acted voluntarily without having any recognizable interest in such payment.

2. A party had agreed to purchase certain mills. A large amount of municipal taxes was overdue on the property of the mills. The purchaser paid these taxes in order to save the mills from being sold in execution. Here, by agreeing to purchase the property, the purchaser acquired sufficient interest which it would want to safeguard. Thus this money could be recovered from the seller of the mills.

***(2) The payment must be such as the other party was bound by law to pay. The words 'bound by law' do not mean that the liability should only be statutory. The person may be bound to make the payment by 'law' or by 'contract'.***

**Examples -**

1. A was the owner of a warehouse. B imported certain goods and kept them in A's warehouse without paying the custom duty. The custom authorities made a demand on A, and he had to pay the duty on those goods. Here B was bound by law to pay the customs duty. A is entitled to recover the amount from B.

2. E left his carriage at P's premises. P's landlord seized the carriage as distress for rent. Here P is bound by contract to pay the rent to his landlord. E paid the rent to obtain the release of his carriage. Here E could recover the amount of rent paid by him.

*Note: It may be noted that if a person is only morally bound to pay, then he will not liable to the person who discharges his moral obligation.*

***(3) The person who made the payment was not himself legally bound to pay the amount.***

**Example -** A held some land on a lease granted by B, a Zamindar. Under the Revenue Law, the tenant is liable to pay the revenue charges on the land. Land revenue fell in arrears, and in order to prevent the termination of the lease, A paid the arrears of revenue charges. In this case, A cannot recover the revenue charges from B as the payment of the same was his own duty.

Moreover, the suit under this section is maintainable only for reimbursement and not for contribution. Thus, where there is a joint liability on joint wrong doers and only one of them discharges the liability, that person cannot claim the contribution from the other person.

**Example -** A and B were fined jointly Rs. 5,000 for selling adulterated ghee. A alone paid the amount of fine. He cannot recover the contribution from B under this section as he himself is also bound for the dues.

*Note: It may be noted that a suit for contribution from a joint promisor can be made under section 43.*

***(4) The payment must not be made to self***

**Example -** A, a Zamindar gave his land on lease to the Forest Department of Gujarat Government. A failed to pay the land revenue to the Government. In order to save the property from being sold, the Forest Department made payment of the land revenues. Here, the payment of money by one Government department to another constitute a payment to self. Thus the Forest Department could not recover this money from A.

The effect of the provision is that;

1. The person who has made the payment of lawful dues of the other, in which he had an interest, is entitled to get the reimbursement from that other person.

2. In a suit under this section, even a personal decree can be passed.

### 8.2.3 Obligation of a Person Enjoying Benefit of a Gratuitous Act

Section 70 of the Indian Contract Act, 1872, provides that, "Where a person lawfully does anything for another person, or delivers anything, to him not intending to do so gratuitously, and such other person enjoys the benefit thereof, the latter is bound to make the compensation to the former in respect of, or to restore, the thing so done or delivered."

*The above provision applies when;*

1. A person has lawfully done something for, or delivered something to the other. Here 'lawfully done' denotes that the act or service done for somebody is not imposed upon him or her. He or she should have the option to accept or reject the services rendered or goods delivered by the other person.

   **Example -** A ploughed a field of B, with a tractor. B's son was present at the time of ploughing. After the ploughing, B sent intimation to the District Development Officer stating that the field has been ploughed satisfactorily. Now A demanded payment for ploughing the field. Here, the act done was not a voluntary act, it was done in pursuance of the wishes of the owner in the presence of his son. Thus it must clearly be regarded as something 'lawfully' done for which B was liable to reimburse A.

2. It has been done by a person not intending to act gratuitously. The person providing goods or services must contemplate payment from the very beginning. If his intention is not to charge any money for goods or services, then he cannot recover for his work or goods.

**Examples -**

1. A was managing the 'estate' of his uncle B expecting remuneration for his services. In this case, A is entitled to receive compensation for his services.

2. A purchased a TV set for giving it as a gift to B, his nephew. He went to his house and left the TV set without saying anything. B installed the TV set in his house. Later on A changed his mind and demanded payment from B for the TV set. In this case, he may not recover the price of TV set as his original intention was not to charge for it.

3. The other person has enjoyed the benefits of goods or services so provided. The benefit must be a direct benefit which is accepted voluntarily by the person to whom it is provided.

**Examples-**

1. Certain villages were irrigated by a tank. Some of the villages were under State tenancy whereas others under Zamindars. Government repaired the tank for its preservation. the Zamindars also enjoyed the benefit thereof. Since the Government had no intention to do so gratuitously for Zamindars, Here, the Zamindars were liable to contribute for the repair

2. A Railway company carried out some land development for its own purpose. Consequently, the adjoining land also got developed and the Municipality started receiving more taxes from the developed area. Railway company filed a suit upon Municipality to contribute to the development charges. Here, the benefit derived by the Municipality was not direct. Thus the Railway company was not entitled to recover contribution from Municipality

*The effect of the provision is that:*

1. The person who has enjoyed the benefit of the act of some other person, done with the expectation of return for it, is bound to make compensation for it. However, he is not bound to pay for the same, if he had no option of refusing the goods or services offered by that other person.

2. The person who does something for the other (without being asked to do so) with the expectation of getting a compensation for it, can claim his rightful compensation from him. However, he can neither sue for 'specific performance' of the contract, nor ask for damages for breach of the contract.

3. The section does not apply where goods or services are provided to a person incompetent to contract.

**8.2.4 Responsibility of Finder of Goods**

Section 71 of the Indian Contract Act, 1872, provides that, "A person who finds goods belonging to another and takes them into his custody, is subject to the same responsibility as a bailee."

The above provision applies when -

*A person finds certain goods belonging to some other person,* and take them in his custody.

The effect of the provision is that -

In such a case, law implies an agreement between the owner and finder of goods. This agreement confers certain rights and duties on the part of the finder of goods which are discussed below.

***A. Duties of the finder***

1. *A finder of lost goods is under no obligation to take charge of them, no matter how valuable the goods are. If however, he takes charge of the lost goods, he is liable to:*

- try and find out the true owner,
- not to appropriate the property to his own use, and
- when the real owner is traced, he must restore the property to him.

*Note: If the finder does not take these measures, he will be guilty of criminal misappropriation of the property under section 403 of the Indian Penal Code.*

2. *The finder is bound to take as much care of the goods as a man of ordinary prudence would have under similar circumstances, taken care of his own goods of the similar nature [Section 151].*

*Note: Section 71 enumerates that responsibilities of a finder of goods are akin to that of a bailee. These shall be discussed in detail in the Chapter 12 on 'Bailment and Pledge'.*

***B. Rights of the finder***

1. *The property in goods shall vest in the finder and he is entitled to retain it against the whole world, except the true owner.*

   **Example** - A picked up a diamond from the floor of B's shop and handed it over to B to keep it till the owner is found. Even after making best efforts, the true owner could not be found. After sometime, A tendered to B, all lawful expenses incurred in finding the true owner and asked him to return the diamond. B refused to do so. Here, A was finder of diamond, and if the true owner is not traceable, he is entitled to keep the diamond against the whole world. Thus B had to return the diamond to A.

   **Comment -** *When we say that the finder has custody of goods, it means that he has taken charge of the goods, it does not mean physical custody only. Thus in the above case, by keeping diamond with the shopkeeper, A has not parted with its custody in terms of section 71.*

2. *The finder has a lien on goods for expenses incurred by him in preserving the goods and finding the true owner.*

   **Example -** A finds certain goods and advertises to find out the true owner. The owner claims the goods but refuses to pay the cost of advertisement and other expenditure incurred by A. Here A can exercise lien over the goods and can sell them to reimburse himself for the lawful charges incurred by him.

*Note: It may be noted that the finder can retain the goods until he receives such compensation but he cannot file a suit for recovery of this money.*

3. *Where the owner has offered a reward for recovery of lost goods, the finder may claim such reward, and may retain the goods until he gets it.*

   **Example -** A offered a reward of Rs. 1,000 to the finder of his lost dog. B found the dog. B can claim Rs. 1,000 from A for returning the dog, and may retain the dog with him till he gets the money.

   *Note: It may be noted here that the finder should have knowledge of the offer for reward to claim it.*

4. *Where the owner of goods refuse to pay the lawful charges to the finder, he can sell the goods in either of the following cases:*

   - when the goods are in danger of being perished.
   - when the lawful charges of the finder, in respect of the thing found, amount to two-thirds of its value or more.

### 8.2.5 Liability of a Recipient of Goods Delivered by Mistake or Under Coercion

Section 72 of the Indian Contract Act, 1872, provides that, "A person to whom money has been paid, or anything delivered, by mistake or under coercion, must repay or return it." The above provision applies when:

*1. A payment has been made or goods have been delivered by mistake to some person. The mistake may be a mistake of law, or a mistake of fact.*

**Example -** A, a lessee in a mining lease paid the royalties at a higher rate though he was supposed to pay at a lower rate. Here, the money paid under mistake of law can be recovered under section 72.

*2. A payment has been made or goods have been delivered under coercion to some person. The word 'coercion' is used in section 72 in its general sense i.e., under pressure, and not as defined in section 15 of the Contract Act:*

**Example -** Certain goods belonging to A, a consignee, were lying with a railway company. The railway company refused to deliver the goods to the consignee unless some illegal charges for carriage are paid. The consignee paid the charges in order to obtain the goods. Here A was forced (it will be considered coercion) to pay the charges to the railway company which were illegally excessive. A is entitled to recover the same from the railway company.

*The effect of the provision is that:*

When a person pays certain money or delivers certain goods under mistake or coercion, to the other, the person to whom it has been so paid or delivered is bound to return the same.

**Example -** A and B jointly owed Rs. 100 to C. A paid Rs. 100 back to C. B, not knowing this fact also paid Rs. 100 to C. In this case, C is bound to pay back Rs. 100 to B paid to him by mistake.

Similarly, the money paid to a wrong person due to abona fide mistake can be recovered back.

**Example -** A paid some money to B by mistake which was due to C. In this case, A is entitled to recover his money from B.

### 8.3 Failure to Discharge Obligations Created by Quasi Contracts

Section 73 of the Indian Contract Act, 1872, provides that, "When an obligation resembling those created by contract has been incurred and has not been discharged, any person injured by the failure to discharge it, is entitled to receive the same compensation from the party in default, as if such person had contracted to discharge it and broken his contract."

An obligation created by a quasi contract is on the same footing as an obligation created by a valid contract actually entered into by the parties concerned. If a person fails to discharge these obligations, then it is treated as a breach of contract and he shall be liable to pay the compensation for the breach of contract.

**Example -** A supplied certain goods to B by mistake. B used the goods as his own. In this case, A is entitled to recover the compensation from B.

# Part - 9

## Performance Of Contracts

**STRUCTURE OF PART - 9**

### 9.1 OBJECTIVES

After reading this Unit, you should be able to understand:

- When a contract is said to be performed
- What are the rules regarding performance of a joint promise and a reciprocal promise
- What is meant by 'appropriation of payments'
- What is 'assignment' and what is its legal impact

### 9.2 Actual or Attempted Performance

The primary duty of contracting parties is to perform their respective contractual obligations.

Section 37 of the Indian Contract Act, 1872, provides that, "The parties to a contract must either perform, or offer to perform, their respective promises, unless such performance is dispensed with or excused under the provisions of this Act, or of any other law."

Thus a contract is said to be performed, when parties make:

1. Actual performance, or
2. Attempted performance (i.e., 'offer to perform' or 'tender to perform').

Law requires this performance to be made, unless it is excused under the provisions of Indian Contract Act, 1872, or any other law in force.

#### 9.2.1 Actual Performance

A party to a contract is said to have actually performed his promise when he has fulfilled all his obligations under the contract. Actual performance brings the contract to an end.

**Example-** A enters into a contract to sell his car to B. A delivers his car to B and B pays promised money to A. Here actual performance has taken place.

### 9.2.2 Attempted performance

Sometimes it happens that the promisor is ready and willing to perform his promise, and offers to perform the same, but promisee refuses to accept it. The motive of the party 'offering to perform' or 'tendering to perform' is to perform the promise. Thus a valid tender of performance is equivalent to the performance of promise, and it discharges a party from his obligations under a contract.

**Example -** A enters into a contract to sell his car to B. A offers to deliver his car to B but B refuses to accept it. It is a tender of performance made by A. By offering the car, A has completed his part of promise.

### 9.2.3 Essentials of a Valid Tender of Performance

A tender of performance is valid if it satisfies the following conditions:

***(1) It should be unconditional [Section 38] -*** The tender of performance must be unconditional. If a tender is accompanied by a condition, which prevents it being a perfect and complete tender, the other party is entitled to reject it.

**Example -** A owed Rs. 5000 to B. He offered to pay Rs. 5000 to B, provided B was ready to rent his house to C. here A's offer of performance is conditional. It is not a valid tender, and B is entitled to reject it.

***(2) It must be entire and not of a part only -*** The offer of performance must be of a whole payment or performance that is due. Thus by rejecting a part payment, the offeree does not lose his right to demand performance. However, he has an option to accept part payment without prejudice to claim his remaining balance.

**Example-** A owed Rs. 5000 to B. He offered Rs. 3000 to B to set off a part of the debt. This is not a valid tender of performance. By refusing to receive this, B does not lose his right to claim Rs. 5000 from A.

***(3) It must be made at proper time and place [Section 38] -*** An offer to perform at time or place which is not proper cannot constitute a valid tender of performance.

**Examples:**

1. A owes B Rs. 1000 payable on 1st of December with interest. On 1st June A offers to pay the amount with interest up to 1st of June. It is not a valid tender because it is made before the due date.

2. A of Delhi contracts with B to deliver 500 bales of cotton at his mill in Faridabad. After 5 days, A sends requisite quantity and quality to B's office in Connaught Place. This is not a valid tender of performance.

*Note: What is proper time and place for performance of a contract is either decided by the terms of contract, or by the rules settled by law in this context. These are discussed in detail in this chapter under the heading 'Time and Place for performance'.*

***(4) The person making the tender must be able and willing to perform it -*** A party making a tender to perform must be in a position and must have a will to perform it.

**Examples:**

1. A offered, by letter to pay the amount due to B. It is not a valid tender. A valid tender of money in payment must be made with actual production of money.

2. A offered to deliver 100 pair of shoe to B under a contract, while he had only 50 pair of shoe in his possession. Here A is not in a position to perform what he is offering. It is not a valid tender.

***(5) The tender must provide reasonable opportunity to the other party -*** The party to whom the tender of performance is offered must have an opportunity to ascertain:

(i) that the party making the tender is able and willing to perform it, and

(ii) that the things offered are same as agreed.

**Example** - Under an agreement to supply goods, A offered goods to B at such a late hour of the appointed day that B had no time to inspect them. The court held that it was not a valid tender.

***(6) The tender must be made to the proper person -*** It must be made to the promisee or his duly authorized agent. Tender made to a stranger is invalid.

**Example -** A owed Rs. 5,000 to B. He offered Rs. 5,000 to C, a close friend of B. Here the tender is not valid, because although C is a friend of B, but B has not authorized him to collect his payment from A.

***(7) Tender in case of joint promises -*** If there are several joint promises, an offer to perform made to anyone of them is valid tender.

**Example-** A owed Rs. 6,000 to X and Y. A offered to pay Rs. 6,000 to Y. It is a valid tender. Note that although an offer of performance made to one of the joint promisees work as a valid tender of performance, when it comes to the actual performance, it must be made with respect to all the promisees jointly. Thus, in the above example, if Y refuses to take Rs. 6,000 - A stands discharged. But if Y accepts it, A is not discharged as against X.

***(8) Tender in terms of money -*** A tender of money must be in legal tender money, and not in any foreign currency, or exchange or cheque. However, a payment by cheque is valid if the person to whom it is made is ready and willing to accept it. Also, tendering a smaller or larger amount is an invalid tender, e.g., offering 100 rupee note to conductor of bus for payment of Re. 1 is not valid tender.

**Example -** A agreed to purchase B's scooter for Rs. 10,000. A offered some jewelry worth Rs. 10,000 and asked him to deliver the scooter. It is not a valid tender of performance. B can very well refuse to deliver the scooter to A.

### 9.2.4 Effect of Refusal to 'Tender of Performance'

Section 38 of the Indian Contract Act, 1872, provides that, "Where a promisor has made an offer of performance to the promisee, and the offer has not been accepted, the promisor is not responsible for nonperformance, nor does he thereby lose his rights under the contract."

When one party tender the performance of his promise, and the other party refuse to accept it, the former party is discharged from his liability. He is excused from performance and becomes entitled to sue the latter for breach of contract.

**Example -** P promised to deliver 50 quintals of rice to R within a week at R's place of business. R promised to pay Rs. 25,000 for the same. After 3 days P send a truck containing 50 quintals of rice to R's place of business. R refused to take the delivery of goods. Here P is relieved from performance of the contract, because he has made an offer of performance which was rejected by R. Now P can sue R for breach of contract.

It may be noted that in case of payment of a debt, the rejection of a valid tender of money by the creditor will not discharge the debtor from the liability for repayment of the debt. But he is not liable for the interest on the same from the date of valid tender.

**Example -** A bought goods from B, and promised to pay Rs. 1000 to B on 10th January. A went to B on 10th January to give Rs. 1000 to him but B did not accept it. Here, though A may not be discharged from payment of Rs. 1000 but he would not be liable to pay any interest thereon from 10th January onwards.

## 9.3 WHEN LAW EXCUSES NON-PERFORMANCE OF CONTRACT

Non-performance of a contract is excused by law in the following cases:

1. When contract is discharged by any mode (other than performance) - We will study various modes of discharging a contract in the next chapter.

2. When promisee neglects to afford reasonable facilities for performance to the promisor.

Section 67 of the Indian Contract Act, 1872, provides that, "If any promisee neglects or refuses to afford the promisor reasonable facilities for the performance of his promise, the promisor is excused by such neglect or refusal as to any non-performance caused thereby."

**Example -** A contracts with B to repair B's house. B neglects or refuses to point out to A the places in which his house requires repair. A is excused for the non- performance of the contract, if it is caused by such neglect or refusal.

## 9.4 WHO SHOULD PERFORM THE CONTRACT

A contract may be performed by -

(1) the promisor himself, or
(2) his legal representative, or
(3) his agent, or
(4) a third person, subject to its acceptance by promisee.

***(1) Promisor himself -*** Section 40 of the Indian Contract Act, 1872, provides that, "If it appears from the nature of the case that it was the intention of the parties to any contract that any promise contained in it should be 'performed by the promisor himself, such promise must be performed by the promisor. In other cases, the promisor or his representatives may employ a competent person to perform it."

Thus a contract has to be performed by the promisor himself, and none else, when:

- there is something in the contract to show that personal performance was intended, or
- by its very nature it requires personal performance by the promisor, like a contract to marry, or a contract to paint, or sing, etc.

In such cases, death of the promisor puts an end to the contract. It cannot be enforced against or by his legal representatives.

**Examples:**

1. A promised to buy 100 Kg. of rice from B @Rs. 25 per Kg. A specifically made it clear that he want to deal with B only, and none else. B dies before delivering rice. Contract comes to an end although the agreement does not involve any personal skill. Here the 'intention of the parties' is supreme.

2. A promised to paint a picture for B for Rs. 2000. A died before completing the painting. No contract exists after his death. His legal representative cannot complete the picture and demand payment.

***(2) Legal Representatives of the promisor -*** The rule laid down in section 37 is that, "promises binds the representatives of the promisors in case of death of such promisors before performance."

Where personal skill or volition (i.e. choice) is not involved in a contract, the legal representatives of a deceased promisor are bound to perform the contract entered into by him. However, their liability is confined to the extent of the ***assets*** obtained from the deceased. In any case, they cannot be held liable personally.

**Examples:**

1. A promised to buy 100 Kg. of rice from B for Rs. 25 per Kg. B dies before delivering rice. In this case, B's representatives are bound to deliver. 100 Kg. of rice to A at the decided time and rate.

2. A borrowed Rs. 1 lakh from B, and promised to repay the same within two months. After a month he died. A left assets worth Rs. 50,000 only. His legal representatives are bound to repay his debt to B. But the repayment can be to the extent of Rs. 50,000 only, because this is all A has left.

***(3) Agent -*** Para 2 of section 40 provides that, "the promisor or his representatives may employ a competent person to perform it."

Where personal skill or volition (i.e. choice) is not involved in a contract, and the promisor, opt to perform the contract through an agent, he can make a valid performance by doing so.

**Example -** A promise to sell 100 Kg. of rice to B. A can appoint an agent to buy 100 Kg. of rice from the market and deliver it to B's place on his behalf. This will constitute a valid performance by A.

***(4) Third person -*** Section 41 of the Indian Contract Act, 1872, provides that, "When a promisee accepts performance of a promise from a third person, he cannot afterwards enforce it against the promisor."

This section applies when a contract is performed by a stranger to the contract. In such a case, promisee has an option to reject it. But once the performance made by third person is accepted by the promisee, the contract comes to an end, and the promisor is discharged from further liability.

**Example -** A borrows Rs. 10,000 from B and promises to repay the same within a month. After 15 days C, the father of A, pays Rs. 10,000 to B against A’s borrowed. B accepts the money. Here A is discharged from his liability to repay Rs. 10,000 to B.

For applicability of section 41, it is essential that the performance under the contract should be in full, and not in part.

**Example -** When A received Rs. 5,500 out of total price of Rs. 7,600 for the timber supplied to B, from a third person towards the price of timber, it being not a full payment or performance, the court held that section 41 is not applicable here. Therefore A is allowed to sue B for Rs. 7,600, and not for the balance (i.e., 7600-5500 = 2100).

However, if a promisee accepts from a third person a lesser sum in full satisfaction of a claim against the promisor, thereafter the promisee cannot recover the balance from the promisor.

## 9.5 WHO CAN DEMAND PERFORMANCE

The performance of a contract can be demanded by :

(1) promisee, or
(2) his legal representative.

***(1) Promisee -*** Promisee is the only person who can demand performance of a promise under a contract. A third person cannot demand the performance even if a promise is made for his benefit.

**Example -** A promised B that he will give Rs. 1000 to C. If A does not give this money to C, only B can demand the performance, C cannot do so inspite of being beneficiary under the contract.

***(2) Legal representative(s) of the promisee -*** When a promisee dies, his legal representative(s) steps in to his shoes. And where personal skill or volition (i.e. choice) is not involved in a contract, the legal representatives of the deceased promisee can demand performance of the contract.

**Example -** A promised to buy 100 Kg. of rice from B for Rs. 25 per Kg. B died before the contract could be performed. In this case, legal representatives of B can demand performance from A.

## 9.6 TIME AND PLACE FOR PERFORMANCE

Rules as to time and place for performance - The rules regarding time and place of performance of a promise are contained in sections 46 to 50, and section 55 of the Indian Contract Act, 1872. These are discussed below:

***(1) Where no time is specified and no application is to be made -*** Section 46 of the Act provides that, "Where, by the contract, a promisor is to perform his promise without application by the promisee, and no time for performance is specified, the engagement must be performed within a reasonable time."

*'Application by the promisee' means that a promisee has to apply to or call upon the promisor to perform the promise.*

Thus where a contract does not specify any time for its performance, and the promisee is not supposed to ask for performance, the contract must be performed within a reasonable time. What is *'reasonable* time' is a question of fact in each case.

***Example -*** M agreed to discharge a debt of S towards a third party, failing which he was to pay such damages as S might have sustained. No time was fixed for performance. Three years lapsed and M did not perform since then. Here, three years was sufficient and reasonable time for performance of this contract, and M is liable to pay damages to S.

**(2) Where time is specified but no application has to be made-** Section 47 of the Indian Contract Act, 1872, provides that, "When a promise is to be performed on a certain day, and the promisor has undertaken to perform it without application by the promisee, the promisor may perform it at any time during the usual hours of the business on such day and at the place at which the promise ought to be performed."

When the day for performance is specified in the contract, and the promisor himself has to perform the promise without being asked by the promisee, the promise may be performed during the usual hours of business on the specified day.

**Example -** A promised to deliver goods at B's warehouse on 1st February. On that day A brings the goods to B's warehouse after usual hours of closing it. Thus goods could not be received by B. Here A has not performed his promise as the goods were not delivered during the usual hours of business.

**(3) Where the time is specified and application is to be made -** Section 48 of the Indian Contract Act, 1872, provides that, "When a promise is to be performed on a certain day, and promisor has not undertaken to perform it without application by the promisee, it is the duty of the promisee to apply for the performance at a proper place and within the usual hours of business."

Sometimes, the day for performance is specified in the contract and the promisor has to perform it only on being asked by the promisee. In such cases, the promisee must make a demand for the performance to the promisor at proper time and place, and within usual hours of business.

The term *'proper time and place'* is a question of fact in each particular case. Example - A promised to deliver 100 tins of ghee on a fixed date. B agreed to specify later on the place and time for delivery of tins. In this case, it is duty of B to inform A about the time and place of delivery.

***(4) Where no place is specified and no application is to be made*** - Section 49 of the Act provides that, "When a promise is to be performed without application by the promisee, and no place is fixed for the performance of it, it is the duty of the promisor to apply to the promisee to appoint a reasonable place for the performance of the promise, and to perform it at such place."

When no place is fixed for the performance and the promisor himself has to perform the contract without being asked to do so, he must first apply to the promisee to appoint a reasonable place for performance. Thereafter he should perform at the place so appointed.

**Example-** A agreed to supply 100 bags of rice to B on a certain day, but no place was fixed for the delivery. In this case, A must ask B for the place of delivery, and supply the rice at the place so decided.

*The rule given in section 49 applies only when no place is fixed for the performance. Where the place is fixed either* expressly *or by implication, the rule mentioned in Section 49 has no application.*

***(5) Where manner and time for performance is prescribed by the promisee -*** Section 50 of the Indian Contract Act, 1872, provides that, "The performance of any promise may be made in any manner, or at any time which the promisee prescribes or sanctions."

**Examples:**

1. B owed A Rs. 2000. A told B that he should deposit this money directly to his bank account in 'X' bank. B deposited money to this account of A. Before A came to know about the transfer, the bank failed. In this case, the payment made by B is a good payment, and A cannot demand the payment again.

2. A owed B Rs. 5000. B desired A to send him a cheque for Rs. 5000 by post. Accordingly A drew a cheque in favour of B and posted the same to his address. In this case the debt is discharged as soon as the envelope containing the cheque is posted by A.

### 9.6.1 Effect of Failure to Perform in Time

The parties to a contract may stipulate that the contract is to be performed within a certain period or time. If one party fails to perform his obligation within such stipulated time, the question may arise - can the other party to the contract rescind the contract on this ground? The answer to this question will depend upon whether 'the time was the essence of the contract'. If time is essence of the contract, the other party can avoid it for its non-performance within that time, otherwise the contract cannot be avoided on this ground.

How to determine whether time is essence of contract - When it is stipulated expressly that time is essence of the contract, there remains no ambiguity about it. But, mere fact that a certain time is stipulated in the contract for its performance does not necessarily make time an essence of the contract. Whether time, in fact, is of essence of a contract or not depends upon:

(i) The terms of the contract

(ii) The intention of the parties, which can be gathered from:

(a) surrounding circumstances,

(b) nature of the subject matter of contract,

(c) construction of the contract.

(iii) The object which the parties had in mind while entering into the contract.

Some well settled presumptions as to the importance of time according to the nature of a contract are discussed below.

In mercantile transactions, stipulations as to time of giving or taking delivery of goods are presumed to be of essence, but stipulations as to time of paying the price of the goods is not deemed to be of essence of a contract.

In contracts of sale of immovable property time is not generally of the essence of a contract. But where circumstances show that time was essence of the contract, e.g., where the sale of immovable property specifically was for the purpose 'of a marriage to take place on a certain date, time is of essence to the contract.

Renewal of lease is something different from the sale of immovable property. Here time is considered as of essence to the contract.

**Example -** C, the lessee of a petrol pump had to apply for the renewal of the lease within a time fixed by the contract. He was late by 10 days in his application for renewal. The landlord refused to renew. The court held that the renewal of lease is a privilege and it must be obtained strictly within the time limited for the purpose. Thus the lessor was not bound to renew the lease.

***(1) Effect of failure to perform in a fixed time when time is essence of contract -*** In such cases, the contract becomes voidable at the option of the promisee. If he choose to rescind the contract, the contract comes to an end, and he can sue for the damages. If he choose to accept the performance at any time other than agreed time, there may be two possible circumstances:

(i) He accepts the performance without any objection. Here he cannot claim compensation for any loss caused to him by such non-performance in time.

(ii) He accepts the performance but at the time of such acceptance, he gives a notice to the promisor that he is going to claim compensation for the damages he has sustained because of his non-performance in time.

**Example -** C, who carried on import business contracted with B to supply certain quantity of Italian cotton. The shipment was to take place in October or November, where date of shipment was subject to import license, and hence was not guaranteed. Subsequently, a part of goods could not be supplied within time mentioned. The buyer wanted to avoid the contract on this ground. The court held that 'in spite of the remark that shipment date was not guaranteed, time was of the essence and the buyer was entitled to avoid the contract'.

***(2) Effect of failure to perform when time is not essence of the contract-*** In such cases, the contract does not become voidable at the option of the promisee. However, he has a right to receive compensation from the other defaulting party for any loss caused to him by the delayed performance.

**Example -** A singer agreed to perform at a theatre for a certain reason and to be present at least six days before the commencement of this engagement. But he reported only two days before. The theatre owner sought to put an end to the contract. Here, this delay was not affecting the substance of the contract. Hence the contract could not be put to an end. However, the theatre owner was allowed to recover compensation for any loss suffered by him due to such delay.

*Note: It may be noted that the promisor should not delay the performance beyond a reasonable time even when the time is not of essence to the contract, otherwise the contract will become voidable at the option of the promisee.*

## 9.7 JOINT PROMISES

What is a joint promise - Where more than one person constitutes a single party to a contract, the promise under the contract is considered as a joint promise. It may take any of the following forms:

(i) Several joint promisors make a promise with a single promisee, e.g., A, B and C jointly promise to pay Rs. 9,000 to D.

(ii) A single promisor make a promise with several joint promisee, e.g., A promises to pay Rs. 9,000 to Band C jointly.

(iii) Several joint promisors make a promise with several joint promisee, e.g., A, B and C jointly promise to pay Rs. 9,000 to D and E.

### 9.7.1 Who can demand performance of joint promises

Section 45 of the Indian Contract Act, 1872, provides that, "when a person has made a promise to two or more persons jointly, then unless a contrary intention appears from the contract, the right to claim performance rests, as between him and them, with them during their joint lives, and after the death of any of them, with the representative of such deceased person jointly with the survivor or survivors, and, after the death of last survivor, with the representatives of all jointly."

Thus the right to demand performance lies with the promises jointly. In case a promisee dies, his legal representative will step into his shoes.

**Example -** A in consideration of Rs. 5,000 lent to him by Band C, promises to repay them within a certain time. In this case, following alternate circumstances may be considered:

(i) When Band C both are alive, they can demand the performance jointly.
(ii) When B dies, his legal representative Q can demand the performance with C jointly.
(iii) When C also dies, his legal representative Rand B's representative Q both can demand the performance jointly.

It may be inferred from the above that in case of joint promises, even a single promisee should not be left out while demanding performance. There is an exception to this rule.

In the case of a debt due to a partnership firm, if a partner dies, the surviving partners can sue to recover it without joining the heirs of the deceased partner.

### 9.7.2 Who should perform a joint promise?

When one person makes a promise, it is his responsibility to perform it. But when two or more persons jointly make a promise, a question arise as to who is responsible to perform it.

***(1) All promisors must jointly fulfill the promise-*** Section 42 of the Indian Contract Act, 1872, provides that, .When two or more persons have made a joint promise, then, unless a contrary intention appears by the contract, all such persons, during their joint lives, and after the death of any of them, his representative jointly with the survivor or survivors, and after the death of the last survivor, the representatives of all jointly, must fulfil the promise."

Thus joint promisors, during their lives must fulfill the promise jointly. If any of them dies, his representative must jointly with the surviving promisors, fulfil the promise and soon.

**Example -** A, B and C jointly promise to pay Rs. 6,000 to D. Here A, B and C must jointly perform the promise. If A, dies before performance, his legal representative must jointly with B and C perform the promise, and so on. In case all three (A, B and C) die before performance, the legal representatives of all of them must perform it jointly.

However, if the parties expressly or impliedly prescribe a different rule in the agreement, then the above rule will not apply.

**Example-** A, B and C jointly promise to pay Rs. 6,000 to D. They agree that in case of death of any of the joint promisors, only the survivor would be liable for the performance. In this case, if A dies, only B and C would be liable for the performance.

***(2) Anyone of the joint promisors may be compelled to perform -*** Para one of section 43 of the Indian Contract Act, 1872, provides that, "When two or more persons make a joint promise, the promisee may, in the absence of express agreement to the contrary, compel anyone or more of such joint promisors to perform the whole of the promise:

Thus the liability of joint promisors is joint and several as against the promisee, unless there is a contract to the contrary.

**Example -** A, B and C jointly promise to pay Rs. 9,000 to D. Here D may compel either A or B or C or all of any two of them to pay the agreed sum.

*Notes:*

1. *When a promisor has a number of heirs, the liability necessarily falls collectively on them. For example, suppose A dies and P and Q inherit his property. In this case, performance can be demanded from both of them (in place of A) jointly, as none of them is individually*

*liable. They are not joint promisors, they are co-heirs.*

2. *If a promisee choose anyone promisor to claim performance of the contract, and gets a decree against him but even after that fails to realise the full amount, he can bring a second suit against the other co-promisors for the balance, say in the above example, if D gets a decree against B but could realise only Rs. 5,000, he can bring a suit on A or C or A and C, for rest of Rs. 4,000.*

### 9.7.3 Rights and Liabilities Amongst Joint Promisors

Joint promisors are liable to perform their promise jointly. In case any of them performs more than his share of obligation, he has right over the others and others are liable to him according to their respective obligations.

***(1) Joint promisors are liable to contribute equally -*** Para two of section 43 of the Indian Contract Act, 1872, provides that, "Each of two or more joint promisors may compel every other joint promisor to contribute equally with himself to the performance of the promise, unless a contrary intention appears from the contract."

Thus, if one joint promisor is made liable to perform the whole promise, he may recover equal contribution from the others, provided they have not agreed differently on this issue.

**Example -** A, B and C jointly promised pay Rs. 9,000 to D. D filed a suit against A, and recovered Rs. 9,000 from him. Now A can claim Rs. 3,000 each from B and C.

***(2) Joint promisors liable to share losses equally -*** Para three of section 43 of the Indian Contract Act, 1872, provides that, "If anyone of the two or more joint promisors makes default in such contribution, the remaining joint promisors must bear the loss arising from such default in equal shares."

Thus if any of the joint promisors make a default in his contribution to the joint liability, the remaining joint promisors must bear the deficiency in equal shares.

**Example -** Considering the above example, C is liable to pay Rs. 3,000 as his contribution. If his estate is not able to pay more than Rs. 1,500, in this case the deficiency of Rs. 1,500 (3000 - 1500) will be shared by A and B equally. Thus the contribution of A, Band C will be Rs. 3,750, Rs. 3,750 and Rs. 1,500 respectively.

***(3) The contribution rule does not apply to principal debtor and surety -*** Explanation to section 43 of the Indian Contract Act, 1872, provides that, "Nothing in this section shall prevent a surety from recovering from his principal, payments made by the surety on behalf of the principal, or entitle the principal to recover anything from the surety on account of payments made by the principal."

When a creditor ask the principal debtor to furnish a surety for repayment of the loan, the principal debtor and surety are considered as joint promisors to the creditor. But the above rule of contribution does not apply to a surety and principal debtor even though they are joint promisors.

In such a case, legal position is that the creditor can recover entire amount of loan either from principal debtor or surety:

- *when he recovers the loan from surety, surety can in turn recover the whole amount from the principal debtor, and*
- *when he recovers the loan from the principal debtor, he cannot claim anything from the surety.*

**Example -** A takes a loan of Rs. 1 lakh from 'X' Bank where B stands as a surety to the bank for repayment of loan by A. A fails to repay the loan. 'X' sue B and recovers the money from him. Here B in turn can recover Rs. 1 lakh from A because principal liability falls upon A only.

***(4) Effect of release of one of the joint promisors by the promisee -*** Section 44 of the Indian Contract Act, 1872, provides that, "Where two or more persons have made joint promise, a release of one such joint promisors by the promisee does not discharge the other joint promisor or joint promisors; neither does it free the joint promisor so released from responsibility to the other joint promisor or joint promisors."

Thus when a promisee release one of the joint promisors from the liability, it does not release the other joint promisors from their responsibility to perform. And the released joint promisor remains liable to the other joint promisors.

**Example -** A, B and C promised to pay Rs. 9,000 to D. D released A from liability. Here Band C remain liable to pay the entire amount of Rs. 9,000 to D. However, A is liable to make his contribution (Rs. 3,000) to B and C.

## 9.8 RECIPROCAL PROMISES

What is reciprocal promise - When one party gives a promise in consideration of other party's promise, both the promises are called reciprocal promises.
Section 2(t) of the Indian Contract Act, 1872, provides that, "Promises which form the consideration or part of consideration for each other are called reciprocal promises." Reciprocal promises may take any of the following forms:

(i) *Mutual and concurrent promises* - Where parties have to perform their promises simultaneously at the same time.

**Example -** A agrees to sell a car of Rs. 1 lakh, price to be paid on delivery. The promise is mutual and concurrent.

(ii) *Conditional and dependent promises-* Where the performance of a promise by one party depends upon the prior performance by the other party.

**Example -** A agrees to construct a bungalow for B. B agrees to supply cement required for building the bungalow. Here performance of A needs prior performance by B. The promises are conditional and dependent.

(iii) *Mutual and independent promises -* Where one party has to perform his promise independently without waiting for the performance or willingness to perform at the end of other party.

**Example -** A agrees to sell a car and delivers it to B on 1st June, 1998, while B agrees to pay Rs. 1 lakh for it on 15th June, 1998. The promises are mutual and independent.

### 9.8.1 Rules regarding performance of reciprocal promises

***(1) Performance of 'Mutual and concurrent' promises -*** Section 51 of the Indian Contract Act, 1872, provides that, "When a contract consist of reciprocal promises to be simultaneously performed. no promisor needs to perform his promise unless the promisee is ready and willing to perform his reciprocal promise."

Thus a promisor is not bound to perform unless the promisee is ready and willing to perform.

**Example -** A and B entered into a contract that A shall deliver goods to B at a price to be paid by instalments, the first instalment to be paid on delivery.

A need not deliver the goods unless B is ready and willing to pay first installment on delivery.

B need not pay the first installment unless A is ready and willing to deliver the goods on payment of first installment.

*Note: What constitutes 'readiness and willingness to perform' depends upon the nature of transaction and facts of each case.*

***(2) Performance of 'conditional and dependent' promises -*** Section 54 of the Indian Contract Act, 1872, provides that, "When a contract consists of reciprocal promises, such that one of them cannot be performed or that its performance cannot be claimed till the other has performed, and the promisor of the promise last mentioned fails to perform it, such promisor cannot claim the performance of the reciprocal promise and must make compensation to the other party to the contract for any loss which such other party may sustain by the non-performance of the contract."

Thus when a party who is to perform first, fails to perform his part of promise, not only the other party is discharged from the obligation of his respective performance, he is also entitled to claim damages for such non-performance.

**Example -** A hires B's ship to convey, from Calcutta to Mauritius, a cargo to be provided by A, in consideration, B receiving a certain freight for his conveyance. A does not provide any cargo for the ship. A cannot claim the performance of B's promise, and must make compensation to B for the loss which B sustains by the non-performance of the contract.

***(3) Performance of 'mutual and independent promises' -*** These are to be performed by each party without waiting for the other to perform his promise. In case of default by any party, the other party can recover damages from the defaulting party, but any party cannot excuse himself from his performance.

**Example -** A and B contracted for sale of a desert cooler. A was to pay price on 1st June, 1998, and B was to deliver cooler on 15th June, 1998. A failed to pay price on 1st June. In this case, B cannot refuse to deliver the cooler on 15th June. However, he can file a suit against A for recovery of the price and damages.

***(4) Liability of the party preventing the other to perform his obligation -*** Section 53 of the Indian Contract Act, 1872, provides that, "When a contract contains reciprocal promises, and one party to the contract prevents the other from performing his promise, the contract becomes voidable at the option of the party so prevented; and he is entitled to compensation from the other party for any loss which he may sustain in consequence of the non- performance of the contract."

Thus if a party is prevented from performance by the other party to the contract, the prevented party has an option to avoid the contract and claim compensation from the latter. The rule is that - no man can complain of other's failure to do something which he has himself prevented the other from doing or performing. The principle is not confined to the acts of direct or forcible prevention, but extends to default or neglect in doing or providing anything without which the other party cannot perform his part.

**Example -** B contracted A to clear waste rock from B's mine within two years. The crusher for the purpose was to be supplied by B. The crusher supplied was so inadequate that the work had to be stopped. A recovered damages from B for the expenses which he incurred in preparing for the work, and for the loss of profit he would have otherwise made by supplying crushed stone to the third party.

*Notes:*

1. *Under this provision, the prevented party has an option to avoid the contract. If the party does not choose to avoid the contract, all the parties are left with their rights and liabilities as before.*
2. *Prevention in performance by third party does not confer any right to prevented party under this provision.*

***(5) Order of performance of reciprocal promises*** - Section 52 of the Indian Contract Act, 1872, provides that, "Where the order in which reciprocal promises are to be performed is expressly fixed by the contract, they shall be performed in that order;

and, where the order is not expressly fixed by the contract, they shall be performed in that order which the nature of the transaction requires:

If a contract expressly states the order of performance, that would govern the matter; if a contract is silent, one has to look to the nature of transaction in order to decide the order of performance. In the latter event, the court may look to the usual practice in the market also.

Subsequent conduct of the parties may not throw any light on the order in which the promises are to be performed.

**Examples:**

1. A and B contract that A shall build a house for B at a fixed price. Here the nature of contract is such that A's promise to build the house must be performed before B pays for it.

2. A and B contract that A shall sell his stock in trade to B at a fixed price, and B promises to give security for the payment of money. A need not perform it until the security is given, for the nature of transaction requires that A should have security for the price before he delivers the stock.

***(6) Legal and illegal reciprocal promises-*** Section 57 of the Indian Contract Act, 1872, provides that, "Where persons reciprocally promise, firstly, to do certain things which are legal. and, secondly, to do certain other things which are illegal. the first set of promises is a contract, but the second is void agreement.

**Example -** A and B agrees that A shall sell B a house for Rs. 10,000, but that, if B uses it as a gambling house, he shall pay A Rs. 50,000 for it. The first set of reciprocal promises, namely, to sell the house and to pay Rs. 10,000 for it, is a contract. The second set is for an unlawful object, namely that B may use the house as a gambling house, and is a void agreement.

This section applies only where there are two distinct severable set of promises, one legal and other illegal. If the parties treat both the kind of transactions as an indivisible whole, the court will regard them as not severable and so avoid the whole.

## 9.9 APPROPRIATION OF PAYMENTS

When a debtor owing several distinct debts to one person, makes a payment, which is. not sufficient to discharge all the debts, the question arises to which particular debt the payment is to be applied. The Act in sections 59 to 61 lays down the underlying principles.

***(1) Where debtor expressly indicates the debts to be discharged -*** Section 59 of the Indian Contract Act, 1872, provides that, "Where a debtor owing several distinct debts to one person, makes a payment to him, either with express intimation, or under circumstances implying that the payment is to be applied to the discharge of some particular debt, the payment, if accepted must be applied accordingly."

Appropriation is the right given to the debtor for his benefit. Thus where debtor states that his payment should be applied towards a particular debt, it has to be appropriated to that debt only. If there is no express intimation, the law will gather his intention from the circumstances.

**Examples:**

1. A owed to B Rs. 10,000 borrowed on 1st January, and Rs. 5,000 borrowed on 1st March. He paid Rs. 5,000 to B expressly intimating that he is repaying the second debt. Thus this payment can be appropriated towards the debt made on 1st March. Note: The express intimation must be at the time of payment, and not subsequently.

2. A owes B, among other debts, 1,000 rupees upon a promissory note, which falls due on the 1st June. On the 1st June A pays to B Rs. 1,000. The circumstances make it clear that the payment should be applied to discharge the promissory note.

***(2) Where the debt to be discharged is not indicated -*** Section 60 of the Indian Contract Act, 1872, provides that, "Where the debtor has omitted to intimate and there are no other circumstances indicating to which debt the payment is to be applied, the creditor may apply it at his discretion to any lawful debt actually due and payable to him from the debtor, whether its recovery is or is not barred by the law in force for the time being as to the limitation of suits."

When debtor does not specify the debt to be appropriated, the right of appropriation devolves upon creditor. The creditor would like to adjust the payment, which is not likely to be recovered. The law has given a privilege to him to appropriate the payments towards the debts, which have become time barred.

**Example -** A owed several debts to B. Among them, there was a debt amounting to Rs. 5,000 which became time barred (i.e., time limit to sue for recovery of debt was expired). A paid Rs. 10,000 to B without specifying anything. B has a right to appropriate Rs. 5,000 towards the time barred debt, and rest Rs. 5,000 towards other debts as per his discretion.

***(3) Where neither party makes an appropriation -*** Section 61 of the Indian Contract Act, 1872, provides that, "Where neither party makes any appropriation, the payment shall be applied in discharge of the debts in order of time, whether they are or are not barred by the law in force for the time being as to the limitation of suits. If the debts are of equal standing, the payments shall be applied in discharge of each proportionately." When debtor and creditor do not use their discretion to specify appropriation, law requires the payment to be adjusted in discharge of the earlier debts first. If there are several debts on the same date, the payment shall be adjusted against each proportionately.

**Example-** A owed three debts to B of Rs. 1,000, Rs. 2,000 and Rs. 3,000 taken on 1st March, 1st April and 1st May, respectively. On 1st July A paid Rs. 2,000 to B. In the absence of any specification, this payment will be adjusted as Rs. 1,000 towards 1st debt of Rs. 1,000, and Rs. 1,000 towards second debt of Rs. 2,000.

*Principal and interest - Where there is a debt carrying interest, money paid and received without any definite appropriation is to be first applied in payment of interest. If a debtor specifies that the money should be appropriated towards principal first, the creditor need not accept the payment on such terms. But once he accepts the payment, he will have to appropriate according to debtor's direction, whatever they are.*

Conclusions - From the above discussion, following conclusions may be drawn :

1. The debtor has, at the time of payment, first right of appropriating the payment.

2. If he fails, then, the option is now given to the creditor to elect the appropriation.
3. But when both the parties fail to appropriate, the law will appropriate in order of time.

## 9.10 ASSIGNMENT OF A CONTRACT

Assignment means transfer of contractual rights and liability by a party to the contract to some other person who is not a party.

R, a manufacturer and seller of 'Metal Sheets', enters into a contract with S. Under their agreement, R delivers 10,000 tons of. Metal Sheets, and S is yet to make payment of contract price worth Rs. 10 lakh.

Suppose R discovers that he needs money right away in order to pay for some raw materials. He may consider either selling his 'contract right to collect Rs. 10 lakh' from S or using the right as security for a loan. In either case, R's transfer of his right is called 'assignment', R himself is called the 'assignor', and the person to whom the right is sold is called the 'assignee'. S is referred to as a 'promisor'.

*Rules regarding assignment:*

Indian Contract Act, 1872, does not contain any specific section dealing with the 'assignment of contracts'. However an inference can be made from some provisions, like section 37 which enables the parties to dispense with performance should also enable them to assign their contractual obligations, and section 40 which requires the performance of contract involving personal performance to be made by the promisor himself, by implication, excludes the right of 'assignment' of such contracts. The rules settled in this regard, on the basis of English Law, and the past judicial decisions are discussed below:

**1.** Contracts involving personal skill, ability, credit or other personal qualifications cannot be assigned, like a contract to marry, or a contract to paint a picture, or a contract to sing.

**2.** The rights and benefits under a contract (not involving personal skill etc.) can be assigned.

3. An obligation or burden under a contract cannot be transferred to a third party. The promisor may have contracted with a particular person by reason of personal confidence which he reposed in him, and, therefore, he can object to the contract being performed by some other person. But when the promisor gives consent to such assignment by the other, it binds him to accept the performance from the assignee.

**Examples**:

(i) A owed Rs. 5,000 to B. Here A cannot assign his liability to C, and enforce B to recover his debt from C. However, if B agrees to accept C as his debtor in place of A, the liability shall stand transferred from A to C.

(ii) D agreed to take from S, a carriage for 5 years. At the end of 3 years, S assigned his business together with the D's contract to R. On learning ",pout the assignment, D refused to abide his contract and returned the carriage. Here, D was entitled to do so because S could not compel D to look to R for the further performance of the contract.

4. An *'actionable claim'* can be assigned, provided it is made in writing. In such a case, it is advisable for assignee to give notice of such assignment to the debtor. Such a notice is useful from several points of view:

(i) It binds the debtor.
(ii) In the absence of notice, the debtor can make payment to the assignor himself which shall amount to a good discharge to him.
(iii) When assignor makes more than one assignment of the same claim, the assignee giving notice first, shall have priority over the others.

*What is an actionable claim* - It is a personal right of property which can only be claimed or enforced by action and not by taking physical possession. A money debt, shares in a company, right of action arising out of a contract, book debts, and an option to repurchase property sold are all examples of actionable claims. It is also known as 'chose in action'. It can be differentiated from a right to physical possession which is known as 'chose in possession'.

*'Chose in action' and 'Chose in possession'* differentiated - Sir John Salmond has given an illustration to differentiate the two, which is as follows. Supposing A has Rs. 10 note

in his pocket and a person forcibly removes it, A has a right to immediately catch the thief and to recover the note from that individual. This is 'chose in possession'. If, on the other hand, A has lent Rs. 10 to B, who has been evading the payment for a long time and A finds B with a note of Rs. 10 in his pocket. Can A forcibly take one of these notes? The answer is 'No'. The only right which A has is to go to a court of law, obtain a decree, arrest the person, or attach the property of B and try to recover the money. Here also A has right to Rs. 10 note, but it is 'chose in action' and not 'chose in possession'.

**5.** An assignment requires some consideration between the assignor and the assignee. In the absence of any consideration between them, the assignment will be revocable by the assignor. But when an assignment made as a gift has been completed by fulfilling essential formalities, it cannot be revoked.

**6.** Assignment of contracts may occur: (a) by act of parties, or (b) by operation of law. When it occurs by operation of law, it may be by insolvency of a person, where his rights and liabilities pass to an official assignee or official receiver as the case may be.

# Part - 10

## Discharge Of Contract

**STRUCTURE OF PART - 10**

## 10.1 OBJECTIVE

After reading this Chapter you should be able to understand:

- What are the various modes in which a contract can be discharged.
- Concept of doctrine of supervening impossibility
- Concept of anticipatory breach

## 10.2 DISCHARGE BY PERFORMANCE

A contract is discharged when parties to it perform their respective obligations under it. The performance may be actual or attempted. This has already been discussed in detail in the previous Unit.

## 10.3 DISCHARGE BY IMPOSSIBILITY OF PERFORMANCE

When performance of a contract becomes impossible due to factors beyond the control of parties, the contract stands discharged. Section 56 of the Indian Contract Act, 1872, deals with the contracts which are impossible to perform, under two different circumstances:

1. Where impossibility is existent at the time of making contract.

2. Where impossibility arises subsequently after the formation of contract.

### 10.3.1 Where Impossibility is Existent at the Time of Making Contract

When an agreement is made which is impossible to perform, it is void from its very inception. Such agreement does not come into existence as a contract. Thus there is no question of discharge of a contract, which never existed. Following are various alternative situations in this context.

1. *Fact of impossibility known to parties -* When a contract is entered into for performance of an act impossible in itself, like a contract to discover a treasure by magic, such contract is void.

2. *Fact of impossibility known to one party -* When a contract is entered into by a person to perform an act knowing that it is impossible, and the other party is not

aware of such fact, the contract is void. However, in such a case, if the latter party sustains any loss because of non-performance of the contract, former party would be liable to make compensation to him.

**Example** - A contracts to marry B while he is already married to C, and being forbidden by law from second marriage. Here although the contract does not give rise to any contractual obligation because it was not possible to be performed when it was made, but A is liable to make compensation to B for non-performance of the promise.

3. *Fact of impossibility unknown to the parties -* When both the parties are ignorant of the impossibility of performance at the time of contract, the contract is void for mutual mistake. For example, A, not knowing that his horse is dead, contracts to sell it to B. The contract is void.

**10.3.2 Where impossibility arises subsequently after the formation of contract**

Sometimes the performance of a contract is possible when it is made by parties. But some event subsequently happens which renders its performance impossible or unlawful In either case the contract becomes void. A contract gets discharged from the moment it becomes void.

Para 2 of section 56 of the Indian Contract Act, 1872, provides that, "A contract to do an act which, after the contract is made, becomes impossible, or, by reason of some event which the promisor could not prevent, becomes void when the act becomes impossible, or unlawful"

Thus a contract becomes void on the ground of subsequent impossibility only if the following conditions are satisfied:

1. The act should have become impossible, or unlawful.

2. The impossibility should have been caused by the circumstances beyond the control of the parties.

3. The impossibility should not be self-induced.

#### 10.3.3 Factors causing impossibility to performance

Various factors that can render performance impossible are discussed below:

***(1) Destruction of the subject matter -*** A common instance of impossibility occurs when something that is necessary to the promisor's performance is destroyed and cannot be replaced. For example, if a farmer promises to deliver tomatoes that are to be grown on a particular farm, destruction of the crop though no fault of the farmer will excuse its performance***.***

**Example -** C agreed to let out a music hall to T for a series of concerts. The hall was destroyed by fire before the date of first concert. Now T could not perform his concerts and sued C for breach of contract. Here, both parties were freed from their contractual obligations because the contract became void due to impossibility of performance.

Where only a part of subject matter of contract is destroyed, it does not absolve the promisor from performance of the contract, in respect of the subject matter, which has not been destroyed.

**Example -** A, a farmer promises to deliver B, 1 Lac Kg. of tomatoes that are to be grown on his farm. Part of the crop gets destroyed, and he could get only 10,000 Kg. of tomatoes from his farm. He sells these tomatoes to C at a higher price. Here A was bound to deliver 10,000 Kg. of tomatoes to B at contract price. B is entitled to sue A to claim damages for not selling him whatever tomato crop A had.

***(2) Failure of the ultimate purpose-*** Where the ultimate purpose for which the contract is entered into fails, the contract becomes void.

***(3) Death or personal incapacity of the promisor-*** If personal performance is required under the contract, it is excused by the serious illness or death of the promisor.

**Examples:**

1. A and B contract to marry each other. Before the time fixed for marriage, A goes mad. The contract becomes void.

2. An artist undertook to sing at a theatre on a particular day. But the artist being too ill could not sing on the day fixed for performance. Here, the contract was discharged due to personal incapacity of the artist, thus he was not liable to pay damages for non-performance.

***(4) A change in law, or government policy rendering further performance illegal*** - Another common situation in which performance becomes impossible occurs when, after a contract is formed, a law or regulation is adopted that makes performance illegal.

**Examples:**

1. An agreement was entered into between D and J relating to the sale and purchase of timber, which involved its import also. Subsequently the State declared import of timber illegal. Here, the whole contract had been discharged by the subsequent change in the law rendering the import of timber illegal.

2. A agreed to sell his land to B. Subsequently, that land was acquired by the Government, and A ceased to be owner of the land. Here, the contract was discharged because it was no more possible for A to sell that land.

***(5) Outbreak of war -*** A contract entered into with an alien enemy during war is void ab initio. A contract entered into before the outbreak of war, gets suspended during the war, and can be revived after the war, provided it does not become time barred. Creation of contract with an alien enemy during the war does not give rise to any contractual rights at all.

**Example -** An Indian firm entered into a contract with a Chinese firm to export 1 Lac Kg. of groundnuts. Before its execution could take place, China declared a war on India. The agreement became void and could not be executed. The parties are discharged from their respective obligations under the contract.

<u>*Some points to be noted:*</u>

1. If war is declared between the country of one of the parties to the contract and a third country, the contract remains binding.

2. Sometimes a party is guilty of delay in performing the contract, and the war is declared in the meantime, on such cases, the guilty party cannot avoid his liability under the contract on the ground of doctrine of supervening impossibility.

### 10.3.4 Effect of doctrine of supervening impossibility

When an untoward event occurs making performance of a contract impossible or unlawful-

1. The contract becomes void and stands discharged.

2. Where one contracting party has obtained a valuable benefit before the time of discharge by reason of anything done in performance of the contract by the other party, there shall be recoverable from the party so benefited such sum as the court considers just. Section 65 of the Indian Contract Act supports this view.

### 10.3.5 Non-Applicability of the Doctrine of Supervening Impossibility-

We have discussed above various factors, which makes performance of a contract impossible or unlawful, and discharge the parties from their contractual obligations. At times it happens that although the performance of a contract does not become absolutely impossible, it becomes more risky, burdensome, unprofitable or difficult. The contracting parties often try to take excuse of supervening impossibility to avoid performance of such contracts, but law denies the same. The circumstances where excuse of impossibility of performance is not acceded by law are discussed below.

***(1) Difficulty in performance -*** The events that make the contract extremely more difficult but not impossible, are not accepted as an excuse for non-performance.

**Example -** A agreed to sell B 300 tons of Sudan groundnuts at Hamburg. The usual sea route at the time of contract was via Suez Canal. Subsequently the State closed Suez Canal to traffic. The other reasonable route was Cape Town, which was comparatively very expensive. A refused to sell the groundnuts on the ground that the performance has become impossible due to closure of Suez Canal. Here, A was bound to ship the groundnuts because the availability of an alternative route makes the performance possible. The only difference is that it is more expensive.

***(2) Commercial hardships -*** A party is not discharged from the performance of the contract simply because some non-contemplated event has made the performance burdensome or non-profitable to him. For example, abnormal rise or fall in prices, a sudden depreciation of currency, an unexpected obstacle to the performance, etc.

**Example -** A agreed to supply certain goods to B. Due to the outbreak of war, there was a sharp increase in the price of the goods. In this case, A is not discharged from his liability to supply the goods at the price decided in the contract.

***(3) Impossibility due to conduct of a third person -*** Impossibility created by the failure of a third person on whose work the promisor relied cannot become a ground to excuse performance.

**Example -** A agreed to sell B, 61 bales of cloth to be manufactured by 'X Mills' as soon as they are supplied to him by the 'X Mills'. Goods were not supplied by X Mills, and A did not supply the same to B. Here, the performance of A is not excused because of failure of supply by X Mills. The clause as soon as they are supplied to him in the contract simply indicate the process of delivery, it does not show the intention to make the contract contingent upon such supply B can recover damages from A for nonperformance.

***(4) Strikes and lock-outs -*** All such events do not discharge the contracts unless specifically provided by the parties. A strike by workmen is manageable (labour is available otherwise), and a lock out is self-induced.

**Example -** A agreed to repair certain machinery of B at a certain price. A failed to repair the machinery due to strike of the workmen. Here, the strike of workmen is not sufficient reason to excuse performance.

***(5) Failure of one of the objects -*** We have discussed above that failure of ultimate purpose of a contract discharge the contract. But if a contract has several objects, failure of one of them does not discharge the contract.

***Example*** - H agreed to hire from the B Co. a boat for the purpose of taking passengers from Herne Bay to watch the Royal Naval Review, and to cruise round the fleet. Owing to the King's illness, the review was cancelled, and H decided not to continue with the proposed trip. Here, the contract was not discharged, the review was not the sole purpose of the contract, the fleet has remained in port and the cruise was still possible. The B Co., was, therefore entitled to the hiring fee.

## 10.4 DISCHARGE BY MUTUAL AGREEMENT

A contract is created by the parties to it. Therefore, it can also come to an end by their mutual agreement. The parties may make a new agreement that will discharge or modify the obligations of one or both parties under the original contract.

Section 62 of the Indian Contract Act, 1872, provides that, "If the parties to a contract agree to substitute a new contract for it, or to rescind or alter it, the original contract need not be performed."

This section provides three different modes of discharging original contract:
***(i) Novation (ii) Alteration, and (iii) Recession.***

Section 63 of Indian Contract Act, 1872, provides that, "Every promisee may dispense with or remit, wholly or in part of the performance of the promise made to him, or may extend the time for such performance, or may accept instead any satisfaction which he thinks fit."

This section provides for another two modes: ***(i) Remission, and (ii) Waiver.*** These modes of discharge of contract by mutual consent are discussed below.

### 10.4.1 Novation

Novation takes place when a new contract is substituted for an existing one. This new contract may be between same parties with new terms, or between new parties with old or new terms. The consideration for new contract is discharge of old contract. A valid novation discharges the old contract.

**Examples -**

1. A owes B Rs. 1,000. B owes C Rs. 1000. B asks A to credit C with Rs. 1000 in his books of account. Both A and C agree to it. A new contract between A and C is substituted in place of old contract between A and B. This is a novation contract between new parties on old terms.

2. A owes Rs. 10,000 to B. Subsequently A and B enters into an agreement where A gives a mortgage of his estate to B for Rs. 5,000 in place of debt of Rs. 10,000. This is a novation contract between old parties on new terms.

*Consent of all parties is necessary for novation.*

**Example -** A owes B Rs. 1000. Bowes C Rs. 1000. B asks A to credit C with Rs. 1,000 in his books of account. A agrees but C does not give assent. Result is that no new contract is entered into.

*Novation should take place before the breach or expiry of old contract.*

**Example** - A agrees to supply rice to B on a particular day; A does not supply rice on that date and commits a breach. B goes to the court to claim damages. A offers B for novation of contract by replacing rice by wheat. Here the old contract is already over, there is no question of novating it. A fresh contract can be made but the old contract cannot be renewed.

*To effect novation, new agreement must be valid and binding. If the new contract is not enforceable for any reasons, the old contract remains binding.*

**Example -** A agrees to supply rice to B on a particular day. Before that date, A agreed to sell opium instead. Here new contract to sell opium is illegal and not enforceable. Thus novation will not be effected, and old contract to sell rice would be valid and subsisting.

### 10.4.2 Alteration

Alteration means change in one or more of the terms of a contract. When a contract is altered by the mutual consent of the parties to the contract, parties to the contract remaining same, a contract stands altered. A valid alteration discharges the original contract, and the parties become bound by the new contract (i.e., contract with altered terms).

**Example -** A enters into a contract with B to supply 100 bales of cotton on 9th August, 1998. Later on they mutually agree to postpone the date of supply to 17th August, 1998. This change amount to alteration of contract.

*When a material alteration is made in a contract by one party without obtaining consent of the other, the parties are discharged from the original as well as* altered *contract. It is discussed further under the heading 'Discharge by operation of law*:

**10.4.3 Rescission**

Rescission means cancellation. When a contract is rescinded, the obligations of both the parties are thereby discharged. Rescission may be express or may be inferred by the circumstances or conduct of the parties. It may occur in any of the following manners:

***(1) When contracting parties mutually agree to rescind the contract.***

**Example -** A agreed to teach painting to B. Subsequently he had to shift to another city. A and B mutually agreed not to give effect to their contract of teaching painting. Both of them got discharged from the contract.

***(2) When one party fails in the performance of his obligations, the other party may rescind the contract without prejudice to his right to claim compensation for breach of contract.***

**Example -** A agreed to supply goods to B on 9th August, 1998, for which B after receipt of goods would pay the price on 17th August, 1998. A failed to supply the goods. B may opt to rescind the contract and need not pay the price. On such recession, both the parties are discharged from contract, where aggrieved party retains right to claim damages suffered due to non-performance of the contract.

Note: A person breaking the contract cannot rescind it.

***(3) When a person at whose option a contract is voidable, like when his free consent is vitiated, rescinds it.***

**Example -** A induces B to enter into a contract by undue influence. Here law gives an option to B to rescind the contract. If he chooses to rescind the contract, both parties are discharged.

Note: An oral res cession agreement is generally binding, even where the original contract was in writing. There is an exception - A rescission contract must be in writing if it involves retransfer of real property.

### 10.4.4 Remission

Remission means acceptance of lesser amount, or lesser degree of performance than what was contracted for in full discharge of the contract. This refers to a state of things prior to the date of performance.

**Example -** A owned large sums of money to B. C offered to pay a lesser sum in satisfaction of B's claim on A. B accepted it. Subsequently B went to the court to claim balance payment from A. Here, the acceptance by B was in full satisfaction and he cannot claim balance from A.

*A remission need not be supported by consideration.*

**Example-** A owes Rs. 5,000 to B. B agree to accept Rs. 2,000 in full satisfaction of his claim against A. This promise is enforceable although it is without consideration, and B cannot demand Rs. 5,000 from A.

*A remission once made is irrevocable.*

**Example-** A owes B Rs. 5,000 payable on 1st June. A is not in a position to meet his liability on the due date, and makes a request to B to extend the time for payment by three months. B accedes to A's request. The promise is binding and no suit can be instituted before the expiry of the extended period of credit although the promise is not supported by consideration.

*Remission may be conditional-* In such a case, the promisor is effectually released only on fulfillment of the condition; if the condition is not fulfilled; the creditor may enforce all his rights.

**Example -** A owed Rs. 10,000 to B. B offered to remit liability of A by Rs. 5,000 if A gives his house to C on rent. Here if A rents his house to C, then only the remission would be effected. Otherwise, the liability of A to repay will remain as before.

### 10.4.5 Waiver

Section 63 says that a person can 'dispense with' the performance of the other, Le., he has a right to waive or abandon his right to demand performance under a contract. On waiver, the other party is discharged from the liability accruing from such abandoned right. To constitute a waiver, neither an agreement nor consideration is necessary.

**Example -** A promised to paint a picture for B. Afterwards, B forbade him to do so. Here B has waived his right to claim the performance from A. A is no longer liable to perform.

### 10.5 DISCHARGE BY LAPSE OF TIME

Every contract must be performed within the stipulated period of time or within a reasonable time according to the nature of the contract. If such time is lapsed, the contract is discharged.

In civil litigation, the obligations are barred by the Limitation Act. The Indian Limitation Act provides that if the performance under a contract is not demanded for three years, the promisor is discharged from his obligations.

**Example-** A sells goods to B for a certain price. A does not demand payment for the same. After the lapse of three years from the date of sale, A loses remedy to go in court and demand payment for the goods sold to B.

In case of contracts where time is essence of contract, non-performance of such contract within the time fixed, discharge the party which is not at fault from his obligations under the contract and gives him a right to sue the defaulting party for damages.

### 10.6 DISCHARGE BY OPERATION OF LAW

A contract is discharged by operation of law in the following cases:

***(1) Death*** - In the contracts of personal nature, death discharges the contract.

**Example -** A agrees to paint a picture for B. A dies. The contract is discharged.

***(2) Insolvency -*** When a person is declared insolvent by law, he is discharged from all the liabilities incurred prior to his such adjudication. Thus, an insolvent is discharged from performing his part of contract by law. His rights and liabilities are transferred to an 'official assignee' appointed by the court.

**Example -** A borrowed Rs. 5,000 from B. Subsequently court declared him 'insolvent'. Now A is relieved from repaying Rs. 5,000 to B.

***(3) Merger -*** When an inferior right accruing to a party under a contract merges into a superior right accruing to the same person, inferior right vanishes into the superior right. This is known as merger. In such a case, the obligation constituted by inferior right is discharged.

**Example-** A man holds property under a lease. Subsequently he buys that property. Now his right as a lessee vanishes. It is merged into the right of ownership, which he has now acquired.

***(4) Unauthorized material alteration -*** When an alteration of a material term of contract is made by a party to the contract without the consent of the other party, both the parties are discharged from the contract by operation of law. The effect of such alteration would be same as cancellation of document.

**Example -** A contracted to sell his plot of 500 sq. m. to B for Rs. 1 Lac. The sale deed was executed accordingly. Before registration, A altered the deed and made it a deed for 300 sq. m. in place of 500 sq. m.. In this case, the contract is discharged.

*A material alteration is one which changes the legal effect of the instrument or is one which alters its legal character or identity. An alteration is immaterial if it is merely correction of clerical errors or making explicit what was already expressed though not completely in the document. Thus, an immaterial alteration does not make any difference to the status of a contract.*

## 10.7 DISCHARGE BY BREACH OF CONTRACT

The *'breach of contract'* means failure of a party to perform his obligations. When one party commits a breach, the aggrieved party becomes entitled to rescind the contract. It, therefore, operates as a mode of discharging a contract.

### 10.7.1 Actual Breach

Where one party fails to perform his contractual obligations on the due date of the performance, or during the performance, he is said to have committed a breach of the contract. Sometimes, a party performs his obligations, but not strictly according to the contract, it is also an actual breach of contract.

**Examples -**

1. A promised to supply B 200 refrigerators on 9th August, 1998. A does not supply the refrigerators on 9th August, 1998. Here A failed to perform on the due date. He is guilty of breach of contract and B is the aggrieved party.

2. S, a seller on May 1 contracts to deliver a thousand gallons of crude oil to buyer B on August 15, and on that date S delivers only 200 gallons with no indication that the balance will be delivered shortly thereafter. Here S has defaulted during the performance. He has committed an actual breach of contract.

*Note: There can be no actual breach of contract by reason of non-performance, so long as the time for performance is not yet arrived.*

*Effect of actual breach -* When a party commits breach of contract, the aggrieved party can rescind the contract and sue for the damages.

When the defaulter party performs or offer to perform his contract promise at a date later then the due date, whether the delayed performance will constitute a breach of contract or not will depend upon whether time is essence of contract or not. In such a case, when time is essence of contract, the aggrieved party can rescind the contract and claim damages, and when time is not essence of the contract, the aggrieved party cannot rescind the contract, but is entitled to claim damages caused, by delayed performance.

**Examples:**

1. In the first example given above, B can avoid the contract, and claim from A, damages suffered by him because of non-delivery of 200 refrigerators. However, if A supplies the refrigerators on 10th August instead of 9th August, B cannot refuse to accept the same (here time is not essence of the contract). But he can claim compensation from A, if he has suffered any loss because of this delayed delivery.

2. In the second example given above, B can cancel the entire contract returning the oil already delivered, and sue S for damages he suffers because of such non-delivery of oil.

### 10.7.2 Anticipatory Breach

Section 39 of the Indian Contract Act, 1872, provides that, "When a party to a contract has refused to perform, or disabled himself from performing, his promise in its entirety, the promisee may put an end to the contract, unless he has signified, by words or conduct, his acquiescence in its continuance."

Thus, if one contracting party indicates to the other, before the arrival of time for performance, that he or she is not going to perform his or her part of bargain, an anticipatory breach has occurred. It may happen in two ways:

***(1) Express breach by words spoken or written -*** Where a party to the contract communicates to the other party before the due date of performance about his intention not to perform it.

**Example -** In March, X contracts to put a sewer line for a city, work to commence by June 1. On April 10, X tells the city management that he will not do the job. It is an express anticipatory breach.

***(2) Implied breach -*** Where a party, by his own voluntary acts disables himself from performing the contract.

**Example -** A agrees to marry B, but before the due date of marriage, she marries C. This an anticipatory breach brought by the conduct of the party.

*Effect of anticipatory breach* - Effect of anticipatory breach can be summarized as under:

1. The aggrieved party may treat the anticipatory breach as actual breach. In this case, he is discharged from performance of his promise under the contract, and is entitled to claim damages from the defaulter party for non-performance of the contract. The party can bring a suit for breach of contract without waiting for the due date of performance.

2. The aggrieved party may decide to ignore the anticipatory breach, and opt to wait for the due date of performance. If a contracting party keeps the promise alive by ignoring anticipatory breach, and regards the contract as continuing, he runs the risk of contract being discharged in some other way prior to the date of performance.

3. Doctrine of anticipatory breach does not apply to promises to pay money debts, such as those found in promissory notes and bonds.

# Part - 11

## Remedies For Breach Of Contract

**STRUCTURE OF PART - 11**

## 11.1 OBJECTIVE

After reading this Unit you should be able to understand:

- The various remedies available in case of breach of a contract
- Under different circumstances which remedy is to be invoked

## 11.2 RESCISSION OF A CONTRACT

### 11.2.1 What is Rescission?

Rescission means cancellation of contract. It may take place in any of the following manners:

***(1) Mutual agreement -*** When the parties to a contract agree to rescind the contract - No legal consequences.

***(2) Breach -*** When one party fails to perform his part of promise properly, other party can rescind the contract - parties are discharged, and aggrieved party can claim damages.

***(3) Option given by law -*** When a party's consent is vitiated, or he lacks capacity to contract, the contract becomes voidable and law gives an option to the aggrieved party to rescind the contract - parties are discharged, restitution can be claimed and in certain cases damages can also be claimed.

### 11.2.2 Consequences of rescission

1. Both the parties are absolved from their respective contractual duties without prejudice to the right of the injured party to claim damages.

2. A person who rightly rescinds a contract is entitled to compensation for any damage which he has sustained through non-fulfillment of the contract. [Section 75]

   **Example -** A, a singer, contracts with B, the manager of a theatre, to sing at his theatre for two nights every week for next two months, and B engages to pay her Rs. 100 for each night's performance. On the sixth night, A willfully absents herself from the theatre, and B, in consequence, rescinds the contract. B is entitled to claim compensation for the damage, which he has sustained through the non-fulfillment of the contract.

3. The party rescinding voidable contract shall, if he has received any benefit there under from another party to such contract restore such benefit, so far as may be, to the person from whom it was received. [Section 64]

**Example -** A induced B by undue influence, to buy his car at an exorbitant price, and delivered his car to B. However, B decided to rescind the contract. In this case, B is bound to return back A's car.

### 11.2.3 Different Options to Avail Relief in Case of Rescission

When one-party commits a breach, other party has two options -

1. He may rescind the contract and sit quietly at home without taking any legal action - in this case, he is discharged from his contractual obligations but remedy of damages is not available.

2. He may file a suit for rescission in the court of law -
   (a) either for rescission only, or
   (b) for rescission and damages both.

*When suit is filed for rescission only -* A suit for rescission may be filed even when no damages are to be claimed, for example, in case of pledge of movable goods, say gold ornaments, if the pledger does not repay the debt as per agreement, the pledgee may file a suit for rescission of the contract in order to free himself from his obligation to return the ornaments if payment is offered at a later date, and to become entitled to sell the ornaments in order to realise his debt.

In these cases, the court may order the rescinding party to return any benefit obtained from the other party in order to maintain the status in which they were when the contract was not entered into.

*When suit is filed for rescission as well as damages -* Damages can be claimed only when the aggrieved party brings a suit to claim damages, either along with the suit to claim rescission, or separately.

*Note: It is important to note that although 'Rescission' is considered as a remedy available to a party in case of breach of contract by the other and in certain other circumstances, its ultimate derivative is claim for damages, which we will be discussing in the following paras.*

## 11.3 SUIT FOR DAMAGES

Damages may be defined as monetary compensation in respect of loss suffered as a result of the breach. The object of awarding damages is to put the injured party, so far as the money is able to do so, in the same position as if the contract had been performed. The general principle applied is that the party who has been harmed by breach of contract is entitled to compensation for losses caused or gains prevented by breach. Law recognize various kinds of losses or damages. Once the court has determined which loss may be recovered, it is then faced with the problem of quantifying such loss, i.e. determining just how much the aggrieved party should receive.

### 11.3.1 Kinds of Damages and Rules to Assess Their Quantum

***(1) Compensatory damages:***

There are two categories of compensatory damages. The first category, general damages, includes all those damages that arise naturally from breach of contract. The second category, called special damages arise due to special circumstances foreseeable by the parties at the time of making contract.

*(a)* <u>*General damages (ordinary damages) -*</u> There are damages that arise naturally from the breach of the contract. They result directly from the fact that the transaction that is the subject of the contract does not occur because of the breach. For instance, if the subject of the contract is the sale of car and the contract is breached by the buyer, the seller has *obviously sustained damages* by not collecting the purchase price. If seller breaches, buyer has sustained damages by not getting the car. Thus general damages are restricted to the 'direct and proximate' consequences and not to the remote or indirect losses or consequences of the breach of a contract.

**Example-** A hires B's ship to go to Bombay, and there take on board, on the 1st January, a cargo which, A is to provide and to bring to Calcutta, *the* freight be paid when earned. B's ship does not go to Bombay. A procures another conveyance for his job. Here A is entitled to receive compensation from B in respect of his trouble and expense in procuring the other conveyance.

(b) *Special damages -* These are the consequential damages caused by the breach of contract due to existence of special circumstances. Such damages are awarded by the court only when at the time of making contract, these special circumstances were foreseeable by the party committing the breach.

**Example -** A contracted with B to buy 1000 tons of Iron @ Rs. 80 per ton, and told him that he needs it by June 5 to deliver it to Z to make a profit out of it. B fails to deliver the same by June 5, and A claims loss of profits from B amounting to Rs. 20,000 (which he would have earned by selling 1000 tons of Iron @ Rs. 100 per ton to Z). Here B is liable to pay these damages to A.

(c) *Measuring of compensatory damages -* Section 73 of the Indian Contract Act, 1872, provides that, "When a contract has been broken, the party who suffers by such breach is entitled to receive, from the party who has broken the contract, compensation for any loss or damage caused to him thereby, which naturally arose in the usual course of things from such breach, or which the parties knew when they made the contract, to be likely to result from the breach of it. Such compensation is not to be given for any remote and indirect loss or damage sustained by reason of the breach."

This section warrants a need to assess damages, general or special, according to the facts of each case.

In the case of a contract for sale or purchase general rule as regards to measuring of the damages is that -

(i) The damages would be assessed on the difference between the contract price and the market price on the date of breach.

(ii) Under a contract of sale of goods, damages can be claimed for breach of condition, or warranty and such damages includes all damages flowing from the breach.

(iii) If the seller is selling services rather than something tangible and the buyer breaches the contract, the calculation of general damages is somewhat different.

*(d) <u>Duty to mitigate damages suffered -</u>* The way in which liability for contract damages is limited by the courts is imposing a duty on the party who has been harmed by a breach of contract to mitigate (keep to minimum) the damages resulting from the breach. In other words, the party who has been harmed may not sit idly and watch the damages accumulate. Moreover the party is supposed to act prudently to minimize such damages.

**Example-** A took a shop from B on rent and paid one month's rent in advance. B could not give possession of shop to A. There were other shops available in the vicinity but A chose not to do business for eight months. After eight months, A sued B for breach of contract claiming damages including advance rent and loss of profits for eight months. Here, he was entitled to a refund of his advance and nothing more, as he failed in his duty to minimize the loss by not taking another shop in the neighborhood.

If a servant is wrongfully dismissed in a service contract, it is his duty to minimize the damages and for this purpose to seek and accept suitable employment.

***(2) Vindictive or Exemplary damages:***

At times breach of contract by one party not only results in monetary loss to the injured party but also subjects him to disappointment and mental agony. In such cases monetary compensation alone cannot provide an appropriate remedy to the sufferings of the injured party. Thus the need for vindictive damages arrives.

Vindictive damages are awarded as a punishment to the wrong doer. Such damages are unusual and quite heavy in amount. Vindictive damages do not form part of the law of contract. The concept is borrowed from the English Law. Generally speaking, these damages are not awarded in ordinary course of breach of contract.

However, there are two kinds of contracts where Indian courts consider awarding vindictive damages:

1. Breach of contract to marry. In this case the amount of the damages will depend upon the extent of injury to the party's feeling. One may be ruined, other may not mind so much.

2. Where a banker refuses to honor the cheque of a customer while having his money in his hands, and the customer thereby suffers loss of reputation.

   **Example -** A banker after agreeing to advance money for W's trip to California, by crediting his Account, wrongfully failed to credit W's Account with the result that W's cheques were dishonored. The court held that W was entitled to damages for humiliation and mental suffering. It was held that the rule in this class of cases is - "The smaller the cheque, the greater the amount of damages".

***(3) Nominal damages:***

Sometimes, a person brings a legal action for breach of contract and proves that a breach actually occurred but fails to prove that any actual damage have been suffered. This may happen, for example, because of the rules for measuring damages and requirement that damages should be foreseeable and proved with certainty. In such a situation, injured party is awarded nominal damages.

Such damages are awarded simply to recognize the right of the injured party to claim damages, and are of very small amount.

**Example -** A contracted to purchase 'LML Scooter' from B, a dealer, for Rs. 25,000. But A failed to purchase the Scooter. However, the demand for the Scooter far exceeded the supply and B could sell the Scooter to Z for Rs. 25,000, i. e., without any loss of profit. Here if B makes a claim upon A for breach of contract, he will be entitled to nominal damages only.

**(4) *Liquidated damages and penalty:***

The contracting parties may stipulate in the contract a sum of money to be paid in case the contract is broken by either party. It may be termed as 'liquidated damages' or 'penalty' depending upon the purpose to fix the sum.

The purpose of fixing a sum as 'liquidated damages' is to compensate the injured party for the loss to be incurred by the breach of the other. Thus it is a fair pre-estimation of the loss to be caused by non-performance of the contract.

The purpose of providing a 'penalty' in a contract is to discourage a party from breaching it and to provide a special punishment if the contract is breached anyway. Thus it is a sum which has no relation to the probable loss, and generally is disproportionate to the damages likely to accrue as a result of the breach.

Section 74 of the Indian Contract Act, 1872, provides that, "When a contract has been broken, if a sum is named in the contract as the amount to be paid in case of such breach, or if the contract contains any other stipulation by way of penalty, the party complaining of the breach is entitled, whether or not actual damage or loss is proved to have been caused thereby, to receive from the party who has broken the contract reasonable compensation not exceeding the amount so named or, as the case may be the penalty stipulated for."

Thus in India, the sum named in the contract is not awarded as damages. It is left to the court to ascertain the actual loss or reasonable compensation and award the same, which will, however, not exceed the sum named in the contract.

**Example -** A agreed to sell B his house for Rs. 1,05,000, provided that on breach of contract, the defaulting party will pay Rs. 10,000 as damages to the other. B broke the contract and A resold the house for Rs. 1,04,000. A sued B and claimed Rs. 10,000. Here, A cannot recover Rs. 10,000 as liquidated damages or penalty, he could only get the actual loss suffered by him, i.e., Rs.1000.

*Note: If in the above example, A would have resold the house for Rs. 90,000 resulting in actual damage of Rs. 15,000 (1,05,000-90,000), even then he would have been able to recover Rs. 10,000 only, this being treated as the maximum amount of damages payable under this contract.*

Exception to the rule in the context of 'penalty' - Section 74 provides that when any person enters into a bail bond, recognizance or other instrument of the same nature, or, under the provisions of any law, or under the orders of the Central Government, gives any bond for the performance of any public duty or act in which the public are interested, he shall be liable, upon breach of condition of any instrument, to pay the whole sum mentioned therein.

**Examples:**

1. A undertakes to repay B a loan of Rs. 1000 by five monthly equal installments with a stipulation that, in default of payment of any installment, the whole amount shall become due. This stipulation is not considered a penalty clause and the contract may be enforced according to its terms.

2. A borrows Rs. 100 from B and gives him a bond of Rs. 200 payable by five yearly installments of Rs. 40 with a stipulation that, in default of payment of any installment, the whole shall become due. This is a stipulation by way of penalty.

### 11.3.2 Measuring interest damages

By and far the largest number of cases decided under section 74 relate to stipulations providing for interest. These stipulations are discussed below.

***(1) Stipulations for enhanced rate of interest -*** Such a stipulation occurring in a contract may have twofold character:

1. Stipulation for increased interest from the date of bond. This is always considered as 'penalty'.

2. Stipulation for increased interest from the date of default. It mayor may not be in the nature of penalty. It is a question of fact to be considered in each case. Generally if the rate of interest payable on default is unreasonable, the court considers it as a penalty.

**Example -** A borrows Rs. 1000 from B on 1st June, 2004. A gives a bond to B for repayment of loan on 1st June, 2005 with interest 12% per annum. The contract contains a stipulation that in case of default interest shall be payable 25% from the date of bond, i.e., 1st June 2004. It is a penalty and cannot be enforced through the court of law.

Alternatively, if the stipulation in the above contract says that in case of default interest shall be paid @25% from the date of default, i.e., 1st June, 2005, the question whether it will be considered a penalty or not will be decided by the court keeping in mind the circumstances of the contract.

Explanation to section 74 provides that - a stipulation for the increased interest from the date of default may be stipulation by way of penalty.

**Example -** A stipulation in the mortgage deed provided that the principal sum should carry simple interest 6% per annum. The interest should be paid annually. In case of default the whole of the principal and interest in arrears becomes repayable 9% interest compounded per annum. Here, this stipulation amounted to penalty and will not be awarded. The injured party was awarded 6% simple interest from 'the date of mortgage till expiry of the period of redemption.

***(2) Stipulations for compound interest -*** Following rules are deduced from various past judicial decisions in this regard:

1. A stipulation for payment of compound interest in place of simple interest at the same rate is not considered as penalty.

2. A stipulation for payment of compound interest in place of simple interest at a higher rate is considered as penalty.

   **Example -** A borrows Rs. 1000 from B @ 10% simple interest to be repaid after two years, with a stipulation that on default, the interest will start compounding @ 10% from the date of default. This is not considered as a penal clause.

   Alternatively if the stipulation provides for the payment of compound interest @20% from the date of default, it will amount to penalty.

***(3) Stipulations for payment of interest at a lower rate, if interest is paid regularly on due dates -*** A stipulation to accept interest at reduced rate if it is paid punctually does not make the original rate of interest a penalty.

**Example -** A bond provides for payment of interest 24% per annum, with a provision that if debtor pays it punctually, the creditor would accept interest 18% annually. On failure of payment of interest on due date, charging of interest 24% will not amount to penalty.

### 11.3.3 Other relevant provisions

Two important aspects in the context of compensation by way of damages are:

1. Cost of bringing a suit in the court of law, and
2. Treatment of 'earnest money', or 'security deposit' in contracts.

***Cost of suit -*** When a party brings upon a suit in the court of law, he incurs expenditure thereby. If his point is proved in the suit, he is entitled to recover the cost of suit in addition to the damages from the defaulter party. However, it is under discretion of the court to award or not to award such costs.

***<u>'Earnest money' and 'Security deposit' -</u>*** Sometimes a party to a contract is required to deposit some money with the other party. This is generally done with a view to ensure performance of the contract. The money so deposited may be either 'earnest money' or 'security deposit'.

The 'earnest money' is part of the purchase price paid in advance. When the transaction goes through it is adjusted against the bill. When transaction falls through by reason of default or failure of the buyer, the other party can rescind the contract and retain the earnest money. Thus, the earnest money is liable to be forfeited.

The 'security deposit' is deposited only as a security for performance of the contract. It is not a part of the purchase price. Thus when a contract is completed it is not adjusted against the purchase price. Law considers it as a 'penalty'. Thus it is not liable to be forfeited.

## 11.4 SUIT FOR SPECIFIC PERFORMANCE

The court may direct the party in breach to carry out the performance of the contract specifically according to the terms of the contract. This is termed as 'Specific Performance' of the contract. This remedy is granted under the Specific Relief Act, 1877. It gives the courts discretionary power to order specific performance instead of or in addition to damages.

The preferred remedy for breach of contract is the payment of money damages. Upon receiving damages, the injured party can buy substitute performance for the promise the other party failed to keep. Specific performance is therefore ordered by the court only if the remedy of money damages is inadequate. For example, things like valuable works of art, patents, and copyrights that are in fact unique are subject to the remedy of specific performance.

Section 14 of the Specific Relief Act, 1877, provides that in certain cases the specific performance of the contract shall not be allowed by the court.

**1.** Where compensation in terms of money is an adequate relief for the non-performance of the contract.

2. Where the contract is of personal nature e.g., a contract to sing a song, or a contract to marry, etc.

3. Where a contract can be determined (i.e., put to an end) by the parties to the contract.

   **Example -** A contracted to sell certain goods to B. Terms of the contract provided that it could be put to an end at the option of the seller, within a specific period on repayment of the consideration. On the due date A refused to sell the goods. In this case B cannot obtain specific performance of the contract as it is determinable at the option of A. If specific performance is allowed, A might at once put an end to the contract by paying consideration to B.

4. Where the performance of the contract requires constant supervision, and courts cannot supervise the carrying out the contract.

5. Where the contract is inequitable (i.e., not fair and just) to either party.

6. Where one of the parties to the contract is not competent to contract like a minor.

## 11.5 SUIT FOR AN INJUNCTION

The term injunction may be defined as an order of the courts restraining a person from doing something which he promised not to do. In relation to the law of contract, the injunction is a useful weapon for the purpose of encouraging performance of a contract involving personal services. This remedy is available only where the contract contains a negative stipulation.

## 11.6 SUIT UPON 'QUANTUM MERUIT' AND 'RESTITUTION'

A contract comes to an end, when either,

- a party commits default, by way of breach, or
- a contract becomes void, or
- a contract becomes voidable and the aggrieved party opts to rescind it

Ending of a contract without performance may give rise to a situation where before the contract came to an end, one party has already rendered some services, or, has supplied some goods or other consideration to the other party. In such a case, proportionate payment can be demanded for these goods or services by bringing a suit upon *'Quantum Meruit'.*

It may also happen that no contract ever existed at all, but still one person do something non-gratuitously for the other, and that other person enjoys benefit thereon. In this case also, proportionate payment can be demanded for these goods or services by bringing a suit upon *'Quantum Meruit'.*

In both the cases mentioned above, when some goods or other consideration has already been passed without any reciprocation, a suit for 'Restitution' can be brought upon.

### 11.6.1 'Quantum Meruit'

Literal meaning of the expression 'Quantum Meruit.' is 'as much as earned', which is legally considered as 'payment in proportion to the work done.'

*'Quantum Meruit is a remedy which is supplementary to the damages,* rather than a form of damages - This remedy has a different purpose than the remedies of money damages, specific performance and injunction.

According to Anson, "whereas the purpose of damages is to place the injured party, as nearly as possible, in the position which he would have been in, if the other party had not broken the contract, the purpose of 'Quantum Meruit' is to restore him to the position which he would have been in, if the contract had not been made."

Rather than putting an injured party in as good a position as he or she would have been if the contract had been performed, when 'quantum meruit' or 'restitution' is awarded, the purpose is to prevent the unjust enrichment of one of the parties.

### 11.6.2 Restitution

Then term 'restitution' may be defined as an act of restoring back to the rightful owner that which has been taken away or lost.

### 11.6.3 Generalizations Based upon the Doctrine of 'Quantum Meruit' and 'Restitution'

Considering the doctrine of 'Quantum Meruit' and 'Restitution' under different circumstances, following generalizations can be made:

***(1) Breach of contract***

When there is a breach of contract, not only the injured party, but the defaulting party is also entitled to claim reasonable compensation for what he has done under the contract.

It may be noted that compensation under Quantum Meruit is in addition to the compensation for damages.

*Suit by a party who has not breached*

**Example -** P was engaged by C to write a book to be published by installments in a weekly magazine owned by C. After a few installments were published, the magazine was abandoned. Here, P could recover on the Quantum Meruit for the instalments already published.

*Suit by party who has breached*

In the previous chapter we have discussed that a party who materially breaches a contract has no contract rights against the other party. Sometimes, however, the application of this principle can cause great deal of hardship to the person who breaches the contract. To save this, law supports the view that a guilty party can sue upon 'Quantum Meruit' provided,

- the contract is divisible, and
- the other party has enjoyed the benefit of his services, although he had an option of declining it.

**Example -** An employee B promised to work for an employer, T, for one year for a specified amount of money. Before the year was up, B left his job without good cause. T refused to pay B anything for the work he performed before quitting on the ground that breach of contract committed by B has discharged him from all his contractual obligations. The court held that the T was liable to B for the reasonable value of the work performed by B.

Here, T's liability was not based on the contract because B's breach had discharged T's duties. Instead, it was based on Quasi-contract, meaning "as if it were a contract". However, T can claim damages from B for breach of contract committed by him.

*If the contract is not divisible, the party in default cannot claim payments on the basis of 'Quantum Meruit:*

**Example -** S agreed to erect two houses and stables for $565 on H's land. S did part of the work and then abandoned the contract. H himself completed the building using some materials left on his land by S. S brought an action upon H for the value of work done and materials left at H's place. Here, S could recover the value of materials because H had the *option* to accept or reject these, but he could not recover the value of the work done because he was entitled to payments only on completion of the work, and H had no option with regard to the partly erected building but to accept that.

***(2) Void Contract***

Section 65 of the Indian Contract Act, 1872, provides that, "When an agreement is discovered to be void or when a contract becomes void, any person who has received any advantage under such agreement or contract is bound to restore it, or to make compensation for it, to the person from whom he received it."

**Example-** C was appointed as 'managing director' of a company at certain remuneration, by the board of directors. Subsequently it was discovered that the board was not qualified to make this appointment and hence it was void. C, in the meantime, rendered services to the company. He sued the company for remuneration for the period he provided services. Here, C could recover on 'Quantum Meruit'.

***(3) No Contract***

Section 70 of the Contract Act says that when services are rendered or goods are supplied to a person without any intention to do so gratuitously, and benefit of the same is enjoyed by the other person, the latter must compensate the former. This compensation may be by way of 'Quantum Meruit' or 'Restitution', or both.

**Example -** A doctor provides emergency medical attention to someone who is unconscious. There is no express contract at all. But doctor would be able to recover in quasi-contract, a reasonable value of his services.

The essence of a legal action based on quasi contract and the remedy of 'Quantum Meruit' and 'Restitution' is to prevent the enrichment of one party at the cost of the other.

Part - 12

## Law Of Contract Relating To The Indemnity And Guarantee

**STRUCTURE OF PART - 12**

## 12.1 OBJECTIVES

After reading this Chapter you should be able to understand:

- What is a contract of indemnity?
- What is a contract of guarantee?
- How they are different?

## 12.2 CONTRACT OF INDEMNITY

Dictionary meaning of the word 'indemnify' is to 'compensate'. When a person assures the other to compensate against the probable cost or loss, a contract of indemnity occurs.

Section 124 of the Contract Act defines "*Contact of Indemnity" as "A contract by which one party promises to save the other from loss caused to him by the conduct of the promisor himself or by conduct of any other person is called a 'contract of indemnity.*

From the bare perusal of the provision defining the "Indemnity" it emanates that Indemnity is the provision under which the *Promisee promises to save the other from loss causes to him (the other) by the promisor's conduct or from the action of a third person.*

Thus to say the least and in the widest sense, it means to recompense for any loss or liability which a person has incurred, such duty arising out of and from an Agreement *(arising out of a contract of indemnity which may be express or implied) or otherwise (from an obligation resulting from the relation of the parties or by Statute e.g. obligations which create statutory rights of being indemnified like between a Principal & Agent, an employer & employee, trustee & the Trust, Partners inter-se & the partnership firm etc.).*

The term "Indemnity" is thus normally used to denote a contract by which the promisor undertakes an original and independent obligation to indemnity, as distinct from a collateral contract in the nature of guarantee by which the promisor undertakes to answer for the default of another person who is to be primarily liable to the promisee. It can thus clearly be understood to mean that the "Indemnity" is to recompense the loss, happening of which is only contingent as against the Indemnifier.

**Example**

A contracts to indemnify B against the consequences of any proceedings which C may take against B in respect of a certain sum of 200 rupees. This is contract of Indemnity.

Section 125 of the Contract Act reproduced below confers right upon the Indemnity-Holder to recover costs, expenses and amounts paid under the terms of the Contract.

An indemnity holder is entitled to recover all the losses incurred by him because of acting on behalf of, or according to the directions of the indemnifier (the promisor). However, the loss should have been incurred by him while acting within the scope of his authority. Section 125 of the Act elaborates on this point. It says that the promisee in a contract of indemnity, acting within the scope of his authority is entitled to recover from the promisor.

1. All damages which he may be compelled to pay in a suit relating to the matter to which the contract of indemnity applies.
2. All expenses paid by the promisee for bringing out or defending such suit, provided he follows instructions of the promisor while doing the same, and where no instructions are there, acts as a man of ordinary prudence would do in his own case.
3. All sums paid by the promisee for reaching to any compromise pertaining to the matter relating to the contract of indemnity, *provided it is as per the directions of the promisor, or is not against the orders of the promisor*, or is such as a man of ordinary prudence would have entered into in his own case.

**Example -** S agrees to sell toasters on behalf of N, and N agrees to indemnify S against any loss caused to him because of manufacturing defect in any toaster. A customer B buys a toaster from S, which burst out on plugging in socket and he sustains personal injuries there from. B sues S to get his loss compensated. S has to pay Rs. 10,000 to B as damage caused to him, and incurs Rs. 1000 in defending the suit. Here S is entitled to get indemnity worth Rs. 11,000 from N.

Alternatively if S reaches to a compromise with B, and pays cost of the toaster and expenses of B's medical treatment amounting to Rs. 10,000, he is entitled to get Rs. 10,000 indemnified from N.

## 12.3 CONTRACT OF GUARANTEE

The defining provision for *Guarantee* is Section 126 of the Contract Act which reads-

*A contract of Guarantee is a contract to perform the promise, or discharge the liability, of a third person in case of his default.*

It may be either oral or written.

The section thus defines the Guarantee as one in which the promisor promises to perform the promise of a third person, or to discharge the liability or obligation of a third person, in the case of the latter's default. It is of utmost importance to note that the defining section in itself provides that the Guarantee may be either Oral or Written.

The Guarantee defined thus implies that it is a promise to answer for the payment of some debt, or the performance of some duty, in the case of failure of another party, who is in the first instance, liable to such payment or performance. It is thus an accessory contract by which the promisor undertakes to be answerable to the promisee for the debt, default or miscarriage of another person, whose primary liability to the promisee must exist or be contemplated.

The person who gives the guarantee is called the 'surety', the person in respect of whose default the guarantee is given is called the 'principal debtor', and the person to whom the guarantee is given is called the 'creditor'.

**Example -** B takes a loan of Rs. 10,000 from L, where S assures L that in case B fails to pay, S will repay the loan to L. Here S is surety, B is the principal debtor, and L is the creditor.

There exist three separate and independent contracts (a) between the Principal Debtor and Surety (b) between the Principal Debtor and the Creditor (c) between the Creditor and Surety.

The liability of the Surety under the Contract Act is absolute and co-extensive with that of the Principal Debtor, unless limited and restricted under the terms of Contract. Thus a party who guarantees the payment of a bill, is liable for all that the principal debtor would be liable for, including costs, interest due under the contract.

## 12.4 DISCHARGE OF SURETY

A Surety is said to be discharge from the liability when his liability. Sections 133-141 of the Contract Act provide for discharge of surety under various circumstances.

*Section 133* provides for discharge of Surety by variance in terms of Contract i.e. any variance made without the surety's consent in the terms of the contract between the principal debtor and the creditor, discharges the surety as to transactions subsequent to the variance.

**Example –** A becomes surety to C for B's conduct as a Manager in C's Bank. Afterwards, B and C contract, without A's consent, that B's salary shall be raised, and that he shall become liable for one-fourth of the losses on overdrafts. B allows a customer to overdraw, and the Bank loses a sum of money. A is discharged from his suretyship by the variance made without his consent, and is not liable to make good his loss.

*Section 134* of the Act provides for discharge of surety by release or discharge of principal debtor i.e. the surety is discharged by any contract between the creditor and the principal debtor, by which the principal debtor is released or by any act or omission of the creditor, the legal consequences of which is the discharge of the principal debtor.

**Example -** A contracts with B for a fixed price to build a house for B within a stipulated time, provided B supplies the necessary timber. C guarantees A's performance of the contract. B omits to supply the timber. C is discharged from his suretyship.

Section 135 of the Act provides for discharge of surety when creditor compounds with, gives time to, or agrees not to sue, principal debtor i.e. any contract between the creditor and the principal debtor, by which the creditor makes a composition with, or promises to give time to, or not to sue, the principal debtor discharges the surety, unless the surety has assented to such contract.

The principle behind making this provision is that where the creditor does something behind the back of the surety, and does it to his prejudice, by advancing facilities to the principal debtor, which are likely to harm the surety, the surety is not bound by his undertaking.

*Section 136* however provides that the surety is not discharged when agreement is made with third party to give time to the principal debtor and not with the principal debtor, the surety is not discharged.

*Section 137* also similarly provides that mere forbearance on the part of the creditor to sue the principal debtor or to enforce any other remedy against him, does not, in the absence of any provision in the guarantee to the contrary, discharge the surety.

**Example -** B owes to C a debt guaranteed by A. The debt becomes payable. C does not sue B for a year after the debt has become payable. A is not discharged from his suretyship.

*Section 138* provides that release of one of the co-surety does not discharge the others.

*Section 139* is another provision which provides for discharge of surety and confer upon the surety a very important right.

The said provision provides that if a creditor does any act which is inconsistent with the rights of the surety, or omits to do any act which his duty to the surety requires him to do, and the eventual remedy of the surety himself against the principal debtor is thereby impaired, the surety is discharged. This is because an Equity intervenes to discharge the surety when the creditor has failed to deal with the security for the debt, as he ought, to reduce or extinguish liability to the extent to which the security would have satisfied the debt.

Where due to negligence of the creditor, the security given by the principal debtor is lost and the right of the surety against the principal debtor is impaired due to any action or inaction of the creditor, the surety is discharged to that extent, this is so when the security is in possession and custody of the creditor and not in the custody of the principal debtor.

This is so specifically in view of the provision of Section 141 of the Act, which confers upon surety right to benefit of creditor's securities which the principal debtor at the time when the contract of suretyship is entered into, and if the creditor loses, or without the consent of the surety, parts with such security, the surety is discharged to the extent of the value of the security.

**Example -** B contracts to build a ship for C for a given sum, to be paid by installments as the work reaches certain stages. A becomes surety to C for B's due performance of the contract. C, without the knowledge of A prepays to B the last two installments. A is discharged by this pre-payment.

The reasons for providing for the protection and taking care of protection of securities is precisely for the reasons and purpose, which is taken care of under Section 140 of the Act, which provides that when a guaranteed debt has become due, or default of the principal debtor to perform a guaranteed duty has taken place, the surety, upon payment or performance of all that is liable for, is invested with all the rights which the creditor had against the principal debtor.

This right which the surety derives is known as "Right of Subrogation". This in short means that once the guaranteed debt is paid, all the rights the creditor had against the principal debtor stands transferred and assigned to and in favor of the surety. This precisely is the reason why the care is also taken to protect the securities and to prevent the security in the hands of and available with the creditor to be preserved. It can thus be safely said that the surety paying off the debt is entitled to all the rights and securities of the creditor as against the principal debtor. The Subrogation is automatic.

*Section 145* of the Act further provides for implied promise to indemnify the surety. It provides that in every contract of guarantee, there is an implied promise by the principal debtor to indemnify the surety, and the surety is entitled to recover from the principal debtor whatever sum he has rightfully paid under the guarantee.

**Example -** B is indebted to C and A is surety for the debt. C demands payment, and on refusal sues for the amount. A defends the claim, having reasonable grounds for doing so, however A is compelled to pay the amount of the debt with costs. A can recover from B the amount paid by A towards the principal debt as well as costs and all other incidental payments.

*Section 146* of the Act provides that all the co-sureties are liable to contribute equally.

**Example -** A, B and C are sureties to D for a sum of Rs. 3000/- lent to E. E makes a default in payment. A, B and C are liable as between themselves, to pay Rs. 1000/- each.

## 12.5 COMPARISON OF CONTRACT OF INDEMNITY AND CONTRACT OF GUARANTEE

The motive of both the contract is to ensure a person against the probable loss out of the deal.

The distinguishing factors between the Indemnity and the Guarantee can be summarized as under:

| INDEMNITY | GUARANTEE |
|---|---|
| Contract of Indemnity is bilateral i.e. between two parties | The Guarantee is a tripartite contract i.e. between three persons : the principal debtor, creditor and the surety |
| Indemnity does not have any privity of contract between the surety and the debtor | Guarantee on the other hands have mutual contracts amongst all three concerned |
| In Indemnity the promisor makes himself primarily liable and undertakes to discharge the liability in any event, without reference to obligation of the third person | In Guarantee there cannot be any Contract unless there is a principal-debtor. |
| The liability arises from loss caused to the promisee by the conduct of the promisor himself or by the conduct of another person | The obligation of the Surety depends substantially on the principal-debtor's default. |
| | Guarantee also involves amongst the three contract one contract which is between the Principal Debtor and the Surety which is in the nature of Indemnity |

# Part - 13

## Agency

**STRUCTURE OF PART - 13**

**13.16** Termination of Agency

- **13.16.1** Termination by Act Of The Parties
- **13.16.2** Termination by Operation of Law
- **13.16.3** When Termination of Agency Takes Effect

**13.17** Irrevocable Agency

- **13.17.1** Agency Coupled With Interest [Section 202]
- **13.17.2** Agent Incurs Personal Liability
- **13.17.3** Agent Partly Exercise the Authority [Section 204]

**13.18** Comparisons

- **13.18.1** Agent and Servant
- **13.18.2** Agent and Independent Contractor
- **13.18.3** Agent and Bailee

## 13.1 Objectives

After reading this Unit, you should be able to understand:

- What is a contract of agency?
- How the law governs rights, duties and liabilities of all the parties to the contract of agency?

## 13.2 Contract of Agency

The contract which creates the relationship of principal and agent is known as contract of agency. A contract of agency has all the essentials of a contract, with some special features of its own, which are discussed below:

***(1) Who can be principal -*** Section 183 of the Indian Contract Act, 1872, provides that, "Any person who is of the age of majority according to the law tQ which he is subject, and who is of sound mind, may employ an agent."
Thus a person who is competent to enter into a contract may appoint an agent.

***(2) Who can be an agent -*** Section 184 of the Indian Contract Act, 1872, provides that, "As between the principal and the third persons any person may become an agent, but no person who is not of the age of majority and of sound mind can become an agent, so as to be responsible to his principal according to the provisions in that behalf herein contained."

From the above, it may be inferred that -

(i) As between the principal and third person, any person may become an agent, even if he is not competent to contract otherwise.
(ii) If a minor, or a person of unsound mind is appointed as agent, principal is bound by his acts, although such agent cannot be held liable either by the principal or by the third party.

Thus it is for the principal to see his interests and to appoint such a person as agent who has contractual capacity.

***(3) Consideration not necessary -*** Section 185 of the Indian Contract Act, 1872, provides that, "No consideration is necessary to create an agency."

Generally an agent is remunerated by way of commission for the services rendered by him. However, no consideration is necessary for the validity of appointment of the agent. The fact, that the principal has agreed to be represented by the agent is a 'detriment' to the principal and constitutes sufficient consideration for the contract of agency.

**Example** - A authorizes his friend B, who has knowledge of computer hardware, to buy a computer for him. B accepts the responsibility. Here a valid contract of agency is created between A and B although no consideration is involved in the contract.
It is worth noting that a gratuitous agent is not bound to do the work entrusted to him by his principal. But once he begins the work, he is bound to complete it.

***(4) Relationship of a principal and agent is fiduciary*** - A contract of agency is one of good faith. The agent must disclose to his principal every fact in his knowledge which may influence the decision of the principal in making the contract. Further, the agent must not deal on his own account and also must not settle adverse title, nor should he use the information obtained in the course of the agency against the principal.

## 13.3 TEST OF AGENCY

The fact that parties call their relationship as an 'agency' does not itself establishes that a contract of 'agency' exists in terms of Contract Law. Thus every person who acts for another is not an agent. For instance, a domestic servant renders to his master a personal service; a person may assist the other in performance of his contractual or other obligations to third parties. But he is not an agent in any of these situations.

In determining whether the agency relationship exists or not, the following questions need be answered:

1. Whether the person (acting as the representative of a principal) has the capacity to bind the principal and make him answerable to the third parties.

2. Whether he can create legal relations between the principal and such third parties and thus establish a privity of contract between the principal and the third parties.

If the answers to these questions are in affirmative, the relationship of agency exists.

## 13.4 CLASSIFICATION OF AGENTS

Agents Can Be Categorized According To The following groupings:

*Classification based on the extent of their authority-*
(i) General agent
(ii) Special agent
(iii) Universal agent

*Classification based on the nature of work performed by agents-*
(i) Mercantile agents
(ii) Non-mercantile agents

### 13.4.1 Classification based on the extent of agent's authority

***(1) General agent*** - A general agent is one who has authority to do all acts connected with a trade, business or employment. For instance, a managing director of a company may have an implied authority to bind the company by doing anything necessary for carrying out the business of the company in the ordinary course. Also an agent of a general class like solicitor, and broker, etc. is considered as a general agent. The authority of a general agent continues until it is terminated. A person dealing with such agent may assume that he has the power to do the all that is usual to do in the business for which he is the general agent.

***(2) Special agent -*** A special agent is one who is appointed to do a particular act. He represents his principal in some particular transaction, e.g., an agent employed to sell a piece of land, or to bid at an auction. As soon as the particular act is performed, his authority comes to an end. A special agent has no apparent authority beyond the limits of his appointment and the principal is not bound by his acts exceeding those limits whether the aggrieved party has its knowledge or not. Thus a person dealing with such agent should make due enquiries from the principal as to the extent of his authority.

***(3) Universal agent -*** A universal agent is an agent who is authorized to do all the acts which his principal can lawfully do under the provisions of the law of the land. Thus he enjoys extensive powers where his authority is unlimited.

**13.4.2 Classification based on the nature of work performed by agents**

***(1) Mercantile agent -*** Section 2(9) of the Sale of Goods Act, defines the term 'Mercantile agent' as an agent who has the authority either to sell the goods, or to consign the goods for the purpose of sale, or to buy the goods, or to raise the money on the security of the goods on behalf of his principal. Thus, a mercantile agent deals with the buying or selling of goods. Following are some important classes of a mercantile agent:

*Factor -* The word 'factor' means an agent entrusted with the possession of goods for the purpose of selling them. He may sell the goods in his own name, give the goods on credit, receive payments and give valid receipt of discharge. A 'factor' has a general lien on the goods of his principal for all charges and expenses due from the principal.

*Broker -* A 'broker' is an agent employed for buying or selling the goods or other property of which he is not entrusted with possession and control. He simply acts as a connecting link and brings the two parties together to bargain, and if the transaction materialises, he becomes entitled to his commission called brokerage. He cannot act in his own name, nor does he have a right of lien.

*Commission agent -* A commission agent is an agent who buys or sells goods for his principal on the best possible terms on his own name and receives commission for his work. He may or may not have possession of goods.

*Del credere agent -* A del credere agent is one who for some extra commission (called del credere commission), guarantees to his principal that third party will perform its financial obligation under the contract. In such cases, if third party fails to pay to the principal any sum due under the contract, the agent pays instead. Thus he occupies the position of a surety as well as agent. However, he is not liable to the third party for any default on the part of the principal. Nor is he liable for any disputes between the principal and the third party relating to the contract or the sum due.

*In ordinary cases the only function of an agent is to effect a contract between his principal and a third party, the agent then drops out. Thus a contract of agency with a del credere agent is a special kind of agency.*

Banker - Generally the relationship between a banker and the customer is that of a creditor and a debtor. However, when the banker buys or sells securities, collects cheques, dividends etc. on behalf of his customer, he acts as an agent.

Auctioneer - An auctioneer is an agent who is appointed to sell the goods at a public auction. He has an authority to receive the auctioned price and sue for the same in his own name. He is like a 'factor' in all aspects except that he has only particular lien over the goods of his principal while a 'factor' has a general lien.

***(2) Non-mercantile agent-*** A non-mercantile agent is an agent who does not usually deal in the buying or selling the goods. Some important categories of non-mercantile agents are advocates, attorneys, wife, etc.

### 13.5 CREATION OF AGENCY

Creation of an agency relationship means creation of a contract of agency between the principal and the agent. Such relationship can be created in any of the following manners:

1. by express agreement
2. by implied agreement
3. by operation of law
4. by subsequent ratification of an unauthorized act.

#### 13.5.1 Agency by express agreement

When an agency is created by words spoken or written, it is said to be an express agency. However, no particular form or set of words is required for appointment of an agent. When it is in writing, it may take the form of power of attorney, or a board's resolution, or a statement in an employment contract saying that the agent is to "sell the goods of the employer", or in any other formal way.

**Examples-**

1. A told B to sell his truck for not below a particular amount and B accepted it, this is an express agency created by words of mouth.

2. A executed a 'power of attorney' in favor of B authorizing B to sell his truck not below a particular amount. This is a written express agency.

*Note: A power of attorney is a sworn statement in writing that another is to act for and in the place of principal.*

### 13.5.2 Agency by implied agreement

Where principal does not expressly give authority to the agent, but it is inferred from the conduct, situation, or relationship of the parties. In such cases courts recognize and impose an agency relationship. Such agency is said to be created by implied agreement.

**Example -** A, a resident of Delhi has a house in Bombay let out to some 'X'. His brother B resides in Bombay. B collects monthly rent from 'X' and remits the amount to A and A accepts it as a matter of routine. In this case, B is an implied agent of A, though he is not expressly appointed by A to collect the rent.

The agency by implied agreement may take any of the following forms:

1. Agency by estoppel
2. Agency by holding out
3. Agency by necessity.

***(1) Agency by estoppel -*** '*Estoppel*' means that a person is stopped from denying the truth of a statement which he has made. Thus where a principal leads third party to believe that the agent does have authority to perform certain act, he is subsequently stopped from denying the fact of existence of agency.

*Section 237* of the Indian Contract Act, 1872, provides that, "When an agent has, without authority, done acts or incurred obligations to third persons on behalf of his principal, the principal is bound by such acts or obligations if he has by his words or conduct induced such third persons to believe that such acts and obligations were within the scope-"of the agent's authority."

**Example -** A tells B in the presence of P that he is p's agent. P does not contradict the statement. If later on B *enters* into a contract with A thinking him to be p's agent, P is bound by that contract. This is a case of agency by estoppel.

*Generally two elements must be there to conclude that an agency is created by estoppel :*

(i) The principal, and not the agent must have created the circumstances leading the third party to believe that the agent is authorized to act.

**Example -** The services of A who was p's agent were terminated. No notice to this effect was given by P. Subsequently, A purchased some goods in the name of P from Mr. T. Here, P was liable to pay the price to T as P did not create circumstances leading the third party to believe that A is not authorized any more to work for P.

(ii) The third party must have reasonably relied on the appearance of authority created by the principal.

**Example -** A principal wrote to a third person saying he has authorized his agent to see him, and, if possible, to come to an amicable arrangement. He gave the agent instruction not to settle for less than a certain amount about which the third person had no knowledge. The agent settled the transaction for less than that amount. Here, the principal was bound by the settlement made by his agent to the third party because he leads him to believe that the agent was authorized to make a settlement on his behalf.

***(2) Agency by holding out*** - A principal is bound by the acts of the agent, if on an earlier occasion, he has made other persons to believe that such acts are done with his authority. But if an agent is held out to have a limited authority, the principal is not liable for his acts done beyond that authority.

**Example-** A gives authority to B, his servant, to buy goods from C, a shopkeeper. A pays to C for all goods purchased by B in routine. One day A gives cash to B for purchase of goods from C. B misappropriates the money and buy the goods on credit. A is liable to C for this purchase also as he held out before C that B is his agent.

Alternatively, if A has authorized B to buy only grocery items C on all earlier occasions, and B buys a radio set from C representing himself to be an agent of A, A will not be liable to C for the price of the radio set because he never held out B to have an authority to buy the same.

*Difference between estoppel and holding out –*

In case of 'estoppel', the principal is passive, keeps quiet and allows another person to give himself out as an agent. In case of holding out, the principal himself holds out to the world that somebody is his agent. Here there is an active assertion or representation by the principal.

***(3) Agency by necessity -*** In certain circumstances law confers upon a person the authority to act as an agent for the other without requiring the consent of that other person. It is called agency by necessity. It is created not by the parties, but by the exigencies of the circumstances.

*Generally the agency by necessity is created in following circumstances:*

*(a) Where the agent exceeds his authority in emergency -* In an emergency, the agent has authority to do all such acts that a person of ordinary prudence would do in his own case under similar circumstances (even though they are beyond his actual authority).

However, such an agency is assumed, provided following essentials exist.

*(i)* There was an actual and definite necessity,
*(ii)* The agent was not in a position to communicate with the principal,
*(iii)* The agent acted bona fide in the interest of the principal, and
*(iv)* The agent has taken all reasonable and necessary steps to protect the interests of the principal.

**Example** - A horse was sent by a train to a destination. There was no one to receive it. The railway company put the Horse with a stable keeper and paid the charges. Here, although the company had no express or implied authority to incur such charges, it has acted in emergency as an agent of necessity, and was, therefore, entitled to claim an indemnity from the owner of the horse.

*(b) A person .acts to save the other's property in emergency [Section 189] -* Where no relationship of principal and agent exists, but a person, in the absence of the other, acts to save the property of that other person, an agency by necessity is created. The idea is that when because of the emergency, the property of interests of the other are in imminent danger, and it becomes necessary to act before the instructions of the owner can be obtained, law *assumes* the consent of the owner to the creation of the relationship of principal and agent, so that such property or interests can be preserved to the extent possible.

**Example -** A and members of his family are out of station. A's house catches fire. B as neighbour, may take all necessary steps to preserve A's house, e.g., summon the fire brigade, break open the doors and do all such things which may be necessary under the circumstances. In this case an agency by necessity is presumed to exist between A and B.

*(c) Where carrier of goods acting as a bailee, does anything to protect or preserve the goods -* In cases of accident and emergency, the carrier of goods having a legal status of bailee acquires a status of agent and can act prudently in order to protect the goods. For example, a master of ship can sell or pledge the goods in order to save their value and such pledge or sale would be binding on the owners of cargo.

**Example -** A consigned certain quantity of butter with Railways. Due to strike, the butter was delayed in transit. The Railways sold the butter because it was of perishable nature. Here, the sale was binding on the owner as the Railways has acted as an agent by necessity

*(d) Where relationship of husband and wife subsists-* The general rule is that the wife is not the agent of her husband and the husband is not the agent of his wife. But one of them may be the agent of the other either by express appointment, or by holding out, or by ratification, or because of necessity. Here we will be discussing the agency by necessity under two circumstances:

**(1) Husband and wife living together-** Where husband and wife are living together and the wife is entrusted with the duty of looking after the household, there is a presumption that the wife can pledge the credit of her husband for the necessaries of life. But this presumption can be rebutted in the following cases:

*(i)* Where purchases are not necessaries, e.g., a T.V. set for a peon.
*(ii)* Where the trader has been expressly told by husband not to give credit to his wife.
*(iii)* Where the wife was provided with sufficient funds to purchase the necessaries.
*(iv)* Where the wife was already provided with the sufficiency of the articles in question.

It may be noted that a husband enjoys no corresponding right to pledge his wife's credit for necessaries.

**(2) Wife living separately from husband -** Where the husband turns the wife out of the house without any justifiable cause, he is bound by any contract made by the wife for necessaries because he is bound to maintain her. But if the wife is living separate from the husband, without any justifiable cause, she cannot make her husband liable even for necessaries.

*Note: This presumption of implied authority exists only between the husband and wife and does not extend to the case of parent and child. Where the child living with the father purchases necessaries, the father of the child will not be liable therefor.*

### 13.5.3 Agency by operation of law

In certain circumstances, the law treats one person as an agent of the other. For example, as per the Partnership Act, every partner of a firm is its agent for the purpose of business of the firm. Moreover, he is also an agent of the other partners of the firm.

### 13.5.4 Agency by ratification

Ratification is an approval of the previous act or contract. It implies the adoption by the principal of an act made by an agent on his behalf, but without his authority. It is also known as 'ex post facto agency', i.e., agency arising after the event.

Section 196 of the Indian Contract Act, 1872, says that, "Where acts are done by one person on behalf of another, but without his knowledge or authority, he may elect to ratify or disown such acts. If he ratifies them, the same effect will follow as if they had been performed by his authority."

**Examples-**

1. A insured B's goods without his authority. Subsequently B confirmed A's act of insuring the goods and accepted the insurance policy. In this case, the insurance policy is as valid as if A had been authorised by B to insure the goods.

2. A insured B's goods without his authority. B did not accept the insurance policy. No contract exists between B and the insurance company.

*Ratification relates back to the time of contract -* When a contract is ratified, the agency comes into existence from the moment the agent acted, and not from the time when the principal ratified. Thus the agency by ratification has the retrospective effect.

*Ratification may be express or implied -* Section 197 of the Indian Contract Act, 1872, provides that, "Ratification may be expressed or may be implied in the conduct of the person on whose behalf the acts are done."

**Example -** Where the manager of an insurance company affected an assurance where he had no authority to do so, but the company accepted the money which was received under the policy, It is sufficient ratification.

### 13.5. 5 *Essentials of a valid ratification*

A ratification to be valid must fulfil the following conditions:

***(1) The agent must expressly contract on behalf of an identifiable principal -*** If an agent acts on behalf of an undisclosed principal, again the doctrine of ratification is not applicable. It is only when an agent profess to act on behalf of an identifiable principal, such transaction can be ratified at a later stage.

***(2) The act should be capable of ratification -*** The act to be ratified must be valid in itself and not illegal. There can be no ratification of an illegal act or an act which is void. Thus, a person cannot ratify a wagering contract entered in his name.

***(3) Only named principal can ratify -*** Only that principal who was named or was identifiable at the time of the contract, can ratify the contract.

***(4) The principal must be in existence -*** Since ratification relates back to an earlier period, principal must be in existence at the time of original contract, otherwise it cannot be ratified at a later stage.

***(5) The principal must be competent to contract -*** The principal must have contractual capacity both at the time of original contract and at the time of ratification. Thus a person cannot ratify a contract made during his minority.

***(6) Ratification must be with full knowledge of facts [section 198] -*** No valid ratification can be made by a person whose knowledge of the facts of the case is materially defective.

Where a principal has adopted or ratified a contract made by an agent, without knowledge of the irregularity, he will not be bound by such contract. However, if the principal says, "I do not know what my agent has done; but I must support him in all he has done", he takes upon himself the risk of any irregularity and he will be bound.

**(7) Ratification must be done within a reasonable time-** If ratification is made after the expiry of the reasonable time, it will not be valid.

**(8) The whole transaction must be ratified [Section 199] -** A person ratifying any unauthorized act done on his behalf ratifies the whole of the transaction of which such act formed a part.

It is not open to the principal to ratify one part and refuse to accept other part of a transaction.

***(9) Ratification must not injure a third person [Section 200] -*** An act done by one person on behalf of another without such other person's authority, which, if done with authority, would have the effect of subjecting a third person to damages, or of terminating any right or interest of a third person, cannot, by ratification, be made to have such effect.

**Example-** A holds a lease from B, terminable on three-month's notice. C, an unauthorized person gives a notice of termination to A. The notice cannot be ratified by B so as to be binding on A.

## 13.6 EXTENT OF AGENT'S AUTHORITY

When a person hires an agent, it does not mean that the agent can represent him in any way he deems fit. An agent can make the principal legally responsible for his acts only when he is authorized by the principal to act that way. To know the extent to which a principal can be liable for the acts of an agent, it is necessary to know all dimensions of the agent's authority. The agent's authority to bind the principal may be discussed under the following heads:

1. Actual or real authority
2. Ostensible or apparent authority
3. Authority in emergency.

### 13.6.1 Actual or Real Authority

It is the authority which is conferred upon the agent by the principal. It may be express or implied.

***Express authority -*** An authority is said to be express when it is given by words spoken or written. This is the most obvious and most common type of authority.

***Implied authority -*** In a commercial transaction or any otJ;1er complex transaction, it is impossible for the principal to express all of the authority that may be needed to carry out the job. It is reasonable for an agent to believe that he has authority to carry out incidental activities for performance of the given task. For example, an agent who is called 'manager' of a business usually has the implied authority to hire employees, and to buy inventory, even if such authority is not expressly given by the principal. An authority is said to be implied when it is to be inferred from the circumstances of the case; and things spoken or written or the ordinary course of dealing, may be accounted circumstances of the case. [Section 187]

### 13.6.2 Ostensible or apparent authority

There may be cases where principal does not give express or implied authority to the agent but courts recognize and impose an agency relationship. It happens when the principal leads third party to believe that the agent has an authority to act on his behalf (actually not being so) and the third party acts on the faith of such representation. The authority of an agent in such cases is termed as 'ostensible' or 'apparent' authority.

The concept of apparent authority was created to protect the reasonable expectations of those in commerce who do business with agents. If the principal is permitted to dispute the authority of the agent in such cases, it would enable him to commit a fraud upon innocent persons.

### 13.6.3 Authority in emergency

An agent ,has authority, in an emergency, to do all such acts for the purpose of protecting his principal from loss as would be done by a person of ordinary prudence in his own case, under similar circumstances. [section 189]

**Example** - A consigns provisions to B at Calcutta, with directions to send them immediately to Cuttack. B may sell the provisions at Calcutta, if they will not bear the journey to Cuttack without spoiling.

### 13.6.4 Delegation of Authority By An Agent

An agent cannot delegate his authority - Section 190 provides, "An agent cannot lawfully employ another to perform acts which he has expressly or impliedly undertaken to perform personally. . . ."

This rule is based on the legal maxim *'Delegatus nonpotest delegare'* which means that a delegate cannot further delegate. An agent is a delegate of the principal and, therefore, he cannot further delegate the authority which he has received from the principal. A principal deputes an agent to do a certain work because of the trust and confidence which the former reposes in the latter, therefore, the latter should not depute some other person to perform the task that he has undertaken to perform personally. That other person called a sub-agent may not enjoy the confidence of the principal.

*Exceptions -* In the following cases delegations made by an agent to a sub-agent is lawful:

1. *Express permission -* Where the principal has expressly permitted such delegation.

2. *Implied permission -* Where it may be inferred from the conduct of the principal that he has permitted to appoint sub-agent.

**Example -** Q asks R to procure 100 wheat bags for him. In the presence of Q, R asks P to complete this job. Q does not object to it. Thus Q is deemed to have permitted delegation.

3. *Custom of trade -* Where by the ordinary custom of trade, a sub-agent may be employed.

   **Example -** Q asks R, a stock exchange broker, to purchase some shares for him. Customarily R can entrust this work to his clerks.

4. *Nature of agency -* Where the work undertaken by the agent is of such nature that it requires delegation.

   Example - A asks his banker to let out his house and collect rent. The banker entrusts the work to an estate agent. The delegation is proper.

5. *Ministerial acts (i.e., clerical or routine work) -* Where the acts to be done are purely ministerial and do not involve exercise of discretion, or personal or professional skill.

6. *Emergency -* Where unforeseen emergencies arise rendering appointment of the sub-agent necessary.

**13.7 SUB-AGENT**

Who is a sub-agent - Section 191 of the Indian Contract Act, 1872, provides that, 'A sub-agent is a person employed by, and acting under the control of the original agent in the business of the agency.'

A sub-agent is a person appointed by an agent to perform functions undertaken by the agent for the principal. The relationship of sub-agent with the original agent is, as between themselves, that of an agent and the principal. Hiring a sub-agent is not the same as hiring employees for the principal. For example, when a personnel officer of a corporation hires employees for the corporation, they are not sub-agents of the personnel officer.

## 13.8 SUBSTITUTED AGENT

Section 194 of the Indian Contract Act, 1872, provides that, "When an agent has an express or implied authority of his principal to name another person to act for the principal and the agent names another person accordingly, such person is not a subagent but a substituted agent of the principal in respect of the business entrusted to him.

Thus a substituted agent is different from a sub-agent. While a sub-agent is the agent of the original agent and the original agent remains responsible for the acts of sub-agent to the principal, a substituted agent becomes the agent of the principal and a direct privity of contract is established between them, and there is no privity of contract between the original agent and the substituted agent. Substituted agent is also called co-agent.

**Example -** A directs B, his solicitor, to sell estate by auction, and to employ an auctioneer for the purpose. B names C, an auctioneer to conduct the sale. Here C is not a sub-agent, but he is a substituted agent of A.

## 13.9 PRETENDED AGENT

Where a person pretends to act as the agent of the other, without being so, he is called a 'pretended agent'. As a matter of fact, a pretended agent has no authority to act on behalf of the principal. When a pretended agent enters into a contract with a third party, there may be two possibilities:

1. Principal ratifies the act of the pretended agent - the effect of the transaction is like any other transaction of agency.

2. Principal does not ratify the act of pretended agent - such agent is liable to make compensation to third party for any loss or damage which he has incurred by so dealing.

## 13.10 DUTIES OF AN AGENT

*The Indian Contract Act imposes following duties upon an agent:*

***(1) To follow principal's directions or customs [section 211]-*** An agent is bound to conduct the business of his principal according to the directions given by the principal or, in the absence of any such directions, according to the customs which prevails in doing business of the same kind at the place where the agent conducts such business. When the agent acts otherwise, and any loss is sustained, he must make it good to his principal. and if any profit accrues, he must account for it.

***(2) To carry out the work with reasonable skill and diligence [section 212] - An agent*** is bound to conduct the business of agency with as much skill as is generally possessed by persons engaged in similar business, unless the principal has notice of his want of skill. Further, the agent is bound to act with reasonable diligence and use his skill.

If principal suffers any damage which is a direct consequence of the neglect, misconduct or lack of skill on the part of the agent, the agent is liable to compensate for such damage. However, he is not responsible for any remote or indirect damages suffered by the principal.

***(3) To render proper accounts [section 213] -*** An agent is bound to render proper accounts to his principal on demand. The duty of an agent to account to his principal is an absolute obligation incidental to the contract of agency.

***(4) To communicate with the principal in case of difficulty [section 214] -*** It is the duty of an agent in cases of difficulty, to use all reasonable diligence in communicating with his principal, and in seeking to obtain his instructions.

Thus where an agent has already not been instructed to deal with an emergent situation, and it arises, the agent should communicate with the principal for the instructions. Where, though communication is possible, and the agent refrains from intimating the circumstances and asking for instructions, it would be open to the principal to repudiate the agent's act.

**Example -** Q sent goods to R for sale. R's shop was very close to river. The civic authorities issued a warning for the forthcoming floods. R placed the goods of Q at a different place to save them from the flood. However, he did not communicated with Q regarding this while it was feasible to communicate. The goods destroyed at the new place also. Here R is liable for the loss to Q.

***(5) Not to deal on his own account [Sections 215 and 216] -*** An agent must not deal on his own account (i.e., in his own interest) in the business of agency, without first obtaining the consent of his principal and acquainting him with all material circumstances which have come to his own knowledge on the subject.

***(6) To pay all sums received for principal [Section 218] -*** Any amount which an agent receives on behalf of the principal has to be paid to the principal. Of course, the agent can make deductions from it in respect of his expenses and remuneration for the business of the agency.

***(7) Not to make secret profits from the agency -*** An agent must not except with the knowledge and assent of the principal, make any profit beyond the commission or remuneration agreed upon between them. If the agent does so, the principal is entitled to recover the secret profit so earned by him. Moreover, the principal may refuse his usual commission, and may terminate his agency.

***(8) Not to delegate authority [Section 190] -*** An agent is not to delegate his authority except in certain circumstances which are discussed earlier under the heading 'Delegation of authority'.

***(9) Duty on principal's death or insanity [Section 209] -*** When an agency is terminated by the principal's death or his becoming of unsound mind, the agent is bound to take, on behalf of the representatives of his late principal, all reasonable steps for the protection and preservation of the interests entrusted to him.

The rule given by section 209 works as an exception to the general rule that 'the contract of agency is terminated on the death or insanity of the principal'.

**Example -** A was an agent of P. P died. The agency terminated on the death of P. Thereafter, A gave acknowledgement of debt to the creditors of P who were unaware of his death. Such an acknowledgement by A, the agent, constituted a reasonable step for protection and preservation of the interests of the principal

## 13.11 RIGHTS OF AN AGENT

***(1) To receive remuneration [Sections 219 and 220] -*** Every agent is clearly entitled to his agreed remuneration, or if there is no agreement, to a reasonable remuneration unless he has acted gratuitously. The difficult question is as to when remuneration becomes due. Section 219 says that, "in the absence of any special contract, payment for the performance of any act is not due until the completion of such act...” This provision raises two questions. When is the act complete? And secondly, is the act a result of the agent's services?

The act is considered as complete as soon as the agent carry out his part of work. It is immaterial that the relevant transaction matured or not.

An agent who is guilty of misconduct in the business of the agency is not entitled to any remuneration in respect of that part of the business which he has misconducted. In addition, he is liable to compensate the principal for any loss caused by the misconduct.

**(2) *To retain his dues [Section 217] -*** The agent has the right to retain his principal's money until his claims, if any, in respect of his remuneration or advances made, or expenses incurred in conducting the business of agency are paid. The right can be exercised on "any sums received on account of the principal in business of agency."

**(3) *To have a lien [Section 221] -*** In addition to the above right of retainer, the agent has the right to retain the goods, papers and other property, whether movable or immovable, of the principal received by him, until the amount due to himself for commission, disbursements, and services in respect of the same has been paid or accounted for to him.

This lien is generally a particular lien. But the contract between the parties may provide for a general lien or for no lien at all.

**(4) *To be indemnified against the consequences of lawful acts [Section 222]*** - The employer of an agent is bound to indemnify him against the consequences of all lawful acts done by such agent in exercise of the authority conferred upon him.

**(5) *To be indemnified against the consequences of acts done in good faith [Section 223] -*** An agent has a right to be indemnified by the principal against the consequences of an act done in good faith though it turns out to be injurious to the rights of third persons.

**(6) *Right to compensation [Section 225] -*** The principal must make compensation to his agent in respect of injury caused to such agent by the principal's neglect or want of such skill.

**Example -** A employs B, a bricklayer in building a house, and puts up the scaffolding himself. The scaffolding is unskillfully put up, and B is in consequence hurt. A must make compensation to B.

***(7) Right of stoppage of goods in transit -*** An agent, like an unpaid seller, has a right to stop the goods in transit to the principal, if-

- he has bought the goods either with his own money or by incurring a personal liability for the price, and
- the principal has become insolvent.

## 13.12 RIGHTS OF A PRINCIPAL

The rights of a principal are based on the duties of an agent. These are as follows:

1. He can enforce various duties of an agent.
2. He can recover compensation from agent for any breach of duty by him.
3. He can forfeit agent's remuneration where the agent is guilty of misconduct in the business of agency.
4. Principal is entitled to any extra profit that an agent makes out of his agency including illegal gratification, if any.
5. Principal is entitled to receive all sums that agent receives on principal's account, even though the transactions entered into by the agent are illegal or void.

## 13.13 DUTIES OF A PRINCIPAL

Duties of a principal are a corollary of the rights of an agent. They are as follows:

1. It is duty of the principal to pay agreed remuneration to the agent. However, where the agent is guilty of misconduct in the business of agency, the principal can forfeit. the agent's remuneration for such work.

2. It is duty of the principal to indemnify the agent for the consequences of all lawful acts entrusted to him, and for all such acts which he perform in good faith. However, he is not bound to compensate the agent against the consequences of unlawful acts.

3. It is duty of the principal to compensate the agent for any loss or damage incurred by him because of principal's negligence or want of skill.

## 13.14 POSITION OF PRINCIPAL TOWARDS THIRD PARTIES

In agency transactions, agent acts for the principal in dealings with persons who are outside the agency relationship. These persons are called 'Third Parties'. A principal is bound by the promises or representations made by an agent to a third party on his behalf if the agent has acted within the authority granted by the principal or by the law.

## 13.15 POSITION OF AN AGENT TOWARDS THIRD PARTIES

An agent is merely a connecting link between his principal and the third party. His main function is to establish contractual relationship between his principal and third parties. Thus as a general rule, an agent cannot personally enforce the contract entered into by him on behalf of his principal, nor can he be personally held liable for such contracts.

Section 230 of the Indian Contract Act, 1872, provides that, "In the absence of any contract to that effect, an agent cannot personally enforce contracts entered into by him on behalf of his principal, nor is he personally bound by them."

### 13.15.1 Circumstances Where an Agent Becomes Personally Liable To Third Parties

In some circumstances, an agent is presumed to be personally liable on the contract to third parties. These circumstances are discussed below:

***(1) The agent expressly agrees -*** When at the time of making contract with the third party, the agent agrees to be personally liable upon the contract.

***(2) The agent acts for a foreign principal -*** Where an agent contracts for the sale or purchase of goods for a merchant residing abroad, he is presumed to be personally liable.

***(3) The agent acts for an unnamed principal -*** Where an agent acts for an unnamed principal and declines to disclose the identity of the principal, or when the principal stops existing before the agent discloses his name to third parties.

***(4) The agent acts for an undisclosed principal -*** Where an agent acts for an undisclosed principal and contracts in his own name, he is personally liable to the third party. But if the third party comes to know about the existence of the principal, he may elect to sue the principal, or the agent, or both.

***(5) The agent acts for the principal who cannot be sued -*** An agent is presumed to incur personal liability where he contracts on behalf of a principal who, though disclosed, cannot be sued. For example, where an agent acts for an ambassador, or foreign sovereign, he is personally liable.

***(6) The agent acts for a non-existent principal -*** Where an agent acts for the principal who does not exist at the time of contracting. For example, the promoters contracting on behalf of the company, which is yet to be incorporated.

***(7) The agent is a pretended agent -*** A pretended agent (if the principal does not ratify his act) is personally liable to third parties for the loss or damage incurred by them because of dealing with him.

***(8) The agent exceeds his authority -*** Where an agent acts in excess of his authority, he is liable to the third parties for his acts committed by exceeding his authority. However, if the acts exceeding authority cannot be separated from the acts within the authority, the agent becomes liable for the whole transaction.

***(9) The agent's authority is coupled with interest -*** Where the agent has an interest in the subject-matter of the contract, he is liable to the third parties to the extent of that interest. As a matter of fact, the agent is a principal for that interest.

***(10) Personal liability under some custom, usage, or trade -*** Where the custom, or usage of a particular trade provides that the agent shall be personally liable for his acts, the agent incurs personal liability. For example, a jobber may hold a broker personally liable as per the custom of trade in a stock exchange.

## 13.16 TERMINATION OF AGENCY

Termination of agency can occur because of something done by the parties themselves or by operation of law (i.e., something beyond their control).

### 13.16.1 Termination by Act Of The Parties

***(1) Mutual agreement -*** Regardless of what the principal and agent have agreed originally, they can agree at any time to end their relationship.

***(2) Revocation by principal-*** The principal can always withdraw his authority from his agent.

***(3) Renunciation by agent -*** Renunciation means 'giving up'. An agency can be terminated by an agent by renouncing the agency relationship with the principal. The agent has been given this right to renounce the agency because a person cannot be compelled to continue as against his will. The renunciation may be express or implied in the conduct of the agent. [Section 207]

**Example -** A appointed B to sell his house. Subsequently, B renounced his agency relationship by tendering a resignation to A. This is an express renunciation by the agent.

However, an agent must give a reasonable notice of renunciation to the principal; otherwise he will be responsible to compensate the principal for any damage resulting thereby [section 206). Further, if the agency is for a fixed period of time, an agent would have to compensate the principal if he renounces his obligations, before the fixed period without the sufficient cause. [Section 205]

### 13.16.2 Termination by Operation of Law

***(1) Completion of business -*** At times an agent is appointed to accomplish a particular object, such as a sale of a house belonging to the principal. When this object is accomplished and nothing else remains to be done, the agency relationship obviously terminates. [Section 201]

**Example -** P employs A, an advocate, to plead his case in the court of law. The court gives his judgment on the case. A's authority comes to an end.

***(2) Lapse of time -*** Where an agent has been appointed for a fixed term, the expiration of the term puts an end to the agency, whether the purpose of the agency is accomplished or not. [Section 201]

***(3) Death or insanity-*** An agency automatically comes to an end on the death or insanity of the principal or the agent.

The Contract Act imposes a duty upon the agent to take all reasonable steps for the protection and preservation of the principal's interests in case the agency gets terminated by the death or insanity of the principal.

Though it is true that the agent need not be a person capable of entering into a contract, still, according to the law, the agency terminates as soon as the agent becomes insane. This is because the agency being the matter of confidence and trust, no principal can reasonably be expected to continue to employ an insane agent.

***(4) Insolvency of the principal -*** The insolvency of the principal puts an end to the agency. But insolvency of the agent does not make any difference.

***(5) Destruction of the subject-matter-*** The loss or destruction of the subject-matter of an agency terminates the agent's authority.

**Example -** X employs Y to sell grains belonging to X stored in a particular storage. The destruction of the grain by fire will extinguish the Y's authority to sell them.

***(6) Principal or agent becomes alien enemy -*** If principal and agent belongs to two different countries, and these countries becomes alien enemies, the relationship of agency between them becomes unlawful and stands terminated.

***(7) Dissolution of a company*** - Dissolution of a company extinguish its existence. Thus if a principal or agent is an incorporated company, its dissolution terminates the agency relationship.

***(8) Change of law -*** If a change in the law makes the agency or the performance of the authorized act illegal, the agent's authority is ordinarily terminated when he learns of the change.

**Example -** S is a salesperson who sells the toys manufactured by P. Subsequently the Government determines that the toys manufactured by P are of dangerous nature and ban them. S's authority to sell them is terminated as soon as he comes to know about the governmental ban.

### 13.16.3 When Termination of Agency Takes Effect

The termination of an agency relationship takes effect with respect to a person from the moment the fact of such termination is communicated to him. Thus although an agency is revoked as a matter of fact, it does not become effective till the time it is made known to the concerned parties.

Section 208 of the Indian Contract Act, 1872, provides that, "The termination of the authority of an agent does not, so far as regards the agent, take effect before it becomes known to him, or, so far as regards third persons, before it becomes known to them: As between the principal and the agent, the authority of the agent ends when he comes to know of the termination.

**Example -** A directs B to sell goods for him, and agrees to give B 5% commission on the price fetched by the goods. A afterwards, by letter, revokes B's authority. B, after the letter is sent but before he receives it, sells the goods for Rs. 100. The sale is binding on A, and B is entitled to Rs. 5 commission on the sale. As regards third persons, the agency does not terminate until they come to know of the fact of termination.

**Example -** A, at Madras, by letter, directs B to sell for him some cotton lying in a warehouse in Bombay, and afterwards, by another letter, revokes B's authority to sell and directs him to send the cotton to Madras. B, after receiving the second letter enters into a contract with C, who knows of the first letter, but not of the second. C pays B the money, with which B absconds. C's payment is good as against A.

Even when the agency is terminated by the death of the principal, the termination is effective only when it comes to the knowledge of the agent.

**Example -** A directs B, his agent, to pay certain money to C. A dies, and D takes out a probate to his will. B, after A's death but before hearing of it, pays the money to C. The payment is good as against D, the executor.

## 13.17 IRREVOCABLE AGENCY

In certain circumstances an agency becomes irrevocable. This happens when

1. the agency is coupled with the interest, or
2. the agent has incurred a personal liability, or

3. the agent has partly exercised his authority.

### 13.17.1 Agency Coupled With Interest [Section 202]

The agency in which the agent has an interest in the subject-matter of the agency is called an 'agency coupled with an interest'. This kind of agency is created to secure the interest of the agent.

**Examples:**

1. P borrows Rs. 10,000 from A. He authorizes A to sell his car, and to retain Rs. 10,000 as repayment of his debt out of the proceeds from the sale of car. This is an agency coupled with interest.

2. A person was entitled to be maintained out of the income of a property. Subsequently, he was given an authority to collect the rent of the property, and retain his maintenance money out of it. This is an agency coupled with interest.

### 13.17.2 Agent Incurs Personal Liability

In the course of agency, if an agent undertakes personal liability, agency becomes irrevocable. The reason being that the principal cannot be permitted to withdraw leaving the agent exposed to risk or liability which he has incurred.

**Example -** A authorizes B to buy 1000 bales of cotton on account of A, and to pay for it out of A's money remaining in B's hands. B buys 1000 bales of cotton Innis own name, so as to make himself personally liable for the price. A cannot revoke B's authority as regards payment for the cotton.

### 13.17.3 Agent Partly Exercise the Authority [Section 204]

When the agent has already exercised some authority, the principal cannot revoke the agent's authority for the acts already done. The principal is bound by the acts already done on his behalf.

**Example -** A authorized B to payout of A's funds lying with him a sum of Rs. 10,000 to C in four equal installments. Subsequently A revoked B's authority by a letter. Before the receipt of the letter, B had already paid one installment of Rs. 2500 to C. In this case, A is bound by this payment.

**13.18 COMPARISONS**

**13.18.1 Agent and Servant**

| **Agent** | **Servant** |
|---|---|
| ***Similarities*** | |
| An agent is a person employed by some other person to work for him. | A servant is a person employed by some other person to work for him. |
| ***Differences*** | |
| Authority - An agent has the authority to act on behalf of his principal and to create contractual relations between the principal and the third parties. | This kind of power is not generally enjoyed by the servant. |
| Control and Supervision – Generally an agent is told what is to be done, but he is not subject to the direct control and supervision of the principal | A servent is generally told what is to be done and how it is to be done. He acts under direct control and supervision of his master and is bound to confirm all reasonable order of his master during the course of his work. |
| Liability - A principal is liable only for the acts of his agent within the scope of his authority. | A master is liable for the wrongful acts of his servant if those acts are done in the course of employment. |
| Remuneration - The mode of remuneration is generally different. An agent receives commission on the basis of work done. | A servant is paid by way of salary or wages |
| No. of persons represented - An agent may work for the several principals at the same time. | A servant usually serves only one master. |

**13.18.2 Agent and Independent Contractor**

A person who undertakes to do something for the other is called an independent contractor. An agent can be compared from an independent contractor in the following respects:

| Agent | Independent Contractor |
|---|---|
| **Similarities** | |
| Agent is a person employed by the other to work on his behalf | An independent contractor is a person employed by the other to work on his behalf. |
| **Differences** | |
| Control and Supervision - Although an agent is not under direct supervision and control of his principal, but he is bound to follow instructions of the principal in carrying out the work. Thus he is subject to some degree of control. | An independent contractor merely under takes to perform a specified task. The mode of performance is left to his discretion. |
| Representative character - An agent can represent the principal and bind him with the contracts entered into with the third parties acting within the scope of his authority. | An independent contractor cannot represent his employer. |

### 13.18.3 Agent and Bailee

| Agent | Bailee |
|---|---|
| **Similarities** | |
| An agent is entrusted with some work on behalf of the principal. | A bailee is entrusted with some work on behalf of the bailor. |
| **Differences** | |
| Subsistence of relationship - The subsistence of relationship of an agent and principal does not necessarily depends upon possession of his principal's property by an agent. | The relationship of a bailor and bailee subsists only so long as the bailee holds some goods belonging to the bailor. |
| Representative capacity - An agent can represent his principal before the third parties acting within the scope of his authority. | A bailee does not have representative capacity. |

# UNIT- III

## LAW OF TORTS

Before dealing with the TORTS, let us imagine a situation which does not provide for a specific law for administration of justice, what would happen in that situation?

The obvious answer would be to administer justice keeping in mind and in accordance with *"JUSTICE, EQUITY AND GOOD CONSCIENCE".*

It means breach of some duty independent of contract giving rise to a civil cause of action and for which compensation if recoverable.

Person committing a tort is called a tort-feasor or wrong doer and his misdoing is a tortuous act.

**CONSTITUENTS OF TORT**

(A) <u>GENERAL</u>

Torts is an instrument for making people adhere to standards of reasonable behaviour and respect the rights and interests of one another. This it does by protecting interests and by providing for situations when a person whose protected interest is violated can recover compensation for the loss suffered by him from the person who has violated the same. A protected interest give rise to a legal right which in turn give rise to a corresponding legal duty. Some legal right are absolute in the sense that mere violation of them leads to the presumption of legal damage. These rights are rights actionable per se. In these cases no proof of actual and factual damage is necessary (Defamation).

Whereas some legal rights are such where there is no such presumption of legal damage and actual loss or damage is necessary to complete the injury (Loss caused due to negligent act eg. Accident due to negligence). These legal rights give rise to qualified damage.

Thus to constitute a tort or civil injury (1) there must be a wrongful act committed by a person (2) the wrongful act must give rise to legal damage or actual damage and (3) the wrongful act must be of such a nature as to give rise to a legal remedy in the form of an action for damages.

Wrongful Act

The act complained of should, under the circumstances, be legal wrongful as regards the party complaining; that is, it must prejudicially affect him in some legal right.

The legal rights may be Private Rights which include all rights which belong to a particular person to the exclusion of the world at large. Some of these rights are (1) right of reputation (2) rights to bodily safety and freedom (3) rights of property. The other category of the rights may be Public Rights which include those rights, which belong in common to the members of the State generally.

To every right there corresponds an obligation or duty.

Damage

Damage means the harm or loss suffered or presumed to be suffered by a person as a result of some wrongful act of another. The sum of money awarded by court to compensate "damage" is called "damages".

In consonance with the maxim *ubi jus ibi remedium* (there is no wrong without remedy). Tort is a civil injury. The wrongful act must come under the category of wrongs for which the remedy is a civil action for damages. The essential for a tort is an action for damages.

Torts are an instrument for making people adhere to standards of reasonable behavior and respect the rights and interests of one another. This it does by protecting interests and by providing for situations when a person whose protected interest is violated can recover compensation for the loss suffered by him from the person who has violated the same. A protected interest gives rise to a legal right which in turn give rise to a corresponding legal duty. Some legal rights are absolute in the sense that mere violation of them leads to the presumption of legal damage. These rights are rights actionable per se. In these cases no proof of actual and factual damage is necessary (Defamation).

Whereas some legal rights are such where there is no such presumption of legal damage and actual loss or damage is necessary to complete the injury (Loss caused due to negligent act e.g. Accident due to negligence). These legal rights give rise to qualified damage.

Thus to constitute a tort or civil injury (1) there must be a wrongful act committed by a person (2) the wrongful act must give rise to legal damage or actual damage and (3) the wrongful act must be of such a nature as to give rise to a legal remedy in the form of an action for damages.

**Remedy**

In consonance with the maxim ubi jus ibi remedium (there is no wrong without remedy). Tort is a civil injury. The wrongful act must come under the category of wrongs for which the remedy is a civil action for damages. The essential for a tort is an action for damages.

**DISCHARGE OF TORTS**

Torts can be discharged as under-

1. Waiver by Election
2. Accord and Satisfaction
3. Release
4. Acquiescence
5. Judgment Recovered
6. Statutes of Limitation

### 1.5.1 Waiver by Election

Where a man has more than one remedy for a tort, and he elects to pursue one of them, giving up the others, the other remedies are waived. He cannot pursue them if he fails in the one elected. Waiver is express or implied: express, when the person entitled to anything expressly and in terms gives it up, in which case it nearly resembles release; implied, when the person entitled to anything does or acquiesces in something else which is inconsistent with that to which he is so entitled. The phrase "waive the tort" does not mean that the tort itself is waived; it is only the right to recover damages for the tort committed that is waived.

There are certain cases in which a person injured by a tort may at his election bring an action of tort, or waive the tort and sue the wrong-doer on a contract implied fictitiously by law. Thus, if the defendant obtains the plaintiff's money by fraud or other wrong, the plaintiff may sue him in tort or for money had and received. Similarly, if a man is wrongfully deprived of his goods, which are afterwards sold, he may bring an action for damages for the tort, or he may sue for the price received by the defendant.

### 1.5.2 Accord and Satisfaction

An accord is an agreement between two or more persons, one of whom has a right of action against the other, that the latter shall render and the former accept some valuable consideration in substitution for the right of action. 'Accord' indicates the agreement, and 'satisfaction' the consideration which makes it operative. When the agreement is executed, and satisfaction has been made, the arrangement is called accord and satisfaction and operates as a bar to the right of action. An accord and satisfaction in favour of one joint tort-feasor operates in favour of them all when the injury is one and indivisible. It can then give rise to but one cause of action, and consequently if satisfaction is accepted as full and complete as against one person, it operates with respect to the entire cause of action.

### 1.5.3 Release

A release is the giving up or discharging of the right of action which a man has or may have against another man. But a release executed under a mistakel6 or in ignorance of one's rights, or obtained by fraud, is not valid.

A covenant not to sue at all is equivalent to a release and may be pleaded in bar. A mere covenant not to sue one of two joint tort-feasors does not operate as a release so as to discharge the other.

### 1.5.4 Acquiescence

Where a person who knows that he is entitled to enforce a right, neglects to do so for a length of time, the other party may fairly infer that he has waived or abandoned his right. But to deprive a man of his legal remedies there must be something more than mere delay.Direct acquiescence takes away the right of action.

### 1.5.5 Judgment Recovered

The cause of action against a wrong-doer in respect of a wrong is extinguished by a judgment obtained in a Court of law. The judgment is a bar to the original cause of action, because it is thereby reduced to a certainty and the object of the suit attained, so far as it can be at that stage; and it would be useless and vexatious to subject the defendant to another suit for the purpose of obtaining the same result. The person injured cannot bring a second action for the same wrong even though it is subsequently found that the damage is much greater than was anticipated when the action was brought. If in an assault a person sustains a broken arm and a broken leg, he must sue for both the injuries in the same action.

### 1.5.6 Statues of Limitation

There is a distinction between wrongs which are actionable per se, and those which are actionable only where the plaintiff can prove that he has suffered actual damage. The period of limitation runs, in the first case, from the time when the wrongful act is committed; in the second, from the time of the plaintiff's first sustaining actual injury.

The periods within which suits can be brought in Indian Courts against wrongdoers for obtaining redress are governed by the provisions of the Indian Limitation Act, 1963.

## 1.6 REMEDIES

There are two kinds of remedies for torts, namely, judicial and extra-judicial. Judicial remedies are remedies which are afforded by the Courts of law; while extra-judicial remedies are those which are available to a party, in certain cases of torts, by his own acts alone. Extra-judicial remedies are (i) expulsion of trespasser, (ii) re-entry on land, (iii) recaption of goods, (iv) distress damage feasant and (v) abatement of nuisance. But these remedies, which are in the nature of self-help, should not be normally resorted to, for the person resorting to them may frequently exceed his rights and may be faced with a case civil or criminal alleging that he took the law in his own hands. It may also create problems of law and order. Judicial remedies are: (1) awarding of damages; (2) granting of injunction; and (3) specific restitution of property. Damages and injunctions are merely two different forms of remedies against the same wrong.

### 1.6.1 Damages

In a suit for damages in a tort case, the Court awards pecuniary compensation to the plaintiff for the injury or damage caused to him by the wrongful act of the defendant. After it is proved that the defendant committed a wrongful act, the plaintiff would be entitled to compensation, may be nominal, though he does not prove any specific damage or injury resulting to him, in cases where the tort is actionable per se. But even in these cases when specific damage is alleged and in all other cases, where tort is not actionable per se, and it becomes the duty of the plaintiff to allege the damage resulting from the wrongful act for which he claims damages, the Court's enquiry resolves in deciding three questions: (1) Was the damage alleged caused by the defendant's wrongful act? (2) Was it remote? and (3) What is the monetary compensation for the damage?

***Causation***

If the damage alleged was not caused by the defendant's wrongful act the question of its remoteness will not arise. In deciding the question whether the damage was caused by the wrongful act, the generally accepted test is known as 'but for' test. This means that if the damage would not have resulted but for the defendant's wrongful act, it would be taken to have been caused by the wrongful act. Conversely it means that the defendant's wrongful act is not cause of the damage if the same would have happened just the same, wrongful act or no wrongful act. Thus when a doctor is negligent in failing to see and examine a patient and give him the proper treatment, the claim will still fail if it is shown on evidence that the patient would have died of poisoning even if he had been treated with all due care. The doctor's negligence in such cases is not the cause of the patient's death.

***Measure of damages is an important aspect so far as the field of valuation and valuer is concerned.***

The expression "measure of damages" means the scale or rule by reference to which the amount of damages to be recovered is, in any given case, to be assessed. Damages may rise to almost any amount, or they may dwindle down to being merely nominal. The law has not laid down what shall be the measure of damages in actions of tort; the measure is vague and uncertain, depending upon a vast variety of causes, facts and circumstances. In case of criminal conversion, battery, imprisonment, slander, malicious prosecution, etc., the state, degree, quality, trade, or profession of the party injured, as well as of the person who did the injury, must be, and generally are, considered by a court in giving damages. "The common law says that the damages due either for breach of contract or for tort are damages which, so far as money can compensate, will give the injured party reparation for the wrongful act. If there be any special damage which is attributable to the wrongful act that special damage must be averred and proved. But restitution is seldom, if at all, really possible and the law provides only for notional restitution, i.e. restitution as nearly as may be by award of compensation. This is specially so when the plaintiff is compensated for non-pecuniary damage such as pain and suffering. At common law damages are purely compensatory, except where the plaintiff is injured by the oppressive, arbitrary or unconstitutional action by the executive or the servants of the Government and when the defendant's conduct has been calculated by him to make a profit for himself which may well exceed the compensation payable to the plaintiff. In latter two classes of cases exemplary damages may be awarded.

***Damages in an action for personal injuries***

Personal injury may cause (a) non-pecuniary as well as (b) pecuniary loss to the plaintiff. Non-pecuniary loss may cover the following heads of damage :(i) Pain and suffering; (ii) loss of amenities, and (iii) loss of expectation of life. Pecuniary loss may cover the following heads: (i) Consequential expenses; (ii) cost of care; and (iii) loss of earnings.

***Injury to Property***

If a chattel be lost or destroyed by a wrongful act of the defendant, the measure of damages is the value of the chattel, but if the chattel be only injured, then the depreciation in its value is the measure, with an extra allowance for the loss of the use of the chattel while it is being repaired or replaced. The measure of damages where goods shipped are lost by fire would be the market value of the goods when and where the goods were damaged less the proceeds of the sale of the damaged goods, and in addition any freight, insurance, and other incidental expenditure which may have been lost. A person to whom a wrong is done is entitled to full compensation for restoring the thing damaged to its original condition. This applies equally to a private person as to a Corporation or trustee. If this is called restitution, a Corporation as well as a private person would be entitled to it, but if by restitution is meant complete reconstruction irrespective of the damage done and then neither a private person nor a Corporation or a trustee is entitled to complete reconstruction irrespective of the damage done.

**Specific Restitution**

The third kind of remedy is the specific restitution of property. Thus a person who is wrongfully dispossessed of immovable property or of specific movable property is entitled to recover the immovable or movable property, as the case may be.

# UNIT - IV

## Law of arbitration and conciliation: salient features

### INTRODUCTION

According to Halsbury, an Arbitration is the reference of a dispute or difference between not less than two parties for determination, for hearing the sides in a judicial manner, by a person or persons other than a court of competent jurisdiction.

***The arbitration and conciliation comes under an Alternate Disputes Resolution.***

In Maharashtra & Gujarat arbitration proceedings are held in respect of Draft Town Planning Schemes framed and published under the provisions of respective Town Planning Acts, where a valuer may be required to either function as an Arbitrator/Town Planning Officer or represent his client who may be either individual owner or a Local Planning Authority. Further a valuer may be required to function as an Arbitrator in case of dispute between two or more parties regarding fair market value of a property. The knowledge of the Law of Arbitration is therefore essential for a professional valuer.

**STRUCTURE OF THE UNIT :**



The Arbitration and Conciliation Act of 1996, India is divided into four parts namely (i) Arbitration (ii) Enforcement of Foreign Awards (iii) Conciliation & (iv) Supplementary Provisions, which deal separately with the various aspects of both domestic and international Commercial Arbitration.

## 1.1 OBJECTIVES

In this Unit the basic important provisions of the Arbitration and Conciliation Act are discussed with its' salient features.

## 1.2 PART – I ARBITRATION

The Appraisal of law relating to Arbitration and Conciliation have been the topic of discussions since its inception. It is not possible to deal with all the provisions in this Unit. The important sections needing attention are however being discussed here so as to have an analytical appraisal of the development of law that has taken place in respect of emergence of the method of alternative disputes resolution by way of Arbitration. This part applies in all statutory (if not inconsistent with provisions of other enactment or statutory Rules) and/or non-statutory cases and is the most part for the professional valuers.

### 1.2.1 Arbitration Agreement - (Section 7)

Arbitration agreement, under this provision, must be in writing and means an agreement by the parties to submit to arbitration all or certain disputes which have arisen or may arise between them in respect of a defined legal relationship. The said agreement, if not contained in the specific arbitration clause, may be inferred from documents signed by the parties, by exchange of letters, telex, telegram or other means of communication and also from admission of the parties not denying the existence of Arbitration. The arbitration clause has always to be treated as an agreement distinct and independent of the main agreement (1999 (5) SCC 651).

### 1.2.2 Power to Refer Parties' to Arbitration Where There is an Arbitration Agreement - (Section 8)

If a judicial authority, in a suit or action brought before it, comes to know about the existence of arbitration agreement with respect to the dispute pending before it, it may refer the parties to arbitration provided the party requiring arbitration so applies to such judicial authority before submitting his written statement on the substance of a dispute.

In Haryana Telcom Ltd. Vs. Sterlite Ltd. (1999 (5) SCC 688), the Supreme Court placed an embargo and held that notwithstanding any agreement between the parties, the arbitrator would have no jurisdiction to order winding-up of a company which power vests under the Companies Act with the competent court and thus a dispute relating to winding-up of a company cannot be referred to arbitration.

### 1.2.3 Interim Order - (Section/s 9 & 17)

The arbitral tribunal has the power to pass an interim order so as to protect the substance of the dispute during the pendency of the arbitral proceedings under Section 17. Similarly the court has the power under Section 9 to pass interim orders before, during and after the arbitral proceedings.

In Sundaram Finance Vs. NEPC India Ltd. (1999 (2) SCC 479), the Supreme Court affirmed this power and held that an interim order can be sought from the court even before commencement of arbitration proceedings.

### 1.2.4 Composition of Arbitral Tribunal - (Section 10)

Under this section, the parties are free to determine the number of arbitrators provided that such number shall not be even numbers. A sole arbitrator can be appointed.

A dispute arose in MMTC Ltd. Vs. Sterlite Ltd. (1996 (6) SCC 716), where in the arbitration clause provided for nomination of the arbitrator by each of the parties and the arbitrators so nominated were required to appoint an umpire. The MMTC Ltd. contended that since the arbitration clause provided for appointment of even number of arbitrators, such clause was not valid in view of provisions of Section 10(1). This controversy was resolved by the Supreme Court by stating that the validity of the arbitration agreement does not depend on the number of arbitrators. The arbitration agreement though specifying an even number of Arbitrator cannot be a ground to render the arbitration agreement invalid in as much as the agreement satisfied the requirement of the section 7 of the Act and as such it is a valid agreement. By nominating an umpire a valid arbitral tribunal of three persons (Odd Number) can be constituted satisfying the requirement of the section 10 of the Act.

### 1.2.5 Appointment of Arbitrators - (Section 11)

Arbitrator can be appointed by agreement of parties and in case of failure of either of the parties, when request is made for appointment, the aggrieved party may approach the Chief Justice of the concerned High Court in case of Domestic Arbitration and the Chief Justice of India in case of International Commercial Arbitration for appointment of arbitrator. All High Courts in India have framed a scheme for such purpose. While appointing the arbitrator, the designated authority shall have due regard to any qualification fixed by the agreement of the parties for the arbitrator and also to other considerations as are likely to secure the appointment of an independent and impartial arbitrator as held by the Hon'ble Supreme Court in the case of ICICI Ltd. Vs. East Coast Boat Building and Engineers (1998 (9) SCC 728). The decision with respect to appointment of arbitrator by a designated authority is normally final and binding on the parties.

### 1.2.6 Section 12, 13, 14 & 15.

The arbitrator has to disclose in writing any circumstances likely to cause justifiable doubts as to his independence or impartiality and in case of any doubt about his independence or impartiality and of his qualification, the authority of the arbitrator can be challenged by a party to the arbitration as per procedure laid down in section 13 and, in case the challenge is unsuccessful, the arbitral tribunal shall continue the proceedings and make an award.

The mandate of an arbitrator shall terminate under Section 14 on his becoming de-jure or de-fecto unable to perform his function, or for his undue delay, or if he withdraws from his office, or the parties agree to the termination of his mandate. In the event of termination of mandate, a substitute arbitrator may be appointed according to the rules that were applicable to the appointment of the arbitrator being replaced. The mandate of an arbitrator is however not terminated by death of any party by whom the arbitrator was appointed [section 40(2)] and the legal heir/representative will substitute the demised party.

### 1.2.7 Jurisdiction of the Arbitral Tribunal – (Section 16)

The arbitral tribunal has power to decide on its own jurisdiction, including any objection with respect to the very existence and validity of the arbitration agreement, and for that purpose, the arbitration clause which forms part of the contract as an agreement independent from the other terms of contract. A decision by the tribunal that the contract is invalid, shall not invalidate the arbitration clause, vide Olympus Superstructure Pvt. Ltd. Vs. Meena Vijay Khetan (1999 (5) SCC 651).

### 1.2.8 Conduct of Arbitral Proceedings - (Section/s 18-25)

The parties to the arbitration have to be treated equally and have to be given full opportunity, by following the principles of natural justice, to present their case (Section

18). The arbitral tribunal shall not be bound by the Code of Civil Procedure or by Indian Evidence Act. Parties are free to agree on procedure and in case of non-agreement, the tribunal shall conduct the proceedings in the manner it consider appropriate. Normally the arbitration proceedings shall be deemed to have commenced on the date on which a request for reference of the dispute to arbitration has been received by the respondent (Section 21). The arbitrator has power under Section 22 to appoint one or more expert/s to report on specific issue and also seek assistance of the court in taking evidence.

### 1.2.9 Making of Arbitral Award and Termination of Proceedings - (Sections 28-33)

No time limit is fixed for making the award, though it is always expected under the scheme of the Act that the tribunal will resolve the dispute in accordance with the substantive law for the time being in force in India. In case of international Commercial Arbitration, the tribunal shall decide the dispute, and failing any such agreement with respect to the applicable law, the tribunal shall apply the rules of law which it considers to be appropriate in the circumstances surrounding the dispute.

In the case of tribunal consisting of more than one arbitrator, any decision of the tribunal shall be made by the majority of the members of the tribunal. A crisis may arise when there is no consensus between the members of the tribunal and when the members of the tribunal take divergent views. In such circumstances, the Arbitration will fail. The parties may settle the matter during the arbitral proceedings either by mediation, conciliation or by other proceedings and in such case the settlement will take the form of award.

### 1.2.10 Form and Contents of Arbitral Award - (Section 31)

(a) The award should be in writing and signed by the members of the tribunal, and unless the parties have agreed otherwise, it must state reason.

(b) The tribunal may at any time during the proceedings make an interim award in any matter with respect to which it may make a final award.

(c) In case of an award for payment of money, the tribunal will award interest.

(d) The award shall state the date and place of arbitration, the cost of arbitration and the party entitled to cost and the party who will pay the cost and the manner in which the cost shall be paid.

### 1.2.11 Termination of Proceedings – (Section 32)

The arbitral proceedings shall be terminated by the final award or by an order of the tribunal under Section (2), i.e. in the circumstances when (a) the claimant withdraws (b) the parties agree on the termination of the proceedings or (c) when the tribunal finds that the continuation of the proceedings has, for some reasons, become unnecessary and impossible.

### 1.2.12 Objection, Appeal, Finality and Enforcement of Award - (Section/s 34- 37)

***Objection to Award (Section 34)***

The correctness of the arbitral award can be objected to under Section 34 in a competent court of law within three months from the date of the award with another grace period of 30 days, with reasonable explanation for not challenging the award within 3 months. The award can be set aside only if –

*(A)the party complaining furnishes the proof of the following -*

(a) He (i.e. the party) was under some incapacity (to present the case).
(b) The arbitration agreement was not valid under applicable law.
(c) He was not given proper notice of appointment of arbitrator or of arbitral proceedings or was otherwise unable to present his case.
(d) The award is beyond scope of reference, vide R.K. Khanna vs. Union of India (1998 (7) SCC 129) and as such the award deals with a dispute not contemplated by or not falling within the terms of the submission to thearbitration.
(e) The composition of the tribunal is not in accordance with the agreement of the parties.

*(B) the Court finds that -*

(a) The subject matter of the dispute was not capable of settlement by arbitration under the applicable law, or
(b) The arbitral award is in conflict with the public policy of India.

***Appeal (Section 37)***

An appeal under section 37 shall also lie from the following orders –

(a) Granting or refusing to grant any interim order under Sec. 9 &17;
(b) Setting aside or refusing to set aside an award under sec. 34;
(c) Accepting the plea of bar of jurisdiction under sec. 16;

No appeal lies from an order passed under section 37 except right to appeal to the Supreme Court by the special leave.

Where the time for making an application to set aside the award under sec. 34 has expired or it has been refused the award shall be enforced in the same manner as if it were the decree of the court.

***Limitation (Section 43)***

Law of limitation squarely applies to arbitration, and for the purpose of limitation, arbitration shall be deemed to have commenced on the date the request for reference is received by the other party. Besides, where an arbitration agreement provides that any claim shall be barred unless some step to commence the arbitration proceedings is taken within time fixed by the agreement of the parties, it must be commenced within that time, and if it is not done, the leave of the court has to be obtained for extension of time to lodge the claim.

### 1.3 PART – II ENFORCEMENT OF FOREIGN AWARDS

A "foreign Award' means an arbitral award on a dispute of commercial nature and made on or after 28th July 1924 if under Geneva Convention Award, or on or after October 1960, if made under New York Convention Award. Enforcement of a foreign award can be refused by the court on some what similar grounds as found in Section 34 of the Act, besides that enforcement of an arbitral award may be refused if the court finds that:

(a) The subject matter of dispute is not capable of settlement by arbitration under Indian law, or

(b) Enforcement of award would be contrary to the public policy of India, i.e. if the making of award was induced or affected by fraud or corruption, which may also mean to include an award contrary to the fundamental principle of Indian law, justice and morality see. Refer: Renu Power Co. Vs. EC (AIR 1994 SC 860).

## 1.4 PART – III CONCILIATION

The provision of conciliation is given under Sections 61-81 under Part III of the Arbitration and Conciliation Act. The conciliation can be initiated by the consensus of the parties and once the machinery of conciliation is set into motion, parties are precluded from initiating any arbitral or judicial proceedings in respect of a dispute which is subject matter of conciliation proceedings except under Section 9 of the Act for interim protection of the substance of the dispute.

A Conciliator, who may be appointed by the parties, is required to assist the parties, in an independent and impartial manner, in reaching an amicable settlement of dispute. A conciliator is required to be guided by the principal of objectivity, fairness and justice, giving consideration to rights and obligations of the parties, usages of the trade and circumstances surrounding the dispute, including any past business practice between the parties. Any settlement arrived at pursuant to conciliation has the same status and effect as an arbitral award.

Another important feature of the conciliation is that the conciliator and the parties are required to maintain confidentiality in all matters related to conciliation proceedings and its fallout. If the conciliation fails then neither of the parties may rely or take benefit of (a) views expressed or suggestions made by the other party in respect of a possible settlement of the dispute, (b) admission made by the other party in the course of conciliation proceedings, (c) proposal made by the conciliator, and (d) the fact that the other party had indicated his willingness to accept a proposal for settlement made by the conciliator.

## 1.5 PART – IV SUPPLEMENTARY PROVISIONS

***Power of High Court to make rules - (Section 82)***

The High Court may make rules consistent with this Act as to all proceedings before the Court under this Act.

***Removal of Difficulties - (Section 83)***

The Central Government may, by notification in the Official Gazette, make rules for carrying out the provision of this Act.

# UNIT – V

# Auction Sale

**INTRODUCTION**

The term 'Sale' is a very common term we use in our daily routine life, but the term 'Contract of Sale' makes us alert. What is a contract? A Contract is an agreement between a seller and buyer. A seller transfers or agrees to transfer the property or goods to the buyer for a price. The term Auction is something different than the usual buyer and seller's term. The subject Auction Sale is one kind of Sale, where the goods or property is sold or proposed to be sold at the highest price and its purpose is to fetch the highest price to the product. An Auction is a proceeding at which people are invited to compete and make offers for the purchase of the property or goods put up for sale by a seller/s through successive offers of advancing sums.

**STRUCTURE OF THE UNIT**

### 1.1 OBJECTIVE

This chapter gives details of various aspects and features of Auction Sale under the legal provision.

### 1.2 DEFINITION AND OBJECT OF AUCTION SALE

A sale by auction is a public sale, where goods are offered to be taken by the highest bidder.

Section – 64 of the Sale of Goods Act deal with **AUCTION SALE** - in case of a sale by auction:

(1) Goods are put for sale in lots; and each is prima facie deemed to be the subject of a separate contract of sale;

(2) The sale is complete when the auctioneer announces its completion with the fall of the hummer or in other customary manner; and until such announcement is made, any bidder may retract his bid;

(3) A right to bid may be reserved expressly by or on behalf of the seller and, where such right is expressly so reserved, but not otherwise, the seller or any one person on his/her behalf may, subject to the provisions hereinafter contained, bid at auction;

(4) Where the sale is not notified to be subject to a right to bid on behalf of the seller, it shall not be lawful for the seller to bid himself/herself or to employ any person to bid at such sale or for the auctioneer knowingly to take any bid from the seller or any such person; and any sale contravening this rule may be treated as fraudulent by the buyer;

(5) The sale may be notified to be subject to a reserved or upset price;

(6) If the seller makes use of pretended bidding to raise the price, the sale is voidable at the option of the buyer.

Auction in common terms is sale in which goods or property is sold to highest bidder.

The important elements of auction are

Auction property → property for auction
Auction price → Price for auction
Auctioneer → Person conducting auction

## 1.3 FEATURES OF THE AUCTION SALE

### 1.3.1 Advertisements:

There has to be an advertisement or proclamation of auction sale, to make public know that such an auction is going to be conducted specifically in the form of public auction, which gives description of goods, date, time, venue of auction sale, the name of the auctioneer and such other conditions of sale like reserve price, and so on.

### 1.3.2 Particulars and Catalogues:

In some auctions the Auctioneer offer particulars and catalogues of goods and other conditions of such auction for the prospective buyers to peruse prior to the auction.

### 1.3.3 Conduct of Sale:

The advertisement specifies how the auction sale will be conducted, it will also specify if there is any other mode than the ordinary one.

### 1.3.4 Mis-description and Misrepresentation:

If either party by guilt, fraud or of deceitful misrepresentation, whereby the bidders are misled; or if either party acts under a mistake as to a material and essential particular, the sale is thereby rendered voidable as to the party affected by the fraud or misrepresentation or the mistake so that he/she can, within a reasonable time, retract.

### 1.3.5 Auction Sale in Lots:

Auction can be in lots; each lot is subject of a separate contract under Sec. 64 (1), and this may be excluded by intention of parties to the contrary. If the goods are sold in separate lots by auction, each lot is prima facie the subject of a separate contract. The goods are displayed in lots, and the auctioneer’s call to bid can amount to mere invitation, and each bid received would be an offer that could quality to become a contract, on acceptance by the auctioneer or his agent.

In a sale by auction, the seller may withdraw goods, or the bidder may retract his bid at any time before they are knocked off for so long as the final consent of both parties are not signified by the blow of the hammer, or in any other customary manner.

### 1.3.6 Reserve Price:

Normal practice is to sell the goods or property to the highest bidder, with the restriction may be imposed by the seller/Auctioneer of minimum sale price i.e. Reserve Price, at which the goods to be sold for and not for less than the amount reserved. Reserve price is not necessarily to be disclosed to the buyer. Condition of reserve price must be made known to the buyer under notification, or else, the reserve price cannot be applied, as reserve price.

### 1.3.7 Right to Bid:

Every bidding is nothing more than an offer on the one side, and not binding on either party till confirmed on the other. The Bidder may withdraw the bid before the fall of the hammer. Any condition prohibiting retraction is bad in law in view of Sec. 64(2) of the Sale of Goods Act. No contract of sale is complete until it is accepted and remains merely an offer. Refusal of the buyer to carry through the bid or confirm the bid till the completion of the auction by the auctioneer and acceptance of the bid, there would be no cause of action for or in favour of the buyer. The auctioneer is equally competent to refuse, as is the buyer to withdraw the offer before acceptance. (AIR 1965 Mad. 14, Coffee Board Vs. Famous Coffee & Tea Works.)

In case of a sale by government auction, the sale is not complete until the bid is accepted in the form of the confirmation of the collector. (Muthu Pillai Vs. Secy of State, 1923 Mad. 582.)

Once an offer is accepted, the goods become the property of the buyer on fall of hammer (1969 S.C. 569, A.V. Thomas & Co. Ltd. Vs. Deputy Commissioner of Agricultural Income Tax & Sales Tax Trivandrum). It is immaterial whether there is any condition like goods not to be removed till payment received. Once the sale is completed, the buyer is the owner and can sell the property immediately.

The Seller cannot bid either directly in person or through other employees. Such sale is voidable in the interest of public policy and equity. Seller can bid only if he has reserved his right to do so in the condition notified, otherwise which is prevented under sec. 64(6). To avoid unnecessary, unscrupulous false rise in the bidding, the buyer can rescind the contract on knowledge and sue for money paid. Even if the seller is allowed only one person on his behalf, the seller can bid straight away. If more persons than one are involved such a bid amounts to fraud. As one can also protect the property more with the intention of enhancing the price, the sale is rendered void, whereas it is not necessary that such person should bid only once.

### 1.3.8 Bidding Agreement – Knock Out:

Combination or agreement between intending bidders not to bid against each other, or refrain from doing so, it is illegal and is known as "Knock out". Such a thing governs Auction (bidding Agreements) Acts 1947 in England but there is no such act in India.

For preventing Auction ring i.e. arrangement whereby the intending bidders agree not to bid against each other, the reason being to allow one of them to buy the goods as cheaply as possible and subsequently to hold their own private auction. This is a criminal offence under the English Act. The Seller can rescind such a sale at the auction. However, it does not apply to joint agreement to purchase goods such as joint venture.

The Auctions Bidding Agreements Act, 1927, provides that it is a criminal offence for a dealer to give or receive consideration etc., for abstaining from bidding. Such knockout agreements are illegal. A dealer is a person who in the normal course of business attends sales by auction for the purpose of purchasing goods with a view to reselling them. Knockout agreements by non-dealers are not necessarily illegal even after the above Act of 1927.

### 1.3.9 Statements on the Rostrum:

Any offer or retraction by either party should, however, be made so loud as to be heard by the others.

But as soon as the hammer is struck down, which is the typical notification by the seller that the offer of the buyer is accepted, the bargain is considered as concluded, and the seller has no right afterwards to accept a higher bid, nor the buyer to withdraw from the contract.

### 1.3.10 Memorandum of Sale:

The auctioneer has to record each and every offer with regard to its sequence and timing, and ultimately the final bid and its confirmation to avoid any mismanagement during the auction, so as to trace out the bidding agreement of the buyers in case there is any, or to keep in check. In case if the seller has reserved his right to bid, he is not misusing it.

### 1.3.11 Duties of Vendor, Purchaser and Public:

It is the duty of the vendor to represent the correct description of the goods to be sold in auction under a advertisement/proclamation. The duty of the purchaser is to deposit the auction money with the auctioneer of the seller and complete the sale procedure as the time stipulated in such auction sale.

**The deposit:** the bidder becomes purchaser as soon as his offer is final on e and it his duty thereafter to deposit the amount as specified in the condition of auction and subsequently to complete the payment as per the condition of mode of payment as specified in the advertisement.

## 1.4 AUCTIONEER AND AUTHORITY OF AUCTIONEER

**Auctioneer:** The Auctioneer is an agent of the owner, the seller, with the authority to sell.

### 1.4.1 Authority of the Auctioneer:

(i) Implied authority to sell the goods on behalf of the seller
(ii) Implied authority to sign the contract on behalf of the seller, but this does not extend to sale of unsold goods
(iii) To receive the deposit from the buyer as per the condition of the auction sale
(iv) To receiver consideration price.

An auctioneer cannot, in general, bind his principal by receiving payment otherwise than in money, as by taking a bill of exchange in payment, unless he was expressly authorized so to do, or unless it was customary, in like cases, to settle by bill.

The authority committed to an auctioneer is a personal trust which he cannot delegate to another without the consent of the owner. He cannot, therefore authorize his clerk to act as agent for his employer, in his absence.

An auctioneer, like every other agent, cannot, ordinarily, purchase the goods of his principal either on his own account, or on behalf of a third person, which may tend directly to the furtherance of fraud.

The auctioneer has no authority to:

(i) Sell by private contract - even if this were to fetch more price than the reserved price.
(ii) To rescind the contract.
(iii) To warrant the goods sold.
(iv) To deliver the goods sold without payment of price.
(v) To allow the buyer to set off dues to him from the seller.

**1.4.2 Rights and Duties of Auctioneer:**

***(a) Rights:***

The auctioneer is the agent of the vendor for the purpose of sale, and has ordinary rights and liabilities of a special agent. He has therefore, a claim on compensation, which is ordinarily in the form of a commission for services, and is determined, in absence of any special agreement, by the common usage and also a right to claim a reimbursement for all expenses and advances, properly incurred by him in the course of his agency.

He is also entitled to sue either party, while he has a beneficial interest. He may, therefore, personally sue his principal for damages, or expenses, or for his commission, or he may as representative of the seller sue the buyer for the price of goods.

*(b) Duties:*

The duties of the auctioneer are in the first place, to take care of the goods, sent to him for sale. Again it is his duty to observe strictly all the instructions of his principal and all the conditions of the sale. If he deviates from them, he will be personally liable for the consequences.

Where an auctioneer, after a sale by public auction, receives a deposit thereof from the vendee, it is his duty, as the agent, or rather as the stakeholder of both vendor and vendee, to retain the deposit until the sale is complete, and it is ascertained to whom the money belongs.

## 1.5 SALES UNDER STATUTE AND BY ORDER OF THE COURT:

The auction sale under any execution proceedings of a decree, or any order or judgment of any court falls under the provisions of Order XXI of the Code of Civil Procedure 1908. The difference in ordinary auction rather than auction under this is that there is an attachment of the goods or property of the judgment debtor under the execution proceedings in this, whereas the seller or owner of the goods or property puts his property or goods in auction. The purpose of auction here is to disburse the claim of decree-holder under the execution of the decree obtained by him by seize and attachment of the property of the judgment debtor.

**1.5.1** Any court executing a decree may order that any property attached by it and liable to sale, or such portion thereof as may seem necessary to satisfy the decree, shall be sold, and that the proceeds of such sale, or a sufficient portion thereof, shall be paid to the party entitled under the decree to receive the same.

**1.5.2** Every sale shall be conducted by an officer of the court or by such other person as the court may appoint in this behalf and shall be made by public auction in manner prescribed.

### 1.5.3 Proclamation of Sales by Public Auction:

(i) Where any property is ordered to be sold by public auction in execution of a decree, the court shall cause a proclamation of the intended sale to be made in the language of such court.

(ii) Such proclamation shall be drawn up after notice to the decree-holder and the judgment- debtor and shall state the time and place of sale, and specify as fairly and accurately as possible:

(a) the property to be sold, or where a part of the property would be sufficient to satisfy the decree, such part;

(b) the revenue assessed upon the estate or part of the estate, where the property to be sold is an interest in an estate or in part of an estate paying revenue to the Government; any encumbrance to which the property is liable.

(c) the amount for recovery of which the sale is ordered; and

every other thing which the court considers material for a purchaser to know in order to judge of the nature and value of the property, provided further that notice of the date for settling the terms of the proclamation has been given to the judgment-debtor by means such as notice of attachment affixed in court of the property attached.

The proclamation shall include the estimate of the value of the property if any given by either or both of the parties.

(iii) Every application for an order for sale under this rule shall be accompanied by statement signed and verified in the manner prescribed for the signing and verification of pleadings and containing, so far as they are known to or can be ascertained by the person making the verification.

(iv) For the purpose of ascertaining the matters to be specified in the proclamation, the court may summon any person whom it thinks necessary to summon and may examine him in respect of any such matters and require him to produce any document in his possession or power relating thereto.

### 1.5.4 Mode of making Proclamation:

1. Every proclamation shall be made and published, as nearly as may be, in the manner prescribed under the rule.

2. Where the court so directs, such proclamation shall also be published in the Official Gazette or in a local newspaper, or in both, and the costs of such publication shall be deemed to be the costs of the sale.

3. Where property is divided into lots for the purpose of being sold separately, it shall not be necessary to make a separate proclamation for each lot, unless proper notice of the sale cannot, in opinion of the court, otherwise be given.

### 1.5.5 Time of Sale:

Where the movable property in the possession of judgment-debtors, and the property attached by actual seizure and taken in custody of attaching officer, unless the property is perishable or expense of it or storage is more. No sale shall, without the consent in writing of the judgment-debtor, take place until after the expiration of at least fifteen days in case of immovable property, and of at least seven days in the case of movable property, calculated from the date on which the copy of the proclamation has been affixed in the court-house of the judge ordering the sale.

The Court may adjourn or stop the sale in its discretion to a specific day and hour.

The defaulting purchaser answerable for the loss on re-sale any deficiency of price which may occur on re-sale by reason of the purchaser's default, and all expenses attending such re-sale, shall be certified to the court by the officer and shall, at the instance of either the decree-holder or the judgment debtor, be recoverable from the defaulting purchaser under the provisions relating to the execution of a decree for the payment of money.

The Decree-holder cannot bid for or buy the property without permission of the Court.

A Mortgagee cannot bid at sale without the leave of the court; if leave to bid is granted to such mortgagee, then the court shall fix a reserve price as regards the mortgagee, or as the court directs.

No officer or other person having any duty to perform in connection with any sale shall, either directly or indirectly, bid for acquiring or attempt to acquire any interest in the property sold.

### 1.5.6 Sale by Public Auction:

Where movable property is sold by public auction, the price of each lot shall be paid at the time of sale, or as soon after as the officer or other person holding the sale directs, and in default of payment, the property shall forthwith be re-sold.

(1) On payment of the purchase-money, the officer or other person holding the sale shall grant a receipt for the same, and the sale shall become absolute.

(2) Where the movable property to be sold is a share in goods belonging to the judgment-debtor and co-owner, and two or more persons, of whom one is such co-owner, respectively bid the same sum for such property or for any lot, the bidding shall be deemed to be the bidding of the co-owner.

### 1.5.7 Delivery of Movable Property:

Where the property sold is movable property of which actual seizure has been made, it shall be delivered to the purchaser.

Where the property sold is movable property in the possession of the some person other than the judgment-debtor, the delivery thereof to the purchaser shall be made by giving notice to the person in possession, prohibiting him from delivering possession of the property to any person except the purchaser.

# UNIT - VI

# Law of Evidence

**Introduction**

Study of law of evidence is useful to the valuers while giving expert evidence or opinion in the court of law or before any other authority. Therefore, this unit provides basic knowledge of law of evidence.

**STRUCTURE OF THE UNIT**

## 1.1 OBJECTIVE

By the end of this chapter student will learn about –

- Definition and explanation of various terminology used in law of evidence.

## 1.2 DEFINITIONS

### 1.2.1 "Fact"

"Fact" means and includes -

1. Anything, state of things, or relation of things, capable of being perceived by the senses;

2. Any mental condition of which any person is conscious.

   (a) That there are certain objects arranged in a certain order in a certain place, is a fact.
   (b) That a man heard or saw something, is a fact.
   (c) That a man said certain words, is a fact.
   (d) That a man holds a certain opinion, has a certain intention, acts in good faith or fraudulently, or uses a particular word in a particular sense, or is or was at a specified time conscious of a particular sensation, is a fact.
   (e) That a man has a certain reputation, is a fact.

### 1.2.2 "Fact in issue"

The expression "facts in issue" means and includes-any fact from which, either by itself or in connection with other fact, the existence, non-existence, nature or extent of any right, liability or disability, asserted or denied in any suit or proceeding, necessarily follows.

**Explanation -** Whenever, under the provisions of the law for the time being in force relating to Civil Procedure, any Court records an issue of fact, the fact to be asserted or denied in the answer to such issue, is a fact in issue.

A is accused of the murder of B.

At his trail the following facts may be in issue:
that A caused B's death;
that A intended to cause B's death;

that A had had received grave and sudden provocation from B;
that A at the time of doing the act, which caused B's death, was by reason of unsoundness of mind, incapable of knowing its nature.

**1.2.3 "Evidence"**

"Evidence" means and includes -

1. All statements which the Court permits or requires to be made before it by witnesses, in relation to matters of fact under inquiry; such statements are called oral evidence.

2. All documents produced for the inspection of the Court; such documents are called documentary evidence.

**1.2.4 "Proved"**

A fact is said to be proved when, after considering the matters before it, the Court either believes it to exist, or considers its existence so probable that a prudent man ought under the circumstances of the particular case, to act upon the supposition that it exists.

**1.2.5 "Disproved"**

A fact is said to be disproved when, after considering the matters before it, the Court either believes that it does not exist or considers its non-existence so probable that a prudent man ought, under the circumstances of the particular case, to act upon the supposition that it does not exist.

**1.2.6 "Not proved"**

A fact is said not to be proved when it is neither proved nor disproved.

**1.3 "MAY PRESUME"**

Whenever it is provided by this Act that the Court may presume a fact, it may either regard such fact as proved, unless and until it is disproved, or may call for proof of it. (s.4).

"Shall presume" - Whenever it is directed by this Act that the Court shall presume a fact, it shall regard such fact as proved, unless and until it is disproved.

"Conclusive proof" - Where one fact is declared by this Act to be conclusive proof of another, the Court shall, on proof of the one fact, regard the other as proved, and shall not allow evidence to be given for the purpose of disproving it.

**"May presume" –** Whenever, it is provided that the Court may presume a fact, the Court may take notice of the fact without calling for its proof or may call upon a party to prove that fact. Here the Court has discretion to presume a fact or not to presume it. Section 90 of the Evidence Act provides that when a document purporting to be thirty years old is produced from a proper custody, the court may presume that the document was signed and written by the person by whom it is purported and is said to have been written and signed. Generally, when a document is filed in a case it is to be proved by adducing evidence as to who wrote the deed and who singed it. If a document produced before the court is thirty years old, the court may dispense with the proof of it and read the document in evidence without calling for the proof of it. The Court may also call for the proof of it and may order that the document will not be read in evidence without being proved. Section 88 of the Evidence Act lays down that when a telegram has been received the court may presume that the message forwarded from a Telegraph Office to a person is the same which was delivered for transmission at the office from which the message was sent. As said above this clause refers to the presumptions of fact. The presumptions of fact have been dealt with in Sections 86, 87, 88, 90 and 114 of the Act.

Raising or not of a presumption is a matter for judicial discretion; and the court must apply its mind in each case to the question whether it is a proper case to raise such presumption. When the lower court does not exercise a proper judicial discretion, in raising the presumption the appellate court must interfere.

It is open to a court upon the proof of a marriage to hold as proved the subsistence of such marriage unless the contrary is proved.

**"May Presume" – Child witness – Evidence – Corroboration –** A dying declaration, or evidence of a prosecutrix in a rape case or the statement of a child witness does not need corroboration to be efficacious in terms of the Evidence Act.

Section 4 of the Evidence Act purporting to explain the terms "may presume" has left entire matter to the court concerned and has provided that while a case may presume a fact as provided in Section 114 thereof, it may also call for the proof of it.

## 1.4 “SHALL PRESUME”

Whenever there is a provision to the effect “that the Court shall presume a fact” the Court cannot exercise its discretion. It is compelled to take the fact as provided, i.e., it shall have to presume the fact. But in this case the Court will be at liberty to allow the opposite party to adduce evidence to disprove the fact so presumed and if the opposite party is successful in disproving it, the Court shall not presume the fact. The term “shall be presumed” means that the court is bound to take the fact as proved until the evidence is adduced to disprove it, and the party interested in disproving must produce such evidence if he can. In the Indian Evidence Act the words “shall presume” indicate that the presumption therein is rebuttable. Section 89 of the Evidence Act provides “that the Court shall presume that every document, called for and not produced after notice to produce, was attested, stamped and executed in the manner required by law”. Sections 79 to 85, 89 and 105 of the Act deal with this clause.

**“Shall presume – Marriage – Proof by conduct –** Nothing is found in Section 50 of the Act or in the proviso thereto to militate or to have anything to do against any presumptions as to the due observance of forms and ceremonies arising from the proof of performance of a marriage in fact. And if the Court, will have to presume due observance of forms and performance of ceremonies, then one would have thought further that the court will have to regard such observance and performance as proved unless they are disproved by evidence in accordance with the principles enacted in the definition of “shall presume” in Section 4 of the Act.

## 1.5 “CONCLUSIVE PROOF” –

Whenever it is mentioned that a fact is a “conclusive proof” of another fact, the Court has no discretion at all. It cannot call upon a party to prove that fact nor can it allow the opposite party to adduce evidence to disprove the fact. When one fact is declared by law to be conclusive proof of another, the Court cannot allow evidence to be given in rebuttal.

Section 41 of the Evidence Act provides inter alia that a final judgment order or decree of a competent court in exercise of matrimonial jurisdiction is a conclusive proof of that legal character. For example suppose A files a suit in a court of law for a declaration that B is his legally married wife. The court gives a decree in favour of A and declares that B is his wife. After a few years in the lifetime of A, B files a suit against D for the property of one C, alleging that she is widow of C. In this case there will be an issue whether B is the wife of C. D files the copy of the judgment of the previous case (A versus B). This judgment will prove that B is legally married wife of A. Now that B is legally married wife of A, is a conclusive proof of the fact that she is not a wife of C. Therefore, after the judgment mentioned above has been filed the court cannot allow B to adduce evidence to prove that she is wife of C and not of A.

"Conclusive proof" in Section 4 of the Evidence Act shows that by declaring certain fact to be conclusive proof of another an artificial probative effect is given by the law to certain facts and no evidence is allowed to be produced with a view to combating that effect. These cases generally occur when it is against the policy of Government or the interest of society that a matter may be further open to dispute. This clause lays down that when a fact is declared to be conclusive proof of another, the Court at the proof the first – (a) must take the second as proved, and (b) shall not allow evidence to rebut the fact presumed to be proved.

If the law says that proof of a particular fact is conclusive about the existence of another fact, that fact may be proved either by some other fact or by that evidence which makes it conclusive. But once the fact which is the conclusive proof of that fact is proved no other evidence would be allowed to detract from the conclusiveness of the evidence.

**"Conclusive proof", "may presume" and "shall presume"** – Meaning of - In respect of a fact which the Court "shall presume", the Court has no option to call for proof of it and has to accept such fact as proved unless and until it is disproved. In both cases of "may presume" and "shall presume" it is, however, open to the party adversely affected by such presumption to adduce evidence to disprove the presumed fact, but in case of a fact which the Court has to regard as conclusively proved by reason of the meaning attributed to the term, "conclusive proof" by Section 4 of the Act. It was not open either to the court or to the party adversely affected by such conclusive presumption to accept or lead evidence in disproof of that conclusive presumption.

### 1.6 ADMISSION

An admission is a statement, oral or documentary which suggests any inference as to any fact in issue or relevant fact, and which is made by any of the persons and under the circumstances hereinafter mentioned. (s.17)

**S.22** When oral admission as to contents of documents are relevant -Oral admissions as to the contents of a document are not relevant unless and until the party proposing to prove them shows that he is entitled to give secondary evidence of the contents of such document under the rules hereinafter contained, or unless the genuineness of a document produced is in question

**S.22** A When oral admission as to contents of electronic records are relevant - Oral admissions as to the contents of electronic records are not relevant, unless the genuineness of the electronic record produced is in question.

**S.23** Admission in Civil cases, when relevant - In civil cases no admission is relevant, if it is made either upon an express condition that evidence of it is not to be given, or under circumstances from which the court can infer that the parties agreed together that evidence of it should not be given

**Explanation** - Nothing in this section shall be taken to exempt any barrister, pleader, attorney or vakil from giving evidence of any matter of which he may be compelled to give evidence under Section 126.

### 1.6.1 Admission – Proof.

Once a party accepts his earlier statements, it becomes a substantive piece of evidence of the fact(s) admitted, therein in view of Sections 17 and 21. it is a different matter what weightage is to be attached to such a statement. Before using such a statement, it was not required to be put to its maker to provide him an opportunity to explain it when he appears as a witness or by calling him as a witness. The purpose of confronting a witness with his earlier statement was altogether different, that is, to test the veracity of his later statement if it differs from the earlier statement.

Vague allegation of ownership does not amount to admission of landlord ship of the owner.

### 1.6.2 Admission to be taken as whole.

One part of the admission cannot be accepted and the other part rejected. Admission to be taken as whole and conviction cannot be based on this evidence.

### 1.6.3 Admissions are not conclusive proof of the matter

There cannot be any doubt that the statement of defendant in her written statement and deposition about the adoption of plaintiff to the deceased is an admission within the meaning of Section 17 of the Evidence Act.

But the law of admissions as propounded as above for the appellant appears to be neither totally correct nor exhaustive. The codified jurisprudence of admissions may be succinctly propounded. As already stated, “Admission” is a statement oral or documentary which suggest inference as to any fact in issue or relevant fact. Therefore, it becomes admissible under rules of evidence. Therefore, the statements of parties in the pleadings become admissions and may be used as evidence against the person making the statement.

It should be emphasized that the rights in a suit cannot be founded merely on admissions which is a rule of evidence and not of legal rights which must be independently established by a party in a court of law.

### 1.6.4 Admission

Admission plays a very important part in judicial proceedings. If one party to a suit or any other proceeding proves that the other party has admitted his case, the work of the court becomes easier. **A** files a suit against **B**alleging that Bis not the last male owner’s daughter’s son and that he **(A)**is the last male holder’s sapinda. **B** files a document in which **A** admitted **B** to be the daughter’s son of the last male holder. This document is not only admissible in evidence but is a very strong and important piece of evidence. Admission has been dealt with in Sections 17 to 23 and 31. the intervening Sections, i.e. 24 to 30 are devoted to confession.

### 1.6.5 Principle

Sections 17 to 20 define “admission”. Section 21 gives as to which party to a proceeding can use admission i.e., it gives as to when an admission by one person can be proved by another and when and in what circumstances it can be proved by the person making the statement. Section 22 excludes the oral evidence against the contents of documents. Section 23 deals with relevancy in civil cases of admission made upon an expressed condition that it shall not be given in evidence.

### 1.6.6 Admission defined

Sections 17, 18, 19 and 20 taken together define “admission”. Section 17 lays down that statements oral or documentary which suggest any inference to any fact in issue or relevant fact made by persons a under the circumstances mentioned in Sections 18, 19 and 20, are admissions. The definition of the term “admission” as used in the Indian Evidence Act will be clear by reading all these four sections together. If all these sections were to be written in one sentence, they would read as follows:-

As admission is a statement, oral or documentary, which suggests any inference as to any fact in issue or relevant fact and which is made by :-

1. A party to the proceeding;

2. An agent to any party whom the court regards under the circumstances of the case, as expressly or impliedly authorized by him (the party) to make them;

3. Parties to suits, suing or being sued in representative capacity if the party making the statement held that representative capacity while making the statement;

4. Persons who have proprietary or pecuniary interest in the subject matter of proceeding, and who make the statement in their character of persons so interested and also if the statements are made during the continuance of the interest of the person making the statements;

5. Persons from whom the parties to the suit have derived their interest in the subject-matter of the suit, if the statements are made during the continuance of the interest of the persons making the statement (Section 18);

6. Persons whose position or liability it is necessary to prove as against any party to the suit, if such statements would be relevant as against such persons (making the statement) in relation to such position or liability in a suit brought by or against them and if such statements are made which the person making them occupies such position or is subject to such liability (Section 19).

7. Persons to whom a party to the suit has expressly referred for information in reference to a matter in dispute (Section 20).

According to the definition given above, the statement of parties to the suits or proceedings and also of persons who are not parties to such suits or proceedings, i.e., of strangers are admissions if they are made under the circumstances mentioned above and suggest any inference as to any fact in issue or relevant fact. Admission is a statement written or oral, as to fact in issue or relevant fact, made by a party to an action or by a person deemed to be entitled to make such statement on his behalf.

### 1.7 S.45 OPINIONS OF EXPERTS

When the Court has to form an opinion upon a point of foreign law, or of science, or art, or as to identity of hand writing or finger-impressions, the opinions upon that point of persons specially skilled in such foreign law, science or art, or in questions as to identity of handwriting or finger impressions, are relevant facts. Such person called experts.

### 1.8 S.101 BURDEN OF PROOF

Whoever desires any Court to give judgment as to any legal right or liability dependent on the existence to facts which he asserts must prove that those facts exist.
When a person is bound to prove the existence of any fact, it is said that the burden of proof lies on that person.

### 1.9 S.102 ON WHOM BURDEN OF PROOF LIES –

The burden of proof in a suit or proceeding lies on that person who would fail if no evidence at all were given on either side.

# UNIT – VII

# Salient Features Of Insolvency And Bankruptcy Code Of India, 2016 Concerning Valuation

**Insolvency** is when an individual or organization is unable to meet its outstanding financial debt towards its lender as it become due. Insolvency can be resolved by way of changing the repayment plan of the loans or writing off a part thereof. If it cannot be resolved, then a legal action may lie against the insolvent and its assets will be sold to pay off the outstanding debts. Generally, an official assignee/liquidator appointed by the Government of India, realizes the assets and allocates it among the creditors of the insolvent.

**Bankruptcy** is a concept slightly different from insolvency, which is rather amicable. A bankruptcy is when a person voluntary declares himself as an insolvent and goes to the court. On declaring him as 'bankrupt', the court is responsible to liquidate the personal property of the insolvent and hand it out to its creditors. It provides a fresh lease of life to the insolvent

## INTRODUCTION

Insolvency and Bankruptcy Code represents the legal and institutional mechanisms in India for dealing with debt default of companies and limited liability entities, partnership firms and individuals. However, this does not automatically cover default by financial service providers, unless notified by the Government.

## OBJECTIVE OF THE CODE

The new law aims to consolidate the laws relating to insolvency of companies and limited liability entities (including limited liability partnerships and other entities with limited liability), unlimited liability partnerships and individuals, contained in a number of legislations , into a single legislation and provide for their reorganization and resolution in a time bound manner for maximization of value of their assets. Such consolidation will provide for a greater clarity in law and facilitate the application of consistent and coherent provisions to different stakeholders affected by business failure or inability to pay debt.

The Code separates commercial aspects of the insolvency proceedings from judicial aspects. While **Insolvency Professionals (IPs)** will deal with commercial aspects such as management of the affairs of the corporate debtor, facilitating formation of committee of creditors, organising their meetings, examination of the resolution plan, etc., judicial issues will be handled by proposed Adjudicating Authorities (**National Company Law Tribunal / Debt Recovery Tribunal)** . One more important institution created under the Code is the 'Information Utility' which would store financial information and data and terms of lending in electronic databases. This would eliminate delays and disputes about facts when default does take place.

The Code also provides a fast track insolvency resolution process for corporates and LLPs. This will be an enabler for start-ups and small and medium enterprises (SMEs) to complete the resolution process in 90 days (extendable to 45 days in deserving cases).

**LIQUIDATION**

In the event that:

i. the COC cannot agree on a workable resolution plan within the IRP Period (i.e. 180 days extendable once by another 90 days);
ii. the COC decides to liquidate the company;
iii. the NCLT rejects the resolution plan; or
iv. the corporate debtor contravenes provisions of the resolution plan, the NCLT shall:
v. pass an order requiring liquidation of corporate debtor;
vi. make a public announcement of corporate debtor entering liquidation; and
vii. require a liquidation order to be sent to the registering authority of the corporate debtor (for example Registrar of Companies in case of companies incorporated under Companies Act).

The IP acting as the resolution professional shall, upon commencement of liquidation shall be appointed as the liquidator for the process, unless replacedbyNCLT.

**THE LIQUIDATION PROCESS**

The liquidation process starts with the winding up order and ends with the order of dissolution of the corporate debtor. It involves realization of the assets of the entity in liquidation and distribution of the realization proceeds among the creditors and other stakeholders who have claim to share the proceeds and other incidental activities by virtue of the liquidator being the trustee for the stakeholders as discussed hereunder:

***Taking possession and control of the liquidation estate of corporate debtor***

The Code lists the assets which shall form the liquidation estate and which the liquidator shall hold as fiduciary for the benefit of all creditors. And also mentions the assets which shall not form part of the liquidation estate. The liquidator has to take into his custody or control all the assets, property,

***Distribution of assets and other aspects***

Section 53 of the Code stipulates in case of liquidation, the assets of the corporate debtor will be sold and the proceeds will be distributed amongst the creditors in the following order of priority:

i. cost of the insolvency resolution process and liquidation;
ii. secured creditors (who choose to relinquish their security enforcement rights and workmen's dues relating to a period of 24 months preceding the liquidation commencement date);
iii. wages and unpaid dues of employees (other than workmen) for a period of 12 months preceding the liquidation commencement date;
iv. financial debts owed to unsecured creditors;
v. statutory dues to be received on account of Consolidated Fund of India or Consolidated Fund of a State (relating to a period of whole or part of 2 years preceding the liquidation commencement date) and debts of secured creditors (remaining unpaid after enforcement of security);
vi. remaining debts and dues;
vii. dues of preference shareholders; and
viii. dues of equity shareholders or partners (as may be applicable)

***Dissolution of corporate debtor***

Where the assets of the corporate debtor have been completely liquidated, the liquidator shall make an application to NCLT for the dissolution of such corporate debtor and NCLT shall order that the corporate debtor shall be dissolved from the date of that order and the corporate debtor shall be dissolved accordingly. A copy of an order of dissolution shall be forwarded to the authority with which the corporate debtor is registered within 7 days from the date of such order

*Moratorium :*

An interim-moratorium period which would commence after filing of the application for a fresh start process and shall cease to exist after elapse of a period of 180 days from the date of application. During such period, all legal proceedings against such debtor should be stayed and no fresh suits, proceedings, recovery or enforcement action may be initiated against such debtor.

However, the certain restrictions are imposed on the debtor during the moratorium period such as the debtor shall be not be permitted to act as a director of any company (directly/indirectly) or be involved in the promotion or management of a company during the moratorium period. Further, he shall not dispose of his assets or travel abroad during this period, except with the permission of the Adjudicating Authority.

**INSOLVENCY RESOLUTION PROCESS**

An application to initiate an IRP under the Code can be either made by the debtor (personally or through an insolvency resolution professional) or by a creditor (either personally or jointly with other creditors through an insolvency resolution professional). However, a partner of a partnership firm is not eligible to apply for an IRP unless a joint application is filed by majority of the partners of the partnership firm.

***Fresh start process :***
Under this process, eligible debtors as specified in the Code can apply to the Debt Recovery Tribunal for a fresh start for discharge of his qualifying debt. After filing an application, an interim- moratorium shall commence on the date of filing of the said application.

The insolvency resolution process consists of a repayment plan by the debtor, for approval of creditor. If approved, the Debt Recovery Tribunal passes an order binding the debtor and creditors to the repayment plan. If rejected, the debtor or creditors may apply for bankruptcy order.

VOLUNTARY LIQUIDATION OF CORPORATE PERSONS :

A corporate person (which includes companies as well as LLPs) may put the entity into voluntary winding up .The conditions and procedural requirements that may be specified by the Board.

**Procedure for voluntary liquidation:**

***1. Declaration of Solvency to be made by the majority of Directors***

Majority of directors of the company/entity must make a declaration verified by an affidavit stating that-

1. they have made a full inquiry into the affairs of the company and they have formed an opinion that either the company has no debt or that it will be able to pay its debts in full from the proceeds of assets sold/ to be sold in the voluntary winding up; and

2. the company is not being liquidated to defraud any person

***2. Documents to accompany the declaration***

1. Audited financial statements and record of business operations of the company for the previous two years or for the period since its incorporation, whichever is later;

2. a report of the valuation of the assets of the company, if any prepared by a registered valuer.

**Registrar of companies and insolvency and bankruptcy board of India to be notified about the general body resolution within seven days**

The company is required to notify the Registrar of Companies and the Insolvency and Bankruptcy Board of India about the general body resolution for voluntary winding up of the company within seven days of such general body resolution or within seven days of the subsequent approval of the general body resolution by the creditors, as the case may be.

**Approval of creditors must be obtained within seven days of general body resolution where the company owes any debt to any person**

If the company owes any debt to any person, approval of the resolution for voluntary winding up of the company is required from creditors representing two-thirds in value of the debt of the company within seven days of general body resolution.

**General body resolution to be passed within four weeks of making of declaration of solvency**

The company should pass a special resolution in a general meeting where the company is to be liquidated voluntarily and appointment of an insolvency professional to act as liquidator.

Or

A resolution of the members of the company in a general meeting requiring the company to be liquidated voluntarily as a result of expiry of the period of its duration, if any, fixed by its articles or on the occurrence of any event in respect of which the articles provide that the company shall be dissolved, as the case may be and appointing an insolvency professional to act the liquidator should be passed.

Voluntary liquidation proceedings in respect of a company shall be deemed to have commenced from the date of passing of the resolution.

Where the affairs of the corporate person have been completely wound up, and its assets completely liquidated, the liquidator can make an application to the Adjudicating Authority for the dissolution of such corporate person.

On such application the Adjudicating Authority shall pass an order for dissolution.

A copy of the order is to be forwarded to the authority with which the corporate is registered with fourteen days.

## REFERENCE TO VALUATION BY REGISTERED VALUERS UNDER THE INSOLVENCY AND BANKRUPTCY CODE, 2016

| S. No. | Topic | Provision |
|---|---|---|
| **1.** | Insolvency and Bankruptcy Board of India (Insolvency Resolution Process for Corporate Persons) Regulations, 2016 | • "registered valuer" means a person registered as such in accordance with the Companies Act 2013 (18 of 2013) and rules made thereunder – Reg. 2(1)(m);<br>• The interim resolution professional shall within seven days of his appointment, appoint two registered valuers to determine the liquidation value of the corporate debtor in accordance with Regulation 35:<br><br>Provided that the following persons shall not be appointed as registered valuers:<br>(a) a relative of the interim resolution professional;<br>(b) a related party of the corporate debtor;<br>(c) an auditor of the corporate debtor in the five years preceding the insolvency commencement date; or<br>(d) a partner or director of the insolvency professional entity - Reg. 27.<br><br>• **Liquidation value- Reg. 35:**<br>1) Liquidation value is the estimated realizable value of the assets of the corporate debtor if the corporate debtor were to be liquidated on the insolvency commencement date.<br>2) Liquidation value shall be determined in the following manner:<br>a) the two registered valuers appointed under Regulation 27 shall submit to the interim resolution professional or the resolution |

| | | |
|---|---|---|
| | | professional, as the case may be, an estimate of the liquidation value computed in accordance with internationally accepted valuation standards, after physical verification of the inventory and fixed assets of the corporate debtor;<br>b) if in the opinion of the interim resolution professional or the resolution professional, as the case may be, the two estimates are significantly different, he may appoint another registered valuer who shall submit an estimate computed in the same manner; and<br>c) the average of the two closest estimates shall be considered the liquidation value.<br><br>• **Information Memorandum - Reg. 36:** The information memorandum shall contain assets and liabilities, as on the insolvency commencement date, classified into appropriate categories for easy identification, with estimated values assigned to each category, the liquidation value, etc.;<br><br>• **Resolution Plan - Reg. 38:** A resolution plan shall identify specific sources of funds that will be used to pay the liquidation value due to operational creditors and liquidation value due to dissenting financial creditors. |
| **2.** | Insolvency and Bankruptcy Board of India ( Liquidation Process) Regulation, 2016 | **Valuation of assets intended to be sold - Reg. 35:**<br>1. The liquidator shall appoint at least two registered valuers to value the assets as required under Regulation 34(2).<br>2. The provisions of Regulation 7 shall apply mutatis mutandis to registered valuers appointed under sub-regulation (1).<br>3. The registered valuers appointed under |

| | | |
|---|---|---|
| | | sub-regulation (1) shall independently submit to the liquidator the estimates of the realizable value of the asset(s) computed in accordance with internationally accepted valuation standards, after physical verification of the assets of the corporate debtor.<br><br>**Asset memorandum -Reg. 34(2):** The asset memorandum shall provide the following details in respect of the assets<br>which are intended to be realized by way of sale value of the asset, valued in accordance with Regulation 35; value of set of assets or assets in parcels or assets in slump sale, as the case may be, valued in accordance with Regulation 35, if intended to be sold as specified in<br>Regulation 32(b), etc. |
| **3.** | Voluntary Liquidation of corporate person - Section 59(3) | Voluntary liquidation proceedings of a corporate person registered as a company shall be accompanied with:<br>• a declaration from majority of the directors of the company verified by an affidavit stating that they have made a full inquiry into the affairs of the company and they have formed an opinion that either the company has no debt or that it will be able to pay its debts m full from the proceeds of assets to be sold in the voluntary liquidation;<br>• a report of the valuation of the assets of the company, if any prepared by a registered valuer. |
| **4.** | Insolvency and Bankruptcy Board of India ( Voluntary Liquidation Process) Regulation, 2017 | **Final Report - Reg. 38(1)(c):** On completion of the liquidation process, the liquidator shall prepare the Final Report consisting of a sale statement in respect of all assets containing-<br>i. the realized value;<br>ii. cost of realization, if any;<br>iii. the manner and mode of Sale;<br>iv. an explanation for the shortfall, if the value realized is less than the value |

| | | |
|---|---|---|
| | | assigned by the registered valuer in the report of the valuation of assets;<br>v. the person to whom the sale is made; and<br>vi. any other relevant details of the sale. |

# UNIT - VIII

## Salient Features Of Companies (Registered Valuers And Valuation) Rules 2017

Please refer to Companies (Registered valuers and valuation) Rules 2017 under Section 247 of the Companies Act, 2013.

# UNIT – IX

# Salient Features of The Securitization and Reconstruction of Financial Assets and Enforcement of Security Interest (SARFAESI) Act, 2002

**INTRODUCTION:**

The Securitization and Reconstruction of Financial Assets and Enforcement of Security Interest (SARFAESI) Act, 2002 is a legislation that helps financial institutions to ensure asset quality in multiple ways. This means that the Act was framed to address the problem of NPAs (Non-Performing Assets) or bad assets through different processes and mechanisms. The enactment of the SARFAESI Act, 2002 enabled banks and financial institutions to sell off their non-performing assets to asset reconstruction companies registered with RBI

The SARFAESI Act gives detailed provisions for the formation and activities of Asset Securitization Companies (SCs) and Reconstruction Companies (RCs). RBI is the regulator for these institutions. As a legal mechanism to insulate assets, the Act addresses the interests of secured creditors (like banks). Several provisions of the Act give directives and powers to various institutions to manage the bad asset problem.

**OBJECTIVES:**

Following are the main objectives of the SARFAESI Act.

- The Act provides the legal framework for securitization activities in India
- It gives the procedures for the transfer of NPAs to asset reconstruction companies for the reconstruction of the assets.
- The Act enforces the security interest without Court's intervention
- The Act gives powers to banks and financial institutions to take over the immovable property that is hypothecated or charged to enforce the recovery of debt.

**FEATURES:**

Major feature of SARFAESI is that it promotes the setting up of asset reconstruction (RCs) and asset securitization companies (SCs) to deal with NPAs accumulated with the banks and financial institutions.

The Act provides three methods for recovery of NPAs, viz:

(i) Securitization;

(ii) Asset Reconstruction; and

(iii) Enforcement of Security without the intervention of the Court.

The Act, thus brings three important tools/powers into asset management of financial banks and institutions – securitization of assets, reconstruction of assets and powers for enforcement of security interests (means asset security interests). To understand the SARFAESI Act, we should know the meaning of these terms as well.

**MEANING**

**What is Securitization?**

Securitization is the process of pooling and repackaging of financial assets (like loans given) into marketable securities that can be sold to investors.

In the context of bad asset management, securitization is the process of conversion of existing less liquid assets (loans) into marketable securities. The securitization company takes custody of the underlying mortgaged assets of the loan taker. It can initiate the following steps:

i. Acquisition of financial assets from any originator (bank), and

ii. Raising of funds from qualified institutional buyers by issue of security receipts (for raising money) for acquiring the financial assets or

iii. Raising of funds in any prescribed manner, and

iv. Acquisition of financial asset may be coupled with taking custody of the mortgaged land, building etc.

**What is asset reconstruction?**

**(i)** Asset reconstruction is the activity of converting a bad or non-performing asset into performing asset. The process of asset reconstruction involves several steps including purchasing of bad asset by a dedicated asset reconstruction company (ARC) including the underlying hypothecated asset, financing of the bad asset conversion into good asset using bonds, debentures, securities and cash, realization of returns from the hypothecated assets etc. The Act also laid the framework to the constitution of Asset Reconstruction Companies (ARCs) specializing in securitizing distressed assets purchased from banks.

Asset Reconstruction Companies take over non-performing assets of banks at discounted rate and manage and dispose of such assets.Reconstruction, is to be done with the RBI regulations and the SARFAESI Act gives the following components for reconstruction of assets –

a) taking over or changing the management of the business of the borrower,
b) the sale or lease of a part or whole of the business of the borrower;
c) rescheduling of payment of debts payable by the borrower;
d) enforcement of security interest in accordance with the provisions of this Act;
e) settlement of dues payable by the borrower;
f) taking possession of secured assets in accordance with the provisions of this Act.

It empowers the Reserve Bank of India to regulate asset reconstruction companies in a changing business environment. It empowers the RBI to carry out Audit and conduct inspections of an ARC from time to time. The RBI may impose a penalty where an ARC fails to comply with any direction issued by RBI;

(ii) exemption from stamp duty on loans assigned by banks and financial institutions to asset reconstruction companies;

(iii) enabling non-institutional investors besides qualified buyers to invest in security receipts by ARCs; specific timeline for taking possession of secured assets; and

(iv) priority to secured creditors in repayment of debts

**What is mean by Non-Performing Asset?**

**'Non Performing Asset'** means an asset or account of a borrower, which has been classified by a bank or financial institution and sub-standard, doubtful or loss asset, in accordance with the directions or guidelines relating to asset classification issued by RBI .

***Other functions of securitisation company or reconstruction company.—***

Any Securitisation company or reconstruction company registered may –

(a) act as an agent for any bank or financial institution for the purpose of recovering their dues from the borrower on payment of such fees or charges as may be mutually agreed upon between the parties;

(b) act as a manager on such fee as may be mutually agreed upon between the parties;

(c) act as receiver if appointed by any court or tribunal.

Provided that no securitisation company or Reconstruction Company shall act as manager if acting as such gives rise to any pecuniary liability.

No securitisation company or reconstruction company which has been granted a certificate of registration, shall carry on, any business other than that of securitisation or asset reconstruction without prior approval of the Reserve Bank.

If in case a securitisation company or reconstruction company is carrying any business other than the business of securitisation or asset reconstruction on or before the commencement of this Act, it will shall cease to carry on any such business within one year from the date of commencement of this Act.

**What is mean by 'enforcement of security interests'?**

The Act empowers the lender (banker), when the borrower defaults, to issue notice to the defaulting borrower and guarantor, calling to repay the debt within 60 days from the date of the notice. If the borrower fails to comply with the notice, the bank or the financial institution may enforce security interests (means interest of the bank/creditor) by following the provisions of the Act:

a) Take possession of the security;
b) Sale or lease or assign the right over the security;
c) Appoint Manager to manage the security;
d) Ask any debtors of the borrower to pay any sum due to the borrower.

If there are more than one secured creditors, the decision about the enforcement of SARFEASI provisions will be applicable only if 75% of them are agreeing.

The SARFAESI Act allows secured creditors to take steps to enforce their security interests in respect of any debt of a borrower that is classified as a non-performing asset without the intervention of a court or tribunal if certain conditions specified in the Act are met.

**Rights of borrower**

A borrower can object to the measures taken under this Act within 45 days without depositing any amount with DRT. However for making application at the second appeal stage Debt Recovery Appellate Tribunal 50% of the amount outstanding has to be deposited which can also be reduced to 25% at the discretion of the Appellate Tribunal.

**Establishment of a Central Registry**

The functions relating to securitisation, asset reconstruction and creation of security interest is sought to be administered and regulated by a Central Registry. A Central Registrar shall head the Registry. The functions of the Central Registry are as under:

- Particulars relating to securitisation of assets, reconstruction of financial assets and creation of security interest are entered in a record called Central Register.
- The records can be kept in electronic form also .
- The particulars of every transaction of securitisation, asset reconstruction or creation of security interest shall be filed within 30 days of the transaction by SCO, RCO or the lender as the case may be.
- Modifications made in the security interest registered with the Registry are to be filed within 30 days of such modification.
- Satisfaction of security interest is required to be filed with the Registry within 30 days of satisfaction.
- Records maintained at the Central Registry are open to inspection for any person on payment of the prescribed fee.

**Need for Central Registry**

The RBI is the regulator of the major player in the Indian Financial System and has to ensure financial intermediaries engage in Securitisation prudently. To prevent fraud in loan cases involving, multiple lending from different banks on the same immovable property, the Central Electronic Registry under SARFAESI Act, 2002 has become operational since 31 March, 2011. The records maintained by the Central Electronic Registry will be available for search by any lender or any other person desirous of dealing with the property.

When the borrower is a company, there is a strong mechanism to verify the charges created by the company on its assets by searching its records maintained with the concerned Registrar of Companies.

Therefore, the establishment of a Central Registry was a welcome idea under the Act and is a necessary step to maintain data relating to the charges created on any asset by any person.

Besides being beneficial to the lenders and innocent third parties, the establishment and notification of the Central Registry would result in advantages given below:

- a single source to verify charges, if any, on any asset created by any entity,
- charges/encumbrances created on the asset of an unregistered entity including individuals, HUF, Association of Persons can be easily traced and the information be readily available,
- chances of use of false title deeds or false representations on the title of the assets can be eliminated. Accordingly, fraud on title of properties can be controlled, minimised and eliminated,
- due diligence on portfolio securitisation can be eased out,
- due diligence on sale and purchase of assets/properties would become easy and transparent,
- gullible public and innocent buyers who are generally left in the hands of unscrupulous real estate brokers and builders can be saved and their interests protected,
- data on charged and encumbered properties can be made available in a transparent manner giving the industry reflection and exposure of the lenders on such assets, and

Since the land records are not computerized in all the states and tracing the title of properties is still a complex problem, the Central Registry would better equip the lender to make a fair assessment of risk undertaken while providing finance against the property, thus making lending more easy and safe.

Bureaucratic delays and fleecing which happens on account of lack of transparency and procedure to determine the encumbrances would be reduced or eliminated, restoring faith in the land record system as well in respect of assets other than real estate.

**CONCLUSION:**

Though the enactment of SARFAESI Act sought to mobilise blocked funds of the banks in the non-performing assets, the various provisions of the acts have created deep sorrows for the genuine buyers. The various provisions meant to balance the requirements of the borrowers and the banks, have their balance of favour tilted towards the banks. These powers are, at majority of the times, mis-utilized by the banks to appropriate their interests against the interests of the buyers. In such a situation it is pertinent for the civil courts to assume a more social responsibility for the larger interest of the borrowers on one hand and to share the responsibilities of the banks to mobilize their funds from the numerous non-performing assets.

# UNIT – X

## Section 5(n) of Banking Regulation Act, 1949

- **SECURED LOAN OR ADVANCE IS DEFINED UNDER SECTION 5(n) OF BANKING REGULATION ACT,1949 as follows:**

**“secured loan or advance”:**
means a loan or advance made on the security of assets the market value of which is not at any time less than the amount of such loan or advance; and

**“unsecured loan or advance” :**
It means a loan or advance not so secured

CVSRTA

# UNIT – XI

## Companies Act 2013 :
## Section 192(2), 230 (1,2,3), 231, 232, 247(1), 281(1)

**Please refer to the Companies Act 2013.**

# INTRODUCTION TO STATISTICS


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Chairman, CVSRTA

# INDEX

# OVERVIEW OF STATISTICS

Statistics is a Science of collection, presentation, analysis, and reasonable interpretation of data. Statistics presents a rigorous scientific method for gaining insight into data.

For example, suppose we measure the weight of 100 patients in a study. With so many measurements, simply looking at the data fails to provide an informative account. However statistics can give an instant overall picture of data based on graphical presentation or numerical summarization irrespective to the number of data points. Besides data summarization, another important task of statistics is to make inference using data and predict relations of variables.

Why valuers are required to study statistics?

Because, valuers estimate the price of an asset on the basis of number of data.

- We collect number of data, for example, in case of real estate;
- Identify the identical or similar asset or property under valuation;
- Identify the various factors which will affect the value of the property such as shape, size, location, social factors like nearness to market, school, hospital, railway station, bus station, playground, recreational places, cinema, theatre, banks, government offices, legal factors like DCR, FSI, ULC Act, Rent Control Act, Technological factors like specifications of building, material of constructions, arrangement of rooms, light, air, ventilation etc;
- Give the weightage to each factor as per the preferences of the local public;
- Find out final weightage score;
- Compare all heterogeneous property by bringing them to the same platform;
- Comparison of heterogeneous property is possible;
- Draw our conclusion about the value.
- in case of plant and machinery, statistical methods are useful in comparison as well as in estimation of balance life.

**OBJECTIVES**

- To show the difference between samples and populations
- To convert raw data to useful information
- To construct and use data arrays
- To construct and use frequency distributions
- To graph frequency distributions with histograms, polygons and ogives

# UNIT – 1

## DATA CLASSIFICATIONS AND PROCESSING, GRAPHICAL REPRESENTATION OF DATA, FREQUENCY DISTRIBUTIONS

### 2.1 DATA

Data is any kind of Information pertaining to any subject, theme or phenomenon.
For example,

- Number of patients visit hospital for check-up
- Selling of car per day
- Number of students using bike.

Data could be of two types:

i. Qualitative: Information relating of occurrence or non occurrence of some phenomenon.
ii. Quantitative: Information dealing with magnitude or amount of values of some entities determining a phenomenon.

A collection of observations is called a data set or simply data, and a single observation is called a data point.

**Collection of data :**

Select the observations so that all relevant groups are represented in the data.

e.g. To determine potential market for a new product, suppose analyst study 100 consumers in a certain area. Analyst must be certain that this group contains people from various income levels, races, neighborhoods, having different educational background, etc.

**Source of data :**

Primary data: Generated or collected directly by the researcher.

Secondary data: Obtained from published sources (Statistical yearbooks / statistical handbooks /population census) such as departmental reports and census and other publications.

**Use of data :**

Data can assist decision makers in making guesses, probable effects of certain characteristics in a given situation.
Past experience can be useful in predicting future trends.

**2.2 SAMPLE AND POPULATION**

- population is a whole, and a sample is a fraction or segment of that whole.
- Statisticians gather data from a sample.
- Use this information to make inferences about the population that the sample represents.

A population is a collection of all the elements we are studying and about which we are trying to draw conclusions.
A sample is a collection of some, but not all, of the elements of the population.

A representative sample contains the relevant characteristics of the population in the same proportions as they are included in that population.

**To find a meaningful pattern in the data**
There are many ways to sort data. If the data is quantitative, we can list the data points from lowest to highest in numerical value. But if the data is qualitative like colour, degree of skill of worker, then we must organize them differently as per organizing principle like divide data into similar category or classes and count the number of observation that fall into each category or class. This is known as frequency distribution.

- Purpose of organizing data is to enable us to see quickly some of the characteristics of the data.

- The information like the range, apparent patterns, what values the data may tend to group around, what values appear most frequent from our sample can be very much helpful in understanding the population and better decision can be made.

**Raw data or Ungrouped data:**

Information before it is arranged and analyzed is called raw or Ungrouped data. Raw because it's unprocessed by statistical methods.

Use of biased and incomplete data leads to poor decisions.

Data array :

It arranges values in ascending or descending order.

## 2.3 FREQUENCY DISTRIBUTION (F.D.)

**It compresses the data :**

In F.D. some information can be lost as compared to array because in array, each data point is listed whereas in F.D., number of data points that fall into each group are recorded but due to construction of F.D., pattern or trend can be ascertained. When data is organized in this form it is called a grouped data.

A F.D. is a table that organizes data into classes i.e. into groups of values describing one characteristic of the data.

Example: 1- Consider the Data ~~array~~ of average sales in thousands, for 20 stores :

| | | | | |
|---|---|---|---|---|
| 2.0 | 3.8 | 4.1 | 4.7 | 5.5 |
| 3.4 | 4.0 | 4.2 | 4.8 | 5.5 |
| 4.3 | 4.1 | 4.3 | 4.9 | 5.5 |
| 3.8 | 4.1 | 4.7 | 4.9 | 5.5 |

The Frequency distribution of the above data :

| Class (Group of similar values of data points) | Frequency (No. of observations in each class) | Relative frequency |
|---|---|---|
| 2.0 to 2.5 | 1 | 1/20 = 0.05 |
| 2.6 to 3.1 | 0 | 0/20 = 0.00 |
| 3.2 to 3.7 | 2 | 2/20 = 0.10 |
| 3.8 to 4.3 | 8 | 8/20 = 0.40 |
| 4.4 to 4.9 | 5 | 5/20 = 0.25 |
| 5.0 to 5.5 | 4 | 4/20 = 0.20 |
| | 20 | 1.00 |

A F.D. shows the number of observations from the data set that fall into each of the several non-overlapping classes.

Note that, In this case, in class 1, we consider all possible values $\geq$ 2 and $\leq$ 2.5, in class 2, all the $\geq$ values 2.6 and < 3.1 etc. In the last class all the values $\geq$ 5.0 and $\leq$ 5.5 are considered.

Suppose 'N' is the no. of observations then ideally No. of classes (C) into which the data should be grouped is given by: $C = 1 + 3.3 \log_{10} N$.

And width of the Class interval is given by:

$$\text{Class width} = \frac{\begin{pmatrix}\text{Next Unit Value after} \\ \text{Largest value in data}\end{pmatrix} - \begin{pmatrix}\text{Smallest Value} \\ \text{In data}\end{pmatrix}}{\text{Total number of class interval}}$$

Example: 2 Consider another dataset:

16.25, 16.52, 16.0, 15.82, 16.77, 16.33, 15.6, 15.8, 16.39, 15.44, 16.64, 15.65, 15.88, 16.18, 15.7, 15.79, 16.27, 15.95, 16.05, 15.93, 16.88, 15.81, 16.59, 15.89, 15.87, 15.52, 15.99, 15.26, 16.30, 17.0

Observe that here, N = 30 and hence, $C = 1 + 3.3 \log_{10} 30 = 1 + 4.87 = 5.87 \cong 6$.

Class width = ( 17.0 - 15.2) / 6 = 1.8 / 6 = 0.3

Thus the Frequency distribution for this data is as follows

| | | Class | Frequency (f) | Relative Frequency |
|---|---|---|---|---|
| 15.2 | to | 15.5 | 2 | 0.06 |
| 15.5 | to | 15.8 | 5 | 0.17 |
| 15.8 | to | 16.1 | 11 | 0.37 |
| 16.1 | to | 16.4 | 6 | 0.20 |
| 16.4 | to | 16.7 | 3 | 0.10 |
| 16.7 | to | 17.0 | 3 | 0.10 |
| | | | 30 | 1.00 |

Note that, In above case, in class 1, we consider all possible values > 15.2 and < 15.5, in class 2, all the > values 15.5 and < 15.8 etc. In the last class all the values > 16.7 and < 17.0 are considered. Such a frequency distribution is called continuous frequency distribution.

In-case we consider classes consisting of only one distinct data value starting from lowest value to highest value like 15.2, 15.3, 15.4, 15.5 ….. 16.9, 17.0 and class frequency as number of times the class value occurs in the data set Then the type of frequency distribution we get, is called discrete frequency distribution.

In case of qualitative data also, if we consider classes corresponding to each category in the data set, we get a discrete frequency distribution.

Example 3:
Guests staying at Marada Inn were asked to rate the quality of their accommodations as being ***excellent*** (E), ***above average (AA)***, ***average (A)***, ***below average (BA)***, or ***poor (P)***. The ratings provided by a sample of size N = 20 guests are shown below:

BA, A, AA, AA, AA, AA, AA, BA, BA, A, P, P, AA, E, AA, A, AA, A, AA, A.

The Frequency distribution for this data is given by:

| Rating | Frequency (f) | Relative Frequency(f/N) | % Frequency ((f/N)100) |
|---|---|---|---|
| Poor | 2 | 0.1 | 10 |
| Below average | 3 | 0.15 | 15 |
| Average | 5 | 0.25 | 25 |
| Above average | 9 | 0.45 | 45 |
| Excellent | 1 | 0.05 | 5 |
| Total | 20 | 1.00 | 100 |

## 2.4 GRAPHICAL/DIAGRAMATIC PRESENTATION OF QUANTITATIVE DATA:

Frequency distribution or relative frequency distribution gives tabular representation of the raw data. Such a grouped / tabular data can be nicely presented in the form of diagrams or graphs for better understanding of the nature of data. Quantitative data can be represented by Histogram, frequency polygon, frequency curve, Ogive curve etc. while; qualitative data can be represented by bar charts, Pie charts etc. We illustrate these diagrams for the examples given above.

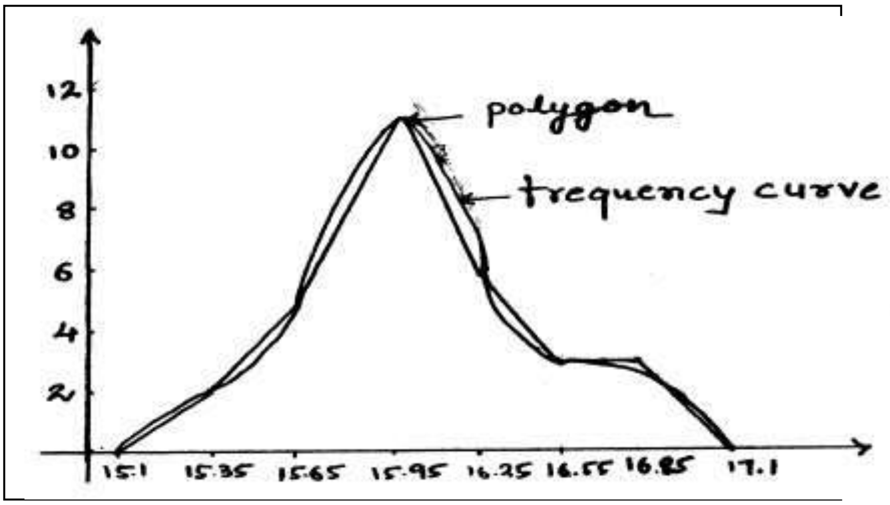
### HISTOGRAM / FREQUENCY POLYGON / FREQUENCY CURVE

graphical presentation of quantitative data is called a Histogram. In histogram, the variable of interest is placed on the horizontal axis and the frequency, relative frequency, or percent frequency is placed on the vertical axis. A rectangle is drawn above each class interval with its height corresponding to the interval's frequency, relative frequency, or percent frequency. A histogram has no separation between rectangles of adjacent classes.

If midpoints of the upper side of the rectangles in a Histogram are connected by straight lines, the resulting curve is called the Frequency Polygon.

If points on frequency polygon are connected by smoothed curve is called Frequency Curve.

Figure -1:  Histogram & frequency polygon for example-2



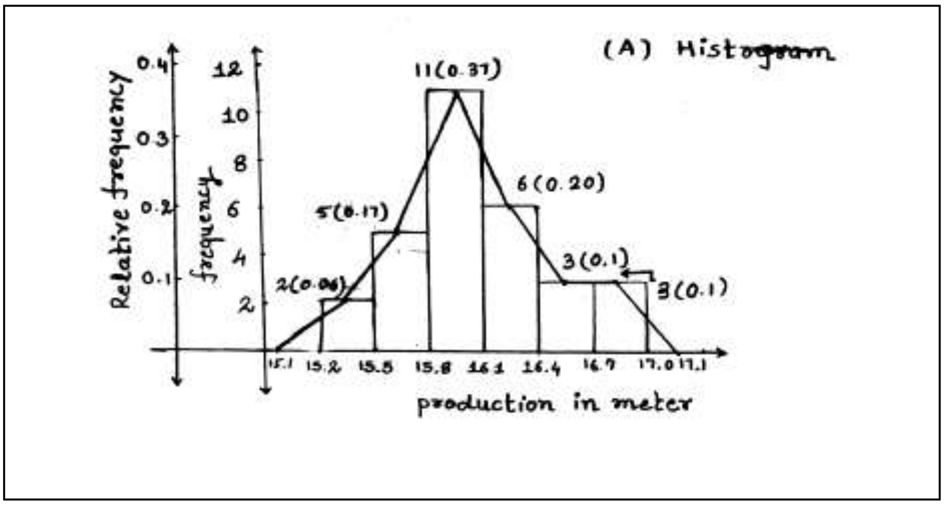




Figure 2: Frequency Polygon and Frequency curve (example-2)

## OGIVE

A cumulative frequency distribution enables us to see how many observation lie above or below certain values, rather than merely recording the number of items within intervals.

A graph of a cumulative frequency distribution is called an ‘Ogive’ (pronounced as ‘Ohjive’).

‘LESS THAN’ OGIVE: Cumulative distribution (≤) for example-2 is given below.

| Class | Cumulative Frequency |
|---|---|
| Less than 15.2 | 0 |
| Less than 15.5 | 2 |
| Less than 15.8 | 7 |
| Less than 16.1 | 18 |
| Less than 16.4 | 24 |
| Less than 16.7 | 27 |
| Less than 17.0 | 30 |

‘More than’ Ogive for example-2 is as follows:

| Class | Cumulative Frequency |
|---|---|
| Less than 15.2 | 30 |
| Less than 15.5 | 28 |
| Less than 15.8 | 23 |
| Less than 16.1 | 12 |
| Less than 16.4 | 6 |
| Less than 16.7 | 3 |
| Less than 17.0 | 0 |

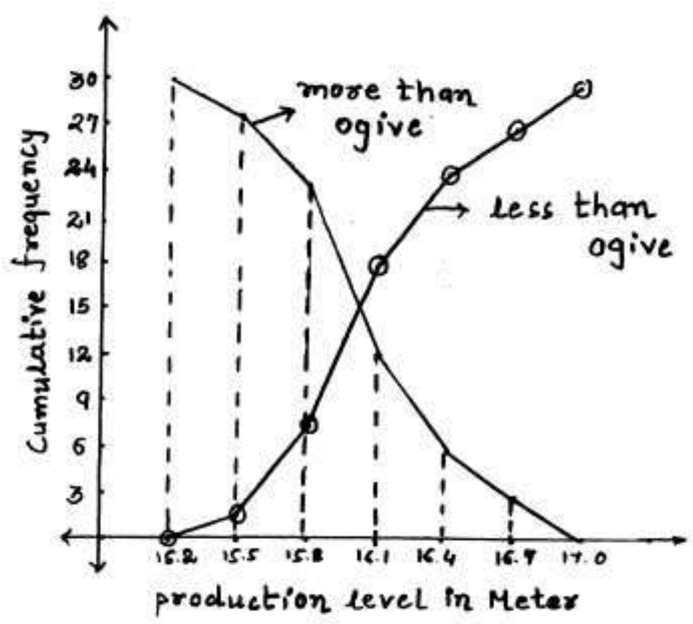



**Figure 3: ≤ and ≥ Ogive**

## 2.5 GRAPHICAL PRESENTATION OF QUALITATIVE DATA:

In contrast to quantitative data graphs that are plotted along a numerical scale, qualitative graphs are plotted using non-numerical categories. In this section, we will examine two types of qualitative data graphs: (1) pie charts, (2) bar charts.

**PIE – DIAGRAM (CIRCLE DIAGRAM)**

A pie chart is a circular depiction of data where the area of the whole pie represents 100% of the data and slices of the pie represent a percentage breakdown of the different classes / categories. Pie charts show the relative magnitudes of the parts to the whole. They are widely used in business, particularly to depict such things as budget categories, market share, and time / resource allocations. A typical Pie chart is depicted below.

Pie Chart for Example 3 is given by:

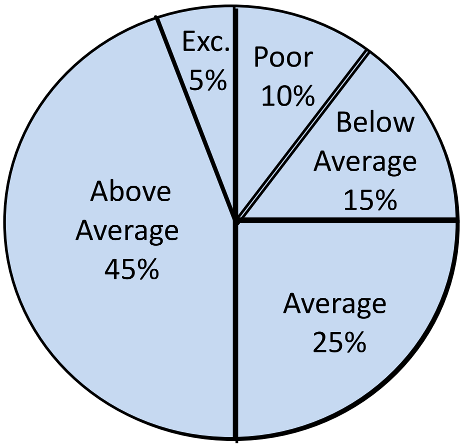



**Figure 4: Pie chart for example 3 (Quality rating)**

**BAR CHART:**

A bar graph or chart contains two or more categories along one axis and a series of bars, one for each category, along the other axis. Typically, the length of the bar represents the magnitude of the measure (amount, frequency, money, percentage, etc.) for each category. It is similar to Histogram except that in this case bars are separated from each other.

Bar chart for example 3 is given below.

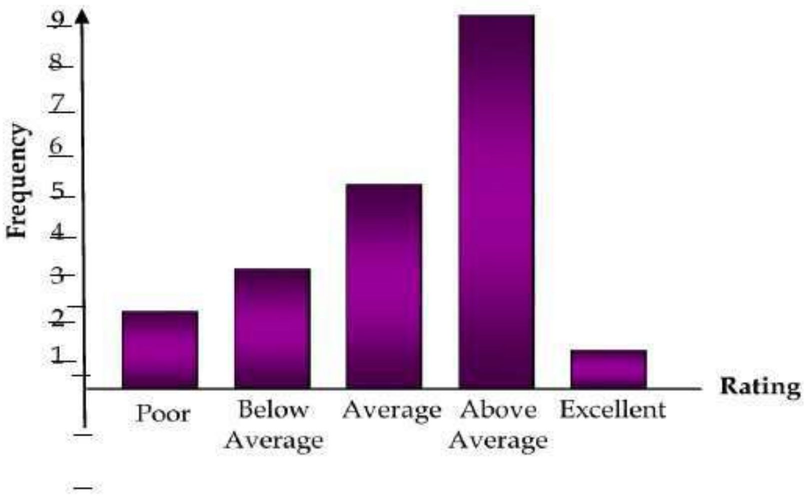



**Figure 5: Bar Chart for example 3**

**2.6 REVIEW**

2.6.1 Here are the ages of 50 members of a country social service programme.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 83 | 51 | 66 | 61 | 82 | 65 | 54 | 56 | 92 | 60 |
| 65 | 87 | 68 | 64 | 51 | 70 | 75 | 66 | 74 | 68 |
| 44 | 55 | 78 | 69 | 98 | 67 | 82 | 77 | 79 | 62 |
| 38 | 88 | 76 | 99 | 84 | 47 | 60 | 42 | 66 | 74 |
| 91 | 71 | 83 | 80 | 68 | 65 | 51 | 56 | 73 | 55 |

Use these data to construct relative frequency distributions using 7 equal intervals and 13 equal intervals. State policies on social service programmes require that approximately 50 percent of the programme participants be older than 50.

a. Is the programme in compliance with the policy?
b. Does your 13-interval relative frequency distribution help you answer part (a) better than your 7-interval distribution?
c. Suppose the Director of Social Services wanted to know the proportion of programme participants between 45 and 50 years old. Could you estimate the answer for her better with a 7 or a 13 interval relative frequency distribution?

2.6.2 High performance bicycle products company in Firozpur, sampled its shipping for a certain day with these results:

Time from Receipt of Order to Delivery (in Days)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 12 | 8 | 14 | 11 | 6 | 7 | 13 | 13 | 11 |
| 11 | 20 | 5 | 19 | 10 | 15 | 24 | 7 | 29 | 6 |

Construct a frequency distribution for these data and a relative frequency distribution. Use intervals of 6 days.

a. What statement can you make about the effectiveness of order processing from the frequency distribution?
b. If the company wants to ensure that half of its deliveries are made in 10 or fewer days, can you determine from the frequency distribution whether they have reached this goal?
c. What does having a relative frequency distribution permit you to do with the data that is difficult to do with only a frequency distribution?

2.6.3 Mr. Amit, a safety engineer for the Ratnagiri Power Generating Station, has charted the peak reactor temperature each day for the past year and has prepared the following frequency distribution:

| Temperature in $^0$C | Frequency |
|---|---|
| Below 500 | 4 |
| 501-510 | 7 |
| 511-520 | 32 |
| 521-530 | 59 |
| 531-540 | 82 |
| 541-550 | 65 |
| 551-560 | 33 |
| 561-570 | 28 |
| 571-580 | 27 |
| 581-590 | 23 |
| Total | 360 |

List and explain any errors you can find in Mr. Franks's distribution.

2.6.4 Here is a frequency distribution of the weight of 150 people who used a passenger lift on a certain day. Construct a histogram for these data:

| Class | Frequency |
|---|---|
| 75-89 | 10 |
| 90-104 | 11 |
| 105-119 | 23 |
| 120-134 | 26 |
| 135-149 | 31 |
| 150-164 | 23 |
| 165-179 | 23 |
| 180-194 | 9 |
| 195-209 | 6 |
| 210-224 | 2 |

a. What can you see from the histogram about the data that was not immediately apparent from the frequency distribution?
b. If each passenger lift chair holds two people but is limited in total safe weight capacity to 400 pounds, what can the operator do to maximize the people capacity of the ski lift without exceeding the sale weight capacity of a chair? Do the data support your proposal?

2.6.5 The V.S. Hospital has the following data representing weight in pounds at birth of 200 premature babies.

| Class | Frequency |
|---|---|
| 0.5-0.9 | 10 |
| 1.0-1.4 | 19 |
| 1.5-1.9 | 24 |
| 2.0-2.4 | 27 |
| 2.5-2.9 | 29 |
| 3.0-3.4 | 34 |
| 3.5-3.9 | 40 |
| 4.0-4.4 | 17 |

Construct an ogive that will help you answer these questions:

c. What was the approximate middle value in the original data set?
d. If premature babies under 3.0 pounds are normally kept in an incubator for several days as a precaution, about what percentage of V.S.'s premature babies will need an incubator?

# UNIT – 2

## MEASURES OF CENTRAL TENDENCY, DISPERSION AND SKEWNESS

**CHARACTERISTICS OF FREQUENCY DISTRIBUTIONS:**

### 3.1 CENTRAL TENDENCY

Data is a set of observations and each observation gives some information / value of interested variable, say x. Now there is a natural tendency to concentrate most of the information at centre point (like centre of gravity). Our aim is to locate this central point and measure the information at this point. Figure - 6 depicts three distributions (curves A, B and C) for values of x. Central locations of Curve 'A' and Curve 'B' is equal but Central locations of Curve 'C' lies to the right of those of Curve 'A' and Curve 'B'.

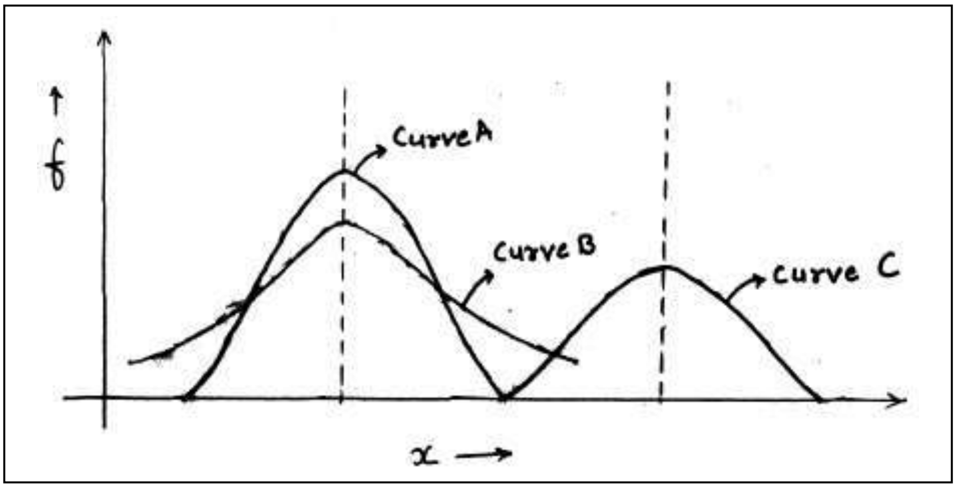



**Figure 6: Central locations of distribution of x**

## 3.2 DISPERSION

Dispersion is the spread of the data in a distribution. i.e. the extent to which the observations are scattered. Curve 'B' has wider spread or dispersion than Curve 'A'.

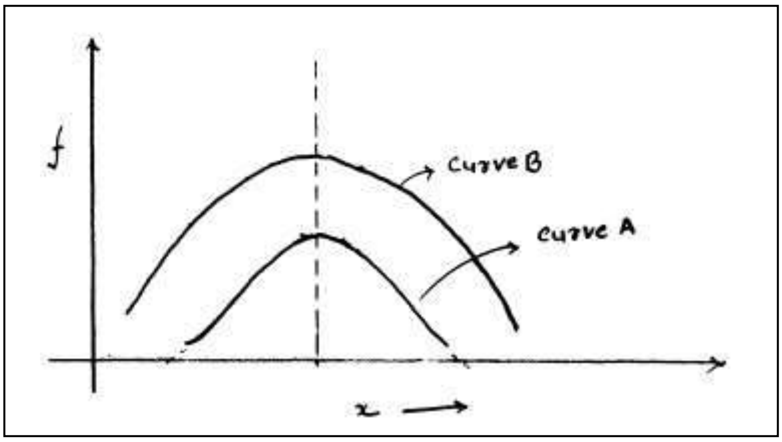



**Figure 7: Dispersion of distribution of x**

Other two characteristics to make decision are: Skewness and Kurtosis

## 3.3 SKEWNESS

Distributions representing the data points in the data set may be symmetrical or skewed.

Symmetrical curve A like shown in figure 8 i.e. if vertical line drawn from center of the curve to Horizontal Axis divides the area under the Curve into two equal parts. Mirror image of the other

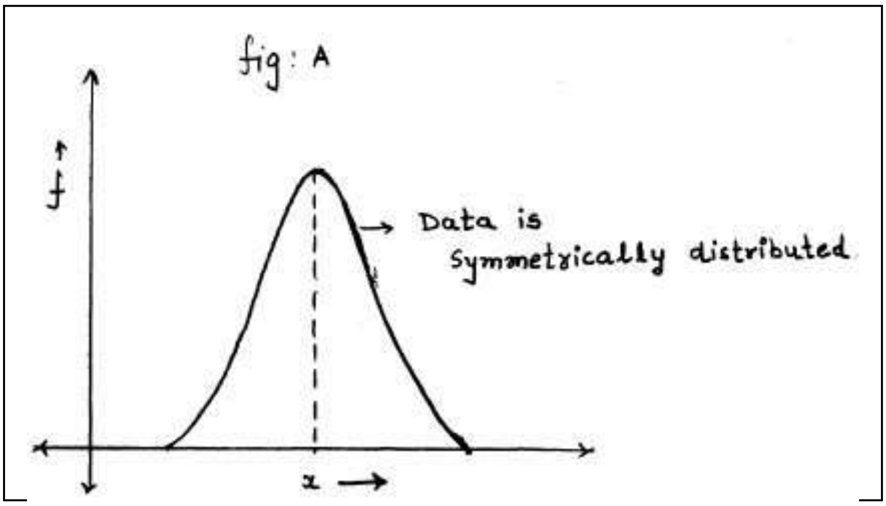



**Figure 8: symmetric distribution**

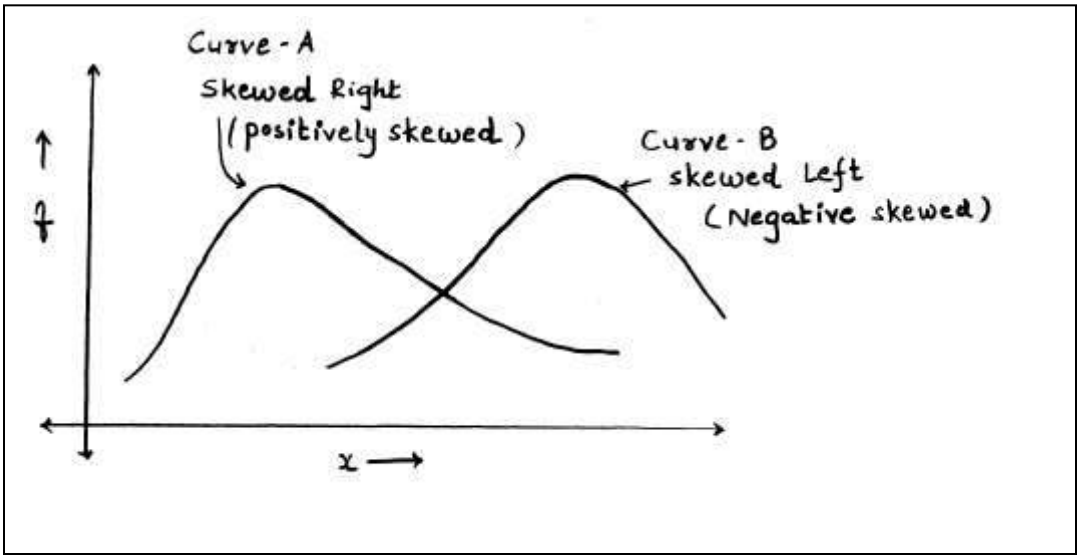



**Figure 9: Skewed distributions**

Curve 'A' and Curve 'B' shown in Figure 9 are skewed curves. They are skewed because values in their frequency distributions are concentrated at either lower or higher end of the measuring scale on the horizontal axis. The values are not equally distributed. Curve 'A' is skewed to right (or positively skewed) because it tails off towards the higher end of the scale. Curve 'B' is just opposite. It is skewed to left (negatively skewed) because it tails off towards the lower end of the scale.

e.g. Curve 'A' might represent the frequency distribution of the number of hours Vs. Supply of the Daily News Paper of distributor. The curve would be skewed to the right, with many values at early hours of the morning and very few in the evening. Stocks will turn over rapidly.

Similarly, Curve 'B' could represent the frequency of the number of days a real estate broker requires to sell a house. It would be skewed to the left, with many values at the high end and few at low, because selling of houses of a big project turns over very slowly.

## KURTOSIS:

Peakedness of a data set is called Kurtosis.

Curve 'A' and Curve 'B' differ only in that one is more peaked than the other.

They have same Central Location and Dispersion and both are symmetrical but the two curves have different degrees of Kurtosis (Different Peak)

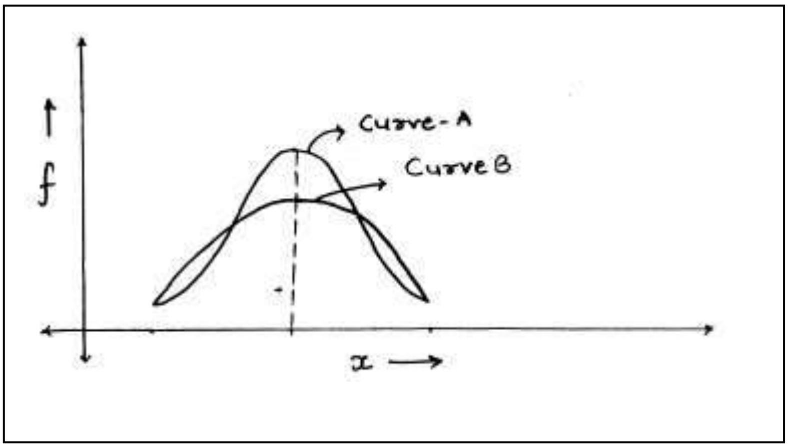



**Figure 10: Distributions with different Kurtosis**

Two curves with same central location. Dispersion and both are symmetrical but different Kurtosis.

### 3.4 MEASURES OF CHARACTERISTICS OF PROBABILITY DISTRIBUTIONS:

In the previous section, various characteristics of a probability distributions like, Central tendency, dispersion, skewness, kurtosis have been discussed conceptually. In this sections we give numerical measures for these characteristics.

**MEASURES OF CENTRAL TENDENCY:**

Commonly used measures of central tendency are Mean, Median and Mode. The formulae for these measures are different for grouped and ungrouped data.

**The arithmetic mean for ungrouped data:**

If the ungrouped data is given as $\{x_1, x_2, \ldots, x_n\}$ then the Mean (the simple Arithmetic mean)

$$\bar{x} = \frac{\{\sum_{i=1}^{n} x_i\}}{n} = \frac{\textit{Sum of all data values}}{\textit{Total number of observations}}.$$

**Example**: 4 Suppose time required to complete the job by 7 labours are as under :

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Worker : | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Time in hours: | 4.2 | 4.3 | 4.7 | 4.8 | 5.0 | 5.1 | 9.0 |

$\bar{x}$ = (37.1) / 7 = 5.3 hours

Observe that the 7th data value 9 is much away from other data values lying in the interval [4.2, 5.1]. If we exclude the worker no.7 and compute mean time for first 6 worker, the mean is 4.7 hours.

This extreme value of 9.0 distorts the value we get for the mean. It would be more representative to calculate mean without including extreme value. Such extreme values in the data are called outliers.

**The Arithmetic Mean for Grouped Data:**

Consider the group data distributed in k class intervals $[a_i, b_i]$ having frequency $f_i$, for i =1, 2, …, k. Let xi = class midpoint = $(a_i + b_i)/2$. Then the Arithmetic mean for such a group data is given by $\bar{x} = \frac{\{\sum_{i=1}^{n} x_i . f_i\}}{n}$, where $n = \sum_{i=1}^{k} f_i$.

**Assumed Mean Method:** This method is used to reduce the computational efforts in computing the arithmetic mean for the group data in which the data values are large. To achieve this, it is assumed that the mean of the data is the midpoint of the middle class, say a. Compute yi = (a – xi) / (Class width) for all i = 1, 2, …, k. Then the Arithmetic mean for such a group data is given by:

$$\bar{x} = a + \bar{y}.(cw) = a + \frac{\{\sum_{i=1}^{k} y_i . f_i\}.cw}{n}, \text{where } n = \sum_{i=1}^{k} f_i.$$

Example 5 Find out the average floor area of the house (arithmetic mean) of a following grouped data :

| | | | | For Assumed Mean Method | |
|---|---|---|---|---|---|
| Class ($a_i - b_i$) Floor area in Sq. ft. | Frequency $f_i$ Nos. of houses | $\left[\frac{a_i + b_i}{2}\right]$ Mid value $x_i$ | $x_i f_i$ | $y_i$ | $y_i f_i$ |
| 100 - 800 | 15 | 450 | 6750 | -3 | -45 |
| 800 - 1500 | 3 | 1150 | 3450 | -2 | -6 |
| 1500 - 2200 | 2 | 1850 | 3700 | -1 | -2 |
| 2200 - 2900 | 2 | 2550 | 5100 | 0 | 0 |
| 2900 - 3600 | 2 | 3250 | 6500 | 1 | 2 |
| 3600 - 4300 | 1 | 3950 | 3950 | 2 | 2 |
| 4300 - 5000 | 0 | 4650 | 0 | 3 | 0 |
| | $\Sigma f_i = 25$ n = 25 | | $\Sigma f_i x_i =$ 29450 | | $\Sigma y_i f_i =$ - 49 |

Average floor area of the house = Arithmetic Mean $\bar{x}$

$$= \frac{\{\sum_{i=1}^{n} x_i . f_i\}}{n} = \frac{29450}{25} = 1{,}178 \text{ sq. ft.}$$

Computing the arithmetic mean for this data by Assumed mean method:

Here, we take assumed mean a = Midpoint of 4th class = 2550.

Class width = 700 and hence $y_i = (x_i - 2550) / 700$, for i = 1, 2, …, 7.

Column 5 and 6 in table gives values of $y_i$'s and $y_i f_i$.

This gives, $\sum_{i=1}^{n} y_i . f_i = -49.$

Hence, $\bar{x} = a + \bar{y}.cw = a + \frac{\{\sum_{i=1}^{k} y_i . f_i\}.cw}{n}.$

$= 2550 + (-49 \text{ X } 700) / 25 = 1178$ sq. ft

- For large number of observations, it's tedious to compute mean.
- Unable to compute the mean for the dataset that has open-ended classes at high or low end of the scale.

e.g. Open ended class like 5.1 and above, 2.1 and less etc.

### 3.5.1 CENTRAL TENDENCY : THE WEIGHTED MEAN

The weighted mean enables us to calculate an average that takes into account the importance of each value to the overall total.

e.g. Labour input in G.I.D.C., Vitthal Udyognagar

| Grade of Labour | Hourly wages in INR | Labour hours per unit Product X |
|---|---|---|
| Unskilled | 50 | 1 |
| Semi-skilled | 100 | 2 |
| Skilled | 150 | 5 |

Arithmetic mean of labour wage

$$= Rs.\left\{\frac{50+100+150}{3}\right\} = \text{Rs. 100 per hour'}$$

But this answer is incorrect.

To get the correct answer, we must take into account that different amounts of each grade of labour.

We should consider, that, how much time each labour has spent. Considering these times 1 hr, 2hr and 5 hr we get

Arithmetic Mean $= \dfrac{(50 \times 1) + (100 \times 2) + (150 \times 5)}{(1+2+5)}$

Average labour cost per unit = Rs.125/- per unit

This type of arithmetic mean is called Weighted arithmetic mean. Note that in this case, data item 50, 100, 150 are assigned the weights 1, 2 and 5.

Thus, the weighted mean $\overline{x_w}$ of the data points $\{x_1, x_2, \ldots, x_n\}$ having corresponding weights (the relative importance of the values of x) $\{w_1, w_2, \ldots, w_n\}$, is given by

$$\overline{x_w} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}.$$

### 3.5.2 CENTRAL TENDENCY : THE GEOMETRIC MEAN

When we are dealing with quantities that change over a period of time, we need to know an average rate of change, such as an average growth rate over a period of several years. In such cases, we need to find is the Geometric Mean (G.M.).

G.M. = $\sqrt[n]{\text{Product of all x values}}$ , where n = No. of x values

Example 6: In very highly inflationary economies, banks must pay high interest rates to attract savings. Suppose let us assume a very unstable and inflationary economy of Iraq, they have decided to pay interest at annual rates of 100, 200, 250, 300 and 400%, which correspond to Growth Factors of 2, 3, 3.5, 4 and 5

| Year | Interest Rate | Growth factor | Saving at the end of the year |
|---|---|---|---|
| 1 | 100% | 2 | $ 1000 x 2 = 2000 |
| 2 | 200% | 3 | 6000 |
| 3 | 250% | 3.5 | 21,000 |
| 4 | 300% | 4.0 | 84,000 |
| 5 | 400% | 5.0 | 4,20,000 |

Suppose initial deposit is $ 1,000. This will grow $ 1000 × 2 × 3 × 3.5× 4 × 5

Arithmetic Growth factor $= \frac{(2+3+3.5+4+5)}{5} = 3.5$

Corresponds to an average interest rate 250%. If the banks actually gave interest at a constant rate of 250% per annum, then $ 1000 would grow to

$ 1000 × 3.5 × 3.5 × 3.5 × 3.5 × 3.5 = $ 5,25,219

This answer will exceed the actual $ 4,20,000 by more than $ 1,05,219.

This is a very big error.

Let's find Geometric Mean for the above case.

G.M. = $\sqrt[5]{\text{Product of all x values}}$

$= \sqrt[5]{2 \times 3 \times 3.5 \times 4 \times 5} = \sqrt[5]{420} = 3.347 \leftarrow$ Average growth factor.

This growth factor corresponds to an average interest rate of (3.347 – 1 = 2.347 ≅ 234.7% per annum). With this growth rate $ 1000 would grow to

$ 1000 × 3.347 × 3.347 × 3.347 × 3.347 × 3.347 = 420028 which is very close to the exact value.

Hence, the appropriate mean in this case is the G.M. which makes significant difference.

### 3.5.3 CENTRAL TENDENCY : HARMONIC MEAN

Harmonic Mean is the reciprocal of the arithmetic mean of the reciprocal of the individual observation. For the ungrouped data { $x_1$, $x_2$, $x_3$, …, $x_n$},

$$\mathrm{H.M.} = \frac{n}{\frac{1}{x_1}+\frac{1}{x_2}+\frac{1}{x_3}+\cdots+\frac{1}{x_3}} = \frac{n}{\sum_{i=1}^{i=n}\left(\frac{1}{x_i}\right)}.$$

For grouped data with discrete distinct data points {$x_1$, $x_2$, $x_3$, …, $x_k$}, with corresponding frequencies {$f_1$, $f_2$, $f_3$, …, $f_k$}, the Harmonic mean is given by

$$\mathrm{H.M.} = \frac{n}{\sum_{i=1}^{i=k}\left(\frac{f_i}{x_i}\right)}, \text{where } n = \sum_{i=1}^{i=k} f_i.$$

For grouped data with continuous data points with k distinct classes having class mid-points {$m_1$, $m_2$, $m_3$, …, $m_k$}, with corresponding frequencies {$f_1$, $f_2$, $f_3$, …, $f_k$}, the Harmonic mean is given by

$$\mathrm{H.M.} = \frac{n}{\sum_{i=1}^{i=k}\left(\frac{f_i}{m_i}\right)}, \text{where } n = \sum_{i=1}^{i=k} f_i.$$

**Example** 7: An automobile driver travels from plain to hill station 100 km distance at an average speed of 30 km per hour. He then makes the return trip at an average speed of 20 kilometer per hour. What is his average speed over the entire distance (200 kilometer)?

Arithmetic Mean = (30 + 20) / 2 = 25 km / hour.

But A.M. is not correct as indicated by the following computations:

| | **Distance** | **Average Speed** | **Time Taken** |
|---|---|---|---|
| Going | 100 kms | 30 kms per hour | 3 hours 20 minutes |
| Returning | 100 kms | 20 kms per hour | 5 hours 00 minutes |
| **Distance** | **200 kms** | | **8 hours 20 minutes** |

Hence, the average speed = 200 / 8.33 = 24 km / hr.

Now, $\mathrm{H.M.} = \frac{2}{\frac{1}{20}+\frac{1}{30}} = \frac{2 \times 60}{5} = 24 \text{ km/hr.}$

Which gives correct average speed.

If distances are same then H.M. is correct 24 kms per hour.

If time is same then Arithmetic mean gives the correct average.

| Speed | Hour | Distance |
|---|---|---|
| 30 kms per hour | 4 | 120 kms |
| 20 kms per hour | 4 | 80 kms |
| | **8** | **200 kms** |

Average speed = $\frac{200}{8}$ = 25 km / hr., which is same as the Arithmetic mean.

### 3.5.4 CENTRAL TENDENCY : THE MEDIAN

The Median is a measure of Central Tendency different from any of the means discussed earlier.

**For ungrouped data:**

The median of a data set is the value in the middle when the data items are arranged in ascending order.

If there is an odd number of items, the median is the value of the middle item.

If there is an even number of items, the median is the average of the values for the middle two items.

Median = $\left(\frac{n+1}{2}\right)^{th}$ item in a data array sorted in the ascending order if number of items n in the array is odd.

Suppose, in a data array, students admitted a valuation programme since last 7 years.

a)

| | | | | | | |
|---|---|---|---|---|---|---|
| 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2003 |
| 13 | 14 | 16 | 17 | 18 | 18 | 19 |

Note that number of data items is odd and data values are already sorted in the ascending order. Hence,

Median = $\left(\frac{n+1}{2}\right)$ = $\frac{8}{2}$ = $4^{th}$ item = 17.

b) No. of completion certificate issued by the Municipal Authority in Anand since last 8 months.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dec'02 | Jan | Feb | March | April | May | June | July'03 |
| 20 | 25 | 28 | 30 | 32 | 35 | 38 | 40 |

Note that here number of data items is 8 which is an even number and data items are sorted in the ascending order. And (n + 1) / 2 = 9 / 2 = 4.5. Hence,

Median = Average of $4^{th}$ and $5^{th}$ data items = (30 + 32) / 2 = 31.

If the raw data is not in sorted order, the data items has to be sorted first and then the above procedure should be applied.

## Median for grouped data

Suppose that the grouped data is organized in the form of following cumulative frequency distribution for data items lying in the interval [a, b].

| Class | frequency | Cumulative frequency |
|---|---|---|
| $a$ - $a_1$ | $f_1$ | $f_1 = C_1$ |
| $a_1$ - $a_2$ | $f_2$ | $f_1 + f_2 = C_2$ |
| $a_2$ - $a_3$ | $f_2$ | $f_1 + f_2 + f_3 = C_3$ |
| - | | |
| - (previous class) | $f_p$ | $C_p$ |
| $a_l$ - $a_u$ (Median class) | $f_m$ | $C_m$ |
| - | | - |
| - | | - |
| $a_n$ - $b$ | $f_{n+1}$ | $f_1 + f_2 + \ldots + f_{n+1} = N$ |

**Median class:** Class in which $\left(\frac{N+1}{2}\right)th$ item lies. That is $C_p < (N + 1) / 2 \leq C_m$,

Where Cp and Cm are cumulative frequencies of previous class (class previous to median class) and median class respectively.

Then the Median = $a_l + \frac{\frac{N}{2} - C_p}{f_m} W$, where

$a_l$ = lower limit of the median class; $a_u$ = upper limit of the median class;

$f_m$ = frequency of the median class;

$W = a_u - a_l$ = class width of the median class.

**Example 8:** Estimate Median from the following group data :

| Area of plot in sq. mt. in TP-1 | Number of plots | Cumulative frequency |
|---|---|---|
| 100 – 105 | 15 | 15 |
| 105 – 110 | 20 | 35 |
| 110 – 115 | 22 | 57 |
| 115 – 120 | 23 | 80 |
| 120 – 125 | 28 | 108 |
| 125 – 130 (Median class) | 30 | 138 |
| 130 – 135 | 35 | 173 |
| 135 – 140 | 45 | 218 |
| | N = 218 | |

Now since $108 < N / 2 = 109 < 138$, the Median class interval is [125, 130].

Hence, in this case, $a_l = 125$; $a_u = 130$; $C_p = 108$, $f_m = 30$ and $W = 130 - 125 = 5$.

Hence, Median = $125 + \left(\frac{109-108}{30}\right) \text{ x } 5$ = 125.167.

### 3.5.5 CENTRAL TENDENCY : MODE

The mode is the value that is repeated most often in the data set. For ungrouped data Mode is the value of the variate for which the frequency is maximum.

Example 9: 1, 2, 3, 4, 5, 5, 5, 5, 6, 7, 8, 8, 8, 9, 9, 10

Here, value 5 is maximum times repeated than any other values.

∴ Mode = 5

If there are two values having maximum frequency then Mode is not an appropriate measure of central tendency.

For a grouped data organized in the following form

| Class | frequency |
|---|---|
| $a$ - $a_1$ | $f_1$ |
| $a_1$ - $a_2$ | $f_2$ |
| $a_2$ - $a_3$ | $f_2$ |
| - | - |
| - (pre-modal class) | $f_{m-1}$ |
| $a_l$ - $a_u$ (Modal class) | $f_m$ |
| - Post-modal class | $f_{m+1}$ |
| - | - |
| $a_n$ - b | $f_{n+1}$ |

Modal class is the class for which the frequency is maximum.

Then the mode for this grouped data is given by:

$$\text{Mode} = a_l + \frac{f_m - f_{m-1}}{2 f_m - f_{m-1} - f_{m+1}} \text{ x } W$$

Where,

$a_l$ = Lower limit of the modal class;

$f_m$ = Frequency of the modal class;

$f_{m-1}$ = Frequency of the class just before the modal (pre-modal) class;

$f_{m+1}$ = Frequency of the class just after the modal (post-modal) class;

W = $a_u$ - $a_l$ = Class width of the modal class.

**Example** 10: Find the modal daily wages of employees in a factory.

| Daily wages in Rs. | Number of workers |
|---|---|
| 100 - 150 | 2 |
| 150 - 200 | 10 = $f_{m-1}$ |
| 200 - 250 (Modal class) | 26 = $f_m$ |
| 250 - 300 | 19 = $f_{m+1}$ |
| 300 - 350 | 11 |
| 350 - 400 | 5 |

$a_l$ = 200; W = class width = 50.

$$\text{Mode} = a_l + \frac{f_m - f_{m-1}}{2f_m - f_{m-1} - f_{m+1}} \text{ x W}$$

$$= 200 + \frac{26 - 10}{52 - 10 - 19} \text{ x } 50$$

= 200 + (16 / 23) × 50 = 234.78

**Example** 11: The summer earnings of a Sardar Patel University students are as under :

| Summer earning in Rs. | No. of students |
|---|---|
| 0 - 500 | 231 |
| | 304 = $f_{m-1}$ |
| 1000 - 1500 (Modal class) | 400 = $f_m$ |
| 1500 - 2000 | 296 = $f_{m+1}$ |
| 2000 - 2500 | 123 |
| 2500 - 3000 | 68 |
| 3000 or more | 23 |

If student aid is restricted to those whose summer earnings were at least 10% lower than the modal summer earnings, how many of the applicants qualify?

a) Modal class = Rs.1,000/- – Rs.1,500/-

b) Hence al = 1000; W = 500. Hence,

$$\text{Mode} = a_l + \frac{f_m - f_{m-1}}{2\,f_m - f_{m-1} - f_{m+1}} \text{ x W} = 1000 + \frac{400-304}{800-304-296} \text{ x } 500$$

= 1000 + (96 / 200) x 500 = 1240.

c) Modal summer earnings = 1240

10% lower than summer earnings = 0.9 × 1240 = 1116

Draw less than Ogive and find out frequency @ 1116 point from the curve :

| | | |
|---|---|---|
| Less than | 0 | 0 |
| Less than | 500 | 231 |
| Less than | 1000 | 535 |
| Less than | 1500 | 935 |
| Less than | 2000 | 1231 |
| Less than | 2500 | 1354 |
| Less than | 3000 | 1422 |

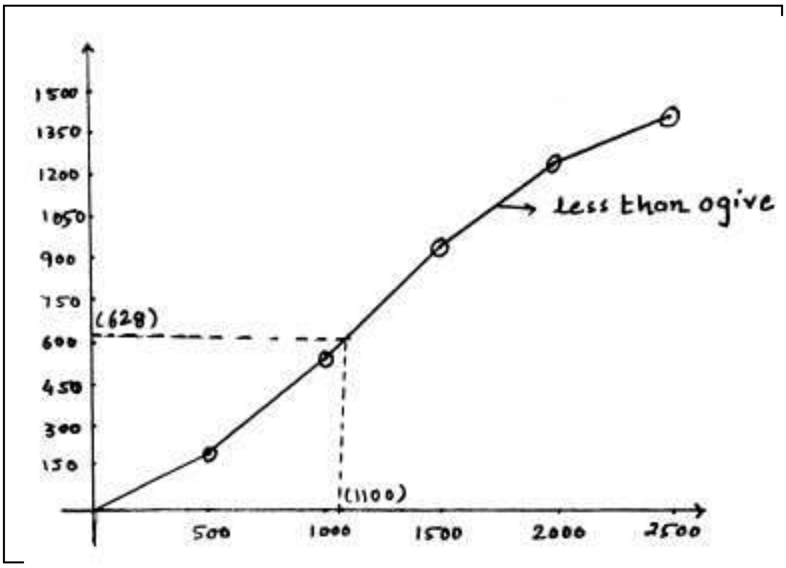
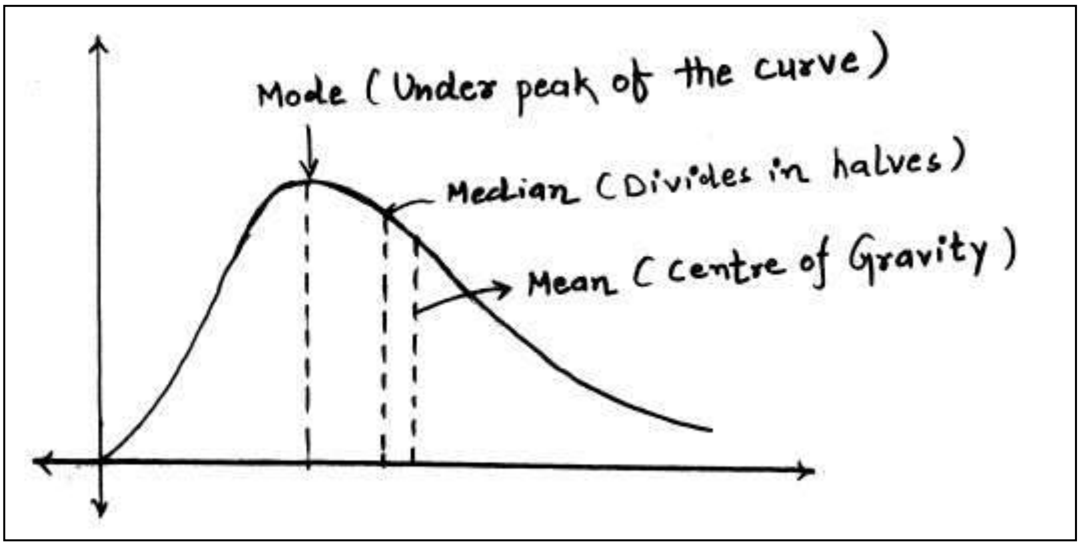



Figure 11: Less than Ogive

Approximately 628 students qualify for students aid.

### 3.5.6 RELATIONSHIP BETWEEN MEAN, MEDIAN AND MODE



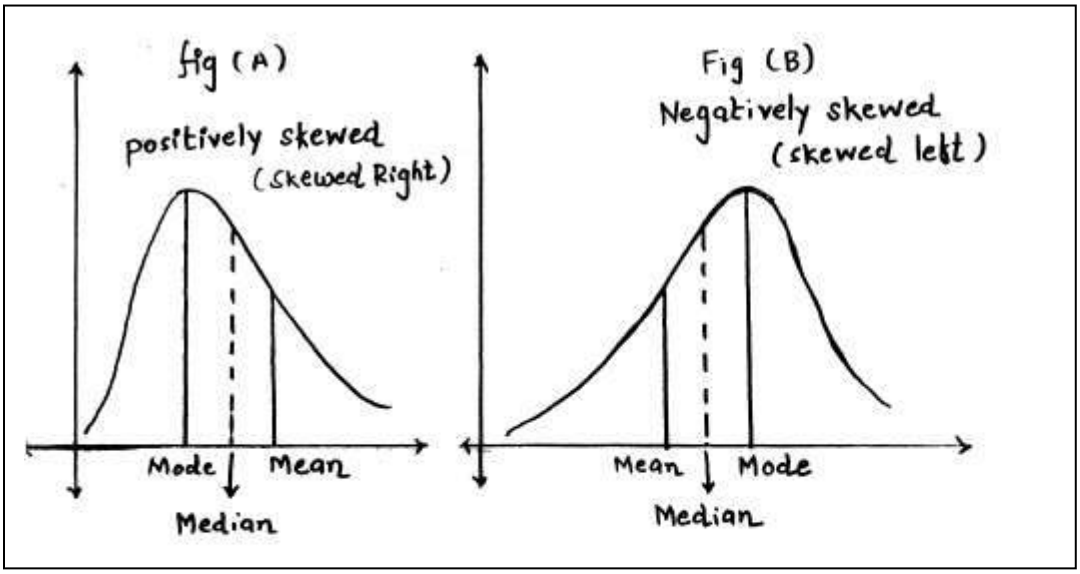




Figure 12: Relative positioning of Mean, Median, and Mode.

Symmetrical distributions have same value for the mean, median and mode.
In a positively skewed distribution (one skewed to the right) as in Figure-A, Mode is the highest point of distribution, the median is to right and mean is right to median and in a negatively skewed distribution mean and median are left to Mode as shown in Figure-B.

**3.5 DISPERSION**

The mean of all three curves is the same, but curve 'A' has less spread (or variability) than curve 'B' which has less spread than curve 'C'. If we measure only the mean of these three distributions, we will miss an important difference among the three curves, likewise for any data, to increase our understanding of the pattern of the data, we must also measure its dispersion – its spread or variability.

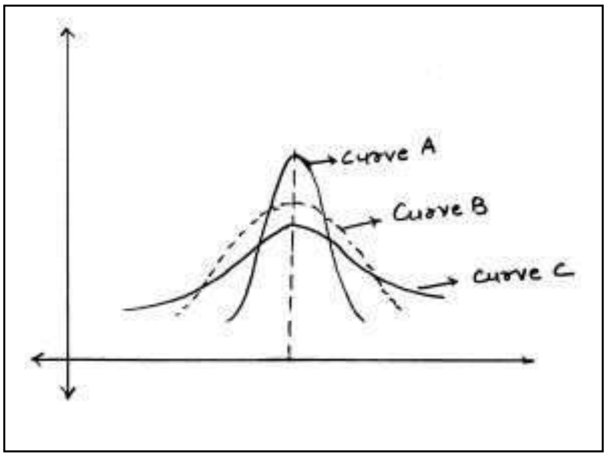



Figure 13: Distributions having same Mean and different dispersions

**Use of dispersion measures**

i. To determine the reliability of an average.
ii. To serve as a basis for the control of the variability means to determine nature and cause of variation in order to control variation itself.
iii. To compare two or more series with regard to their variability.
iv. To facilitate the use of other statistical measures.

## MEASURES OF DISPERSION : RANGE

**3.6.1** The range is the difference between the highest and lowest observed values.

Range = highest observed value - lowest observed value

Example 12:

Annual Selling of books:100 150 135 149 104 103 99 98 164 170 75 151 155 175

Range = 175 - 75 = 100

**Example** 13:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Series 'A' | 56 | 6 | 56 | 56 | 56 | 56 | 6 | 56 |
| Series 'B' | 6 | 10 | 16 | 26 | 36 | 46 | 56 | 56 |
| Series 'C' | 356 | 356 | 345 | 348 | 349 | 350 | 310 | 306 |

Range for Series 'A', 'B', 'C' is same 50 but it does not mean that the distributions are alike, therefore Range is most unreliable guide to the dispersion of the values within a distribution.

Range cannot be computed in case of open-end distribution.

### 3.6.2 MEASURES OF DISPERSION : THE INTERQUARTILE RANGE

Range is based on two extreme items and it fails to take account of the scatter within the range. From this, there is a reason to believe that if the dispersion of the extreme items is discarded, the limited range thus established might be more instructive. For this purpose there has been a developed measure, called the inter-quartile range, the range which includes the middle 50% of the distribution. That is, one-quarter of the observations at the lower end, and another quarter of the observations at the upper end of the distribution are excluded in computing the inter-quartile range.

Inter-quartile range represents the difference between the third quartile and the first quartile.

Inter-quartile range = $Q_3 - Q_1$

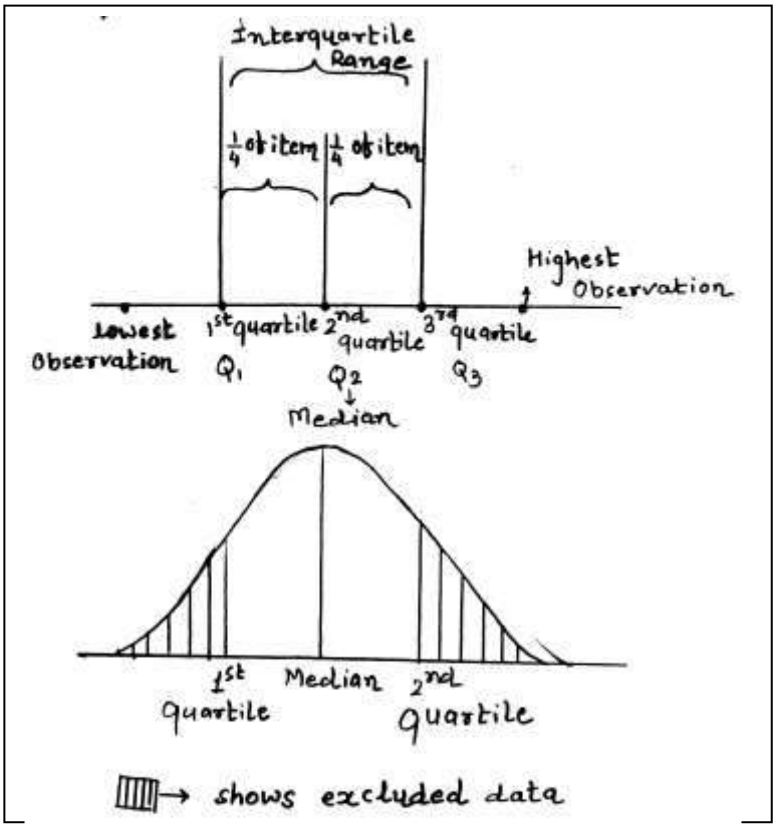



Figure 14: Inter-quartile range

The quartiles divide the area under the distribution into four equal parts, each containing 25% of the area. As shown in the figure, 25% observations have values below Q1 and 75% above Q1. Where as for Q3, 75% observations have values below Q3 and 25% above Q3. The second quartile is the median. The formulae for Q1 and Q3 can be obtained on the same lines as that of the Median.

Width of the four quartiles need not be equal.

### 3.6.3 MEAN DEVIATION FROM MEAN

The Mean Deviation is also known as the average deviation.

It is the `average difference between the items in a distribution and the median or mean of that data.

Consider an ungrouped data with data values $\{x_1, x_2, \ldots, x_n\}$, having mean $\bar{x}$.

Let $d_i = |x_i - \bar{x}|$ = deviation of xi from mean, for I = 1, 2, ..., n

= Absolute value of $(x_i - \bar{X})$ (ignoring + or – signs). Then

Mean Deviation from mean = $\frac{\sum_{i=1}^{n} d_i}{n}$.

For a grouped data with k classes having class mid-points as $\{x_1, x_2, ..., x_k\}$, and frequencies $\{f_1, f_2, ..., f_n\}$, having mean as $\bar{X}$,

Mean Deviation from mean = $\frac{\sum_{i=1}^{n} d_i f_i}{\sum_{i=1}^{n} f_i}$.

Co-efficient of Mean Deviation (C. D.) = (Mean Deviation (MD)) / Mean.

Example 14: Calculate the mean deviation from mean and also co-efficient of mean deviation for following data :

| Sale price (Rs. in lakhs) | Number of Transaction ( fi ) | (Mid-point) xi | xi fi | di | fi di |
|---|---|---|---|---|---|
| 7.5 - 12.5 | 2 | 10 | 20 | 12 | 24 |
| 12.5 - 17.5 | 4 | 15 | 60 | 7 | 28 |
| 17.5 - 22.5 | 6 | 20 | 120 | 2 | 12 |
| 22.5 - 27.5 | 8 | 25 | 200 | 3 | 24 |
| 27.5 - 32.5 | 5 | 30 | 150 | 8 | 40 |
| | $\sum_{i=1}^{5} f_i = 25$ | | $\sum_{i=1}^{5} x_i f_i = 550$ | | $\sum_{i=1}^{5} d_i f_i = 128$ |

Mean $\bar{X} = \frac{\sum_{i=1}^{5} x_i f_i}{\sum_{i=1}^{5} f_i} = \frac{550}{25} = 22$

Mean deviation from Mean $= \frac{\sum_{i=1}^{5} d_i f_i}{\sum_{i=1}^{5} f_i} = \frac{128}{25} = 5.12$

Co-efficient of Mean deviation $= \frac{Mean\ deviation}{Mean} = \frac{5.12}{22} = 0.2327$

Example 15: Calculate mean deviation from Median and Co-efficient of mean Deviation for the data given in above example

| Sale price (Rs. in lakhs) | Number of Transaction ( fi ) | (Mid-point) xi | Cumulative frequency | di | fi di |
|---|---|---|---|---|---|
| 7.5 - 12.5 | 2 | 10 | 2 | 12.8 | 25.6 |
| 12.5 - 17.5 | 4 | 15 | 6 | 7.8 | 31.2 |
| 17.5 - 22.5 | 6 | 20 | 12 | 2.8 | 16.8 |
| 22.5 - 27.5 | 8 | 25 | 20 | 2.2 | 17.6 |
| 27.5 - 32.5 | 5 | 30 | 25 | 7.2 | 36 |
| | $\sum_{i=1}^{5} f_i = 25$ | | | | $\sum_{i=1}^{5} d_i f_i = 127.2$ |

Here N = 25 and N / 2 = 12.5 and hence Median class interval is [22.5, 27.5].

And $f_m = 8$; $f_p = 6$; and class width = 5; Hence,

Median = $a_1 + \frac{\frac{N}{2} - C_p}{f_m} W = 22.5 + \frac{12.5 - 12}{8} \times 5 = 22.5 + 0.3125 \cong 22.8.$

In this case, $d_i = | x_i - \text{Median} |$.

Mean deviation from Median = $\frac{\sum_{i=1}^{5} d_i f_i}{\sum_{i=1}^{5} f_i} = \frac{127.2}{25} = 5.088$

Co-efficient of Mean deviation from Median = $\frac{\textit{Mean deviation from median}}{\textit{Median}}$

$= \frac{5.088}{22.8} = 0.2232$

CVSRTA

### 3.6.4 THE STANDARD DEVIATION AND THE VARIANCE

It is most important and widely used measure of studying dispersion. The standard deviation concept was introduced by Karl Pearson in 1823. Its significance lies in the fact that it is free from those defects from which the earlier methods suffer and satisfies most of the properties of a good measure of dispersion.

Standard deviation is also known as root mean square deviation for the reason that it is the square root of the mean of the squared deviations from the arithmetic mean. The mean of the squared deviations from the arithmetic mean is called the variance.

The standard deviation measures the absolute dispersion (or variability of a distribution). The greater the amount of dispersion or variability, greater the standard deviation, means greater will be the magnitude of the deviations of the values from their mean.

A small standard deviation means a High degree of uniformity of the observation as well as homogeneity of a series.

A large standard deviation means just the opposite.

Thus, if we have two or more comparable series with identical or nearly identical mean, it is the distribution with the smallest standard deviation that has the most representative mean.
Hence, standard deviation is extremely useful in judging the representativeness of the mean.

**Difference between Mean Deviation and Standard Deviation**

Both of the measures of dispersion are based on each and every item of the distribution, but they differ in the following respects :

i. Algebraic signs are ignored while calculating mean deviation whereas in the calculation of standard deviation signs are taken into account. However, the signs become redundant while computing the standard deviation.

ii. Mean deviation can be computed either from median or mean. The standard deviation, on the other hand, is always computed from the arithmetic mean because the sum of the squares of deviation of the items from the arithmetic mean is the least.

### 3.6.5 POPULATION VARIANCE ('$\sigma^2$' SIGMA SQUARED)

If a Population consists of **ungrouped data** with data values {$x_1$, $x_2$, …, $x_N$}, having mean μ, then the population variance ($\sigma^2$) is defined as

$$\sigma^2 = \frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N} = \frac{\sum_{i=1}^{N} x_i^2}{N} - \mu^2.$$

The last equality can be proved mathematically.

"Units in which the variance is expressed cause a problem i.e. units are the squares of the units of the data:

Dollars squared, this is confusing, to rectify this confusion, square root of variance is considered which is standard deviation, we take square root of unit as well as value in standard deviation ($\sigma$), then the unit of $\sigma$ becomes the same as original data".

**Population Standard Deviation** ($\sigma$)

The population standard deviation for the **ungrouped data** as above is the square root of the population variance

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \mu)^2}{N}} = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{N} - \mu^2}.$$

**Example** 16: The rate (Rs. per sq. ft.) which the residential have been sold in a locality are as under : (ungrouped Population)

| | | | | |
|---|---|---|---|---|
| 40 | 140 | 170 | 190 | 220 |
| 60 | 140 | 170 | 210 | 240 |
| 120 | 150 | 180 | 210 | 250 |

Find out the variance and standard deviation of rate of residential plots in rupees per sq. ft.

| Observation<br>($x_i$) | Mean (2)<br>$\mu = \frac{2490}{15}$ | Deviation<br>($x_i - \mu$)<br>(1) − (2) | (Deviation)$^2$<br>$(x_i - \mu)^2$ | (Observation)$^2$<br>$(x_i)^2$ |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| 40 | 166 | – 126 | 15876 | 1600 |
| 60 | 166 | – 106 | 11236 | 3600 |
| 120 | 166 | – 46 | 2116 | 14400 |
| 140 | 166 | – 26 | 676 | 19600 |
| 140 | 166 | – 26 | 676 | 19600 |
| 150 | 166 | – 16 | 256 | 22500 |
| 170 | 166 | 4 | 16 | 28900 |
| 170 | 166 | 4 | 16 | 28900 |
| 180 | 166 | 14 | 196 | 32400 |
| 190 | 166 | 24 | 576 | 36100 |
| 210 | 166 | 44 | 1936 | 44100 |
| 210 | 166 | 44 | 1936 | 44100 |
| 220 | 166 | 54 | 2916 | 48400 |
| 240 | 166 | 74 | 5476 | 57600 |
| 250 | 166 | 84 | 7056 | 62500 |
| $\sum x_i = 2490$ | | | $\sum(x_i - \mu)^2 =$ 50960 | $\sum x_i^2 = 464300$ |

$$\sigma^2 = \frac{\sum_{i=1}^{n}(x_i - \mu)^2}{N} = \frac{50960}{15} = 3397.33$$

Or

$$\sigma^2 = \frac{\sum_{i=1}^{n} x_i^2}{N} - \mu^2 = \frac{464300}{15} - (166)^2 = 30953.33 - 27556 = 3397.33$$

Hence, Standard deviation $\sigma = \sqrt{3397.33}$ = Rs. 58.28 per sq. ft.

- If a population consists of a **grouped data** with k classes having class mid points as {$x_1$, $x_2$, …, $x_k$}, and frequencies {$f_1$, $f_2$, …, $f_k$}, having mean as $\mu$, then the population variance ($\sigma^2$) is defined as

$$\sigma^2 = \frac{\sum_{i=1}^{k} \mathrm{f_i}(x_i - \mu)^2}{N} = \frac{\sum_{i=1}^{k} \mathrm{f_i} {x_i}^2}{N} - \mu^2, \text{where } \mathrm{N} = \sum_{i=1}^{k} \mathrm{f_i}$$

The population **standard deviation** for the **grouped data** as above is the square root of the population variance

$$\sigma = \sqrt{\frac{\sum_{i=1}^{k} \mathrm{f_i}(x_i - \mu)^2}{N}} = \sqrt{\frac{\sum_{i=1}^{k} \mathrm{f_i} {x_i}^2}{N} - \mu^2}.$$

Example 17: Determine the variance and Standard Deviation of area of 100 plots in the Town Planning Scheme No.1 of Anand.

| Class (Sm) Area in Sq.Mt. | Mid point x (1) | Freq. $f_i$ (2) | . $f_i$ . $x_i$ (3) = (1) × (2) | Mean .μ (4) | $x_i$– .μ (1) – (4) | $(x_i – .\mu)^2$ $((1) – (4))^2$ | $f(x_i - \mu)^2$ (2) x $((1) – (4))^2$ | $x_i^2$ | $f_i x_i^2$ |
|---|---|---|---|---|---|---|---|---|---|
| 70 – 80 | 75 | 4 | 300 | 125 | - 50 | 2500 | 10000 | 5625 | 22500 |
| 80 – 90 | 85 | 7 | 595 | 125 | -40 | 1600 | 11200 | 7225 | 50575 |
| 90 -100 | 95 | 8 | 760 | 125 | -30 | 900 | 7200 | 9023 | 72200 |
| 100-110 | 105 | 10 | 1050 | 125 | -20 | 400 | 4000 | 11025 | 110250 |
| 110-120 | 115 | 12 | 1380 | 125 | -10 | 100 | 1200 | 13225 | 158700 |
| 120-130 | 125 | 17 | 2125 | 125 | 0 | 0 | 0 | 15625 | 265625 |
| 130-140 | 135 | 13 | 1755 | 125 | 10 | 100 | 1300 | 18225 | 236925 |
| 140-150 | 145 | 10 | 1450 | 125 | 20 | 400 | 4000 | 21025 | 210250 |
| 150-160 | 155 | 9 | 1395 | 125 | 30 | 900 | 8100 | 24025 | 216225 |
| 160-170 | 165 | 7 | 1155 | 125 | 40 | 1600 | 11200 | 27225 | 190575 |
| 170-180 | 175 | 2 | 350 | 125 | 50 | 2500 | 5000 | 30625 | 61250 |
| 180-190 | 185 | 1 | 185 | 125 | 60 | 3600 | 3600 | 34225 | 34225 |
| | | N=100 | 12500 | | | | 66800 | | 1629300 |

Hence, Mean = $\frac{\sum_{i=1}^{k} f_i x_i}{N}$ =12500 / 100 =125;

$$\sigma^2 = \frac{\sum_{i=1}^{k} f_i (x_i - \mu)^2}{N} = 66800 / 100 = 668;$$

Hence, Standard deviation $\sigma = \sqrt{668} = 25.84$.

## Sample Variance

If the population size is very large then computing measures of central tendency and dispersion is quite time consuming or in some cases data for the entire population may not be available. In such cases population measures are estimated by taking a sample and computing these measures for the sample.

### For Ungrouped data

If a Sample consists of **ungrouped data** with data values $\{x_1, x_2, \ldots, x_n\}$, having mean $\bar{x}$ then

a) If sample size (no. of observations, n) is large relative to the size of the population ( generally n > 30), then we compute sample variance using following formula, which is same as that of population variance ,

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n} = \frac{\sum_{i=1}^{n} {x_i}^2}{n} - \bar{x}^2.$$

b) But, when sample size is sufficiently small relative to the size of the population (n < 30) the above estimate is not good and hence we use formula

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1} = \frac{\sum_{i=1}^{n} {x_i}^2}{n-1} - \frac{n\,\bar{x}^2.}{n-1}$$

### For Grouped data

If a Sample consists of a grouped data with k classes having class mid points as {x1, x2, …, xk}, and frequencies {f1, f2, …, fk}, having mean as $\bar{x}$,, then

(a) If sample size is greater than 30, then sample variance

$$s^2 = \frac{\sum_{i=1}^{k} \mathrm{f_i}(x_i - \bar{x})^2}{N} = \frac{\sum_{i=1}^{k} \mathrm{f_i} {x_i}^2}{N} - \bar{x}^2, \text{where } \mathrm{N} = \sum_{i=1}^{k} \mathrm{f_i}$$

(b) If sample size is less than 30, then sample variance

$$s^2 = \frac{\sum_{i=1}^{k} \mathrm{f_i}(x_i - \bar{x})^2}{N-1} = \frac{\sum_{i=1}^{k} \mathrm{f_i} {x_i}^2}{N-1} - \frac{N\bar{x}^2}{N-1}, \text{where } \mathrm{N} = \sum_{i=1}^{k} \mathrm{f_i}$$

**Sample Standard Deviation**

As in the case of a population standard deviation, sample standard deviation in above four cases is the square root of the sample variance in the respective cases. For example, for sample of small size, consisting of a grouped data as above, the sample standard deviation

$$s = \sqrt{\frac{\sum_{i=1}^{k} f_i (x_i - \bar{x})^2}{N-1}} = \sqrt{\frac{\sum_{i=1}^{k} f_i {x_i}^2}{N-1} - \frac{N\bar{x}^2}{N-1}}, \text{where } N = \sum_{i=1}^{k} f_i$$

Standard score of an item in a sample.

$$\text{Sample standard score} = \frac{x - \bar{x}}{s}$$

x = Observation from the sample

$\bar{x}$ = Sample mean

s = Sample standard deviation

Example 18:

In an attempt to estimate potential future demand, the National Motor Company did a study asking married couples how many cars the average energy-minded family should own in 1998. For each couple, National Motor Company averaged the husband's and wife's responses to get the overall couple response. The answer were then tabulated, and it is as under:

| Number of cars | Frequency |
|---|---|
| 0 | 02 |
| 0.5 | 14 |
| 1.0 | 23 |
| 1.5 | 07 |
| 2.0 | 04 |
| 2.5 | 02 |

a) Calculate the variance and the standard deviation.
b) Since the distribution is roughly bell-shaped, how many of the observations should theoretically fall between 0.5 and 1.5? Between 0 and 2 ? How many actually do fall in those intervals?

Answer :

| No. of Cars – x | Frequency - $(f)$ | fx | $x^2$ | f $x^2$ |
|---|---|---|---|---|
| 0 | 02 | 00 | 0 | 0 |
| 0.5 | 14 | 07 | 0.25 | 3.5 |
| 1.0 | 23 | 23 | 1 | 23 |
| 1.5 | 07 | 10.5 | 2.25 | 15.75 |
| 2.0 | 04 | 08 | 4 | 16 |
| 2.5 | 02 | 05 | 6.25 | 12.50 |
| | ---------- | -------------- | --------------- | --------- |
| | ∑ = 52 | ∑ = 53.5 | ∑ = 13.75 | 70.75 |

$$\bar{x} = \frac{\sum \text{fixi}}{\sum \text{f}} = \frac{53.5}{52} = 1.0288 \text{ cars,}$$

$$S = \sqrt{\frac{\sum \text{fx}^2}{n-1} - \frac{n\,\bar{x}^2}{n-1}} = \sqrt{\frac{70.75}{51} - \frac{52 \times (1.0288)^2}{51}} = \sqrt{1.387 - 1.079} = \sqrt{0.308}$$

= 0.55 cars.

c) (0.5, 1.5) is approximately $\bar{X}$ + s, so about 68% of data, or 0.68 × 52 = 35.36 Observation should fall in this range. In fact, 44 observations fall into this interval.

(0,2) is approximately $\bar{x}$ + 2s, so about 95% of data, or 0.95 × 52 = 49.4 Observation should fall in this range, in fact, 50 Observations fall into this interval.

**Use of the Standard Deviation (S.D.)**

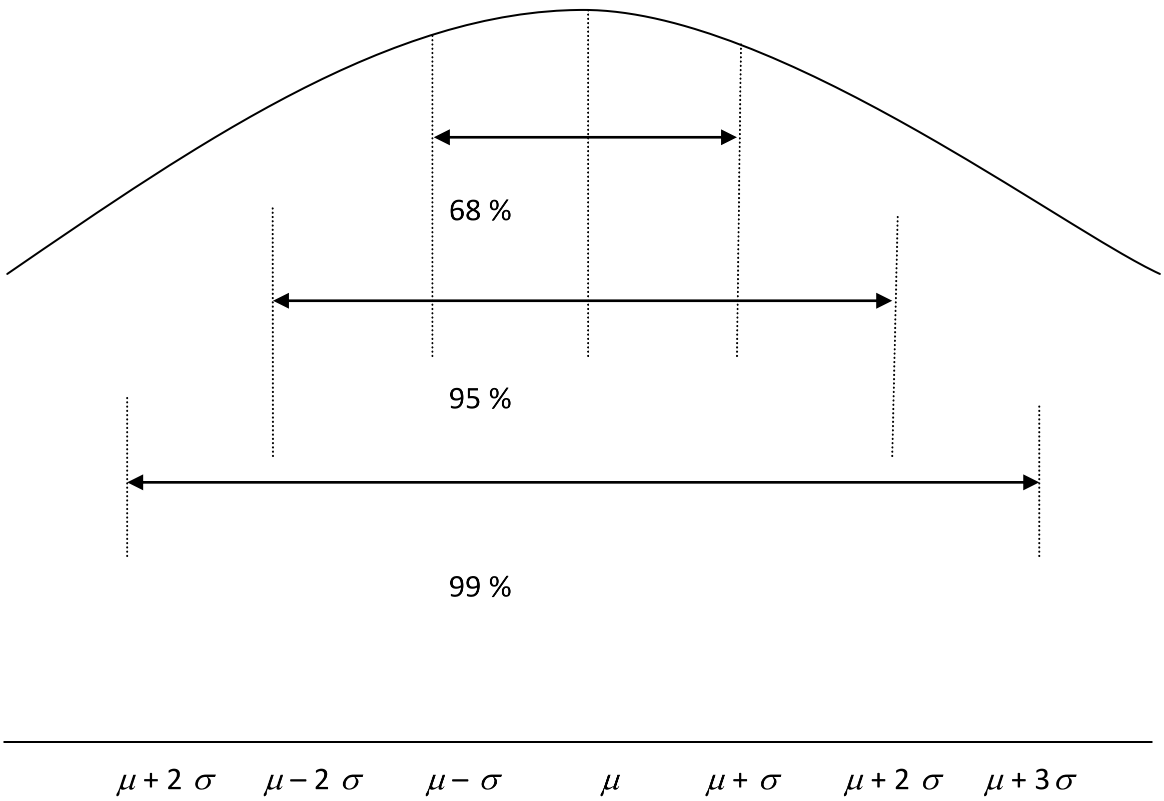



**Figure 15: Number of observations in the given interval**

We can measure with even more precision, the percentage of items that fall within specific ranges in a symmetrical, bell-shaped curve as shown in Figure A.

About 68% of the values in the population will fall within ± one S.D. from the mean.

≅ 95% within ± 2 × S.D. from the mean.

≅ 99% within ± 3 × S.D. from the mean.

If you analyse the above example.

By part (a), Mean = Rs.166/- per sq. ft. and $\sigma$ = Rs.58.28 per sq. ft.

$\mu - 2\sigma$ = 166 - 2 × 58.28 = 166 - 116.56 = 49.44

$\mu + 2\sigma$ = 166 + 2 × 58.28 = 166 + 116.56 = 282.56.

14 values out of 15 values are actually falling within this interval ($\mu - 2\sigma$, $\mu + 2\sigma$)

i.e. 93.33% of items fall in ($\mu - 2\sigma,\ \mu + 2\sigma$) interval, i.e. close to 95% for an interval of Mean $\pm$ 2$\sigma$ of a bell-shaped curve theoretically.

### 3.6.6 Concept of a Standard Score

The S.D. is also useful in describing how far individual items in a distribution depart from the mean of the distribution.

Standard score gives us the number of S.D. a particular observation lies below or above the mean.

Population Standard Score = $\frac{x - \mu}{\sigma}$, Where, x = Observation from the population;

$\mu$ = Population mean; and $\sigma$ = Population standard deviation.

Suppose, we observe a rate of Rs.210/- per sq. ft., the standard score of an observation 210 is

$$\frac{210 - 166}{58.28} = 0.755.$$

The standard score indicates that a rate of Rs.210/- per sq. ft. deviates from the mean by 0.755 times standard deviation.

### 3.6.7 Co-efficient of the Standard Deviation

The standard deviation cannot be the sole basis for comparing two distributions. If we have a standard deviation 10 and mean 5, the values vary by an amount twice as large as the mean itself. On the other hand, if we have a S.D. 10 and a mean 5000, the variation relative to mean is insignificant. Therefore, we can not know the dispersion of a data set until we know the S.D. and the mean both.

What we need is a relative measure that will give us a feel for the magnitude of the deviation relative to the magnitude of the mean. The coefficient of variation is one such relative measure of dispersion. It relates S.D. and mean by expressing the S.D. as a % of mean.

**Coefficient of Variation**

$$\text{Population Coefficient of variation} = \frac{\overbrace{s}^{\text{S.D.}}}{\underbrace{\bar{x}}_{\text{mean}}} \times 100$$

**Example 19:**

In a quality control department, a laboratory technician A completes on average 40 analyses per day with S.D. of 5 and technician B completes on average 160 analyses per day with a S.D. of 15. Which employees shows less variability?

Co-efficient of variation = $\frac{S}{\bar{X}} \times 100$

For A – $\frac{5}{40} \times 100$ = 12.5%

For B – $\frac{15}{160} \times 100$ = 9.4%

Technician B shows less variability.

Example 20: Sachin Tendulkar scores 10,000 test runs with an average 54 and S.D. 9 whereas Brian Lara has scored 8000 test runs with an average 60 and S.D. 18. who is most reliable player?

C.V. of Sachin Tendulkar = $\frac{S}{\bar{X}} \times 100 = \frac{9}{54} \times 100$ = 16.66%.

C.V. of Brian Lara = $\frac{18}{60} \times 100$ = 30.00%.

Sachin Tendulkar is more reliable than Brian Lara.

## 3 SKEWNESS

When a distribution is not symmetrical it is said to be asymmetrical or skewed.
A distribution is said to be ‘skewed’ when the mean and the median fall at different points in the distribution and the balance (or center of gravity) is shifted to one side or the other to left or right.

**Difference between Dispersion and Skewness**:

Dispersion is concerned with the amount of variation rather than with its direction. Skewness tells us about the direction of the variation or the departure from symmetry.

In fact, measure of skewness are dependent upon the amount of dispersion.

### 4.1 Measures of Skewness

Measures of skewness tell us the direction and extent of asymmetry in a series and permit us to compare two or more serie-s with regard to these. They may be either absolute or relative.

Absolute $s_k$ = $\overline{X}$ − Mode

If $\overline{X}$ > Mode, Skewness will be positive

$\overline{X}$ < Mode, Skewness will be negative.

The greater the distance, whether positive or negative, the more asymmetrical the distribution.

Absolute (When skewness is based on quartiles) Sk = $Q_3 + Q_1 - 2$ Median.

The various measures of central tendency and dispersion can be expressed in terms of Statistical Moments which are defined as follows:

For an ungrouped data with data values $\{x_1, x_2, \ldots, x_n\}$, having mean $\bar{X}$, the for any positive integer k, **the k$^{th}$ Moment about origin** is defined as $M_k^o = \frac{\sum_{i=1}^{n} {x_i}^k}{n}$.

The $k^{th}$ **Moment about Mean** is defined as:

$$M_k^m = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^k}{n} \quad or \quad \frac{\sum_{i=1}^{n}(x_i - \bar{x})^k}{n-1},$$

depending on whether the data corresponds to a sample of size significantly small as compared to the size of the population from which the sample is drawn. This definition immediately yields that

a) First moment about origin is the Mean.
b) Second moment about mean is the Variance.

**The Third moment about mean** measures the Skewness of the data, In fact, the Skewness of an ungrouped data as given above is defined as:

Skewness = $\frac{M_3^m}{s^3}$, where s is the standard deviation.

### 4.2 Kurtosis

Kurtosis is the degree of peakedness of a distribution, usually taken relative to a normal distribution.

Kurtosis in Greek means 'Bulginess'. In statistics Kurtosis refers to the degree of flatness or peakedness in the region about the mode of a frequency curve. The degree of Kurtosis of a distribution is measured relative to the peakedness of Normal Curve.

If a curve is more peaked than the normal curve, it is called 'leptokurtic'. In such a case items are more closely bunched around the Mode. On the other hand, if a curve is more flat-topped than the normal curve, it is called 'platykurtic'. The normal curve itself is known as 'mesokurtic'.

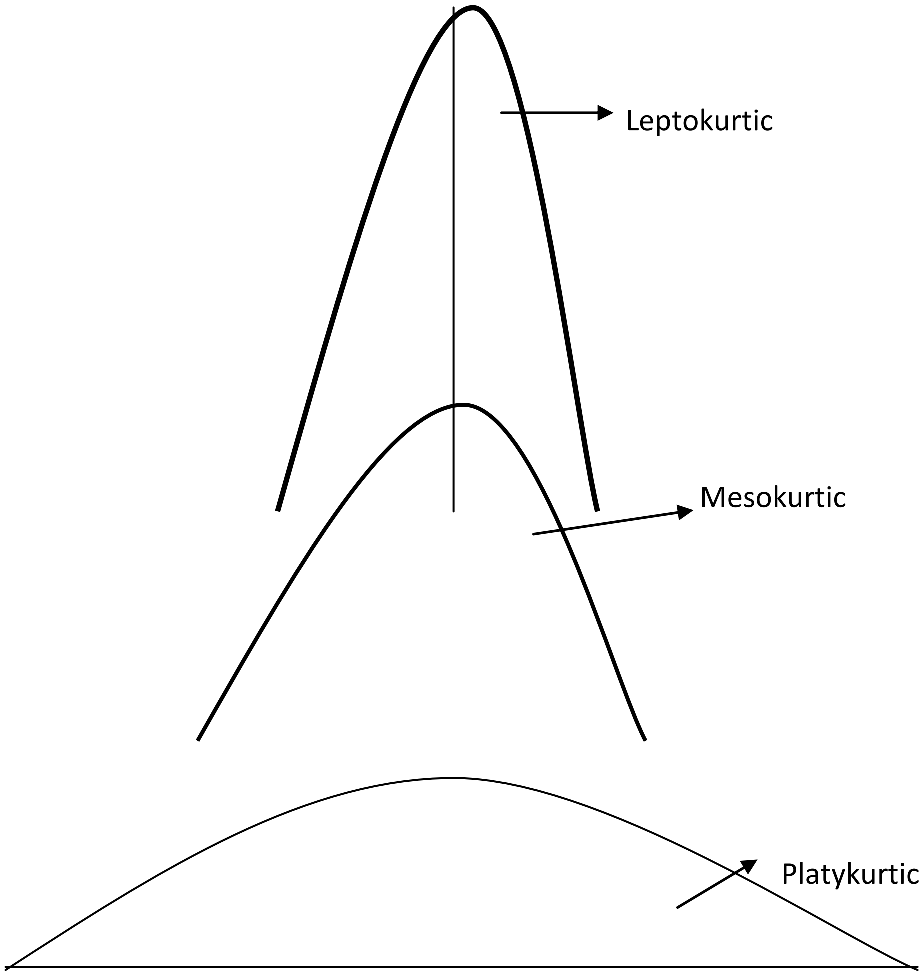



**Figure 16: Kurtosis**

One of the measures of Kurtosis depend on the fourth Moment about Mean and is defined as: Kurtosis = $\frac{M_4^m}{s^4}$, where s is the standard deviation.

### 4.3.1 Exercises

1. Comfy Furniture Company has a revolving credit agreement with the UTI Bank. The loan showed the following ending monthly balances last year in Rs. :

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jan. | 121,300 | Apr. | 72,800 | July | 58,700 | Oct | 52,800 |
| Feb. | 112,300 | May | 72,800 | Aug. | 61,100 | Nov | 49,200 |
| Mar. | 72,800 | June | 57,300 | Sept. | 50,400 | Dec | 46,100 |

The company is eligible for a reduced rate of interest if its average monthly balance is over Rs.65,000. Does it quality?

2. DB's Store advertises, "If our average prices are not equal or lower than everyone else's, you get it free." One of DB's customers came into the store one day and threw on the counter bills of sale for six items she bought from a competitor for an average price less than DB's.
   The items cost in Rs.

   1.29 2.97 3.49 5.00 7.50 10.95

   DB's prices for the same six items are Rs.1.35, Rs.2.89, Rs.3.19, Rs.4.98, Rs.7.59, and Rs.11.50. DB told the customer, "My and refers to a weighted average price of these items. Our average is lower because our sales of these items have been."

   7 9 12 8 6 3

   Is DB getting himself into or out of trouble by talking about weighted averages?

3. Ajanta Distribution Company, a subsidiary of a major appliance manufacturer, is forecasting, regional sales for next year. The Ahmedabad, with current yearly sales of Rs.193.8 million, is expected to achieve a sales growth of 7.25 percent; the Vadodara branch, with current sales of Rs.79.3 million, is expected to grow by 8.20 percent; and the Anand branch, with sales of Rs.57.5 million, is expected to increase sales by 7.15 percent. What is the average rate of sales growth forecasted for next year?

4. The growth in bad-debt expense for Desktop Office Supply Company over the last few years is as follows. Calculate the average percentage increase in bad-debt expense over this time period. If this rate continues, estimate the percentage increase in bad debts for 1997, relative to 1995.

| 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|
| 0.11 | 0.09 | 0.075 | 0.08 | 0.095 | 0.108 | 0.120 |

5. rat ---??(Pl Check) Marketing compares prices charged for identical items in all of its food stores. Here are the prices charged by each store for a pound of salt last week:

Rs.1.08 0.98 1.09 1.24 1.33 1.14 1.55 1.08 1.22 1.05

a) Calculate the median price per pound.
b) Calculate the mean price per pound.
c) Which value is the better measure of the central tendency of these data?

6. For the following frequency distribution determine

(a) The median class.
(b) The number of the item that represents the median.
(c) The width of the equal steps in the median class.
(d) The estimated value of the median for these data.

| Class | Frequency | Class | Frequency |
|---|---|---|---|
| 100 – 149.5 | 12 | 300 – 349.5 | 72 |
| 150 – 199.5 | 14 | 350 – 399.5 | 63 |
| 200 – 249.5 | 27 | 400 – 449.5 | 36 |
| 250 – 299.5 | 58 | 450 – 499.5 | 18 |

7. Here are the ages in years of the cars worked on by the Autocare Workshop last:

5 6 3 6 11 7 9 10 2 4 10 6 2 1 5

a) Compute the mode for this data set.
b) Compute the mean of the data set.
c) Compare parts (a) and (b) and comment on which is the better measure of the central tendency of the data.

8. The age of a sample of the students attending, Veer Narmad Community College this semester are:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 19 | 17 | 15 | 20 | 23 | 41 | 33 | 21 | 18 | 20 |
| 18 | 33 | 32 | 29 | 24 | 19 | 18 | 20 | 17 | 22 |
| 55 | 19 | 22 | 25 | 28 | 30 | 44 | 19 | 20 | 39 |

a) Construct a frequency distribution with intervals 15-19, 20-24, 25-29, 30-34, and 35 and older.

b) Estimate the modal value

c) Now compute the mean of the raw data.

d) Compare your answers in parts (b) and (c) and comment on which of the two is the better measure of the central tendency of these data and why.

9. Here are student scores on a Principles of Valuation quiz. Find the 80$^{th}$ percentile.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 95 | 81 | 59 | 68 | 100 | 92 | 75 | 67 | 85 | 79 |
| 71 | 88 | 100 | 94 | 87 | 65 | 93 | 72 | 83 | 91 |

10. The IPCL Company is considering purchasing a new fleet of company cars. The financial department's director, Mr. Bharat Parikh, sampled 40 employees to determine the number of miles each drove over a 1-yearperiod. The results of the study are as follow. Calculate the range and interquartile range.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3,600 | 4,200 | 4,700 | 4,900 | 5,300 | 5,700 | 6,700 | 7,300 |
| 7,700 | 8,100 | 8,300 | 8,400 | 8,700 | 8,700 | 8,900 | 9,300 |
| 9,500 | 9,500 | 9,700 | 10,000 | 10,300 | 10,500 | 10,700 | 10,800 |
| 11,000 | 11,300 | 11,300 | 11,800 | 12,100 | 12,700 | 12,900 | 13,100 |
| 13,500 | 13,800 | 14,600 | 14,900 | 16,300 | 17,200 | 18,500 | 20,300 |

11. The ABCL, Ltd., a Bollywood casting company, is selecting a group of extras for a movie. The ages of the first 20 men to be interviewed are

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 50 | 56 | 55 | 49 | 52 | 57 | 56 | 57 | 56 | 59 |
| 54 | 55 | 61 | 60 | 51 | 59 | 62 | 52 | 54 | 49 |

The director of the movie wants men whose ages are fairly tightly grouped around 55 years. Being a statistical buff of sorts, the director suggests that a standard deviation of 3 years would be acceptable. Does this group of extras qualify?

12. Bharat Electronics is considering employing, one of two training programs. Two groups were trained for the same task. Group 1 was trained by program A; group 2, by program B. For the first group, the times required to train the employees had an average of 32.11 hours and a variance of 68.09. In the second group, the average was 19.75 hours and the variance was 71.14. Which training program has less relative variability in its performance?

# UNIT – 3

## ELEMENTARY THEORY OF PROBABILITY AND PROBABILITY DISTRIBUTIONS, SAMPLING AND SAMPLING DISTRIBUTIONS, ESTIMATION

### 5. ELEMENTARY THEORY OF PROBABILITY

Suppose MGVCL is starting a project designed to increase the generating capacity of one of its Power plants in Gujarat. The project is divided into two sequential stages: stage-1 (design) and stage-2 (Construction). The management has to estimate the time required to complete each stage of the project depending on analysis of similar construction projects. Or if management set a goal of 1year for completion of the entire project, then one has to find the chances of completion of the project within the given time limit.

Probability theory plays a central role in dealing with problems involving such uncertainties.

As other illustrations, one would like to know the chances that a property will be sold at a price higher than the value fixed by the valuator?

Probability is a numerical measure of the likelihood that an event will occur or measure of the degree of uncertainty associated with an event.

A probability is a number which ranges from 0 (zero) to 1 (one) ( in percentage 0% to 100%).
Assigning a probability of 'zero' means that something will happen, is unlikely and a probability of 1 indicates that something will almost certainly happen.

### 5.1 Experiments and Sample space

One of the approaches to define probability is the experimental approach, which is based on Experiments and their outcomes.

In probability theory, an event is one or more of the possible outcomes of doing something e.g. if we toss a coin, getting tail or head are events.

An Experiment is a process that generates well-defined outcomes. On any single repetition of an experiment, one and only one of the possible outcomes will occur. The Sample space for an experiment is the set of all experimental outcomes which are also called as Sample points. The following table gives few illustrations of some experiments and corresponding sample spaces:

| **Experiments** | **Sample Space** |
|---|---|
| Toss a Coin | { Head, Tail } |
| Roll a Die and observe a number on the Top face | { 1, 2, 3, 4, 5, 6 } |
| Select a part for inspection | { defective, non-defective } |
| Play a cricket match and note the result for your Team | { win, Lose, Tie } |
| Toss two coins | { (H, H), (H, T), (T, H), (T, T) } |
| Measure the height of any student in your class | Set of numbers representing Heights of the students. |

**5.2 Assigning Probabilities**

Once all experimental outcomes (Sample space) are known, next task is to assign probability to each outcome (Sample point). When the Sample space is finite, this task can be done using one of the following three approaches.

- Classical
- Relative frequency
- Subjective method.

Whatever approach is used there are two basic requirements for assigning probabilities.

If the Sample space for an experiment is S = { e1, e2, ……, en} and if P(ei) is the probability assigned to the outcome ei then the requirements are:

(i) $0 \leq P(ei) \leq 1$ for all i. (ii) $P(e1) + P(e2) + \text{-----} + P(en) = 1$

**Classical Approach**

This method is used when all the outcomes are equally likely and hence probability assigned to each outcome must be same. Thus if the Sample space is S = { e1, e2, ……, en} , then P(ei) = 1/n, for all .

illustrations: 1.Tossing a fair coin experiment. Then S = { H, T } and P(H) = P(T) = ½.

2. Rolling a fair die experiment. Then S = {1, 2, 3, 4, 5, 6} and P(1) = P(2) = P(3) = P(4) = P(5) = P(6) = 1/6.

**Relative Frequency Method**

This method is used when data are available to estimate the proportion of times the experimental outcome will occur if the experiment is repeated large number of times.
Thus if the sample space is S = { e1, e2, ……, en}, then

$$P(ei) = \frac{Number\ of\ times\ ei\ occurs\ as\ per\ data}{Total\ number\ of\ times\ the\ experiment\ is\ repeated} = Relative\ frequency\ of\ ei.$$

Illustration: A toothpaste manufacturing company is studying five different package designs. In an actual experiment, 100 consumers were asked to pick up the design they preferred. The following data were obtained. Assign probability of preference to each of the five designs.

| Design | No. of times preferred | Probability of preference |
|---|---|---|
| 1 | 5 | 5 /100 = 0.05 |
| 2 | 15 | 15 / 100 = 0.15 |
| 3 | 30 | 0.3 |
| 4 | 40 | 0.4 |
| 5 | 10 | 0.1 |

**Subjective method**

This method is used when experimental outcomes cannot be judged to be equally likely and little relevant data is available. Hence any other information available, such as previous experience or intuition, can be used to assign the probability. Thus,

P(ei) = degree of belief (on a scale from 0 to 1), on the bases of the available information, that ei will occur.

It is subjective and depends on the person who is assigning the probability. Different persons may assign different probabilities to the same outcome.

Illustrations: 1. Whether it will rain on a cloudy day?

Two outcomes are possible { Yes, No }. Relevant data may or may not be available. A well experienced person in the region can predict the chances of rain which in turn will assign probabilities to these outcomes.

2. Whether a particular Stock will rise tomorrow?
Possible outcomes are { rise, fall, will not change}. An experienced player in the stock market can predict probabilities of all these outcomes.

**5.3 Event and their Probabilities**

Corresponding to any experiment, any subset of the Sample space is called an Event. Or Event is a collection of some Sample points

Illustrations: 1. Experiment: “Tossing of two coins”.

Event E1: Getting at least one head = { (H, H), (H, T), (T, H) }.

2. Experiment: “Roll a Die”

Event E2: Getting an even number on Top = { 2, 4, 6 }

**Probability of an event**

It is equal to the sum of probabilities of the Sample points in the event.

Note that for any experiment, the Sample space S and empty set ϕ is itself an event and P(S) = 1 & P(ϕ) = 0. For illustrations 1 and 2 above the probabilities are given by:

1. P(E1) = P((H, H)) + P((H, T)) + P((T, H)) = ¼ + ¼ + ¼ = ¾.

2. P(E2) = P(2) + P(4) + P(6) = 1/6 +1/6 + 1/6 = ½

3. Consider the experiment in the Relative Frequency illustration. Suppose event

E3 = {Design-2, Design-3}. Then P(E3) = P(2) + P(3) = 0.15 + 0.3 = 0.45.

## 5.4 Basic laws of probability:

**Complement of an Event:**

Suppose a sample space of an experiment is S and A is an event (i. e. A is a subset of S). Then Complement event of A, denoted by $A^c$ is the subset of S that contains all the sample points of S which are not in A. In any probability application, either event A or its complement $A^c$ must occur. Hence P(A) + $P(A^c) = 1$ or $P(A^c) = 1 – P(A)$

illustration: Consider Experiment: "Roll a Die"

Event A = Getting an even number on Top = { 2, 4, 6 }. Then P(A) = ½
Now, $A^c$ = Getting an odd number on Top = { 1, 3, 5 }. Then Clearly,

$P(A^c)$ = 3/6 = ½ = 1 – ½ = 1 – P(A).

**Union of two events**

Union of two events A and B is the event containing sample points that belong to A or B or both and is denoted by A U B.

**Intersection of two events**

Intersection of two events A and B: It is the event containing the sample points belonging to both A and B and is denoted by A  B.

1. **Law of Addition**

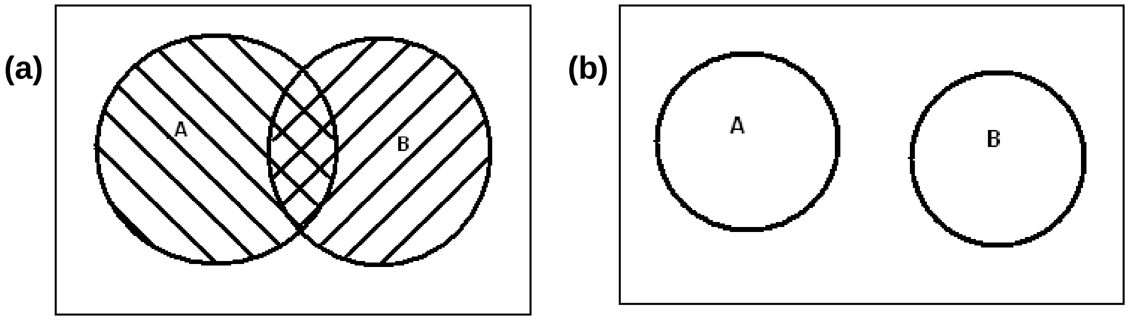



**Figure 1: (a) Union and intersection of events (b) Mutually exclusive events**

P(A U B) = P(A) + P(B) – P(A  B)

Event (A⋂B) is contained in both A and B as well as in A U B. In order to calculate P(AUB) when we add P(A) and P(B), P(A  B) is added twice and hence we subtract once.

**illustration:** In a small Assembly plant with 50 workers, each worker is expected to complete work assignment on time in such a way that the assembled product will pass a final inspection. Some of the workers fail to meet the performance standards by completing work late or assembling a defective product. At the end of the performance evaluation period, production manager found that 5 workers completed work late, 6 workers assembled a defective product and 2 workers both completed work late, and assembled a defective product. What is the probability that the production manager decided to assign a worker a poor performance rating?

Event A = A Worker completed work late.
Event B = A worker assembled a defective product.
Event C = worker is assigned a poor performance rating by the production manager.
Clearly C = A U B. From given data,
P(A) = 5 / 50 = 0.1;  P(B) = 6 / 50 = 0.12  and  P( A ⋂B) = 2 / 50 = 0.04.

Therefore by Addition law,

P( C) = P (A U B) = P(A) + P(B) – P( A $\cap$B) = 0.1 + 0.12 – 0.04 = 0.18

**Mutually exclusive events**

Two events A and B are said to be Mutually exclusive if there is no sample point common to both A and B, i. e. A B = ϕ and hence P(A B) = 0. Hence the Addition law for Mutually exclusive events reduces to: P(A U B) = P(A) + P(B).

illustration: Consider Experiment: "Roll a Die"

Event A = Getting an even number on Top = { 2, 4, 6 }. Then P(A) = ½

Event B = Getting a number which is a multiple of 3 on Top = {3, 6 }. Then Clearly,

P(B) = 2/6 = 1/3. Then A ∩ B = {6} ≠ ϕ. Hence, A and B are not mutually exclusive.
Let event C = Getting a number which is divisible by 5. Then A ∩ C = ϕ and hence, A and C are mutually exclusive. Observe that A U C = {2, 4, 5, 6} Hence,

P(A U C) = 4/6 = 2/3 = 1/2 + 1/6 = P(A) + P(C).

## A collectively exhaustive list

When a list of the possible events that can result from an experiment includes every possible outcome, the list is said to be collectively exhaustive.
Illustration: Consider the experiment: Tossing of two coins. Let A = Getting at least one head and B = Getting at least one Tail. Then A = {HH, HT, TH} and B = {HT, TH, TT}. Then A U B = {HH, HT. TH. TT} = S. And hence events A and B are collectively exhaustive.

Here are few Examples.

**Example 1:**

Find out the probability of getting an ace in a single trial

$$P = \frac{4\, ace}{52} = \frac{4}{52}$$

**Example 2:**

Find out the probability of getting 53 Sundays in a leap year (366 days)

52 weeks × 7 = 364 days

Remaining 2 days and probability of being Sunday on these 2 days is $\frac{2}{7}$ = 0.286.

**Example 3:**

Find out the probability of getting 5 Sundays in a February month in a leap year (i.e. 29 days in February in a leap year)

4 week: 4 × 7 = 28 days

The probability of remaining one day is Sunday = $\frac{1}{7}$ = 0.143

**Example 4:**

Find out the probability of getting a sum of 9 on the top of two dice thrown together. Also find out the probability of getting a sum of 8 on the top of two dice thrown together.

A = Outcomes giving sum 9 are: {(6, 3), (3, 6), (5, 4), (4, 5)};

B = Outcomes giving sum 8 are: {(6, 2), (2, 6), (5, 3), (3, 5), (4, 4)}

Total outcomes = 36.

Hence P(A) = 4 / 36 = 1 / 9 = 0.111; and P(B) = 5 / 36 = 0.139.

## 6 PROBABILITY DISTRIBUTIONS

In an experimental approach probability assignment depends on the specific experiment and its Sample space. However, the concept of Random variable helps us to view Sample space of any experiment as well as any event associated with the experiment as a subset of set of all real numbers R.

**Discrete and Continuous random variables.**

Random variable is a Numerical description of the outcome of an experiment or it associates a numerical value with each possible experimental outcome. Thus, For an experiment with Sample space S, a random variable X is a function from S to R, the set of all real numbers and we write X: S R.

- A random variable that assumes either a finite or countably infinite number of values is called a Discrete Random variable (DRV).

e.g. (i) The month in which a person is born' is a DRV which takes values 1, 2, .., 12.

(ii) No. of persons working in an industry is a DRV which may take any positive integer value.

(iii) Number of customers arriving at the service counter is a DRV which may take any non-negative integer value.

- A random variable that assumes any numerical value in an interval or collection of intervals is called a Continuous Random variable.

  e..g. (i) Pressure or temperature of steam in the boiler.

  (ii) Time in minutes between two successive customers arriving at a service counter can take any real value $x \geq 0$.

  (iii) Percentage of the Statistical methods course completed in 10 lectures is a continuous random variable taking any value x between 0 and 100.

**Probability Distribution**

If S is a sample space and X is a random variable the probability assignment can be done by assigning probabilities to subsets of X(S) R. A Probability Distribution for a random variable describes how probabilities are distributed over the values of the random variable.

The distribution of discrete (continuous) random variable is called discrete (continuous) distribution.

**Example 5:** Suppose, in a clinic, the number of patients have been treated during last 100 days are recorded as under:

| No. of patients treated: | 100 | 105 | 110 | 112 | 115 | Total Observations |
|---|---|---|---|---|---|---|
| Nos. of days: | 10 | 20 | 40 | 20 | 10 | 100 |

Probability distribution and its graph for the discrete random variable 'Number of patients treated'

| Number of patient treated (Value of random variable) | Probability that the random variable will take on this value |
|---|---|
| 100 | 0.1 |
| 105 | 0.2 |
| 110 | 0.4 |
| 112 | 0.2 |
| 115 | 0.1 |

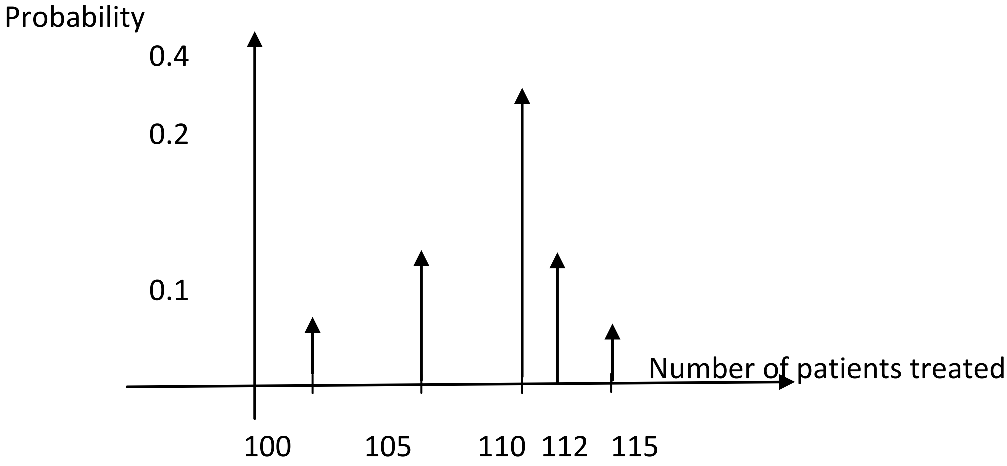



**Figure 2: Graph of PD**

For a Discrete Random variable X over a sample space S, X(S) is either finite or an infinite sequence of real numbers. Thus, X(S) = {x1, x2, … , xn} or {x1, x2, ….}. Equivalently, we may say that X(S) = {1, 2, …. ,n} or X(S) = { 1, 2, …, n, ....}.

Discrete probability distribution on X(S) is defined by a function f: $X(S) \longrightarrow R$, which is called as Probability (mass) function which provides the probability f(xi) for each xi in X(S), so that f(xi) $\geq$ 0 for all i & $\sum_i f(xi) = 1$

Any event associated with a discrete random variable X on a sample space S can be viewed as a subset of X(S). And hence, in the Discrete case an event E = {$x_{i1}$, $x_{i2}$, . , $x_{ik}$} where i1, i2, … are positive integers, so that $x_{i1}$, $x_{i2}$ … all are in X(S). Then

P(E) = f($x_{i1}$) + f($x_{i2}$) + …. + f($x_{ik}$), where f is Probability mass function (Pmf).

Example 6: The following data were collected by counting the number of operating rooms in use at Sayaji general Hospital in the month of jun, 2010.

| No. of operating rooms in use | 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|
| No. of days. (frequency) | 6 | 7 | 10 | 7 | 30 |

a. Construct a PD for the number of operating rooms in use on any given day.
b. Show that the PD is a valid DPD.
c. Find the probability that on a given day, 2 or more rooms are in use.

Answer: (a) We can find Probability distribution by relative frequency method:

| No. of operating rooms in use | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Relative frequency (Probability) | 6/30= 0.2 | 7/30= 0.234 | 10/30=0.333 | 7/30= 0.233 |

(b) Since P(i) > 0, for I = 1, 2, 3, 4 and P(1) + P(2) + P(3) + P(4) = 1, this is a valid Probability distribution.

(c) P(2 or more rooms in use) = P({2, 3, 4}) = P(2) + P(3) + P(4) = 0.8.

**Distribution for a continuous random variable:**

Let 'X' be a continuous random variable defined over an interval (a, b) i.e. $a \le x \le b$, or $(-\infty, \infty)$ then probability density function of the random variable X is defined by f(x) satisfying the conditions.

(i) $f(x) \ge 0$ for any $a \le x \le b$ or $-\infty < x < \infty$

(ii) $\int_a^b f(x)dx = 1 \; or \; \int_{-\infty}^{\infty} f(x)dx = 1$

Probability density function f(x) does not directly give probabilities. However, the area under the graph of f(x) corresponding to a given interval gives the probability that CRV assumes a value in that interval.

Probability of any particular value of CRV must be zero. Since area under the graph of f(x) at any particular point is 0.

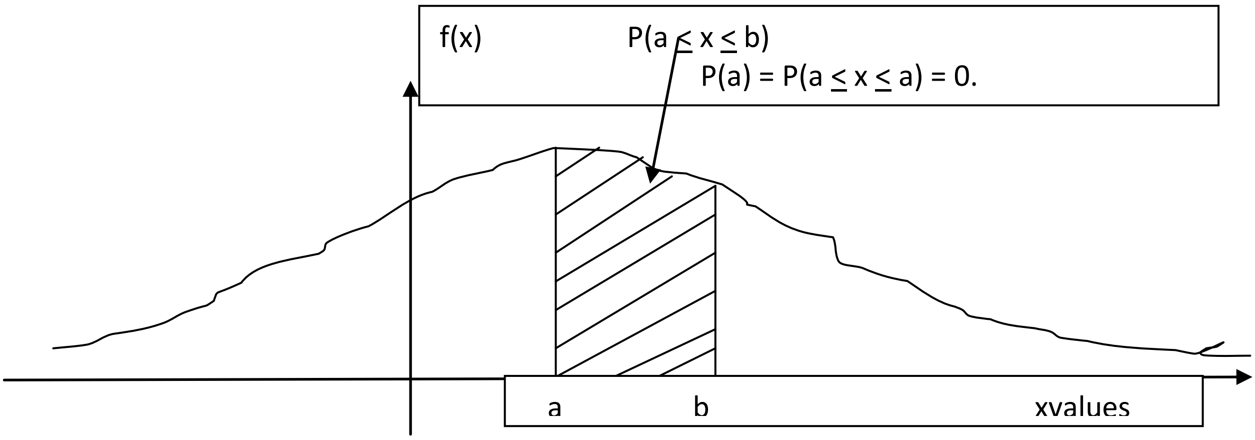



**Figure 3: PDF of CRV**

**Some well known Probability Distributions:**

In probability theory there are many theoretical Probability Distributions which are suitable for random variables associated with some specific experiments. In Statistical inference these distributions play a central role. Most commonly used distributions are discussed below.

**The Binomial Distribution**

The Binomial Distribution is the widely used probability distribution of a discrete random variable.

BPD is associated with a Binomial experiment having following Properties:

- It consists of a sequence of n identical trials.
- Two outcomes are possible on each trial. One of these outcomes is referred as Success and other as Failure.
- The probability of success, denoted by p (Consequently the probability of failure, (1- p) does not change from trial to trial.
- The trials are independent.

If properties 2, 3, 4 are present, we say that trials are generated by a Bernoulli Process. For a Binomial experiment, let x be a Discrete Random variable denoting number of successes in n trials. The PD associated with this Random variable is called the Binomial Probability Distribution.

Now, from combination formula, the number of outcomes providing exactly x successes in n trials is given by: $C_x^n = \frac{n!}{x!(n-x)!}$

Also, Probability of a particular sequence of n trials with x successes = $p^x (1- p)^{(n-x)}$

For a binomial experiment with n trials, the random variable x will take values 0,1, 2, …, n. Then from previous discussion it is clear that the BPD is given by the Binomial probability mass function f, given by

$$f(x) = C_x^n \, p^x (1-p)^{(n-x)}, \quad for\ x = 0,1,\dots,n.$$

Where, n = number of trials and

p = Probability of success are called the parameters of the BPD and will assume particular values in any illustration.

Example 7: Forty percent of business travelers carry either a cell phone or a Laptop. For a sample of 15 business travelers, If x = number of travelers carrying either a cell phone or a Laptop, Compute the Probability that

(a) x = 3 (b) x is at least 3. (c) 12 of the travelers carry neither a cell phone nor a Laptop.

Answer: Here, the experiment can be regarded as a Binomial experiment with n = 15 and p = 0.4.

(a) P( x = 3) = f(3) =
=((15x14x13)/(2x3))$(0.4)^3(0.6)^{12}$ = 0.063

(b) P ( x $\geq$ 3) = f(3) + f(4) +..+f(12) = 1- f(0) - f(1) – f(2)
= 1– $(0.6)^{15}$ – 15(0.4)$(0.6)^{14}$ – (15x14/2)$(0.4)^2(0.6)^{13}$ = 0.973

(c) P(12 of the travelers carry neither a cell phone nor a Laptop) = P(x = 3) = 0.063.

Computing Binomial probabilities P(x) for any value of x (between 0 and n), for given n and p is usually time consuming and difficult. To avoid these difficulties, the readymade tables giving P(x) for various values of parameters n and p and for all possible values of x for a specific values of n and p are available. Following is the sample of such a table:

| n | x p | 0.05 | 0.15 | 0.25 | 0.40 |
|---|---|---|---|---|---|
| 9 | 0 | 0.6302 | 0.2316 | 0.0751 | 0.101 |
| | 5 | 0.0000 | 0.0050 | 0.0389 | 0.1672 |
| | 9 | 0.0000 | 0.0000 | 0.0000 | 0.0003 |
| 10 | 7 | 0.0000 | 0.0001 | 0.0031 | 0.0425 |
| | 10 | 0.0000 | 0.0000 | 0.0000 | 0.0001 |

We may use these tables for computing P(x).

For example if n = 10 and p = 0.15, P(7) = 0.0001

For n = 9, p = 0.4, P(5) = 0.1672.

For n = 9, p = 0.25, f(5) = ?; For n = 10, p = 0.4, f(7) = ?

Software packages like EXCEL, SPSS, SAS, MINITAB, also provide a capability to compute Binomial probabilities.

**The Poisson Distribution**

Consider the Discrete Random Variable x representing number of occurrences of an event over a specified interval of time or space. For example,

The arrivals of trucks and cars at a toll booth; number of customers arriving at a service counter in a day;

- Number of cars on express way between Vadodara and Ahmedabad at 9 am;
- Number of leaks in 100 miles of pipeline, etc., In each of these cases the values x can take are 0,1, 2,. .

Such experiments are called Poisson experiments and their Probabilities are described by Poisson Probability Distribution.

Properties of a Poisson Experiments:

1. The probability of occurrence is the same for any two intervals of equal length.
2. The occurrence or non-occurrence in any interval is independent of the occurrence or non-occurrence in any other interval.

Poisson Probability function: PPD is defined thrugh the following PDF. For any x $\geq$ 0, the probability of x occurrences in an interval,

$$f(x) = \frac{\mu^x e^{-\mu}}{x!}, \text{where } \mu \text{ is the parameter which represents Mean arrival rate and e} = 2.711828.$$

**Example 8**: Consider a Poisson distribution with a mean of two occurrences per time period.

a) Write the appropriate PPF and compute probability of 2 occurrences in one time period.
b) Write PPF to determine the probability of x occurrences in 3 time period and Compute probability of 5 occurrences in 3 time period.

Answer: (a) Since parameter gives mean occurrences in time period which is given to be 2, the PPf is given by

$$f(x) = \frac{2^x e^{-2}}{x!}$$

and hence, f(2) = (22 e-2)/2! = 2 e-2.

(b) Mean arrivals in 3 time periods is 6, PPf is

$$f(x) = \frac{6^x e^{-6}}{x!}$$

and f(5) = ($6^5$x$e^{-6}$)/5!.

Tables giving Poisson probabilities for any x $\geq$ 0 for various values of parameter $\mu$ are available A part of which is given below:

| $\mu$ x | 9.1 | 9.4 | 9.7 | 10 |
|---|---|---|---|---|
| 0 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| 5 | 0.0581 | 0.0506 | 0.0439 | 0.0378 |
| 10 | 0.1198 | 0.1228 | 0.1245 | 0.1251 |
| 15 | 0.0208 | 0.0250 | 0.0297 | 0.0347 |
| 15 | 0.0208 | 0.0250 | 0.0297 | 0.0347 |
| 15 | 0.0208 | 0.0250 | 0.0297 | 0.0347 |
| 20 | 0.0007 | 0.0010 | 0.0014 | 0.0019 |

Thus, for $\mu$ = 9.4, f(10) = 0.1228; For $\mu$= 10, f(15) = 0.0347; For $\mu$= 9.7, f(5) = 0.0439.

**Poisson Distribution as an Approximation of the Binomial Distribution**

The Poisson distribution can be a reasonable approximation of the Binomial under conditions: When $n$ is large and p is small, Where, $n$ is number of trials and p is the binomial probability of success.

**The Normal Distribution**

A very important continuous probability distribution is Normal Distribution. Many natural phenomena follow a Normal PD.

For example, CRVs representing heights and weights of people, test scores, amounts of rainfall, etc. do follow NPD.

The PDF defining a NPD, is defined in terms of mean and standard deviation of the corresponding CRV values. In general PDF for a NPD is given by

f (x) = $\frac{1}{\sigma\sqrt{2\pi}}, e^{-(x-\mu)^2/2\sigma^2}$ $\mu$

where ?= Mean, **σ =** Standard deviation; π = 3.14159; & e = 2.71828.

The NPD is a symmetric distribution and it shape is Bell shape. NPD is identified by two parameters and σ and is denoted by N(σ).

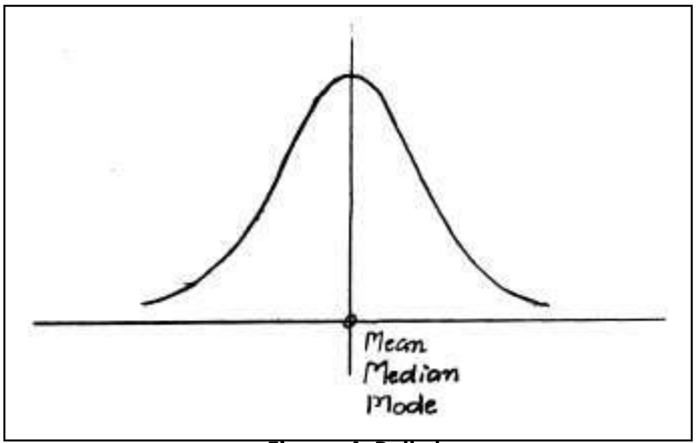


**Figure 4: Bell-shape curve**

Most of the real-life populations do not extend forever in both directions, but for such populations the normal distribution is a convenient approximation.

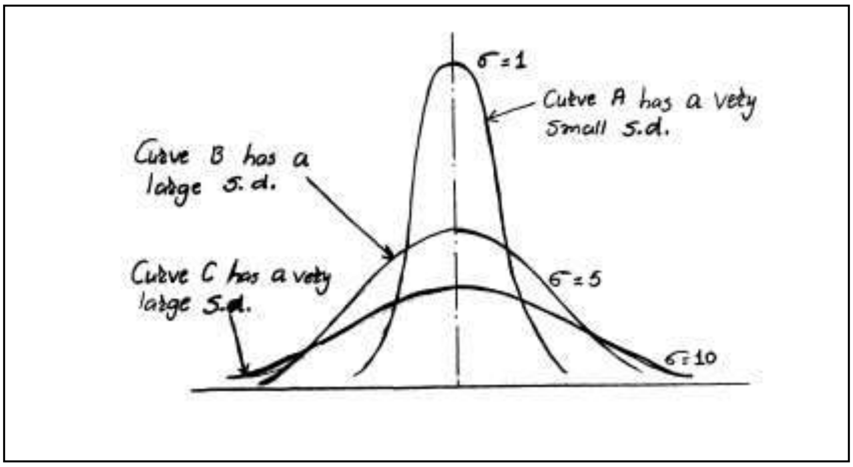
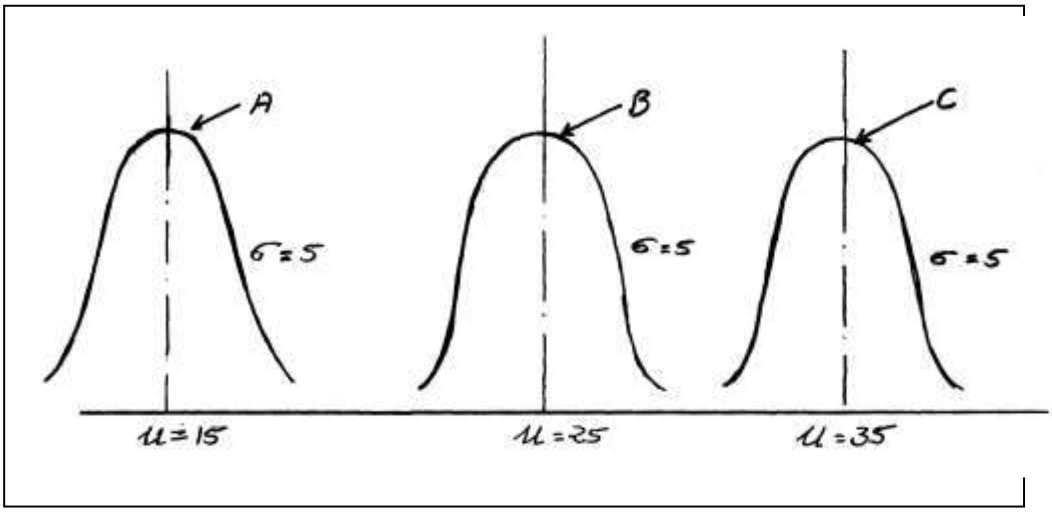
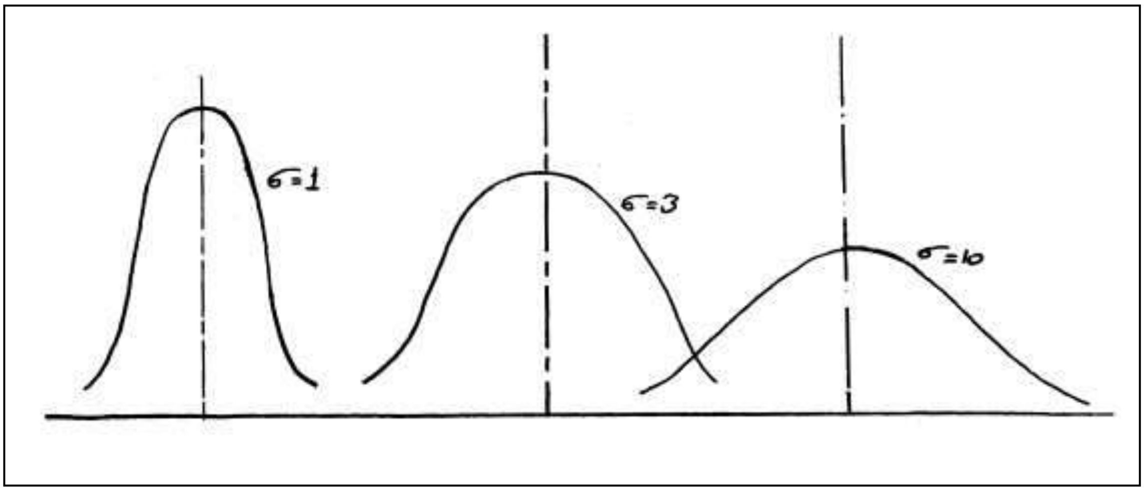



**Figure – 5: NPDs with same Mean & different values of σ**


A
B
C
σ = 5
σ = 5
σ = 5
μ = 15
μ = 25
μ = 35


σ = 1
σ = 3
σ = 10

1. The highest point on the Normal curve is at the mean which is also the Median and Mode of the distribution.
2. The mean of the NPD can be any numerical value: Negative, zero, or positive. The Bell shape of the NPDs with same standard deviation are same and the position of the curve depends on the value of the mean.
3. The NPD is symmetric, with the shape of the curve to the left of the mean a mirror image of the shape to the right of the mean. The tails of the curve extend to infinity asymptotically in both directions. Because of symmetry skewness measure of the NPD is 0.
4. The Standard deviation determines how flat and wide the curve is. Larger value of s. d. result in wider, flatter curves, showing more variability in the data.
5. Probabilities for NRV are given by areas under the curve. Total area under the curve for NPD is 1. Because of symmetry the areas under the curve to the right and to the left of the mean are both 0.5.
6. No matter what the values of $\mu$ and $\sigma$ are for a normal probability distribution, the total area under the normal curve is 1.00, so that we may think of areas under the curve as probabilities. To compute Probability that a CRV is within any specific interval, we must compute area under the normal curve over that interval.
7. The percentage of values in some commonly used intervals are:

   68.3% values lie in the interval $[\mu - \sigma, \mu + \sigma]$

   95.4% values lie in the interval $[\mu - 2\sigma, \mu + 2\sigma]$

   99.7% values lie in the interval $[\mu - 3\sigma, \mu + 3\sigma]$

   That is $P(\mu - 3\sigma \le x \le \mu + 3\sigma) = 0.997$.

**Standard Normal Distribution**

A Normal probability distribution with mean 0 and standard deviation 1 is called the standard Normal distribution (SND). Thus SND is N(0, 1).
If a continuous random variable X follows a normal distribution N($\mu$, $\sigma$) then $Z = \frac{X-\mu}{\sigma}$ follows standard Normal distribution N(0, 1).

For the standard NPD these areas have been computed and are available in the form of a table as given below. Since the NPD is symmetric the table gives probabilities of z

being in the interval [0, z] which is: $\int_0^z f(x)\,dx$

where $f(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}$

| z | 0.0 | 0.02 | 0.04 | 0.06 | 0.08 |
|---|---|---|---|---|---|
| 0.0 | 0.0000 | 0.0080 | 0.0160 | 0.0239 | 0.0319 |
| 0.5 | 0.1915 | 0.1985 | 0.2054 | 0.2123 | 0.2190 |
| 1.0 | 0.3413 | 0.3461 | 0.3508 | 0.3554 | 0.3599 |
| 1.5 | 0.4332 | 0.4357 | 0.4382 | 0.4406 | 0.4429 |
| 2.0 | 0.4772 | 0.4783 | 0.4793 | 0.4803 | 0.4812 |
| 2.5 | 0.4938 | 0.4941 | 0.4945 | 0.4948 | 0.4951 |

The z is the standard Normal variable and from the table, we get the probability

$P(0.0 \leq z \leq 1.0) = 0.3413$; Then by symmetry $P(-1.0 \leq z \leq 0.0) = 0.3413$;

$P(-1.0 \leq z \leq 1.0) = P(-1.0 \leq z \leq 0.0) + P(0.0 \leq z \leq 1.0) = 0.3413 + 0.3413 = 0.6826$;

Using properties of Normal distribution, we can compute $P(a \leq z \leq b)$, the probability for z in any interval [a, b]. And for any continuous random variable following normal distribution $N(\mu, \sigma)$, using the fact that $Z = \frac{X-\mu}{\sigma}$ follows N(0, 1) we can compute probability $P(a \leq x \leq b) = P(\frac{a-\mu}{\sigma} \leq Z \leq \frac{b-\mu}{\sigma})$ which can be computed from the table.

## 7.0 SAMPLING AND SAMPLING DISTRIBUTIONS

A Population is the set of elements of interest in any study and a Sample is a subset of population.

For example, if we are interested in knowing the students from Vadodara, who will be interested in taking a training for valuation at the centre for valuation studies. Then Population is the set of all students from Vadodara, who are eligible to take such training. In order to compute number of such students, it may be infeasible to ask every student about his interest. What normally we do is select few students randomly from various sections from Vadodara and ask them about their interest, and from that estimate the required number. The set of students whom we select is the sample.

The accuracy of such estimates will depend on whether the selected sample appropriately represents the population or not. And this will depend on nature of the population and method of selecting a sample. The Sampling methods can be classified as Probability (Random) sampling method and Non-probability (Non-random or Biased) Sampling methods.

**7.1 Probability (Random) sampling methods:**

Elements selected in the sample have a known probability of being selected. Advantage of probability sampling is that the Sampling distribution of the appropriate sample Statistic generally can be identified and used to make a probability statement about the error associated with the sample results. Methods included are: (i) Simple Random Sampling (ii) systematic sampling.(iii) Stratified Random Sampling (iv) Cluster sampling.

**Simple Random Sampling**

The process of selecting a Simple Random Sample depends on whether the population is finite or infinite.

Sampling from a finite population:

A SRS of size n from a Finite Population of size N is a sample selected such that each possible sample of size n has the same probability of being selected.

Procedure: Choose the elements for the sample one at a time in such a way that, at each step, each of the remaining elements in the population has equal chance of being selected.

To ensure randomness in the selection we use table of random numbers as given below

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 63271 | 59986 | 71744 | 51102 | 15141 | 80714 | 58683 | 93108 |
| 88547 | 09889 | 95436 | 79115 | 08303 | 01041 | 20030 | 63754 |
| 55957 | 57243 | 83865 | 09911 | 19761 | 66535 | 40102 | 26646 |
| 46276 | 87453 | 44790 | 67122 | 45573 | 84358 | 21625 | 16999 |
| 20711 | 55609 | 36100 | 29430 | 70165 | 02421 | 32001 | 15987 |

Selection procedure using Table of Random numbers:

- Assign the numbers 1 to N to every element of the population. Let k = Minimum digits required to store N.
- Start from any cell in the table and select the numbers in forward or backward direction. The digits of the numbers selected are regrouped to form numbers of k digits.
- If a number in this list is within 1 to N, the corresponding element form the population is selected in the Sample, otherwise the number is ignored. The process continues till all n elements are selected.

**Sampling from an Infinite Population**

In Practice, a population being studied is usually considered Infinite if it involves on going process that makes listing or counting every element in the population impossible. For example:

- All order that could be processed by a mail-order firm.
- All emergency phone calls that could come into a Police Station.

A simple Random Sample from an infinite population is the Sample selected such that the following conditions are satisfied: (1) Each element selected comes from the population. (2) Each element is selected independently.

**Systematic sampling**

In case of a large population taking a SRS is time consuming and systematic sampling provides a good alternative to SRS. If sample of size n is required from a population of size N, we may sample one element for every N/n elements in the population. A systematic sample in this case involves selecting randomly one of the first N/n elements of the population list. The other elements in the sample are identified by moving systematically through the population list and identifying every (N/n) th element after the first randomly selected element. Since first element is selected randomly, a systematic sample is usually assumed to have properties of a SRS. The assumption is more valid if elements in the population are randomly ordered.

**Stratified sampling**

To use stratified sampling, we divide the population into relatively homogeneous groups, called STRATA. Then we use one of two approaches. Either we select at random from each stratum a specified number of elements corresponding to the proportion of that stratum in the population as a whole or we draw an equal number of elements from each stratum and give weight to the results according to the stratum's proportion of total population. With either approach, stratified sampling guarantees that every element in the population has a chance of being selected.

Stratified sampling is appropriate when the population is already divided into groups of different sizes. The advantage of stratified samples is that when they are properly designed, they more accurately reflect characteristics of the population from which they were chosen than do other kinds of samples.

**Cluster sampling**

In cluster sampling The elements of the population are divided into separate groups called clusters. Each element of the population lies into one and only one cluster. A Simple random sample of clusters is then taken. All elements within each sampled cluster form the sample.

Cluster sampling works best when each cluster provides a small scale representation of the population. If all clusters are alike in this regards, sampling a small number of clusters will provide a good estimate of the population parameter. One of the primary application is Area sampling, where clusters are city blocs or well defined areas. Cluster sampling generally requires a large sample, however it requires lower operational cost.

**7.2 Non-probability (Non-random or Biased) Sampling methods:**

Elements are selected as per convenience or Judgment of the designer. Methods in this class are: (i) Convenience sampling (ii) Judgment sampling.

**Convenience sampling**

Convenience sampling is a non-probability sampling technique, in which the sample is identified primarily by convenience. Elements are selected without pre-specified probabilities of being selected. It has an advantage of relatively easy sample selection and data collection. However, it is impossible to evaluate the "goodness" of the sample in terms of the representativeness of the population. No statistically justified procedure allows a probability analysis and inference about the quality of the sample results. Example of convenience sampling are: a professor conducting research at the university may use his students as sample elements; an inspector may sample a shipment of oranges by selecting oranges haphazardly from among several crates; wild life captures, etc.

**Judgment sampling**

This is also a non-probability sampling technique in which the person most knowledgeable in the subject of the study selects elements of the population that he or she feels are most representative of the population. Often this method is a relatively easy way of selecting a sample. A reporter may select two or three MPS, judging that these MPS reflect the general opinion of the parliament. However, the quality of the sample results depends on judgment of the person selecting the sample. We should be cautious in drawing conclusions based on judgment samples used to make inferences about populations.

### 7.3 Sampling Distribution:

point estimates of the population parameters depends on the SRS used for finding the estimates. If the sample changes then estimates also change. If we consider the Process of selecting a SRS as an experiment, the sample mean $\bar{x}$ is the numerical description of the experiment and hence $\bar{x}$ a random variable. So, $\bar{x}$ have a mean, standard deviation and a probability distribution, called a Sampling distribution of $\bar{x}$,

The Mean or Expected value of $\bar{x}$, E ( $\bar{x}$ ) = $\mu$, the population mean.

The Standard deviation $\sigma_{\bar{x}}$ of $\bar{x}$ (Standard error of mean) is given by:

$$\sigma_{\bar{x}} = \sqrt{\frac{N-n}{N-1}}\left(\frac{\sigma}{\sqrt{n}}\right) \text{ For a Finite Population and } \sigma_{\bar{x}} = \left(\frac{\sigma}{\sqrt{n}}\right) \text{ for an Infinite Population.}$$

In case when Population is "large" and sample is relatively "small", that is n/N $\leq$ 0.05, i.

e. sample size is < 5% of Population size, then also, $\sigma_{\bar{x}} = \left(\frac{\sigma}{\sqrt{n}}\right)$.

Form of the sampling distribution of $\bar{x}$, is normal for any sample size if the population has a Normal or nearly Normal distribution.

If the population has any other distribution, by Central Limit theorem, the Sampling distribution of ? can be approximated by a Normal distribution as the Sample size n becomes large. $\bar{x}$

General Statistical practice is to assume that for most applications, the Sampling distribution of can be approximated by ? a Normal distribution whenever the sample size n is $\geq$ 30.

Similarly we have Sds for other population parameters like and p. $\sigma$ These Sds help us make probability statement about how "good" the point estimate of respective population parameter is.

## 8.0 PARAMETER ESTIMATION

A sample statistic (various Statistical measures for sample) are used to estimate a population parameter. An estimator is a sample statistic used to estimate a population parameter. There are two types of estimates (1) Point Estimate (2) Interval Estimate.

### 8.1 Point Estimate

A point estimate is a single number that is used to estimate an unknown population parameter e.g. A firm estimates the next year's average profit as :25 Lakhs.

| Population parameter | Point Estimate (Sample Statistics ) |
|---|---|
| Population Mean | Sample Mean |
| Population Standard deviation | Sample SD |
| Population Proportion p | Sample proportion = x / n<br>x = No. of samples with a specific property |

Note that if sample changes the point estimates will also change and hence point estimates are not reliable.

### 8.2 Interval Estimates and Confidence Intervals

An interval estimate is a range of values used to estimate a population parameter. That is one finds an interval around a point estimator in which a population parameter is expected to lie. e.g. A firm estimate its next year's profit as : Between 20 and 30 Lakhs. It indicates the error in two ways: (i) By the extent of its range and (ii) By the probability of the true population parameter lying within that range.

General form of Interval estimate is: Point Estimate + Margin of error. The purpose of Interval estimate is to provide information about how close the point estimate to the value of Population parameter. We also, compute a confidence or probability with which we can say that the population parameter will lie in the estimated Interval. In fact, given a confidence level L, we find the Interval estimate which is called L% confidence Interval. In estimation, the most commonly used confidence levels are 90%, 95%, and 99%. But we are free to apply any confidence level. We illustrate the computation of Confidence Interval for population Mean when population standard deviation is known.

In order to develop Interval estimate of the Population Mean, either Population $\sigma$ SD or

Sample SD s must be used to compute the margin of error. Although $\sigma$ is rarely known exactly, from historical data or other information we can obtain a good estimate of prior to sampling. In $\sigma$ ch a case we consider that $\sigma$ is known. Earlier we have computed the probabili $\bar{x}$ that the estimate of population m $\mu$ n will be within a given distance of In the Interval estimate for $\bar{x}$ given probability we compute Mar $\mu$ of error, so that lies in the Interva $\bar{x}$ - Margin of error, + Margin of error] with the given probability . W $\bar{x}$ compute the margin $\mu$ f error using the fact that the Sampling distribution of $\sigma/\sqrt{n}$ is Normal with mean & SD .

Procedure for determination of t the $\bar{x}$ Confidence Interval (Interval estimate with confidence level L) for : $\mu$

i. Choose Confidence level (90%, 95% or 99%) that is take L = 0.9, 0.95 or 0.99.

ii. Determine c such that Z(c) = L / 2, from the standard Normal distribution table.

iii. Compute Sample mean $\bar{x}$ .

iv. Sampling distribution of $\bar{x}$ is Normal distribution with mean $\mu$ and SD $\sigma/\sqrt{n}$ and $\frac{\bar{x}-\mu}{\sigma/\sqrt{n}}$

Z = as standard Normal distribution where $\sigma$ is known SD of the population.

v. Z(c) = L / 2 means Prob ( -c ≤ Z ≤ c) = L. That is, Prob ( $\frac{-c\sigma}{\sqrt{n}} \le \bar{x}-\mu \le \frac{c\sigma}{\sqrt{n}}$ ) = L.

Thus, Prob ( $\bar{x}-\frac{c\sigma}{\sqrt{n}} \le \mu \le \bar{x}+\frac{c\sigma}{\sqrt{n}}$ ) = L is the desired confidence interval. This means

for any sample with mean $\bar{x}$ $\mu$ lies in the confidence interval $\left[\bar{x}-\frac{c\sigma}{\sqrt{n}},\ \bar{x}+\frac{c\sigma}{\sqrt{n}}\right]$

with probability L. Since Z follows the standard Normal distribution, the value of c for different values of L is given in the following table.

| L% | L/2 | c |
|---|---|---|
| 90 | 0.45 | 1.645 |
| 95 | 0.475 | 1.96 |
| 99 | 0.495 | 2.576 |

**Example 9:** For a random sample of 36 items and a sample mean of $\bar{x}$ = 211, compute a 95% confidence interval for $\mu$ if the population standard deviation is 23.

By above formula the 95% confidence interval for $\mu$ is

$$\left[\bar{x}-\frac{c\sigma}{\sqrt{n}},\ \bar{x}+\frac{c\sigma}{\sqrt{n}}\right]=\left[211-\frac{1.96\ x\ 23}{\sqrt{36}},\ 211+\frac{1.96\ x\ 23}{\sqrt{36}}\right]=[203.487,\quad 218.513].$$

In computing confidence intervals for when $\bar{x}$ is not known $\sigma$ or for population standard deviation or other population parameters one has to use other probability distributions like Student's t distribution, Chi-Square Distribution, F Distribution etc., however the procedure remains same.

# UNIT – 4

## SIMPLE TEST OF SIGNIFICANCE, REGRESSION AND CORRELATION, MULTIPLE CORRELATION COEFFICIENT

### 9.0 SIMPLE REGRESSION AND CORRELATION

In business, the key to decision making often lies in the understanding of the relationships between two or more variables. For example, a company in the distribution business may determine that there is a relationship between the price of crude oil and their own transportation costs. Or a valuator may like to know relationship between the value of an asset in a specific locality and the average family income in that locality Regression analysis shows us how to determine nature and correlation analysis shows how to determine the strength of a relationship between two variables.

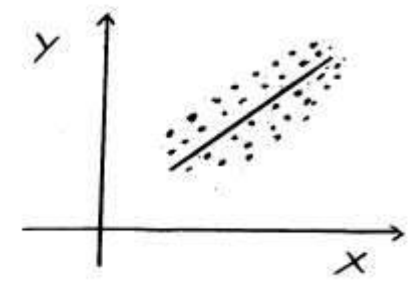
### 9.1 REGRESSION ANALYSIS

**Regression analysis** is the process of constructing a mathematical model or function that can be used to predict or determine one variable by another variable or other variables. The most elementary regression model is called **simple regression** or **bivariate regression** involving two variables in which one variable is predicted by another variable. In simple regression, the variable to be predicted is called the **dependent variable** and is designated as y. The predictor is called the **independent variable**, and is designated as x. In simple regression analysis, only a straight-line relationship between two variables is examined.

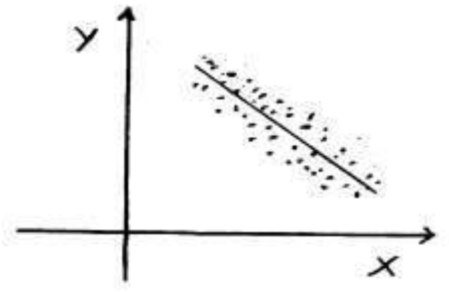
Usually, the first step in simple regression analysis is to construct a **scatter plot** (or scatter diagram), i. e. Plotting the data points $\{(x_i, y_i) \mid I = 1, 2, \ldots, n\}$on XY plane. This yields preliminary information about the shape and spread of the data and will help us in deciding whether a line or some other curve will fit the data better.

Possible relationships between X and Y which can be inferred from scatter diagram are as indicated below:

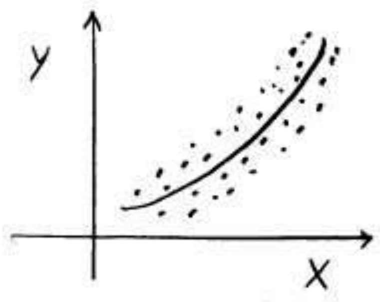
(a) Direct Linear



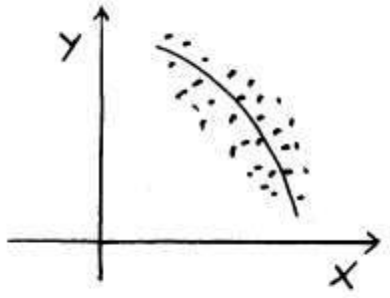

(b) Inverse Linear



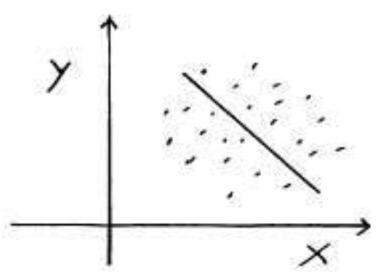

(c) Direct Curvilinear



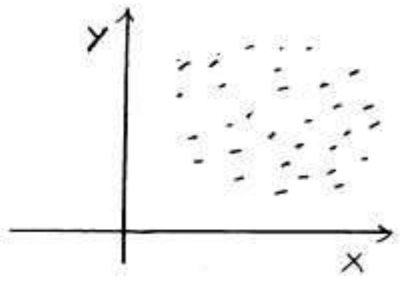

(d) Inverse Curvilinear




(e) Inverse Linear with more scattering




(f) No Relationship



Graph (e) illustrates an inverse linear relationship with a widely scattered pattern of points. The wider scattering indicates that there is a lower degree of linear association between the independent and dependent variable than there is in graph (b). The pattern of points in graph (f) seems to indicate that there is no linear relationship between the two variables, therefore, knowledge of the past concerning one variable does not allow us to predict future occurrences of the other. We shall restrict our study to linear regression only.

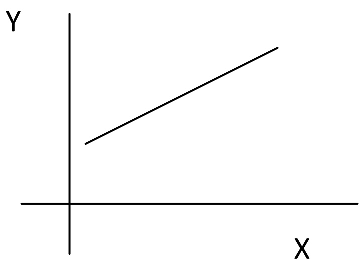
Next step is to determine the straight line having equation in the form where $\hat{y}$ = the predicted value of $y$; $b_0$ = the population $y$ intercept; $b_1$ = the population slope.

To determine the equation of the regression line of y on x, for a sample of data, one must determine the values for $b_0$ and $b_1$, so that sum of the squared error, namely, $\sum_{i=1}^{n}(\hat{y}_i - y_i)^2$ is minimum. It can be shown by using Calculus that:

$b_1 = \frac{\sum_{i=1}^{n}(y_i - \bar{y})(x_i - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$ *and* $b_0 = \bar{y} - b_1\bar{x}$, Where $\bar{x}$ abd $\bar{y}$ are respectively are the Means of x values and y values, gives the desired minimum squared error.

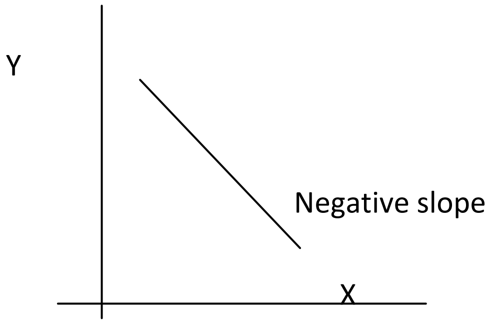
Type of relationship are as discussed below

**(1) Direct (positive) Linear relationship**




Plotting the independent variable on the X-axis and the dependent variable on the Y-axis, the above graph shows a direct Linear relationship. The slope of this line is positive because Y increases as X increases.

**(2) Inverse (negative) Linear relationship**




In the above graph, the dependent variable Y decreases (increases) as the independent variable X increases (decreases). This relationship is characterized by Negative Slope. This represents inverse relationship between X and Y.

## 9.2 CORRELATION ANALYSIS

Correlation analysis is the statistical tool that can be used to describe the degree to which one variable is linearly related to another.

Often, correlation analysis is used in conjunction with regression analysis to measure how well the regression line explains the variation of the dependent variable Y.

Correlation can also be used to measure the degree of association between two variables and is measured in terms of a widely used sample Karl-Pearson coefficient of correlation, *r*. For the sample data set $\{(x_i, y_i) \mid I = 1, 2, \ldots, n\}$,

Coefficient of correlation r is given by, $$r = \frac{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)\left(y_i - \bar{y}\right)}{\sqrt{\left[\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2\right]\left[\sum_{i=1}^{n}\left(y_i - \bar{y}\right)^2\right]}}.$$

The formula indicates that r is a number that ranges from -1 to 0 to +1, representing the strength of the relationship between the variables. An *r* value of +1 denotes a perfect positive relationship between two sets of numbers. An *r* value of -1 denotes a perfect negative correlation, which indicates an inverse relationship between two variables: as one variable gets larger, the other gets smaller. An *r* value of 0 means no linear relationship is present between the two variables.

**Example 10:** Determine the value of the coefficient of correlation, *r* and the equation regression line for the following data.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *X* | 4 | 6 | 7 | 11 | 14 | 17 | 21 |
| *Y* | 18 | 12 | 13 | 8 | 7 | 7 | 5 |

Answer:

| $x_i$ | $y_i$ | $U_i = x_i - \bar{x}$ | $V_i = y_i - \bar{y}$ | $U_i^2$ | $V_i^2$ | $U_iV_i$ |
|---|---|---|---|---|---|---|
| 4 | 18 | - 6 | 9.25 | 36 | 85.56 | - 55.5 |
| 6 | 12 | - 4 | 3.25 | 16 | 10.56 | - 13 |
| 7 | 13 | - 3 | 4.25 | 9 | 18.06 | -12.75 |
| 11 | 8 | 1 | - 0.75 | 1 | 0.56 | - 0.75 |
| 14 | 7 | 4 | - 1.75 | 16 | 3.06 | - 7 |
| 17 | 7 | 7 | - 1.75 | 49 | 3.06 | - 12.25 |
| 21 | 5 | 11 | - 3.75 | 121 | 14.06 | - 41.25 |
| $\sum x_i = 80$ | $\sum y_i = 70$ | | | $\sum U_i^2 =$ | $\sum V_i^2 =$ | $\sum U_iV_i =$ |
| $\bar{x} = 10$ | $\bar{y} = 8.75$ | | | 248 | 134.92 | - 142.5 |

$r = \frac{-142.5}{\sqrt{248 \times 134.92}} = \frac{-142.5}{182.92} = -0.78$ which indicates almost perfect negative relationship.

Now, $b_1 = \frac{-142.5}{248} = -0.57$ and $b_0 = \bar{y} - b_1\bar{x}$ = 8.75 + 0.57 x 10 = 3.05.

Hence Regression line of y on x is given by $\hat{y} = 3.05 - 0.57\,x$.

## 9.3 MULTIPLE REGRESSION AND CORRELATION ANALYSIS

We can use more than one independent variable to estimate the dependent variable to increase the accuracy of the estimate. This process is called multiple regression and correlation analysis.

e.g. Suppose the real estate agent who wishes to relate the number of houses and the number of firm sold in a month to the amount of his monthly advertising. Certainly, we can find a simple estimating equation that relates these three variables.

# UNIT – 5

## TIME SERIES

### 10.0 TIME SERIES

Time-series analysis is one quantitative method we use to determine PATTERNS in data collected over time.
Time-series analysis is used to detect patterns of change in statistical information over regular intervals of time. We project these patterns to arrive at an estimate for the future.
Thus, time-series analysis helps us to cope up with uncertainty about the future.

We use the term time series to refer to any group of statistical information accumulated at regular intervals. There are four kinds of change, or variation, involved in time-series analysis:
1. Secular trend 2. Cyclical fluctuation 3. Seasonal variation
4. Irregular variation

**Secular trend**
The value of the variable trends to increase or decrease over a long period of time.

**Cyclical fluctuation**
The most common example of cyclical fluctuation is the business cycle. Over the time, there are years when the business cycle hits a peak above the trend line. At other times, business activity is likely to slump, hitting a low point below the trend line. The time between hitting peaks or falling to low points is at least 1 year and it can be as many as 15 or 20 years.

**Seasonal variation**
The seasonal variation involves patterns of change within a year that trend to be repeated from year to year.

**Irregular variation**
In many situations, the value of a variable may be completely unpredictable, changing in a random manner.

**Trend Analysis** :

Of the fair components of a time series, secular trend represents the long-term direction of the trend component is to fit a line visually to a set of points on a graph.

# UNIT – 6

## INDEX NUMBERS

### 11.0 INDEX NUMBERS

An index number measures how much a variable changes over time. We calculate an index number by finding the ratio of the current value to a base value. Then we multiply the resulting number by 100 to express the index as a percentage. This final value is the percentage relative. Note that the index number for the base point in time is always 100.

### 11.1 TYPES OF INDEX NUMBERS

There are three principal types of indices: the price index, the quantity index, and the value index. A price index is the one most frequently used. It compares levels of prices from one period to another. The familiar Consumer Price Index (CPI), measures overall price changes of a variety of consumer goods and services and is used to define the cost of living.

A quantity index measures how much the number or quantity of a variable changes over time.

The last type of index, the value index, measures changes in total monetary worth. That is, it measures changes in the Rupee value of a variable. In effect, the value index combines price and quantity changes to present a more informative index. Usually, an index measures change in a variable over a period of time, such as in a time series. However, it can also be used to measure differences in a given variable in different locations. This is done by simultaneously collecting data in different locations and then comparing the data. The comparative cost-of-living index, for example, shows that in terms of the cost of goods and services, it is cheaper to live in Anand, than in Mumbai.

A single index may reflect a composite, or group, of changing variables. The Consumer Price Index measures the general price level for specific goods and services in the economy. It combines the individual prices of the goods and services to form a composite price index number.

**Uses of Index Numbers**

Index numbers such as the Consumer Price Index are often cited in news reports as general indicators of the nation's economic condition. Management uses index numbers as part of an intermediate computation to understand other information better. Seasonal indices were used to modify and improve estimates of the future. The use of the Consumer Price Index to determine the real buying power of money is another example of how index numbers help increase knowledge of other factors.

**Sources of Index Numbers**

Almost all government agencies distribute data about their activities, from which index numbers can be computed. Many financial newspapers and magazines provide information from which index numbers can be computed. When you read these sources you will find that many of them use index numbers themselves. In India, R.B.I. publishes indices.

## 11.2 UNWEIGHTED AGGREGATES INDEX

The simplest form of a composite index is an unweighted aggregates index. Unweighted means that all the values considered in calculating the index are of equal importance. Aggregate means that we add, or sum, all the values.

An unweighted aggregates index is calculated by adding all the elements in the composite for the given time period and then dividing this result by the sum of the same elements during the base period. The formula for this index is:

$$\frac{\sum Q_i}{\sum Q_0} \times 100$$

Where,

$Q_i$ = quantity of each element in the composite for the year in which we want the index

$Q_0$ = quantity of each element in the composite for the base year

## 11.3 WEIGHTED AGGREGATES INDEX

This weighting allows us to include more information than just the change in price over time. It also lets us improve the accuracy of the general price level estimate based on our sample. The problem is to decide how much weight to attach to each of the variables in the sample.

The formula for this index is:

$$\frac{\sum P_i Q}{\sum P_0 Q} \times 100$$

where

$P_i$ = price of each element in the composite in the current year.

$P_0$ = price of each element in the composite in the base year.

Q = quantity weighting factor chosen

## 11.4 LASPEYRES METHOD

The Laspeyres method, which uses quantities consumed during the base period, is the method most commonly used because it requires quantity measures for only one period. Because each index number depends on the same base price and quantity, management can compare the index of one period directly with the index of another.

Laspeyres formula is given by

$$\frac{\sum P_i Q_0}{\sum P_0 Q_0} \times 100$$

Where,

$P_i$ = prices in the current year

$P_0$ = prices in the base year.

$Q_0$ = quantities sold in the base year

## 11.5 PAASCHE METHOD

The second way to compute a weighted aggregates price index is the Paasche method. Finding a Paasche index is similar to finding a Laspeyres index. The difference is that the weights used in the Paasche method are the quantity measures for the current period rather than for the base period.

Paasche's formula is given by

$$\frac{\sum P_i Q_i}{\sum P_0 Q_i} \times 100$$

Where,

$P_i$ = current-period prices

$P_0$ = base-period prices

$Q_i$ = current-period quantities

## 11.6 FIXED-WEIGHT AGGREGATES METHOD

The third technique used to assign weights to elements in a composite is the fixed-weight aggregates method. It is similar to both the Laspeyres and Paasche methods. However, instead of using base-period or current-period weights (quantities), it uses weights from a representative period. The representative weights are referred to as fixed weights. The fixed weights and the base prices do not have to come from the same period.

The formula for this index is:

$$\frac{\sum P_i Q_2}{\sum P_0 Q_2} \times 100$$

where

$P_i$ = current-period prices

$P_2$= base-period prices

$Q_2$ = fixed weights.

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# ENVIRONMENTAL ISSUES IN VALUATION


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Kirit P. Budhbhatti

Chairman, CVSRTA

# INDEX

# MODULE-1

## ENVIRONMENTAL ISSUES AND POLLUTION

As stated in Professional Standards (PS2) of the Royal Institution of Chartered Surveyors' (RICS) Valuation Global Standards 2017, if the valuer does not have the required level of expertise to deal with some aspect of the valuation assignment properly, then he/she should decide what assistance is needed. With the express agreement of the client where appropriate, the valuer should then commission, assemble and interpret relevant information from other professionals, such as specialist valuers, environmental surveyors, accountants and lawyers.

However, para 10.7 of General Standards IVS 105 (Valuation Approaches and Methods) of International Valuation Standards 2017 stipulates that regardless of the source of the inputs and assumptions used in a valuation, a ***valuer must*** perform appropriate analysis to evaluate those inputs and assumptions and their appropriateness for the *valuation purpose*.

Asset Standard IVS 300 – Plant and Equipment (under IVS 2017) illustrates environment-related factors that may need to be considered for valuation of plant and machinery.

Asset Standard IVS 400 – Real Property Interests (under IVS 2017) requires that the responsibility for identification of actual or potential environmental risks should be stated in the Scope of Work (refer IVS 101) and Investigations and Compliance (refer IVS 102). Else if the client agrees, a typical special assumption that 'the property is free from contamination or other environmental risks' should be incorporated in the valuation report only for certain purposes.

Valuation Practice Guidance Application VPGA 8 - Valuation of Real Property Interests of RICS (2017) discusses environmental matters in three parts : (a) Natural environmental constraints, (b) Non-natural constraints, and (c) Sustainability. As the valuers may not have specialised knowledge and experience required to comment on environmental factors, it may be appropriate to recommend that an advice of environmental expert be obtained when the potential presence of these factors can be established in the course of a valuation inspection through normal enquiries or by local knowledge.

Judicious juxtaposition of the above guidelines of the RICS and IVS 2017 implies that though valuers themselves need not be environmental experts, it is imperative for the valuers to have fundamental knowledge about environmental issues and to scrutinize the data provided by environmental experts prior to their application for valuation of such affected properties.

**1.0 INTRODUCTION**

Environment means water, air and land and the interrelationship that exists as between and amongst these media (water, air and land) and human beings, other living beings including micro-organisms and property. Humans continuously interact with the environment and alter the environment by various activities like:

- Rapid Industrialization;
- Urbanization;
- Population explosion; and
- Modern life styles.

But the interaction results into environmental pollution. Thus, environmental pollution means alteration of the composition of the environment which will have deleterious effect on human health or quality of life.

Environmental pollution also means "the presence of any pollutant in the environment which imparts adverse effect on the marketability of an asset."

Environmental pollutant may be defined as "Any solid, liquid, gaseous or other substance present in such concentration which may be or tend to be injurious to the environment giving rise to adverse effect on the marketability of asset."

Whenever the quality of environment is deteriorated due to presence of any foreign matter, environmental pollution is said to have occurred. The 'foreign matter' is a "pollutant". A pollutant can be a substance which when enters in the environment either purposefully or through some act of nature, it significantly changes the composition of the environment and shows adverse effect on human health.

Contamination is defined as alteration of physical, chemical and/or biological characteristics of the environment which may not necessarily create deleterious effect due to lesser concentration but contaminant(s) in higher concentration become pollutants that may ultimately lead to degradation or deterioration of the value of assets.

Thus, there can be a contaminated environment without it being polluted but there cannot be a polluted environment without it being contaminated.
Environmental quality standards have been established focusing on humans as opposed to the ecosystem at large. Such standards are extremely difficult to specify.

## 1.1. TYPES OF ENVIRONMENTAL POLLUTION

Environmental pollution can be broadly classified based on any given compartment or region of the environment which they negatively impact, contributing to the multiple causes of pollution. The various components of environment are air, water, noise and land, and correspondingly the environmental pollution is classified as air pollution, water pollution, noise pollution and land (and soil) pollution. Some of the pollutants include gases, metals and their salts, agro-chemicals including pesticides, biomedical waste, heat, vibration and plastic.

Every type of pollution (air, water, noise, land, industrial, soil, light, thermal, etc.) has its own distinguishing causes and environmental effects. Understanding pollution and its various causes can help address the various concerns linked to environmental degradation and destruction, and the dangers it brings to human health.

**Air Pollution**

Any deleterious change in the composition of the clean atmospheric air is known as air pollution.

Air pollution means presence of one or more contaminants in the atmosphere such that the contaminant's concentration, characteristics and exposure is injurious to public health or welfare.

According to the definitions under Section 2(b) of the Air (Prevention and Control of Pollution) Act-1981, 'air pollution' means the presence in the atmosphere of any air pollutant. Under Section 2(a) of the Act, 'air pollutant' means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.

The sources of anthropogenic air pollution are (i) Stationary sources like mining and quarrying, refineries and chemical factories, power plants, industrial facilities, sewage and waste treatment, (ii) Community sources like heating of homes and buildings, laundry services, (iii) Mobile sources like diesel and gasoline-powered automobiles, trains, marine vehicles, aeroplanes, and (iv) Indoor sources like tobacco smoking, combustion emissions, asbestos and Volatile Organic Compounds (VOCs).

Thus, air contaminants include suspended particulate matter (dusts, fumes, mists, and smokes), gaseous pollutants (gases and vapours), odours, radio-active materials, noxious chemicals or any other material in the outdoor atmosphere.

Out of the various air contaminants, the **Criteria Air Pollutants** are the only air pollutants with national ambient air quality standards that define allowable concentrations of these substances in **ambient air**. The criteria air pollutants are six common air pollutants defined by the United States Environment Protection Agency (USEPA) and World Health Organization (W.H.O) as these pollutants are found causing harm to health, environment and damage to property thereby affecting adversely the property valuation. These criteria air pollutants also prescribed by the Central Pollution Control Board (CPCB) of India include Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Sulphur Dioxide (SO2), Particulate Matter (PM10), Lead (Pb) and ground level Ozone (O3). The National Air Quality Standards are given in Table 1 below.

**Table 1 : National Ambient Air Quality Standards for Criteria Air Pollutants**

| Pollutant | Time Weighted Average | Concentration in Ambient Air | |
|---|---|---|---|
| | | Industrial, Residential, Rural and Other Areas | Ecologically Sensitive Area (notified by Central Government) |
| Sulphur Dioxide ($SO_2$), $\mu g/m^3$ | Annual*<br>24 hours** | 50<br>80 | 20<br>80 |
| Nitrogen Dioxide ($NO_2$), $\mu g/m^3$ | Annual*<br>24 hours** | 40<br>80 | 30<br>80 |
| Particulate Matter (size less than 10 µm) or $PM_{10}$, $\mu g/m^3$ | Annual*<br>24 hours** | 60<br>100 | 60<br>100 |
| Ozone ($O_3$), $\mu g/m^3$ | 8 hours*<br>1 hour** | 100<br>180 | 100<br>180 |
| Lead (Pb) , $\mu g/m^3$ | Annual*<br>24 hours** | 0.50<br>1.0 | 0.50<br>1.0 |
| Carbon Monoxide (CO), $mg/m^3$ | 8 hours*<br>1 hour** | 02<br>04 | 02<br>04 |

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of monitoring.

*Source:* National Ambient Air Quality Standards, Central Pollution Control Board Notification in the Gazette of India, Extraordinary, New Delhi, 18th November 2009.

The valuers are concerned due to damage caused to the property by increasing levels of air pollutants. The property essentially consists of variety of elements including buildings made of masonry and concrete, ceramics and glass used for decorative finishes, paints used to adorn wall surfaces, curtains and other furnishes made from fabrics. On account of air pollution, the frequency of painting of the property increases leading to an additional cost and reducing the value of such property. The determination of damage by air pollution and its impact on valuation of the assets is extremely complex.

### 1.1.1. WATER POLLUTION

When the level of pollutants in water is more than their prescribed standards, water is said to be polluted. Under Section 2(e) of the Water (Prevention and Control of Pollution) Act-1974, 'water pollution' means such contamination of water or such alteration of physical, chemical or biological properties of water or such discharge of any sewage or trade effluent or any other liquid, gaseous or solid substance into water(whether directly or indirectly) as may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial industrial, agricultural or other legitimate uses, or to the life and health of animals or plants or aquatic organisms.

The main pollutants in water include various chemical compounds (organic and inorganic), oils and grease, silt, heated water from thermal power plants, fertilizers and pesticides, pathogens present in the domestic wastewater and gases dissolved in rain water.

The water supplies from natural and anthropogenic sources are contaminated by sewage, storm water, direct discharge of effluents from industries, pesticides brought through agricultural runoff, runoff from the solid waste disposal sites, corrosion of material used in distribution of water including plumbing systems, oil spills, development of algae in rivers due to presence of nutrients and sunlight, application of certain chemical agents such as chlorine and aluminium in water treatment processes, discharge of toxic substances, discharge / dumping of waste materials into water bodies, sediments from soil erosion, surface runoff from contaminated land and leaching from landfill sites.

Pollutants from the solid wastes dissolve in rain water and ultimately get mixed with underground water through percolation in the soil system (referred to as ground water pollution). Groundwater contamination by contact with toxins contained in the ground is a serious concern as this water may flow downstream and thus carry contamination to considerable distances.

All the pollutants have adverse impact for human, animal or plant life. The impact depends upon the type of the pollutants and their concentration.

Valuer always takes into consideration the source of the water supply and the water quality characteristics while determining the value of the real estate. Valuers have to make a broad assessment of the water resource, potential assessment of treatment of water for the individual estate or assessment of quality of water supplied by municipal transmission for the given estate.

**Thermal Pollution**

Thermal pollution occurs when water bodies are degraded in terms of altering their temperatures. It commonly happens when people or industries undertake activities that suddenly decrease or increase the temperature of a natural water body which may include lakes, rivers, oceans or ponds.

Thermal pollution is a huge menace and is mainly influenced by power plants and industrial manufacturers that use water as a coolant. Urban stormwater runoff from parking lots and roads also discharges water of elevated temperatures into adjacent water bodies.

When water is either used as a coolant, discharged from stormwater runoff at elevated temperatures, or released from reservoirs with unnaturally cold temperatures, it changes the natural temperature of water bodies. Therefore, thermal pollution is one aspect of the wider subject of water pollution. The alterations of natural water resource temperatures can have dire consequences on aquatic life and the local ecosystems.

### 1.1.2. NOISE POLLUTION

Noise pollution is an environmental phenomenon but a non-physical contamination as it does not directly affect the various media like air-water-land. Noise is undesired sound and an unwanted disturbance. Transmission of noise which is capable of producing physiological impact in an individual is defined as noise pollution. Noise pollution may interface with various activities of humans like work, recreation, communication and rest/sleep. It may create annoyance and stress.

On account of urbanization, the demand of transport facilities has increased. Due to the power-driven vehicles and jet aircrafts, the problem of noise has become substantially serious. At some locations, noise levels are much above the acceptable level. 'Hearing loss' is becoming frequent phenomenon in many of urban centres of our nation.

Valuation of property is dictated by its location. For illustration, an apartment located close to a cricket stadium or a school will be valued less than properties not affected by the noise emanating from these facilities. This is because too much noise adding to the nuisance value will have a negative impact on pricing.

### 1.1.3. LAND POLLUTION

Land pollution is the destruction or decline in quality of the earth's land surfaces in term of use, landscape and ability to support life forms. Many times, it is directly and indirectly caused by human activities and abuse of land resources. Land pollution takes place when waste and garbage is not disposed off in the right manner and as such, introduces toxins and chemicals on land.

Land pollution can be broadly classified as:

- Contamination of land due to uncontrolled storage & disposal/dumping of solid and hazardous chemicals/wastes onto soils in the form of herbicides, fertilizers, pesticides, or any other form of the consumer by-products. e.g. the past use of site for storing chemicals might have resulted in contamination of soils and groundwater with arsenic and organo-chlorine compounds.
- Alteration of land due to land uses like deforestation, farming, mining, developmental works like transport and communication.

Acid rain, construction sites, solid waste, mineral exploitation, agricultural chemicals and deforestation are the primary causes of land pollution.

***<u>Contaminated Sites</u>***

Environment Protection Policy of Australian Capital Territory Government (2000) has discussed land contamination as under:

Land contamination can arise from a range of commercial, industrial, or agricultural land uses and activities, particularly when the land use has involved hazardous materials. These substances if not managed properly may threaten human health or the environment or may affect the current or future land use.

The activities which have potential to adversely impact on human health and the environment are many. Some of them are given below:

- commercial incineration of wastes (including medical, chemical and municipal wastes)
- commercial landfills
- sewage and industrial effluent treatment plants
- petroleum storage tanks
- electricity generation
- commercial use of chemicals
- preservation of timber

It is therefore necessary to ensure an integrated approach considering public health, planning, occupational health and safety, hazardous and toxic waste management for addressing contamination.

The U.K. Environment Act states that:

"Contaminated land is any land which appears to the local authority in whose area it is situated to be in such a condition by reason of substance in, on or under the land that:

(a) significant harm is being caused
**Or**
(b) there is a significant possibility of such harm
**Or**

(c) pollution of controlled waters is being caused
**Or**
(d) is likely to be caused"

The question therefore is "What is significant?" In other words, what level of contamination is acceptable and at what point is it unacceptable? An explanation by the Department of Environment on the basis of harm caused, is as under:

- Chronic or acute toxic effect, i.e. serious injury or death to humans
- Irreversible or other adverse change in functioning of an ecological system
- Substantial damage to or failure of building
- Disease or other physical damage or death of livestock or crops kept, reared or grown on the land in question or adjacent land such that there is a substantial loss in their value.

Thus the effect of contamination on human heath, certain protected ecological systems, property in the form of crops-livestock-buildings-plant &machinery and controlled waters must be considered.

The principal causes of contamination of land include:

(1) uncontrolled disposal of industrial, solid and hazardous wastes on land
(2) uncontrolled burning of solid waste on land
(3) improper storing either temporarily or permanently of toxic substances/wastes, discarded chemicals, industrial reject materials
(4) deposition of stack emissions and toxic substances during transfer via atmosphere
(5) soil pollution caused by industrial effluents running uncontrolled over the land.

## 1.2 ENVIRONMENTAL DEGRADATION AND STEPS TO RESTORE ENVIRONMENTAL DAMAGE

Our environment is deteriorating for the last two centuries and almost every part of the planet has been touched by it in one way or the other. Environmental pollution refers to the degradation of quality and quantity of natural resources. The primary cause of environmental degradation is human disturbance.

The industrial revolution of 19$^{th}$ century mechanized the production and manufacturing of goods and introduced the use of machinery and other heavy equipments-which in turn, used fuels as source of energy, which deteriorate the environment. The modern technological progress is actually the root cause of the environmental deterioration.

### 1.2.1 CAUSES OF ENVIRONMENTAL DEGRADATION

Different kinds of human activities are the main reasons of environmental degradation. These have led to environment changes that have become harmful to all living beings. The waste products, smoke emitted by vehicles and industries increase the amount of poisonous gases in the air. Unplanned urbanization and industrialization help to increase pollution of the sources of water and have also caused air and sound pollution.

Environmental changes are based on many factors including:

- Urbanization
- Industrialization
- Over-population
- Economic growth
- Deforestation
- Intensification of agriculture
- Increase in energy use
- Increase in transportation.

### 1.2.2 STEPS TO RESTORE ENVIRONMENTAL DEGRADATION

The degradation has adverse impacts on humans, plants, animals and micro-organisms. To cope up with the critical situation, we need to make optimum use and management of resources, sustainable development, adoption of green concept and above all community participation in all developmental activities.

1. **Reform Current Systems : Reformation of the current system with more strict laws towards environmental pollution and degradation must be implemented.**

2. **Promote Green Jobs : Lift people out of poverty and reduce environmental impact at the same time.**

3. **Televise Real-Time Debates and Discussions Among Environmental Experts and Representatives from Other Sectors :** Millions of people are working to solve various environmental crises. They should be heard and others should learn more about the issues from them. TV and internet videos can help reach a wide audience and get people involved. To get the most out of it, these forums would need to be live, unscripted and open to people of diverse backgrounds and opinions.

4. **Abandon ‘Cap and Trade’ System :** The global cap and trade system sets limits on carbon emissions for businesses around the world. It is set up so that the worst polluters can buy “pollution credits” from those who stay under the limit and pollute less. Supporters argue that this not only sets realistic goals to decrease pollution, but economically incentivizes businesses to pollute less. It may sound like a good idea, but there are serious negative consequences to cap and trade.

Another way to deal with pollution would be to hold polluters criminally liable through the justice system for violation of other's property. We each own our lungs and air pollution violates those boundaries. Sufficient penalties make polluting prohibitive so it is phased out and the real costs of healthy goods will become apparent.

5. **Account for Externalized Costs :** Humans rely on nature for their survival. We are threatening all life on this planet without accounting for our impact along the way and tracking how well forests are regenerating, other species are surviving, and water systems are maintaining themselves.

6. **Label Genetically Modified Foods :** There is currently no way to know if your food is genetically-modified despite the fact that there are significant environmental and health hazards associated with GMO's (Genetically Modified Organisms).

7. **Promote Renewable Energy and "New Energy" Technology :** The burning of fossil fuels is polluting the air, fueling war and global conflict, and breeding dependence on oil-rich countries. But efficient, sustainable alternatives exist that can revolutionize the energy industry. Exciting innovations in the solar and wind industries have been emerging in recent years – prices are more competitive; energy generation is more efficient; and adoption is more common worldwide.
   Some of such established strategies include:
   - **Decrease our reliance on oil** and use it to make the transition to renewable alternatives.
   - **Employ alternative energy sources** including wind and solar to power a large portion of the world.
   - **Stop suppressing and further develop "New Energy" resonant technology devices** to make clean, abundant power accessible everywhere.

8. **Phase out, stop or shifting environmentally harmful subsidies: Government should develop strategy for removal of subsidies that are directly or indirectly causing harm to the environment.**

Each year the world's taxpayers provide billions of dollars in subsidies for environmentally destructive activities, such as fossil fuel burning, over-pumping aquifers, clear-cutting forests, and overfishing. This essentially implies that the world is spending lot of money annually to subsidize its own destruction.

One way to correct the situation is **tax shifting** - raising taxes on activities that harm the environment so that their prices begin to reflect their true cost and offsetting this with a reduction in income taxes. A complementary way to achieve this goal is subsidy shifting.

A world facing economically disruptive climate change can no longer justify subsidies to expand the burning of coal and oil. Shifting these subsidies to the development of climate-benign energy sources such as wind, solar, biomass, and geothermal power will help stabilize the earth's climate. Shifting subsidies from road construction to rail construction could increase mobility in many situations while reducing carbon emissions.

In a troubled world economy where many governments are facing fiscal deficits, the tax and subsidy shifts can help balance the books, create additional jobs, and save the economy's eco-supports. Tax and subsidy shifting promise greater energy efficiency, cuts in carbon emissions, and reductions in environmental destruction.

9. **Trusts – A Tool to Manage the Commons :** Land or resources belonging to or affecting the whole of a community are generally referred to as the 'commons'. One compelling way to deal with management of the commons is to create trusts that are designed to protect natural resources for present and future generations. This is already being done in many countries with considerable success. e.g. the Pacific Forest Trust, the Marin Agricultural Land Trust, the Oregon Water Trust.

10. **Set up Systems for Voluntary Co-operation :** The environment varies so much from place to place that it doesn't make sense to have sweeping national solutions to environmental crises. Rather, people should have a say within their community about how to deal with local environmental issues.

## 1.3 REVIEW YOUR UNDERSTANDING

1. Water pollution means
   - A. Level of pollutant is more than the prescribed standard
   - B. Contamination of water
   - C. Alteration of physical, chemical or biological properties of water
   - D. All the above

2. Environmental pollution means
   - A. Presence of any pollutant in environment which causes adverse impact on human health and ecosystem
   - B. Alteration of characteristics leading to degradation of quality of environment
   - C. Presence of pollutants in any form but in such concentration which may tend to be injurious to environment giving rise to adverse effect on marketability of assets
   - D. All of the above

3. Air pollution means
   - A. Level of pollutant is more than the prescribed standard
   - B. Contamination of water
   - C. Alteration of physical chemical or biological properties of water
   - D. None of the above

4. In which type of contaminant, Noise Pollution is categorized?
   - A. Hazardous and toxic material
   - B. Industrial wastewater
   - C. Physical contamination
   - D. Non–physical contamination

5. State the principal causes of contamination of land.

# MODULE-2

## OUTLINE OF ENVIRONMENTAL LEGISLATIONS

### 2.0. INTRODUCTION

Even before India’s independence in 1947, several environmental legislations existed but the real impetus for bringing about a well-developed framework came only after the UN Conference on the Human Environment (Stockholm, 1972). The UN Conference on Human Environment at Stockholm in 1972 influenced the need for integrated legal mechanism to conserve the natural resources, protect the environment and ensure healthy human life. Under the influence of this Stockholm Declaration, the National Council for Environmental Policy and Planning within the Department of Science and Technology was set up in 1972. This Council later evolved into a full-fledged Ministry of Environment and Forests (MoEF) in 1985 which today is the apex administrative body in the country for regulating and ensuring environmental protection.

Climate change was also an agenda in the ministry (MoEF) but it was explicitly made a priority in 2014 and the ministry was renamed as Ministry of Environment, Forest and Climate Change (MOEFCC) in May 2014.

After the Stockholm Conference, constitutional sanction was given to environmental concerns in 1976 through the 42$^{nd}$ Amendment, which incorporated them into the Directive Principles of State Policy and Fundamental Rights and Duties.

**Constitutional Provisions related to Environment**

Article 21 – Right to pollution free environment

Article 48A - imposes a duty on the State to protect and improve the environment, and to safeguard the forests and wild life of the country.

Article 51A(g) - imposes duty on every citizen to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures.

Since the 1970s, an extensive network of environmental legislation has grown in the country. The MoEF and the pollution control boards (CPCB i.e. Central Pollution Control Board and SPCBs i.e. State Pollution Control Boards) together form the regulatory and administrative core of the sector.

The major legislative measures brought about in India for protection of environment and human health can be broadly grouped into the following categories:

(i) Water
(ii) Air
(iii) General (Environment Protection)
(iv) Forest and Wildlife
(v) Industrial Health and Safety.

Some of the major legislations emphasised in this study material include:

1. The Water (Prevention and Control of Pollution) Act, 1974
2. The Water (Prevention and Control of Pollution) Cess Act, 1977
3. The Air (Prevention and Control of Pollution) Act, 1981
4. The Environment (Protection) Act, 1986.

The Water Act provides for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water. Apart from the Water Act which deals with the prevention & control of water pollution and the Air Act which is concerned with the prevention-control-abatement of air pollution, the Environment (Protection) Act-1986 was enacted to be a comprehensive legislation for the protection and improvement of environment and for matters connected therewith. The scope and definition of 'Environment' was expanded to include water, air and land and the interrelationship which exists among and between water, air and land, and human beings, other living creatures, plants, microorganisms and property. The Environment Protection Act also provides for handling of hazardous substances. Under this Act, the statutory powers are mostly conferred on the Central Government. However, the Central Government is vested with the power of delegating the powers under the provisions of the Act to an Authority constituted or to the Authorities to be specified with the residuary power retained in them.

The Water (Prevention and Control of Pollution) Cess Act, 1977 was passed by Parliament to provide for the levy and collection of cess on water consumed by persons with a view to augment the resources of the CPCB and the State Pollution Control Boards. This Act by giving 70% rebate to the scheduled industries encourages the industries to take up serious measures to control pollution in accordance with the conditions laid down under the Water Act, 1974.

This financial incentive is in addition to the already existing financial incentives given to the industries under the Income Tax Act as well as subsidies on clean manufacturing technology and pollution control given by certain State Governments. These incentives vary across States depending on their respective industrial policies. Earlier, service tax exemption was given on services provided by way of construction, erection, installation, commissioning, completion, fitting out, repair, maintenance, renovation or alteration of pollution control or effluent treatment plant *except when located in a factory*.

### 2.1 THE WATER(PREVENTION AND CONTROL OF POLLUTION) ACT, 1974

This Act provides for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water. For carrying out above objects, the Act contemplates the constitution of Central Pollution Control Board (CPCB) at the National level and State Pollution Control Boards at State level. The CPCB apart from functioning as a coordinating national level body, also acts as a State Board in respect of the Union Territories. These have since been constituted. This Water Act defines water pollution and prescribes penalties besides establishing administrative machinery like CPCB and SPCB. The Boards are given comprehensive powers to advise, coordinate and provide technical assistance in the prevention &control and abatement of water pollution. These Boards are entrusted with the task of monitoring the state of water pollution in the country and laying down standards of permissible level of pollution.

Any person who wants to locate an industry has to check whether the area in which he wants to locate an industry is in the areas declared under Section 19 of the Water Act or not. In the absence of any notification excluding that area, the Water Act applies throughout the State and therefore the proponent has to conform to the provisions of the Act. In so far as the Union Territory of Delhi is concerned, there is no such exclusion and therefore the Water Act can be enforced in the whole of the Union Territory of Delhi.

Further, under the amended Section 25 of the Water Act read with Section 26, unlike the non-amended sections, it requires previous consent of the State Board to establish or to take any steps to establish any industry. The Boards control sewage and industrial effluent discharges by approving, rejecting or conditioning (like the location, construction and use of the outlets as well as nature and composition of new discharges) the application seeking consent to discharge.

The State Board must maintain and make public a register containing particulars of Consent Order. The Act empowers a State Board, upon 30 days of notice to a polluter, to execute any work required under a consent order which has not been executed. The Board may recover the expenses for such work from the polluter. The students are advised to read Section 25 of the Act. This Act prohibits dumping of poisonous, noxious or polluting matter into the streams and wells, as well as any activity which impedes the flow of the water of a stream. The boards are authorized to take action against polluters by imposing conditions aimed at discouraging pollution and can prosecute the polluter.

It is the duty of valuer to ensure that the occupier of the industry has fulfilled all the obligations under this Act before he makes any transaction of buying or selling of the industrial property under your advice.

This Act was amended in 1988.

**2.1.1 THE WATER(PREVENTION AND CONTROL OF POLLUTION) RULES 1975** and **Amendment Rules 2011** regulate the qualifications and other terms & conditions of the service of the members of the Central Pollution Control Board.

**2.1.2 THE WATER(PREVENTION AND CONTROL OF POLLUTION) CESS ACT 1977** provides for the levy and collection of cess or fees on water consuming industries and local authorities. This cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water Act, 1974. The Act was last amended in 2003.

**2.1.3 THE WATER(PREVENTION AND CONTROL OF POLLUTION) CESS RULES 1978** contains the standard definitions and indicate the kind of and location of meters that every consumer of water is required to affix.

## 2.2 THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

This Act provides for the prevention, control and abatement of air pollution in the nation. This Act mainly regulates and control emissions from automobiles and industrial plants. Under the Air Act, all industries operating within designated air pollution control areas must obtain consent from the State Boards.

The States are required to prescribe emission standards for industry and automobiles after consulting the Central Board as regards the ambient air quality standards. The Central Board for the prevention and control of water pollution is also authorized to implement and enforce the Air Act as well. This body lays down standards for the quality of the air.

Under Section 19, the Central Board is given powers mainly to coordinate the activities of State Boards. Section 19 of the Act contemplates declaration of air pollution control areas. The State Government may, after consultation with the State Board, by notification in the Official Gazette declare any such area for the purposes of the Act. For example, the entire Union Territory of Delhi having been so declared, is in air pollution control area for the purposes of this Act. The Board may prohibit the use of any fuel other than approved fuel in the area causing air pollution.

Under Section 21 of the Air Act, only with the previous consent of the State Board a person shall establish or operate any industrial plant in air pollution control area.

Under Section 22 of the Air Act, any person carrying on any industry or operating any industrial plant in any air pollution control area is prohibited from discharging or causing or permitting to be discharged the emission of any air pollutants in excess of the standards laid down by the State Board.

Further, no person shall, without the consent of the State Board, operate an industrial plant involving industries specified in schedule in air pollution control area.

Under Chapter VI of the Act, the penalties in case of failure in complying with the directions issued under Section 21 or Section 22, is imprisonment for a term which shall not be less than one year and six months but which may extend to six years and with fine, and in case the failure continues, with an additional fine which may extend to five thousand rupees for every day during which such failure continues even after the conviction for the first such failure.

**2.2.1 THE AIR (PREVENTION AND CONTROL OF POLLUTION) RULES, 1982** define the procedures of the meetings of the Boards and the powers entrusted to them.

**2.2.2 THE AIR (PREVENTION AND CONTROL OF POLLUTION) AMENDMENT ACT, 1987** empowers the central and state pollution control boards to meet with grave emergencies of air pollution.

### 2.3 THE ENVIRONMENT (PROTECTION) ACT, 1986

This Act passed by Parliament on 23rd May, 1986 authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and/or operation of any industrial facility on environmental grounds. It also provides for taking appropriate steps for the protection and improvement of human environment, the decisions of which were taken at the United Nations Conference on the Human Environment held at Stockholm in June 1972 in which India also participated. This Act further aims at implementing the decision aforesaid in so far as they relate to protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property.

Section 3(2)(v) confers powers on the Central Government to restrict the area in which any industry, operation or process or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards. By virtue of this Act, the Central Government is empowered to take all needful actions for prevention, control and abatement of environmental pollution. The powers include coordination of actions by states, planning and execution of nationwide programmes and laying down environmental quality standards. The Central Government is also empowered to make rules which may provide for the prohibition and restrictions on the location of industries and carrying on the processes and operations in the different areas.

Section 8 of the Act clearly provides that no person shall handle or cause to handle any hazardous substance except in accordance with such procedure and after complying with such safeguards as may be prescribed.
This Act also includes the power of handling hazardous substances, prevention of environmental accidents, research, inspection of polluting units, establishment of laboratories, dissemination of information etc. A complete set of administration procedure and organization structures are also envisaged under the Act.

Penalty for each contravention of the provision of this Act is imprisonment for a term which may extend to five years or with a fine which may extend to one lakh rupees or with both, and in case the failure or contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention. If the failure or contravention continues beyond a period of one year after the date of conviction, the offenders shall be punishable with imprisonment for a term which may extend to seven years.
This Act was last amended in 1991.

**2.3.1 THE ENVIRONMENT (PROTECTION) RULES, 1986** and subsequent amendments lay down the procedures for setting standards of emission or discharge of environmental pollutants. The Rules prescribe the parameters for the Central Government, under which it can issue orders of prohibition and restrictions on the location and operation of industries in different areas. The Rules lay down the procedure for taking samples, serving notice, submitting samples for analysis and laboratory reports. The functions of the laboratories are also described under the Rules along with the qualifications of the concerned analysts.

**2.3.2 HAZARDOUS WASTE (MANAGEMENT AND HANDLING) RULES, 1989** are framed with the objective to control the generation, collection, treatment, import, storage, and handling of hazardous waste.
Some of the other Rules for hazardous substances management notified by MOEF / MOEFCC include:

- The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules 1996 and Amendment Rules 2015
- The Rules for Manufacture, Use, Import, Export and Storage of Hazardous Micro-organism, Genetically Engineered Organisms or Cells, 1989 (amended 2010)
- Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (and Amendment Rules 2000)
- The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- The Bio-Medical Waste (Management and Handling) Rules, 1998 and (Amendment) Rules, 2003
- Plastic Waste (Management & Handling) Rules, 2011
- Several other Rules notified by the MoEF (*refer* www.moef.nic.in)

**2.3.3 THE PUBLIC LIABILITY INSURANCE ACT, 1991** (amended 1992) and **The Public Liability Insurance Rules, 1991** (amended 1993) - The main objective of these legislations is to provide for damages to victims of an accident which occurs as a result of handling any hazardous substance. The Act applies to all owners associated with the production or handling of any hazardous chemicals.

**2.3.4 THE BIOMEDICAL WASTE (MANAGEMENT AND HANDLING) RULES, 1998** is a legal binding on the health care institutions to streamline the process of proper handling of hospital waste such as segregation, disposal, collection, and treatment.

**2.3.5 THE SOLID WASTE MANAGEMENT RULES, 2016** apply to every urban local body, outgrowths in urban agglomerations, census towns, notified areas, notified industrial townships, areas under the control of Indian Railways, airports, airbases, ports and harbours, defence establishments, special economic zones, State and Central government organisations, places of pilgrims, religious and historical importance as may be notified by respective State government from time to time and to every domestic, institutional, commercial and any other non residential solid waste generator situated in the areas **except** industrial waste, hazardous waste, hazardous chemicals, bio medical wastes, e-waste, lead acid batteries and radio-active waste, that are covered under separate rules framed under the Environment (Protection) Act, 1986.

These rules lay down the duties of waste generators and authorities and the frequency of review of implementation of these Rules at various levels.

**2.3.6 THE CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT RULES, 2016**

The rules shall apply to every waste resulting from construction, re-modeling, repair and demolition of any civil structure of individual or organisation or authority who generates construction and demolition waste such as building materials, debris, rubble.

Every waste generator shall prima-facie be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated.

Local authority shall be responsible for proper management of construction and demolition waste within its jurisdiction including placing appropriate containers for collection of waste, removal at regular intervals, transportation to appropriate sites for processing and disposal.

**2.3.7 THE NOISE POLLUTION (REGULATION AND CONTROL) AMENDMENT RULES, 2002** lay down such terms and conditions as are necessary to reduce noise pollution, permit use of loud speakers or public address systems during night hours on or during any cultural or religious festive occasion.

**2.3.8 WETLAND (CONSERVATION AND MANAGEMENT) RULES, 2010** are notified to ensure better management, conservation and prevention of degradation of existing wetlands.

The **Wetlands (Conservation and Management) Amendment Rules, 2016** decentralise wetlands management by giving states powers to not only identify and notify wetlands within their jurisdictions but also keep a watch on prohibited activities.

**2.3.9 MISCELLANEOUS NOTIFICATIONS**

- The Ozone Depleting Substances (Regulation and Control) Rules, 2000
- Noise Pollution (Regulation and Control) Rules, 2000 as amended till 2010
- Coastal Regulation Zone notifications
- Environmental Clearance and Environmental Impact Assessment notifications (1994 to 2016)
- Environment Standards - industry specific (*refer* www.moef.nic.in)

## 2.4 THE NATIONAL GREEN TRIBUNAL ACT, 2010

This Act provides for the establishment of National Green Tribunal (NGT) for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters.

Both the National Environment Tribunal Act 1995 and the National Environment Appellate Authority Act 1997 were repealed by the enactment of the NGT Act in 2010.

As per the provisions of the NGT Act 2010, the National Environment Appellate Authority (NEAA) established under the NEAA Act 1997 stands dissolved and the cases pending before the NEAA stand transferred to the NGT.

## 2.5 FOREST AND WILDLIFE

### 2.5.1 THE INDIAN FOREST ACT 1927

It is one of the many surviving colonial statutes. It was enacted to 'consolidate the previous laws relating to forests that were passed before the 1920s, the transit of forest produce, and the duty leviable on timber and other forest produce'.

The Act gave the State Government the power to create Reserved Forests, and the right to use Reserved Forests for Government use alone. It also created Protected Forests, in which the use of resources by local people was controlled. Some forests were to be controlled by the village community, and these were called village Forests. The Act remained in force till the 1980s when it was realized that protecting forests for timber production alone was not acceptable. The other values of protecting the services that forests provide and its valuable assets such as biodiversity began to overshadow the importance of their revenue earnings from timber.

This led to the Forest Conservation Act of 1980 and its amendment 1988.

### 2.5.2 THE FOREST (CONSERVATION) ACT 1980 and Rules 1981

The principal objective of this Act is protection of and the conservation of the forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end, the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.

The Act was amended in 1988 and Rules were amended in 1992.

Forest conservation is the planned management of the forest environment to prevent its exploitation, destruction or neglect. There is a need for conservation of forests as population increases rapidly, resources are constantly exploited, pollution is dramatically increasing with respect to time and damages caused by the development activities are irreversible.

Section 2 of this Act requires the approval of Central Government before a State Government "de-reserves" a reserved forest, uses forest land for non-forest purposes, assigns land to private person or corporation or clears forest land for the purpose of reafforestation. In other words, the Act provides restriction on the de-reservation of forest or use of forest land for non-forest purpose. Here, non-forest purpose means breaking up or clearing of any forest land or portion thereof for cultivation of tea, coffee, spices, rubber, palms, oil bearing plant, horticultural crops or medicinal plants or for any purpose other than reafforestation.

But non-forest purpose does not include any work relating to conservation, development and management of forests and wildlife e.g. establishment of check-posts, fire-lines, construction of fencing, bridges, culverts, dams, pipelines, waterholes, pipelines etc.

An Advisory Committee constituted under section 3 of this Act advises the Government with regard to the grant of approval under Section 2 and any other matter connected with conservation of forests.

Whoever contravenes or abets the contravention of any of the provisions of section 2 of this Act, shall be punishable under Section 3A with simple imprisonment for a period which may extend to fifteen days.

Section 4 empowers the Central Government to make rules for carrying out the provisions of this Act by notification in the official gazette.

**2.5.3 THE WILDLIFE (PROTECTION) ACT 1972, Amendment 1993 and Rules 1995** were framed with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Wild Life (Protection) Amendment Act, 2002 was enacted in January 2003 and punishment and penalty for offences under the Act have been made more stringent.

**2.5.4 THE BIOLOGICAL DIVERSITY ACT 2002** and **Biological Diversity Rules 2004** are framed to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge associated with it.

## 2.6 INDUSTRIAL SAFETY AND OCCUPATIONAL HEALTH LAWS

The basic aim of the concerned law making and amending authorities is to devise laws which provide safety standards to protect the basic needs of workers and take care of their welfare. Legislation on occupational health and safety has existed in India for several decades. The principal health and safety laws are based on the British Factories Act.

**The Factories Act 1948, the Mines Act 1952, The Dock Workers (Safety, Health & Welfare) Act 1986 and The Building & Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 are some of the laws which contain provisions regulating the health of workers in an establishment whereas the Employees' State Insurance Act 1948 and the Workmen's Compensation Act 1923 are compensatory in nature.**

Some of the other relevant legislations dealing with occupational safety and health (OSH) are:

- Explosives Act, 1884;
- Dangerous Machines (Regulations) Act, 1923;
- Indian Boilers Act, 1923;
- Petroleum Act; 1934;
- Plantation Labour Act, 1951;
- Indian Atomic Energy Act, 1962;
- Insecticides Act, 1968;
- Radiological Protection Rules; 1971;
- Electricity Act, 2002.

### 2.6.1 THE FACTORIES ACT, 1948

The Factories Act, 1948 (amended in 1987) was enacted with the object of protecting factory workers from subjecting to unduly long hours of bodily strain or manual labour. It lays down that employees should work in healthy and sanitary conditions so far as the manufacturing will allow and that precautions should be taken for their safety and for the prevention of accidents.

The Factories Act, however, is applicable only to factories that employ 10 or more workers; it covers only a small proportion of workers.

The Act defines a 'worker' as any person employed directly or through any agency (including a contractor), whether for remuneration or not in any manufacturing process or in any work incidental to or connected with the manufacturing process. It is required that work performed should be connected with the product which is produced in the manufacturing process.

This Act is enforced by the State Governments through factory inspectors.

### 2.6.2 THE MINES ACT, 1952

This is an Act to amend and consolidate the law relating to the regulation of labour and safety in mines (coal, metal and oil) and extends to the whole of India.

The significant obligations under the Mines Act and the Mines Rules, 1955 include the formation of safety committees in every mine where more than 100 persons are employed; providing a notification of accidents and the appointment of workmen's inspectors by the manager (one inspector for every 500 miners).
The Act states that adolescents (not completed 15 years) are prohibited from any mining operation; the initial and periodical examination of miners is to be conducted and notice has to be provided for any notifiable diseases.

The Directorate of Mines is empowered to undertake safety and occupational health surveys in the mines and the central government is empowered to appoint a "competent" person for inquiring into the occupational diseases that have been detected.

### 2.6.3 THE DOCK WORKERS (SAFETY, HEALTH & WELFARE) ACT, 1986

This Act regulates health, safety, welfare and other working conditions of employees in ports and docks with an emphasis on reducing accident rates on ports and docks.

**THE DOCK WORKERS (SAFETY, HEALTH & WELFARE) RULES, 1990** apply to all major ports in India as defined in the Major Ports Act, 1963.

### 2.6.4 THE BUILDING AND OTHER CONSTRUCTION WORKERS (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996

This is an Act to regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures and for other matters connected therewith or incidental thereto Section 47 contains penal provisions for contravention of provisions regarding safety measures under the Act.

**(1)** Whoever contravenes the provisions of any rules made under section 40 shall be punishable with imprisonment for a term which may extend to three months, or with fine which may extend to two thousand rupees, or with both, and in the case of a continuing contravention, with an additional fine which may extend to one hundred rupees for every day during which such contravention continues after conviction for the first such contravention.

**(2)** If any person who has been convicted of any offence punishable under sub-section (1) is again guilty of an offence involving a contravention or failure of compliance of the same provision, he shall be punishable on a subsequent conviction with imprisonment for a term which may extend to six months or with fine which shall not be less than five hundred rupees but which may extend to two thousand rupees or with both:

Provided that for the purposes of this sub-section, no cognizance shall be taken of any conviction made more than two years before the commission of the offence for which the person is subsequently being convicted.

### 2.6.5 THE WORKMEN’S COMPENSATION ACT, 1923

This Act creates legal obligation on the employer to pay compensation to workmen involved in accidents arising during the course of their employment. The objective of the Workmen’s Compensation Act is to make provision for the payment of compensation to a workman only, i.e., to the concerned employee himself in case of his surviving the injury in question and to his dependants in the case of his death.

The prerequisites for payment of compensation to such injured workmen are as follows:

- Personal injury must be caused.
- There must be temporary, total or partial disablement due to an accident, which also includes occupational diseases.

The State Government is to appoint a Commissioner to decide the liability of an employer to pay compensation, the amount and duration of compensation, among other issues. An appeal may lie to the High Court in case the applicant has grievance against the Commissioner's orders.

Compensation is decided on the nature of injury caused. Where the injury from an accident results in the death of the workman, the minimum compensation payable is around Rs.50,000 and the maximum may extend to Rs.3 lacs. In case of permanent total disablement and permanent partial disablement, compensation may extend to Rs.60,000, depending on its nature. Further the amount of compensation is calculated on the wage-group to which the workman belongs and the time-period for which he has worked

### 2.6.6 THE EMPLOYEES' STATE INSURANCE ACT, 1948

It is a social welfare/security legislation enacted with the object of ameliorating various risks and contingencies sustained by workers while serving in a factory or establishment.

It is designed to provide cash benefit in the case of sickness, maternity and employment injury, payment in the form of pension to the dependents of workers who died of employment injury and medical benefit to workers. It recognizes the contributory principle against such contingencies, provides protection against sickness, replaces lumpsum payments by pension in the case of dependents benefit and places the liability for claims on a statutory organization.

The Act lays down provisions to set up an ESI Corporation, to promote measures to improve health and welfare of insured persons and a Medical Benefit Council to advise the Corporation on medical benefits, certification, etc. The Medical Boards have to ascertain the percentage of disability of injured workers before submitting their report to the Corporation in order to grant compensation to the workers.
Section 39 of the Act makes the employer primarily liable for the payment of contribution on behalf of himself and his employees towards the ESI Fund.

In case of misuse of the contribution by employer, the employee can sue the employer in the Employees' State Insurance Court set up by the respective State Government.

## 2.7 REVIEW YOUR UNDERSTANDING

1. In which year was the Stockholm Conference held?
   A. 1992
   B. 1972
   C. 2005
   D. 1872
2. What was the objective of Stockholm Conference?
   A. Preservation and improvement of natural resources and wildlife
   B. Preservation and improvement of human environment
   C. Preservation and improvement of forest and natural environment
   D. None of the above
3. Which Act, expanded definition of “environment” to include water, air, land and the interrelationship which exists among and between water, air, land and human other living being and property?
   A. The Water ( Prevention and Control of Pollution) Act, 1974
   B. The Water ( Prevention and Control of Pollution ) Cess Act, 1977
   C. The Air (Prevention and Control of Pollution) Act,1981
   D. The Environment ( Protection) Act, 1986
4. Which Act provides for maintaining the wholesomeness of water in the nation?
   A. The Water (Prevention and Control of Pollution) Act, 1974
   B. The Water (Prevention and Control of Pollution ) Cess Act, 1977
   C. The Air (Prevention and Control of Pollution) Act,1981
   D. The Environment (Protection) Act, 1986
5. Which one is said to be non-forest use under Forest Conservation Act?
   A. Construction of fencing
   B. Construction of Check post
   C. Plantation of tea
   D. Clearing up portion of forest land
6. The penalty imposed for contravention of Forest Conservation Act,1980 is
   A. Maximum 15 days of simple imprisonment
   B. Maximum 30 days of simple imprisonment and fine
   C. Minimum 15 days of simple imprisonment and a fine
   D. One year simple imprisonment and Rs.10000/- fine

7. The Advisory Committee constituted under Forest Conservation Act advises
   A. State Government on any matter of forest management
   B. As regards approval of government grants
   C. In recruitment of staff for forest resources
   D. All of the above
8. Discuss the provisions of the Forest Conservation Act, 1980

# MODULE-3

## VALUATION OF ENVIRONMENTALLY AFFECTED PROPERTY

### 1.0 INTRODUCTION

The objective of studying environmentally affected property is to provide guidance to the valuers in preparing valuation brief when environmental factors may have influence on the asset values.

The environmental factors which are important in asset valuation are those which are potentially detrimental to real property and plant & machinery. These may be on account of environmental factors like gases, heat, radiation, noise, vibration, chemicals, hazardous substances as well as odour impacting air, water, groundwater, soil and having direct or indirect effect on the individual asset. The assets may be important from the aesthetic, archaeological, historical and heritage point of view and may belong to the private sector or to the Government.

### 3.1 CONTAMINATED PROPERTY

When the buyer is devoid of the property rights i.e. the exclusive rights partly or fully to possess, enjoy, dispose etc. due to contamination, the property is said to be contaminated. In other words the environmental factors play their role in interference of the property rights. They create an indirect restraint in the use of property owned. When the contamination can result or is likely to result or has already resulted in the diminished utility of the property, the property is said to be contaminated. It is immaterial whether the diminished utility is for a short-term or long-term duration.

The monetary value of the contaminated property is always diminished. This is because the term monetary value has its basis in economics. The monetary value of the property is determined in the market where there are buyers and sellers and when there is a supply and demand of these goods and services.

### 3.2 ENVIRONMENTAL CONTAMINATION

Broadly, environmental contamination has been divided into two types, viz. Physical contamination and Non–physical contamination.

### 3.2.1. PHYSICAL CONTAMINATION

Physical contamination is on account of presence of physical contaminants in the environment. Physical contaminants are substances present in, on or near a subject property in measurable quantities and identified as having harmful environmental impact. It also includes substances which are hazardous i.e. ignitable, corrosive, toxic or reactive.

A hazardous substance is any substance or preparation which by reason of its chemical or physico-chemical properties or handling is liable to cause harm to human beings, other living beings, plants, microorganisms, property or the environment which has an adverse effect on marketability of the assets.

In ordinary words, the physical contaminants are those contaminants which may bring change resulting from human perception. These may include asbestos, heavy metals such as lead, mercury or mining products like arsenic, cyanide, pesticides or organic compounds like formaldehyde, coal tar from coal used in power house operations etc.

### 3.2.2. NON-PHYSICAL CONTAMINATION

Non-physical contamination is the result of non-physical contaminants present in the environment. Contaminants that have no tangible physical substance are defined as non-physical contaminants. In other words, all contaminants other than physical contaminants are non-physical contaminants. These contaminants are in many forms and are considered as 'real' as the physical contaminants. Illustrations include – proximity to noise sources often diminishes utility and therefore property value, or electromagnetic radiation originating from nearby power lines or radio-wave transmission devices.

### 3.3 CONTAMINATED SITE

As defined by the Contaminated Sites Management Working Group of Treasury Board of Canada Secretariat, a contaminated site is that at which, substances occur at concentrations (1) above background levels and pose or are likely to pose an immediate or long term hazard to human health or the environment, or (2) exceed levels specified in policies and/or regulations.

The Canadian Council of Ministers of the Environment has developed a national classification system for contaminated sites (NCSCS, 2003) to provide a basis for classifying sites according to their current and potential adverse impact on human health and environment. According to their priority for action, contaminated sites are placed into classes one to five, namely:

**Class-1**: **High Priority for Action**– available information (assessment) indicates that action (*e.g.*, further site characterization, risk management, remediation, etc.) ‘is required’ to address the existing concerns for public health and safety.

**Class-2**: **Medium Priority for Action**– available information (assessment) indicates that there is a high potential for adverse impacts due to off-site migration, although threat to human health and the environment is generally not imminent. Action is ‘likely required’.

**Class-3**: **Low Priority for Action**- available information (assessment) indicates that the site is currently not a high concern. However, additional investigation may be carried out to confirm the site classification and some degree of action ‘may be required’.

**Class-N : Not a Priority for Action** - available information (assessment) indicates that there is probably no significant environmental impact or human health threats and there is action ‘not likely required’ unless new information becomes available indicating greater concerns when the site be re-examined.

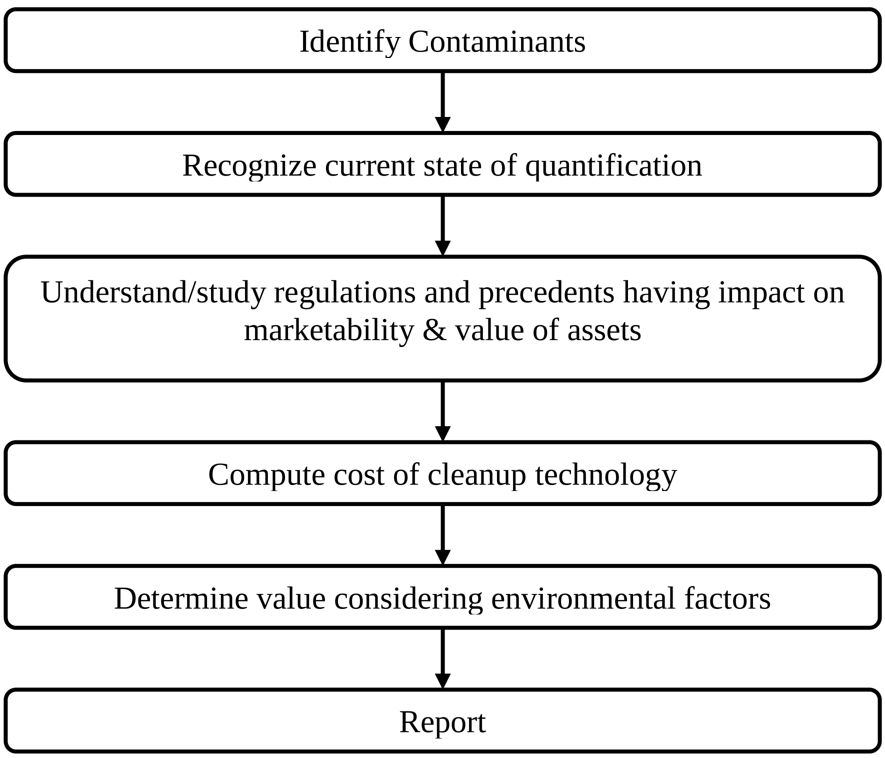
**Class-I** or **INS : Insufficient Information** – some initial site assessment action has been taken but there is insufficient information to classify the site and additional information is required.
NCSCS is a tool specifically for the classification and prioritization of contaminates sites. The system screens sites with respect to the need for further action (e.g. characterisation, risk assessment, remediation, etc.) to protect human health and environment.

## 3.4 CONCEPT AND PRINCIPLES OF VALUATION OF ENVIRONMENTALLY AFFECTED PROPERTY

The ‘Environmental Impact Assessment' subject addresses the impact of environmental contamination on asset value. To understand such effect, valuers must have knowledge on the following aspects:

- CONTAMINANTS: The substances, contaminants or conditions currently thought to produce contamination.
- DETECTION, MONITORING and ABATEMENT: Recognizing the current state of detection, monitoring and abatement technology.
- LEGAL STATUS: Understanding the legal state of current regulations and court decisions (precedents) which have greater impact on the marketability and value of asset.
- HAZARDOUS SUBSTANCES: List of the substances that are hazardous and their level of concentration which are considered harmful, their clean up technology and such other treatments.
- REMEDIATION: The effect of technology that facilitates safe and efficient clean-up of contaminant and help in minimizing or reducing the stigma value (negative value).However, the cost factor must be identified. It may include :
  (1) Cost of Physical clean up, and
  (2) Continued costs of monitoring and legal costs.

Schematic block diagram showing important aspects that valuer must know for valuation of contaminated property.



## 3.5 LIABILITY OF VALUERS AS TO CONTAMINATION

Public or residents near nuclear power plants may not be aware of potential effect of radon gas emitted from such plants. Similarly, public may not be aware of potential impact of electromagnetic radiation from proximity to overhead power distribution lines of transmission towers or about hazards associated with the use of asbestos as construction material. But the valuers must be aware of the impact of such environmental factors as applicable to valuation of assets. The valuer is also liable for value determination and valuation calculations considering environmental factors while ultimate preparation of valuation of assets - may it be for financial statements, market value estimates, security against loan and all such other purposes.

Valuers should have primary knowledge as to quality of data of site which may include:

- ✓ Proposed use of data/ information
- ✓ Nature of adjacent land or similar type of assets.
- ✓ Source(s) of contamination and elimination if possible by substitute
- ✓ If elimination not possible, temporary measures as to how to cover it to make the property fit for use.
- ✓ Mitigation of contamination by optimum use of technology

Valuers are also required to encompass the substantial report on environmental factors considered while preparing valuation of assets in the valuation report. A detailed report in a clear narrative text must be prepared. It must delineate each factor identified, its concentration and its impact on property, level of mitigation and cost of removal of stigma on the property under consideration.

## 3.6 APPOINTMENT OF AN ENVIRONMENTAL EXPERT

A valuer is unlikely to have knowledge or skills to undertake an environmental audit in accordance with the Environment (Protection) Act-1986 or guidelines given by the Ministry of Environment and Forests, New Delhi. However, valuers may employ environmental expert or client may appoint a suitable consultant. But in any case, valuers must have primary knowledge as to the quality of data regarding the subject site and its proposed temporary or permanent use.

Amongst the other items which might be introduced in brief are:

a) Can the source of contamination of hazard be successfully eliminated economically?

b) If the contamination of hazard cannot be entirely eliminated, can it be converted or contained so as to make the property fit for a particular use? or

c) Is it possible to mitigate the effect of the contamination of hazard in any way?

The expert's report then covers the following:-

- ⇨ Identification of hazard, its degree and extent. (i.e. identification and qualification)
- ⇨ Treatment, measured to be taken to bring the property to acceptable condition.
- ⇨ Cost of such measures (and effects of any such works undertaken).

**3.6.1 SAFEGUARDING THE VALUER- TEMPORARY MEASURE**

If a consultant is not appointed, the standard clause for safeguarding valuers from legal implications can be written as under:

"We have neither made any attempt nor arranged for any investigation to be carried out to determine whether or not any deleterious or hazardous material has been used in the construction of this property and we are therefore unable to report that property is free from risk in this respect. For the purpose of this evaluation, we have assumed that such investigation would not disclose the presence of any such material to any significant extent."

**3.7 REVIEWING YOUR UNDERSTANDING**

1. In which type of contaminant Chromium is categorised?
   - Domestic wastewater
   - Industrial wastewater
   - Physical contamination
   - Non-physical contamination

2. The objective of environmental valuation is
    - preparing valuation brief for the client
    - determining the value of the assets in conditions of contamination
    - determining the factors of the contamination
    - none of the above

3. A valuer is likely to have
    - knowledge or skills to undertake an environmental audit
    - knowledge of hazardous material present in the property
    - primary knowledge as to the quality of data regarding site
    - none of the above

4. List the various physical and non-physical contaminants.

5. Define contaminated land and contaminated property and discuss their ingredients

6. State the principal causes of contamination of land.

7. Define contaminated site and contaminated land and bring out causes of the same.

8. Show by a block diagram the important aspects the valuers must know for the valuation of contaminated property.

# MODULE-4

## GENERAL EFFECTS OF CONTAMINATION OF PROPERTY

### 4.0 INTRODUCTION

Valuation is the act of determining the value of the asset which is based on its quality, nature and utility which includes all forms of rights and interest arising out of the asset. The impacts of the presence of the contaminants normally lead to value diminution compared with open market price. The impact therefore means change in the value of the assets on account of presence of contaminants.

Impacts can be short term or long term depending upon the persistence or duration of the impacts. It is necessary to identify the short term and long term impacts because its significance is based on duration it remains on the environment. The loss of grass or other low lying herbaceous vegetation on a particular property is a short term impact because the said property can be re-vegetated through seeding and manure in a relatively short period of time. The loss of value of the asset therefore in such cases is temporary or short term. But the loss of a mature forest can be considered as a long term impact because of the time required to re-forest the area and for the trees to reach maturity. The loss of the value of the asset in such cases is permanent or long term.

### 4.1 GENERAL EFFECTS OF CONTAMINATED PROPERTY ON VALUATION

The property market as such has now become sensitive to various detrimental effects on account of contamination caused to the assets. The general effects of contaminated property on its valuation can be enumerated as under:

**FALL OF DEMAND**

The demand of the contaminated property falls because normally no buyer will be interested to purchase such a property when non-contaminated property is available in the market. Fall of demand and fall of price of a property is due to the stigma. ‘Stigma’ is intangible factor. It may not be measurable in terms of remediation cost or cost to cure but certainly affects market value.

#### 4.1.2. FALL OF PRICE

The buyer may demand discount on account of contamination. The discount demanded may or may not be in proportion to the level of contamination. It is otherwise also obvious that fall of demand leads to fall of price.

#### 4.1.3 ASSETS OFF THE MARKET

Some companies in absence of the market data on contaminated assets believe that assets would not be sold at any price and such companies keep the assets off the market.

Normally, valuers keep themselves abreast of the market price of the various assets and they would however be deprived of such important information when the assets are contaminated. It has been observed that valuers find it very difficult to collect the data about contamination and analyse them for the valuation purposes.

#### 4.1.4 RISK OF LAW SUITS

It is a substantial fact that the companies have fear that buying a contaminated asset may create contingent liabilities associated with law suits. If the subject property has used any hazardous material in construction and the valuer has not taken into consideration the impact of such materials while preparing valuation brief, there are chances that litigation may take place on account of carelessness on the part of the valuer. It may attract various criminal offences like cheating and thereby dishonestly inducing delivery of the property or offence on account of using as genuine a forged document which was known to the valuer to be forged.

Thus litigation is likely to take place against the seller or valuer and it may be difficult to prove innocence of the seller or the valuer as regards the knowledge of the presence of the contaminant(s). As a result, both the seller may refrain from buying and the valuer from valuing such contaminated property.

#### 4.1.5 REDUCED MARKET VALUE

Whenever stigma is attached, the property remains in less demand even though complete clean-up has been established. This creates situation similar to the ‘obsolescence’. This is because the market will pay less for a once-contaminated but now restored property; the value of the property is diminished. Thus, an effect of this nature may be for some temporary period and efforts should be made to re-establish the market for that restored property.

Even though the water from a previously contaminated well now meets all environmental standards, the property value remains reduced till the seller builds a new well in different location or establishes an independent alternate water supply.

If the property owner makes no attempt to overcome the stigma and thereby accepts a lower price for the property, the price may not accurately reflect market.

#### 4.1.6 DIFFICULTY IN GETTING FINANCE

It is difficult to mortgage and get finance on contaminated properties especially when the property is known to be contaminated. This is so because the return on investment on such property is believed to be such that the finance companies foresee risk in funding project on such contaminated land.

#### 4.1.7 DIFFICULTY IN GETTING FUNDS FOR REMEDIATION

For a contaminated property, remediation is most essential to enhance its utility. Remediation means that act or process of eliminating environmental contamination from, on, in or under the asset to restore the asset to an uncontaminated state. It is also difficult to obtain additional funds for remediation. Even the funds are made available by some finance companies after many efforts. It can be concluded that such properties may increase the borrowing liabilities.

### 4.2 COST TO CURE

Cost is defined as a resource sacrificed or forgone to achieve a specific objective. Cost is considered as monetary amount that must be paid to acquire goods and services. Thus for combating the problem of contamination, some ‘costs’ are attached to acquire that objective. The cost comprises of Direct Costs and Indirect Costs.

Direct costs are those related to the particular cost object that can be traced to it in an economically feasible way.

Indirect costs are those related to the particular cost object but cannot be traced to it in an economically feasible way.

Broadly, costs arising from contamination are those costs which are related to either controlling the contamination or repairing the contaminated part of the property. Other costs are associated while the part property is under remediation and part is in use like operating, disruption, utility, stigma and so on.

### 4.1 STIGMA DUE TO ENVIRONMENTAL FACTORS - INTANGIBLE COST

The loss in property value resulting from a property's bad reputation on account of contamination is defined as 'Environmental Stigma'. As an intangible negative input factor, stigma is a market-imposed penalty that can affect a property that is known to be contaminated.

Thus, it must be borne in mind that the value of contaminated property ultimately depends not only on the extent of the contamination but also the way in which the contamination is perceived.

The reluctance of potential buyers to take on a once contaminated property because of fears of future liability and fears of hidden clean-up costs are intangibles that are difficult to translate into quantifiable costs.

Stigma may not be measurable in terms of cost to cure but may affect the market value when it is determined through sales comparison approach. According to Advisory Opinion (AO-9) in Uniform Standards of Professional Appraisal Practice (USPAP 2016-17) of the Appraisal Foundation-USA, **Environmental Stigma** is 'as an adverse effect on property value produced by the market's perception of increased environmental risk due to contamination'.

Environmental stigma is market imposed activity which has direct bearing on property value on following type of properties:

- **Environmentally contaminated property or source site**– these properties are absolutely known to be contaminated and market is not in a position to hide or make them off the market.
  These properties have adverse effect on value produced by the market perception of increased environmental risk due to contamination.
  Non-source sites are sites onto which, contamination generated from a source site has migrated.

- **Environmentally suspected property**-these are as such suspected to be contaminated and confirmatory reports are not available. These properties contribute stigma on account of following reasons:
  1. Risk of the remediation costs which are hidden
  2. Trouble factor
  3. Fear of future law suits
  4. Lack of saleability and mortgage-ability.

- **Environmentally remediated property**-these are the properties once known to be contaminated and remediation work is completed and now free from contamination. These properties contribute stigma due to following risks:
  1. Risk about its absolute remediation
  2. Risk of additional clean up in future and
  3. Risk of unexpected perception

- **Environmentally adjacent or proximate property/site** - these are the properties which were never contaminated but they are located in proximity to a contaminated property. Adjacent property shares a common property line with the source site. These properties are never reported to be contaminated but the stigma is attached to them as they are likely to be contaminated because they are believed to be very near to hazardous waste.
  Such property however can only be determined by people’s perception and cannot be generalized.

  While non-source sites are themselves also contaminated, adjacent and proximate sites in the neighbourhood are not contaminated but are affected by stigma.

## 4.4 COST TO CONTROL

Controlling a hazard encompasses both controlling by Systematic Operation & Maintenance and renovation which may include taking suitable steps to mitigate the impact of contamination on the assets. In short, it is the gross cost for controlling a hazard in a property.

## 4.5 COST TO PUBLIC LIABILITY

A toxic substance can destroy the life or it may tend to harm the health of a living animal or plant. Every substance has the ability to act as either a poison or a remedy, including water. The dose and the duration of exposure generally determine whether the given substance has harmful or beneficial effects. Toxic contamination may give rise to public liability. This cost is required to be incurred as the public at large is affected. The unanticipated release of toxic gases or flumes or contaminants onto the surrounding property may lead to substantial public liability. Discharge of improperly treated effluent may pollute the water body and presence of any toxic substance may get entry in the user of the said water body.

Public liability leads to a loss in property value because of following two reasons:

(a) The owner has to pay the costs related to the release of the toxic contaminants onto the surrounding properties and

(b) The owner may have to defend law suits associated with contamination. e.g. When contaminants penetrate into the ground water which is used for public water supply scheme.

## 4.6 COST TO DISRUPTION

The cost of disruption is cost of disturbance experienced during the remediation stage. This is indirectly the cost of remediation due to disrupted use of property on account of contamination. This is a fact that during the remediation period, a part of the property which is absolutely free from contamination can be used whereas the remaining part remains under renovation. The cost of disruption is due to trouble in operation temporarily or permanently due to contamination.

Cost to disruption is remediation cost e.g. Asbestos removal from office may require renovation expenses. Broadly the cost of disruption includes:

- removal of contamination from the subject property
- disposal of contaminant to the safer location like landfill site or incinerator site
- renovating the part of the property
- displacement of occupant/tenant, if any, and bringing other tenants

It is difficult to determine the cost of disruption. We may however estimate the profit from a business before disruption and after disruption.

## 4.7 COST TO OPERATION

Contamination may result into increase in operation and maintenance costs. This is because contaminated property may need extra supervisory personnel, additional testing, careful monitoring as well as security.

Similarly, special insurance of the property during remediation process, higher utility expenses like special ventilation system and the general & administrative expenses also ultimately increase.

## 4.8 COST TO UTILITY

This is the cost when the property cannot be fully utilized by the owner on account of contamination. The plans have been made for remediation. But the sanction of the plans has not yet been received. In other words the property is used partially. Thus cost to utility is due to lack of utility. Some portion of the property is under 'non-use' stage and cannot be utilized for the purpose for which it was contemplated.

Cost to utility can also be defined as deferred utility. Deferred utility indicates that the value of the property will be raised in future. This has obviously, therefore, a direct impact on the property value. Any contaminated property will show some impairment in its utility and thus value is affected.

Though the cost of utility and the cost of disruption apparently seem to be the same, it is not so. The cost to disruption is due to the remediation taking place in the property. No portion of the property is under 'non-use'. Cost to utility is prior to remediation. No option is available except waiting for the sanction from the authority and keeping the part of the property under 'non-use'. This normally happens when the contamination is quite less and the property has still substantial utility.

### 4.9 REDUCED REVENUES

When a contaminated property is given on rent, the rental value gets reduced. In other words, the net income gets diminished. This is so because the contaminated property as seen earlier under the head 'Operation & Maintenance Cost' will increase the operating expenses. The rent receivable will be reduced when the operating expenses are deducted from gross rent.

Sometimes the revenue may be found reduced though there is no contamination. This happens during the transition period when the building permit is awaited from the competent authority and tenants have feelings that the property is lightly contaminated. During this period it may be difficult to attract the tenants.

### 4.10 FORMAT OF VALUATION REPORT OF CONTAMINATED PROPERTY

In the profession of valuation, the format for valuation reports depending upon the purpose, are available or have been prescribed e.g. by Rule 8-D, Form No.O-1 under the Wealth Tax Act, 1957. Nevertheless, a concise format for valuation report on contaminated assets is not prescribed by any of the authority. Environmental Site Assessment (ESA) is the tool for valuation of the contaminated assets.

The format given below is purely for the guidance of the valuers and may be altered as per requirements. However, following minimum essential ingredients may be incorporated.

- **Basic Information of Contaminated Property**
  Name of the contaminated property valued, postal address of the site and details of the environmental agency including qualifications of environmental professional should be stated in the beginning of the report.

- **Introduction of Valuer and the Environmental Agency**
  This should bring out the summary of the terms and conditions under which the valuer has assigned the job to the environmental agency. Based on the purpose of the valuation, methodology used can be determined for ESA. This should be reflected under the head of 'Introduction'.

- **Major Elements in a valuation report for contaminated assets**
  The major components in a valuation report for contaminated assets should be stated under the following heads:
  - detailed site description and record studies
  - interviews and environmental site reconnaissance
  - inventory quantification of the contaminants
  - legal requirements
  - abatement technology
  - valuation process findings and conclusion followed by declarations

**4.11 REVIEW YOUR UNDERSTANDING**

1. The demand of the contaminated property falls as
   A. The seller is ready to sell at a lower rate
   B. Buyer is not interested in purchasing contaminated property
   C. Buyer has option of purchasing non-contaminated property
   D. None of the above
2. Which one is not environmental risk?
   A. Additional risk in financing
   B. Additional risk in buying
   C. Additional risk in investing
   D. None of the above

3. Which one is incorrect with reference to environmental stigma?
   A. Stigma is difficult to be explained
   B. Stigma is difficult to measure
   C. Stigma is equal to cost to cure
   D. None of the above
4. Environmentally contaminated property is
   A. Property known to be contaminated and market is not in a position to hide
   B. Property known to be contaminated and market is in a position to hide
   C. Property is suspected to be contaminated and confirmatory reports are not available
   D. None of the above
5. Environmental suspected property is
   A. Property known to be contaminated and market is not in a position to hide
   B. Property known to be contaminated and market is in a position to hide
   C. Property is suspected to be contaminated and confirmatory reports are not available
   D. None of the above
6. Environmentally remediated property is
   A. Never contaminated property
   B. Known to be contaminated and remediation work is completed
   C. Property is suspected to be contaminated and confirmatory reports are not available
   D. None of the above
7. Environmentally adjacent property is
   A. Never contaminated property
   B. Property which was never contaminated but are located in proximity
   C. Property is suspected to be contaminated and confirmatory reports are not available
   D. None of the above
8. Define environmental stigma. Explain whether environmental stigma is equivalent to the cost to cure.
9. Explain the word 'Environmental stigma' and discuss its bearing on different types of properties.

10. Cost to control is
   A. The gross cost of controlling a hazard in a property
   B. The cost of breaking the routes of chemical absorption
   C. The cost of remediation
   D. None of the above
11. In some of the industries, notices are displayed as regards protection from hazards at the work. What type of cost is it?
   A. Cost to reduce revenues
   B. Cost to utility
   C. Cost to control
   D. None of the above
12. The hazardous chemical enters normally by three routes. Which one is false from the options given below?
   A. Inhalation
   B. Dermal
   C. Ingestion
   D. Contact
13. Surveillance is examination of hazardous processes.
   A. Daily
   B. Periodically
   C. Annually
   D. None of the above
14. Providing isolation of risk from transportation of hazardous material forms
   A. Control by renovation
   B. Control by remediation
   C. Control by O & M
   D. None of the above
15. Public liability leads to a loss in property value because
   A. The owner has to pay the costs related to release of the toxic contaminants onto surrounding properties
   B. The owner has to control hazards by O & M programme
   C. The owner has to incur the expenses on administrative control
   D. None of the above

16. The duration of the operating cost is
    - A. For the specific period
    - B. Frequently occurring
    - C. Twice in a year
    - D. None of the above
17. Write short notes on followings:-
    - A. Cost to disruption
    - B. Cost to utility
    - C. Cost to reduced revenues

# MODULE-5
## ENVIRONMENTAL VALUATION TECHNIQUES

### 5.0 INTRODUCTION

The existence of contamination is a factor that affects the highest and best use (HABU) of a subject property and the valuer should analyse the contamination's impact on the use of subject property. Contamination or the risk of contamination can result in a diminished utility for a property and the type of impact (short or long term) will determine the particular valuation techniques to be applied. These impacts include (*source: Appraisal Guidelines – Environmental Impacts, Public Works and Government Services, Canada, 1998*):

- Cost of controls (remediation)
- Change in operating costs
- Limitations in maximum income that could be anticipated, and
- Loss of marketability due to public perceptions of increased risk (stigma).

<u>The valuer should understand that the value of a contaminated property may not be measurable by simply deducting the remediation costs from the value as-if unaffected</u>. Other factors may influence value and must be considered, including the impact of stigma and the possibility of change in highest-and-best use as well as potential income.

The following are some of the specialised terms and definitions given in AO-9 of USPAP (2016-17) that are relevant for contaminated property valuation.

- **Unimpaired Value:** The market value of a contaminated property developed under the hypothetical condition that the property is not contaminated.

- **Impaired Value :** The market value of the property being appraised with full consideration of the effects of its environmental condition and the presence of environmental contamination on, adjacent to, or proximate to the property. Conceptually, this could be considered the "as-is" value of a contaminated property.

- **Diminution in Value (Property Value Diminution) :** The difference between the unimpaired and impaired values of the property being appraised. This difference can be due to the increased risk and/or costs attributable to the property's environmental condition.

- **Remediation Cost:** The cost to cleanup (or to remediate) a contaminated property to the appropriate regulatory standards. These costs can be for the cleanup of on-site contamination as well as mitigation of off-site impacts due to migrating contamination.

When the appraiser addresses the diminution in value of a contaminated property and/or its impaired value, the appraiser must recognize that the value of an interest in impacted or contaminated real estate may not be measurable simply by deducting the remediation or compliance cost estimate from the opinion of the value as if unaffected (unimpaired value). Rather, *cost, use* and *risk* effects can potentially impact the value of contaminated property.

***Cost effects*** primarily represent deductions for costs to remediate a contaminated property. These costs are usually estimated by someone other than the appraiser, and should include consideration of any increased operating costs due to property remediation. The appraiser should also be aware that the market might not recognize all estimated costs as having an effect on value.

***Use effects*** reflect impacts on the utility of the site as a result of the contamination. If the contamination and/or its cleanup rendered a portion of the site unusable, or limited the future highest and best use of the property, then there could be a use effect on value.

***Risk effects*** are typically estimated by the appraiser and often represent the most challenging part of the appraisal assignment. These effects are derived from the market's perception of increased environmental risk and uncertainty. The analysis of the effects of increased environmental risk and uncertainty on property value (environmental stigma) must be based on market data, rather than unsupported opinion or judgment.

It is an unacceptable practice to assume that environmental contamination will reduce the value of a property without adequate support derived from information in the relevant real estate market.

These three potential effects (cost, use, risk) influence the value of a potentially impacted site according to the following formula:

Impaired value = Unimpaired value
- Cost effects (remediation and related costs)
- Use effects (effects on site usability)
- Risk effects (environmental risk/stigma)

In general, the **unimpaired value of the property** being appraised can be estimated using (i) sales comparison approach, (ii) cost approach and (iii) income approach. Estimating the effects of environmental contamination on real property value usually involves the application of one or more specialized valuation methods.

The **impaired value** of a property that may be impacted by environmental contamination, can **rarely be estimated through one of the traditional approaches to value** due to data limitations and other factors; thus, alternative methods must be utilized but these should also be based on relevant market data.

**Cost effects** are derived from remediation costs, which typically are estimated by environmental specialists. Assuming the market recognizes these costs, the appraiser can usually deduct them as a lump sum from the unimpaired value in a similar manner to a capital expenditure for deferred maintenance. When a discounted cash flow analysis used, the anticipated costs can be deducted from the projected cash flows in the periods in which they are projected to occur. Uncertainty regarding cost estimates, projection, and timing would be reflected in the environmental risk premium added to the unimpaired property or equity yield rate (risk effect).

**Use effects** can be analyzed by estimating the highest and best use of the subject contaminated property in an impaired and unimpaired condition. If the conclusions of the two highest and best use analyses are the same, then there are no use effects on value. If they differ, then the unimpaired and impaired values would be estimated for different uses and compared.

**Risk effects** are derived from the perceived environmental risk and uncertainty related to a property's environmental condition. Measuring this element usually requires more sophisticated and less direct techniques as below:

- Analysis of environmental case studies
- Paired Sales Analysis of potentially impacted properties
- Multiple Regression analysis of potentially impacted neighbourhood areas or properties in proximity to a contamination source
- Market Interviews to collect data and information used in other approaches or to support and supplement the results of other analyses
- Income Capitalisation Analysis - adjustment of income and yield capitalization rates to reflect environmental risk premiums in an income capitalization analysis

Valuing contaminated properties is complex because circumstances are different for each affected property and because sufficient comparable sales may be unavailable, difficult to obtain, or subject to unreasonable or unsupportable adjustments for varying conditions and situations. Nevertheless, as in all other types of property valuation, **three approaches to value are recognized** and should be used (*source :Standard on the Valuation of Properties Affected by Environmental Contamination*, *International Association of Assessing Officers, USA, 2016*).

### 5.1 SALES COMPARISON APPROACH

The sales comparison approach also known as market approach is the systematic gathering, recording and analysing data of similarly affected properties recently sold and comparing sales to the contaminated property being valued. When adequate data exist for similarly affected properties, this approach is considered the most objective and supportable.

The sales comparison approach requires sufficient sales of similar properties. As in the general sales comparison approach **when data on comparable contaminated properties are limited**, the valuer should expand strata, the period from which sales are drawn, and geo-economically defined areas. However, appropriate adjustments must be made to ensure that proper comparability is achieved.

Rather than relying only on the limited data available for similarly contaminated property, **sales of similar uncontaminated (or unimpaired) property can also be used**. In this way a benchmark, unencumbered value can be established for the subject property, after which adjustments can be made for the contamination. Such adjustments should be based on the cost to cure (properly discounted or amortized), imposed limitations on use, increased insurance and financing costs, and potential liability.

This is the process wherein **joint efforts of valuers and environmental expert** are needed. The contribution of the valuer is to undertake valuation of *impaired* property or *as if unimpaired* but comparable in characteristics whereas the contribution of environmental engineer is to compare the contaminant present and the level of contamination of the comparable contaminated properties identified by the valuer with the subject property proposed to be valued.

The following steps are followed in this method:

**Step 1 - Identification of Contaminated Properties**

Identify as far as possible contaminated/impaired properties that are comparable. List the similar characteristics which can be considered comparable.

This involves both impaired / unimpaired properties and the contamination level that are comparable to the subject property. This is the investigation which cannot be exercised only by the valuer. Environmental expert reports about the presence of contaminant and the contamination level of comparable properties and the contamination level of subject property.

**Step 2 - Analyses and Comparison**

In this step, joint efforts are made in collecting necessary information about each such contaminated property and complete information of subject property is recorded.

The next step is to analyse the asset properties and contaminant characteristics. This will provide a scientific platform to analyse the market correctly and compare them with the subject property being valued.

The objective here is to establish the prices by comparable features of properties and contaminant. The comparable features of the properties are those which are considered in estimation of unimpaired value. It may include location, size, age, type of construction, etc. The comparable features of the presence of contaminant include the type of the contaminant(s) or hazardous substance(s) present in the properties being identified to be similar.

**Step 3 - Adjustment of prices of comparable properties**

In the third step, the differences between the sales of contaminated properties and the subject property are adjusted. The technique to be used is the same as generally used for unimpaired property.

**Step 4 - Determination of the value estimate or stigma assessment**

This is the final step of arriving at a value estimate**.** After the comparable sales of impaired properties have been carefully analysed and adjusted, the value estimate can be determined by 'adjusted sales'.

### 5.1.1 ILLUSTRATIONS ON SALES COMPARISON APPROACH

(1) A property has original unimpaired value of Rs.90,00,000/-. The comparable sales of the similar contaminated/impaired property transacted adjacent to such property very recently show that the value is Rs.55,45,000/-. The cost of remediation is found to be Rs.20,00,000/-. Determine the stigma value.

⇨ The sale evidenced from unimpaired property is given. Comparable price of contaminated site is also furnished.

Step 1 - Estimate the property value diminution due to contamination.

- Unimpaired Value : Rs.90,00,000/-
- Impaired Value : Rs.55,45,000/-
- Property Value Diminution : Unimpaired Value – Impaired Value

= Rs.(90,00,000-55,45,000) = Rs.34,55,000

Step 2 - Determine the stigma considering the remediation cost.

- Property Value Diminution : Rs.34,55,000/-
- Cost of Remediation : Rs.20,00,000/-
- Stigma Value : Value Diminution – Remediation Cost

= Rs.(34,55,000 - 20,00,000)

= Rs.14,55,000/-

(2) Determine the stigma value in percentage based on the following data gathered by scientific method.

| Sr. no. | Transaction after due adjustments | Amount (Rs.) |
|---|---|---|
| 1 | Sale Price derived from comparable non-contaminated assets | 5,00,000/- |
| 2 | Sale Price derived from comparable contaminated sites | 2,50,000/- |
| 3 | Cost of remediation as worked out by environmental consultant | 2,00,000/- |

⇨ Step 1 - Estimate the Property Value Diminution.

| Sr. no. | Transaction after due adjustments | Amount in Rs. |
|---|---|---|
| a | Sales from non-contaminated (unimpaired) assets | 5,00,000/- |
| b | Sale price of contaminated (impaired) site | 2,50,000/- |
| c | Property Value Diminution (a – b) | 2,50,000/- |

Step 2 - Determine the stigma considering the remediation cost.

| Sr. no. | Transaction after due adjustments | Amount in Rs. |
|---|---|---|
| d | Property Value Diminution | 2,50,000/- |
| e | Remediation Cost | 2,00,000/- |
| f | The amount of stigma (d – e) | 50,000/- |
| g | The value of stigma in percentage (f/a) | 10 |

From the illustration, it will be seen that even after the remediation works are completed, the original value is not regained in the market. The difference of the Property Diminution Value and Remediation Cost is the market imposed penalty which is known as Stigma. Here, the stigma is 10% which is quite low.

(3) Determine the current value of the property having 40 acre land parcel. Value prior to contamination was Rs.22,50,000peracre. Comparable sales of similar size, similarly contaminated properties indicate a value of Rs.4,05,000 per acre. This includes the cost of clean-up which is already capitalized in the sales price of the comparable sales.

Step1 - Determine the as-if unimpaired value of the property.

| | | |
|---|---|---|
| Thus, the unimpaired value | = | Area x unit rate |
| | = | 40 acres x Rs.22,50,000/acre |
| | = | Rs.9,00,00,000/- |

Step 2 - Determine the value after contamination discovery

| | | |
|---|---|---|
| Thus, Impaired Value | = | Area x unit rate |
| | = | 40 acre x Rs.4,05,000/acre |
| | = | Rs.1,62,00,000/- |

Step 3- The value after discovery of contamination is itself the current value of the property.

### 5.1.2 REVIEW YOUR UNDERSTANDING

1. The Sales Comparison Approach involves:
   - A. Analysing the sales of contaminated properties
   - B. Comparing the sales of subject property
   - C. Comparing level of contamination
   - D. None of the above
2. In a 'Sales Comparison Approach':
   - A. There is no need to hire the services of environmental expert
   - B. There is a need to hire the services of environmental expert
   - C. Joint efforts of valuers and environmental experts are needed
   - D. None of the two are needed
3. Which step is not involved in the Sales Comparison Approach?
   - A. Identification of contaminated properties
   - B. Analysing and comparing the asset and contaminants characteristics
   - C. Preparing a report of environmental contaminants present in the adjacent property.
   - D. Adjusting price of comparable properties and determination of value estimate.

4. Which one is the most important connotation to use 'Sales Comparison Approach'?

   A. Sufficient statistics of comparable contaminated assets must exist along with environmental expert's report.

   B. Not only the amount of contamination but the risk associated must be known to be the same.

   C. Manufacturing and process of comparable properties must be identical

   D. The current and future utility of the comparable contaminated properties must be the same.

5. Explain the steps involved in sales comparison approach in detail.

6. Discuss the conditions which must be satisfied to use the sales comparison approach.

7. A property has an original (unimpaired) value of Rs.66 lakhs. The derived sale price from comparable sales of adjacent properties is Rs.45.66 lakhs. The cost of remediation as per environmental expert is Rs.18 lakhs. Determine stigma value.

8. Determine stigma value in percentage when the cost of remediation is found to be Rs.25 lakhs for subject property. Sale price from contaminated sitesisRs.30 lakhs and sale price from non-contaminated assets is Rs.42 lakhs.

9. Determine the current value of the property from following data.

| Sr. no. | Description | Rs in Lakhs |
|---|---|---|
| 1 | Value of property with contamination | 55.35 |
| 2 | Comparable sales value inclusive of remediation | 38.65 |

## 5.2 COST APPROACH

The principle of cost approach is determination of cost of producing a similar property as a replacement, so it is clear that in this approach the valuation must calculate the replacement cost by adjusting the estimates of the remediation cost and diminution in value of the property resulting from market impact due to stigma. The estimation part for stigma is difficult.

The estimate becomes higher if the provable loss is overstated because when the costs are not foreseeable, it is the general tendency of the valuer to be on higher side.

The cost approach is often applicable in cases of environmental contamination, provided the present worth of direct and indirect costs is calculated and used and provided adjustments are made for overestimation or underestimation of costs and impact. The cost approach, however, may ignore the value-in-use concept and thereby overstate the impact of costs to cure contamination problems.

This approach is normally used in all techniques for contaminated property valuation in different form, but to value the properties which are not leased or not within the orbit of sale in open market, the only approach viable in all such cases is the cost approach.

The following steps are followed in this method:

**Step1 - Estimating the value of the subject property as if unimpaired**

This is the step wherein the cost of substitution is estimated considering the **hypothetical condition** (*contrary to the fact*) that there is no contamination. This is the usual process for a valuer to determine the estimate based on comparative area method, unit in place method, index method or the actual quantity method by considering every physical component, certain specific features and based on their marketability or utility. Here, the current utility must be considered based on the judgment of valuer.

<u>**Step2 - Determining the direct and indirect costs due to contamination**</u>

Primarily, direct cost in the contamination is <u>cost to cure</u>. It is the clean-up cost required to bring the property to a status of unimpaired in the market. This would therefore also include the stigma factor. Thus in this step, the valuer with the help of environmental expert must determine the following costs:

**(a) The cost of remediation**

The cost of remediation depends upon many factors viz.

- Type of the property
- Nature of the pollution
- Concentration of each of the contaminants present
- Sequence of the treatment which is most economical and effective for a given situation
- Designing of the treatment system consisting of many components
- The estimated cost of such system or components.

**(b) The stigma factor based on 'provable losses**'

The provable loss can be calculated by associating the property with utility. It is the period for which the property or part of the property remained in non-use or non-functional stage. This is the duration when the contamination was first noticed to the appointment of environmental consultant who submitted the remediation plans to the owner. The further period of the 'provable loss' is the time it has taken to undertake the remediation- the period till the property value moves up to current market value. Thus the provable loss will take into consideration the following costs:

- Cost of disruption
- Cost of operation
- Cost to utility
- Cost to revenue
- Cost to liability

These 'costs' as a 'provable loss' can be well assessed by the assessors/valuers.

**(c)** The **specialized costs** which include the additional costs for management of remediation and clean-up.

The specialized costs may include:

- Contamination related legal expenses, that is professional legal fees for dealing with State Pollution Control Board, Government or courts;
- Contamination related insurance expenses- additional insurance during the remediation programme;
- Cost of discovery of contamination like professional fees to consultants;
- Future monitoring cost to avoid recurrence of such contamination, a part t`ime environment engineer for periodic monitoring of the property to take action at the appropriate time before the matter reaches to market;
- Cost to cure functional non-use i.e. obsolescence are then added to accrued depreciation.

**Step3 - Estimating the value of contaminated properties considering both the steps 1 and 2**

The cost approach is based on the premise that the market value of an improved parcel is equal to the market value of the land plus the current construction costs of the improvement less accrued depreciation.

The cost to cure a problem reduces the utility of property and should be considered a form of functional or economic obsolescence of improvements. This would then be added to the accrued depreciation because current replacement cost new would be based on the assumption of a typical, presumably clean environment.

The cost to cure includes all expenses associated with a cleanup, including the expenses that reduce stigma.

Specialised cost such as contamination-related legal and insurance expenses, above those that would be typical for ordinary operation, must be considered. In addition, provision must be made for the cost of discovery of contamination and future monitoring to watch for recurrence of contamination.

### 5.2.1 ILLUSTRATIONS ON COST APPROACH

**(A)** The subject land (25 m x 50 m) is located in the vicinity of secured landfill. The reproduction cost is found to be Rs.4,200/- per $m^2$.

The cost of contaminant containment (in terms of $m^2$ basis) is found to be Rs.505/-. Based on the provable loss during the containment, stigma was worked out to Rs.302/-$m^2$. The accrued depreciation may be ignored. Determine the replacement cost of improved property.

⇨ **Market Value**

| | | |
|---|---|---|
| Reproduction cost of land | = | Area x unit rate |
| | = | 25 m x 50 m x Rs.4200/$m^2$ |
| | = | Rs.52,50,000/- |
| Cost of remediation | = | 25 m x 50 m x Rs.505/$m^2$ |
| | = | Rs.6,31,250/- partial |
| Stigma due to non-use factor | = | 25 m x 50 m x Rs.302/$m^2$ |
| | = | Rs.3,77,500/- |
| Total Costs due to contamination | = | Rs.(6,31,250 + 3,77,500) |
| | = | Rs.10,08,750/- |
| Replacement Cost of improved land | = | Rs.52,50,000 +Rs.10,08,750 |
| | = | Rs.62,58,750/- |

**(B)** Determine the market value if the cost of construction is found diminished on account of discovery of contamination by 35% of its current construction cost. The industrial property worth Rs.20,00,000/- located in Sachin Industrial Estate, Gujarat (India) was constructed in the year 1995. The construction index of 1995 is 1450 and that of current year is 2000.

⇨

**Step 1**

Estimate the current construction cost as if the property is unimpaired

$$= \text{Rs.}20{,}00{,}000 \times \frac{2000}{1450}$$

= Rs.20,00,000 x 1.38

= Rs.27,60,000/-

**Step 2**

| | | |
|---|---|---|
| Accrued depreciation | = | Rs.27,60,000 x 0.35 |
| | = | Rs.9,66,000/- |

**Step 3**

| | | |
|---|---|---|
| Impaired Value | = | Rs.27,60,000 - Rs.9,66,000 |
| | = | Rs.17,94,000/- |

### 5.2.2 REVIEWING YOUR UNDERSTANDING

1. Cost Approach involves
   - A. Estimating the value of subject property unimpaired and determination of remediation cost
   - B. Comparing level of contamination
   - C. Comparing sales of contaminated properties
   - D. None of the above
2. What is the principle of Cost Approach for contaminated property valuation?
   - A. Determination of cost of producing similar property as a replacement
   - B. Systematic gathering, recording and analysing data of similarly affected properties and comparing sales of the contaminated property being appraised
   - C. Determination of income which the contaminated property still can derive
   - D. None of the above

3. In the cost approach
   - A. There is no need to hire environmental consultant
   - B. There is a need to hire environmental consultant
   - C. Only valuer is needed
   - D. None of the above

4. Determining direct cost in the contamination in the Cost Approach is
   - A. Cost to cure
   - B. Cost to operation
   - C. Cost to utility
   - D. None of the above

5. The ‘specialised costs’ in the Cost Approach is
   - A. Additional costs for management of remediation and clean up
   - B. Cost to construct new facilities
   - C. Cost to operation
   - D. None of the above

6. What is the 'Provable Loss' as applied in Cost Approach of valuation of contaminated property? Explain the term in detail.

7. Discuss the steps involved in cost approach for contaminated property valuation.

8. The subject property is located near the biomedical waste incinerator site. Determine the market value of land from the following data.

| | | |
|---|---|---|
| Cost of land | = | Rs.62.50 lakhs |
| Cost of remediation | = | Rs.12.80 lakhs |
| Stigma due to non-use factor | = | Rs.8.40 lakhs |

9. The current construction cost of the property as if unimpaired is Rs.50 lakhs. The construction cost of contaminated property is Rs.16.50 lakhs. Determine the market value of the property.

## 5.3 INCOME APPROACH

The income approach estimates property value by determining the present value of the projected typical income stream for the type of property. Income-producing properties are the most common property type influenced by environmental regulations and subject to contamination. Often the greatest and most easily measured effect is on the ability of the property to continue to generate income. For this reason, the income approach is often the most suitable approach for contaminated properties.

The income approach is also effective in dealing with the situation that occurs when even the present worth of the cost to cure a problem far exceeds the replacement cost of property. There is a value-in-use to the owner even where no other market exists so long as the owner continues to operate the facility. Value-in-use may be impaired by temporary closure or loss of customers, and therefore some adjustments in income stream and income-determined value is likely.

The basic principle involved in this approach is to estimate the impact of the contaminant on the value. This is determined based on the reduced ability of a subject property to generate the income. Income approach estimates reasonable estimate of value because in this process, the present value of the property is derived by measuring actual income against income typical for properties of the same type.

The logic behind this principle is the relation of property usefulness / utility and the income generated from it. Contaminated property by definition itself has diminished utility and therefore the income generated is reduced.

Following steps are followed in this technique.

**Step1 - Estimating the annual gross income stream by obtaining market rental data**

Use of market rental data assumes that the property has utility (is still in use or will be shortly) and is capable of commanding rent. When these conditions are met, market rental data forms an important source for establishing the "base capitalization rate". The income stream however is required to be modified to account for the cost to cure the contamination problem and any loss of utility.

- Modification should be based on the amortised present worth of actual costs, recognising that permissible alternatives may limit costs to those necessary to satisfy the regulatory agency, not necessarily the full cost to cure the problem.
- Further, income modification may be necessary to account for more expensive substitute processes or materials that can no longer be manufactured on site. Adjustments to reflect temporary closure or loss of customers must also be considered.

The primary objective of income capitalization is translating incomes into value. The data of gross income of the contaminated property may help the valuer in selecting capitalization rate that reflect the real estate investment market in its true sense. The overall capitalization of rate of contaminated properties from market sales can be determined by using the ratio of net income to selling price.

The income stream however is diminishing provided immediate actions are taken to remediate it. In other words, the income stream requires to be altered by considering two aspects i.e. Cost to cure and the loss of utility of the property. The cost to cure should be based on the amortized present worth of the actual costs.

To determine the annual gross rental and arrive at the appropriate capitalization rate, the valuer must keep the database of contaminated and remediated properties containing data like the type of the real estate, contamination, costs, market history and capitalization rate in consideration while determining value.

**Step2 - Obtaining income or allowable expenses related to contamination**

The allowable expenses which must be subtracted from the gross income are the expenses incurred to remove the specific contaminant and includes amortized present worth of the cost to cure. Cost to cure as usual includes the disruption cost as there is a partial loss of income due to its partial non-use.

Cost to discovery of contamination including professional fees paid to the environmental expert is an allowable expense.

Legal expenses for handling litigation on account of contamination and monitoring expenses are allowable expenses. Ongoing monitoring is often expensive and inflation will often increase costs which are often incurred over lengthy periods. Any money spent for improving operation may also be a part of allowable expense. Other unforeseen expenses may be disclosed during the clean-up operation and can also be considered a part of the allowable expenses. Ongoing monitoring and inflation will increase the cost with respect to time. These aspects must be considered in developing modified income streams.

In summary, all the expenses associated with removal of contaminant which are actual, current or reliably anticipated must be recorded. It must be remembered that the expenses documented must be provable. Expenses to be used should be based on current cleanup mandates and not the ones that are invoked only upon sale of property or change in use Subtracting allowable expenses from gross income gives effective gross income or net income.

**Step3 - Determination of the Value of contaminated property using Capitalization Rate**

Capitalization is the process of converting net income of a property into its equivalent capital value. Capitalization process reflects the time value of money by reducing or discounting future income to present worth by the Year's Purchase concept.

$$Y = V*R$$

where,

Y = Yield

V = Value of the property

R = Rate of return

As such, capitalization rate in the income approach is such a rate of return that directly or indirectly provides for return on investment (interest) and return of investment (capital recovery).

The capitalized rate is based on the equity yield rate, mortgage terms and anticipated appreciation or depreciation. In many cases of contaminated properties, mortgages may be unobtainable and future appreciation is applicable. Contaminated properties also suffer from lack of appeal due to possible future clean up requirement and public liability exposure. This leaves the equity yield rate as the major component of capitalization rate.

In developing this rate, the presumption must be that the property is still capable of producing income. Adjusted rates may be developed for property not currently producing income but expected to do so at a predictable level at a predictable time in future. The capitalization rate must reflect the difference between comparable contaminated and uncontaminated properties. Capitalisation rate may be increased to reflect added risk.

- **Financing (unusual term)**

  Financing is known to affect property value. The impact is particularly significant when favourable or unfavourable financing is obtained because the market has already accepted the influence of typical financing costs.

  In the case of environmentally contaminated properties, two types of financing effects need to be considered:

  (i) the ability of a prospective buyer to finance the purchase of the property; and

  (ii) the terms for financing the actual costs to cure contamination problems.

  If prospective buyers cannot obtain typical financing due to the problem, the cash equivalency value of the property will be diminished. If terms for financing the costs to cure problems are poor, additional liability or unfavourable debt will reduce buyer income anticipation and thereby reduce market value.

  Demand for alternative uses particularly those compatible with contaminated site will result in sale. Financing may facilitate a sale but will require adjustment in any sales analysis. Income generation is predicted based on the report of environmental expert as to the date of completion of the remediation project. When the market comes to know that remediation is in process, perception starts improving and the stigma effect begins to diminish.

### 5.3.1 ILLUSTRATIONS ON INCOME APPROACH

(A) Kamal had rented his property at Rs.30,000/- per annum net of outgoings. The yield upto last year was found to be 10%. Subsequent to the complaint made by the tenant, the discovery of the contaminant was made and the yield was found to be 12%. Determine the value of contaminated property.

⇨

**<u>Step 1</u>**

Determine the value of the <u>unimpaired</u> property

Net Income (NI) = Rs.30,000 per annum

Unimpaired Value = NI x YP

= Rs.30,000 x $\frac{100}{10}$

= Rs.3,00,000/- (1)

**<u>Step 2</u>**

Determine the value of the <u>impaired</u> property as found in the current year

Net income = Rs.30,000/- per annum

Impaired Value of property = NI x $YP_{impaired}$

= Rs.30,000 x $\frac{100}{12}$

= Rs.2,50,000/- (2)

**<u>Step 3</u>**

Determine the loss in value of contaminated property or Property Value Diminution

= (1) - (2)

= Rs.3,00,000 – Rs.2,50,000

= Rs.50,000/-

(B) The effective gross income of the industrial property contaminated due to chromium fumes is Rs.88,25,540/-. The annual expenses towards the cost to cure and other legal and disruption expenses are Rs.38,78,200. From similar contaminated property, it indicates that 9% rate of return is appropriate. Find the value estimate of the property.

⇨

| | | |
|---|---|---|
| Effective gross income | = | Rs.88,25,540/- |
| Annual expenses | = | Rs.38,78,200/- |
| Net income | = | Rs.88,25,540 – Rs.38,78,200 |
| | = | Rs.49,47,340/- |

Capitalization rate is 9% or 0.09

Thus, Impaired Value $= \frac{Net\ income}{Capitalization\ rate}$

$= Rs. \frac{49,47,340}{0.09}$

= Rs.5,49,70,444/-

(C) An industrial property is leased at rent of Rs.220/- per sq. ft and has an annual net operating income of Rs.55,00,000/-. The said property is found to be partially contaminated. The loss of the useful space will reduce the net operating income to Rs.42,50,000/- during the clean-up operations which may be completed within one year.

The remediation contract is given on turnkey basis to M/s. Enviro Group who will be paid for in 5 equal instalments of Rs.12,50,000/- every year over five years.

The yearly payment of instalment is proposed to be made from the net operating income. The rents are expected to be absolutely market based and market-derived discount rate is 12%.

⇨

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| Net Income (Rs.) | 30,00,000 | 30,00,000 | 30,00,000 | 30,00,000 | 30,00,000 |
| Present Value Factor | 0.892857 | 0.797194 | 0.71178 | 0.635518 | 0.567427 |
| Present Value of Income (Rs.) | 26,78,571 | 23,91,582 | 21,35,340 | 19,06,554 | 17,02,281 |

Term Value = Rs.(26,78,571 + 23,91,582 + 21,35,340 + 19,06,554 + 17,02,281)

= Rs.1,08,14,328/-

Residual (or Reversionary) Value = Terminal Income x $YP_{perpetuity}$ x PV factor

$$= \text{Rs.}55{,}00{,}000 \times \frac{100}{12} \times \frac{1}{(1+0.12)^5}$$

= Rs.2,60,05,833/-

Value of Lessor's Interest = Term Value + Residual value

= Rs.(1,08,14,328 + 2,60,05,833)

= Rs.3,68,20,161/-

(D) The net income of the contaminated property is Rs.32,28,540/-. The market derived overall capitalization rate for this property is 11%. The income of a similar uncontaminated property is Rs.55,14,775/-. Determine the loss in value.

⇨

- Contaminated property net income = Rs.32,28,540/-

  Hence, Impaired Value $= \dfrac{Income}{Capitalization\ rate}$

  $= \dfrac{32{,}28{,}540}{0.11}$

  = Rs.2,93,50,364/-

- Uncontaminated property net income = Rs.55,14,775/-

  Hence, Unimpaired Value $= \dfrac{55{,}14{,}775}{0.11}$

  = Rs.5,01,34,318/-

- Property Value Diminution = Unimpaired Value – Impaired Value
  = Rs.(5,01,34,318 - 2,93,50,364)
  = Rs.2,07,83,954/-

Thus, Rs.2,07,83,954/- represents the indicated loss in value due to contamination and required clean up.

(E) Find percent reduction in value from following data.

1) The value of the non-contaminated property by comparison approach – Rs.15,00,000
2) Effective contamination control and management measures – Rs.75,000
3) Regular monitoring of the site – Rs.10,000
4) Clean up of onsite contamination – Rs.3,50,000
5) Indemnity insurance for the future – Rs.10,000
6) Control of migration from other sites – Rs.15,000
7) Present value of Re.1 after 20 years @ 7.5% - 0.235
8) Anticipated economic life of building, years - 20
9) Avoidance of origination of contamination of adjacent sites – Rs.1,00,000

⇨

Total Cost of Remediation = (75,000 + 10,000 + 3,50,000 + 10,000 + 15,000 + 1,00,000)
= Rs.5,60,000 incurred at the end of 20th year

Present value of treatment = Total Cost x PV factor for 20 years
= Rs.5,60,000 x 0.235
= Rs.1,31,600/-

Adjusted Value (excluding Stigma Allowance) = Rs.15,00,000 – Rs.1,31,600
= Rs.13,68,400/-

i.e. 13,68,400 / 15,00,000 or 91.27%

% Reduction in Value = (100 - 91.27)%
= 8.73%

## 5.3.2 REVIEW YOUR UNDERSTANDING

1. Contaminated property receive reduced income because
   - A. It has diminished utility
   - B. property is off the market
   - C. It has lost the reputation
   - D. None of the above
2. Base capitalization rate can be established based on
   - A. Market rental data
   - B. Real estate market current rate
   - C. Remediation cost
   - D. None of the above
3. The allowable expenses which must be subtracted from the gross income
   - A. Is expense involved to remove the specific contaminant
   - B. Are expenses involved to remove the specific contaminant and amortized present worth of the cost to cure
   - C. Is the amortized present worth of the cost to cure
   - D. None of the above
4. Which one is not allowable expense in income approach of valuation?
   - A. Cost to cure
   - B. Disruption cost
   - C. Cost of discovery of contaminant and legal expenses
   - D. Cost of maintenance
5. Explain the process of income approach with each step in detail.
6. Shweta rented the property at Rs.6000/- per month. The yield upto last year was found to be 12%. Subsequent to the complaint made by the tenant and the contaminant cadmium in excess concentration was discovered, the yield was found to be 14%. Determine the value of contaminated property.
7. The net income of the contaminated asset is Rs.55 lakhs and the market derived overall capitalization rate is 11%. The income of a similar unimpaired property is Rs.75 lakhs. Determine the loss in value.
8. Find reduction in value from following data of contaminated property.
   - (a) Value of non-contaminated property by comparison approach – Rs.22 lakhs

(b) Effective contamination control – Rs.1.0

0 lakh

(c) Regular monitoring of site – Rs.0.5

0 lakh

(d) Cleanup cost – Rs.4.0

0 lakh

(e) Insurance – Rs.0.2

0 lakh

(f) Control of migration from other sites – Rs.0.3

0 lakh

(g) Present value of Re.1 for 20 years @ 7.5% – Rs.0.2

35 lakh

(h) Anticipated economic life of building – 25

years

(i) Avoidance of origination of contamination of adjacent sites – Rs.1

lakh

9. Determine the value estimate of property from the following data

- Effective gross income Rs.80 lakhs
- Annual cost to cure, legal & disruption expenses Rs.32 lakhs
- Rate of return from similar contaminated property 9%

**I*I*I*I*I*I*I***

# PROFESSIONAL ETHICS AND STANDARDS

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Kirit P. Budhbhatti

Chairman, CVSRTA

# Model Code of Conduct as notified by MCA under the Companies (Registered valuers and valuation) Rules 2017 and Other Engagement Considerations

## 1. Integrity and Fairness:

- A valuer should, in the conduct of his/its business, follow high standards of integrity and fairness in all his/its dealings with his/its clients and other valuers.
- A valuer should maintain integrity by being honest, straightforward, and forthright in all professional relationships.
- A valuer should endeavour to ensure that he/it provides true and adequate information and shall not misrepresent any facts or situations.
- A valuer should refrain from being involved in any action that would bring disruption to the profession.
- A Valuer shall keep public interest foremost while delivering his services.

## 2. Professional Competence and Due Care:

- A valuer should always render high standards of service, exercise due diligence, ensure proper care and exercise independent professional judgment.
- A valuer should carry out professional services in accordance with the relevant technical and professional standards that may be specified from time to time.
- A valuer should continuously maintain professional knowledge and skill to provide competent professional service based on up-to-date developments in practice, prevailing regulations/guidelines and techniques.
- In the preparation of a valuation report, the valuer should not disclaim liability for his/its expertise or deny his/its duty of care, except to the extent that the assumptions are statements of fact provided by the company and not generated by the valuer.

A valuer should have a duty to carry out with care and skill, the instructions of the client insofar as they are compatible with the requirements of integrity, objectivity and independence.

- A Valuer should clearly state to his client the services that he would be competent to provide and the services for which he would be relying on other valuers or professionals or for which the client can have a separate arrangement with other valuer/ professional.

- A professional valuer should take reasonable steps to ensure that those working under the professional valuer's authority in a professional capacity have appropriate training and supervision.
- If a professional valuer does not have the professional knowledge and necessary experience to competently undertake a valuation assignment that is offered, the professional valuer should decline that assignment.

**3. Independence and Disclosure of Interest:**

- A valuer should act with objectivity in his/its professional dealings by ensuring that his/its decisions are made without the presence of any bias, conflict of interest, coercion, or undue influence of any party, whether directly connected to the valuation assignment or not.
- A valuer should not take up an assignment under the Act/Rules if he/it or any of his/its relatives or associates is not independent in relation to the company and assets being valued.
- A valuer should maintain complete independence in his/its professional relationships and shall conduct the valuation independent of external influences.
- A valuer should wherever necessary disclose to the clients, possible sources of conflicts of duties and interests, while providing unbiased services.
- A valuer should not deal in securities of any subject company after any time when he/it first becomes aware of the possibility of his/its association with the valuation, and in accordance with the SEBI (Prohibition of Insider Trading) Regulations, 2015.
- A valuer should not indulge in "mandate snatching" or "convenience valuations" in order to cater to the company's needs or client needs. A valuer should communicate in writing with a prior valuer if there is knowledge of any prior valuer having been appointed before accepting the assignment.
- As an independent valuer, the valuer should not charge success fee.
- In any fairness opinion or independent expert opinion submitted by a valuer, if there has been a prior engagement in an unconnected transaction, the valuer should declare the past association with the company.

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## 4. Confidentiality:

- A valuer should not use or divulge to other clients or any other party any confidential information about the subject company, which has come to his/its knowledge without proper and specific authority or unless there is a legal or professional right or duty to disclose.

## 5. Information Management:

- A valuer should ensure that he/ it maintains written contemporaneous records for any decision taken, the reasons for taking the decision, and the information and evidence in support of such decision. This should be maintained so as to sufficiently enable a reasonable person to take a view on the appropriateness of his/its decisions and actions.
- A valuer should appear, co-operate and be available for inspections and investigations carried out by the Registration Authority, any person authorised by the Registration Authority, the Valuation Professional Organisation with which he/it is registered or any other statutory regulatory body.
- A valuer should provide all information and records as may be required by the Registration Authority, the Tribunal, Appellate Tribunal, the Valuation Professional Organisation with which he/it is registered, or any other statutory regulatory body.
- A valuer while respecting the confidentiality of information acquired during performing professional services, should maintain proper working papers for a period of three years or such longer period as required in its contract for a specific valuation, for production before a regulatory authority or for a peer review. In the event of a pending case before the Tribunal or Appellate Tribunal, the record should be maintained till the disposal of the case.

## 6. Gifts and Hospitability:

- A valuer, or his/its relative should not accept gifts or hospitality which undermines or affects his independence as a valuer.
- A valuer should not offer gifts or hospitality or a financial or any other advantage to a public servant or any other person, intending to obtain or retain work for himself/ itself, or to obtain or retain an advantage in the conduct of profession for himself/ itself.

**7. Remuneration and Costs:**

- A valuer should provide services for remuneration which is charged in a transparent manner, is a reasonable reflection of the work necessarily and properly undertaken and is not inconsistent with the applicable rules.
- A valuer should not accept any fees or charges other than those which are disclosed to and approved by the persons fixing his/ its remuneration.

**8. Occupation, employability and restrictions:**

- A valuer should refrain from accepting too many assignments, if he/it is unlikely to be able to devote adequate time to each of his/ its assignments.
- A valuer should not engage in any employment, except when he has temporarily surrendered his certificate of membership with the Valuation professional Organisation with which he is registered.
- A valuer should not conduct business which in the opinion of the Registration Authority or the registered valuer organisation is inconsistent with the reputation of the profession.

# VALUATION OF PLANT AND MACHINERY

**Authors**

Mr. Hemant Vasavada, Mr. Sanjay Shah, Mr. Jignesh Shah,
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Mr. Darshan Dave, Mr. Sanjay Patel, Mr. Jayesh Lad

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**Please refer to the following literature:**

(a) Valuation of plant and machinery (Theory & Practice) 2017 3rd Edition
(b) Valuing machinery & equipment, the fundamentals of appraising machinery & technical assets -3rd Edition by American Society of Appraisers

for

the following topics of the syllabus of this subject

- Role, functions and responsibilities of a plant and machinery valuer
- Cost, price, value and valuation;
- Types of Market, Demand and Supply curve, Bell curve for overall sales performance (Probability Distribution)
- Annuities – capitalization – rate of capitalization – years purchase -- sinking fund – Redemption of capital – Reversionary Value

**Definitions of the various terms:**

(a) Plant and machinery, furniture, fixtures and fittings – the judicial interpretation of these terms (b) Market value, Highest and best use value

**Meaning of the terms:**

Basis of Valuation. Value in use, value in exchange, value to the buyer, value to the seller, value to the occupier, value in existing use in situ, value in existing use in ex-situ, value in alternative use in situ, value in alternative use in ex-situ, liquidation value in situ/ex situ, orderly liquidation value, forced sale value.

- Investment property, marketable non-investment property, non-marketable -non-investment property with their characteristics and approaches to value.
- Factors having direct bearing on value (valuation maxims) like: physical, legal, social,economic,utility,marketability,transferability,scarcity,present worth of future benefits and intangible rights
- **Identification of plant and machinery/Physical verification of plant and machinery**

- Inventory (listing of machinery) and data to be collected while taking inventory
- Importance of Technical specifications of plant and machinery in valuation exercise
- Assessment of Condition of PME based on visual inspection
- Comparing inventory with plant and machinery records maintained by the company
- Ascertaining discrepancy
- Identification of productive, non-productive, surplus and off-balance sheet assets

- Age, effective age, total economic life, economic balance life, physical life and their importance in valuation.
- Factors affecting life both in terms of years or hours used based on type of assets, sources of economic useful life, study of maintenance schedules of plant.
- Difference between historical cost, acquisition cost, book cost, written down value and net book value.
- The items of building to be treated as plant and machinery-like chimneys to the boiler, brick, concrete or RCC foundation for plant and machinery, water and sewerage installations, effluent treatment plant etc.
- Installed capacity of the plant, actual production, raw material availability, level of technology used such as current or obsolete, issues if any regards to these.
- Part, fraction and whole valuation
- Relationship of Earnings and Assets
- Difference between business specific economic viability and economic obsolescence.
- Efficiency of plant layout, imbalances in different production sections and their relevance in valuation

**Three approaches to value – cost, market and income**

**Cost approach**

- Reproduction cost new, replacement cost new, depreciated reproduction cost/ depreciated replacement cost (DRC), Difference and similarity in DRC and market value
- Difference between Reproduction cost new and replacement cost new
- Methods of computation of reproduction cost new
  - Market inquiry of current cost of brand new machine with identical specifications from same manufacturer i.e replica
  - Indexation and its limitations
  - Cost to capacity method and its limitation
- Methods of computation of replacement cost new when identical machine/plant is not available i.e. machine/plant of like kind and type-factors to be taken into consideration
- Direct and indirect costs for estimation of Reproduction new /Replacement cost new
- Meaning of the term depreciation for wear and tear. Factors influencing depreciation-its measurements and application by valuers of plant and machinery. Concept of salvage value and scrap value along with the basis of the same.
- Methods of depreciation – observed deterioration, straight line, diminishing balance (WDV),
- Difference between accounting and technical depreciation
- Factors to be taken into consideration for selection of depreciation method

- Obsolescence-technological, functional and economic
- DRC subject to potential profitability
- Limitations of cost approach.

**Market Approach-Sales comparison method**

- Data collection
- Elements of comparability and application of appropriate weightages to identified comparable to estimate value of subject plant and machinery asset being valued. Instances when sales comparison method is not feasible and limitations of sales comparison method.

**Income Approach**

- The concept of income approach
- Gross income-outgoings, net income and year's purchase
- Actual income Vs Potential income
- Terminal income
- Remunerative and accumulative rates of interest and various methods of determining the same
- Capitalization of earnings method
- Discounted future earnings method (DCF Technique)
- Pitfalls of DCF technique

**Process of Valuation**

Check List for Valuation of Plant and Machinery, documents to be studied prior to Plant Visit/Inspection, ABC analysis
The items to be treated as plant and machinery
The items to be treated as land and buildings
Physical verification (survey and inspection)
Data collection and valuation analysis under replacement cost new method (cost approach)

**Broad categories of machines to be encountered by plant and machinery valuers in actual practice -**

Valuation of a machine for which current cost of identical brand new machine is available

Valuation of a machine for which current cost of identical brand new machine is not available

Valuation of a machine which is no longer manufactured

• The reasons for the differences in the prices of the machines with same technical specifications and features by different manufacturers
• The factors to be considered while adopting cost approach.
• Data collection and valuation analysis under -Cost, market and income approaches

**Leasing of plant and machinery**

- Definition of Lease
- Leasing, hiring and renting
- Obligations of supplier of asset, user of asset, hire purchase company/lessor in cases of loan, supplier's credit, hire purchase and leasing
- Leasing as an instance of bailment, nature of the bailment agreement, features of bailment, contracts law on bailment
- Leasing rules
- Types of leases and their characteristics
- Steps in the structuring of a lease contract
- Leasing from point of view of lessor/Lessee
- Limitations of leasing
- The structure of a lease agreement
- Treatment of leased assets in company accounts – accounting practice for leased plant and machinery as per Indian Accounting Standard
- Assessment of lease related risk
- Risk and Return trade-off

• Valuation of leased plant and machinery
• Valuation of plant and machinery for following purposes:
  - Mergers and acquisitions (including purchase price allocation)
  - Financial statements
  - Impairment
  - Auction
  - Insurance
  - Leasing
  - Disposal
  - Capital raising
  - Corporatization and privatization
  - Stamp duty
  - Any other purpose not referred above

**Case laws**

• Fixture - Holland Vs. Hodgson (1872) L.R.7C.P.328 AT 335
• Plant and Machinery in nature of land and buildings - Duncan's case - AIR 2000 SC 355
• Obsolescence – Westingshouse Electric Corporation US 1993 NCApp.710.379S.E.2D 37(1989)
• Just because a Plant and Machinery are fixed in the earth for better functioning it does not automatically become an immovable property - Sirpur Paper Mills Pvt. Ltd Vs. The Collector of Central Excise 1998(1) SCC 400
• Plant and Machinery in nature of land and buildings - Official Liquidator Vs. Sri Krishna Deo and Ors. (AIR 1959 All 247)

Valuation of specialized plant and machinery by Cost approach is subject to potential profitability - Symex Holdings Ltd. Vs. Commissioner of State Revenue, Victoria, Australia (2007 VSC 159)

The study material for the balance topics is given as under hereinafter from page no. 2:

(i) Construction and use of valuation tables by Rashmi K. Gandhi

(ii) The Depreciation under Income Tax Act, 1961 as well as Companies Act 2013, Useful lives to compute depreciation as per Schedule II of Companies Act,2013, Factors to be considered for componentization of Assets

(iii) Machine tools by Hemant Vasavada

(iv) Factory Equipment by Sanjay Shah given in this section later.

(v) Utility Equipment used as engineering services in an Industry by Hemant Vasavada.

(vi) Impact of Indian accounting standards, International Valuation Standards and Standards to be published by Ministry of Corporate Affairs, GOI on valuation of plant and machinery.

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Kirit P. Budhbhatti

Chairman, CVSRTA

## I. Construction and use of valuation tables

Valuation of an asset is principally an economic decision and hence all parameters which affect this decision have to be thoroughly understood and evaluated by a valuer. Interest rates prevalent in the market at the time of relevant date of valuation is one such parameter. Similarly yield or return expected by an investor on his capital investment in an asset is also equally important aspect for consideration by a valuer because value of any asset yielding monthly or yearly income depends on the rate of interest on investment expected by an investor.

A Valuer is also concerned in his working about the present worth of a rupee receivable at some future date. If an investor buys from a Lessor a leased-out asset which will revert back to the lessor at some future date, say after 20 years, a valuer must know how to evaluate present worth of said asset revertible after 20 years. It is therefore clear that a valuer must thoroughly learn and understand mathematical working process of compound interest tables and formulae to estimate value under different circumstances.

In this section we shall discuss and study various formulae and their applications to arrive at the value of a rupee/ rupee per annum receivable in future / during specified period. In other words, we can say that the study of these tables will enable a valuer to ascertain monetary evaluation of the asset.

Working process and formulae given herein after would enable a valuer to work out required rupee value under different circumstances. However ready made valuation tables are also available giving such values for different periods at different rates of interests. Valuation Tables prepared by Shri. A.E. Mirams, a prominent valuer of the past, are well known and these tables are very useful as it saves lot of time of a valuer in working out actual figures from fundamentals. Some books on valuation also gives these ready valuation tables. However, if such tables are not readily available, required figures can be worked out from basics viz. by use of respective formulae discussed below. Construction of new Valuation Tables for higher or lower interest rates is possible with the help of these formulae.

1.0 Simple Interest Amount Working : If we want to work out gross amount that would accrue at the end of given period of time, on the principal sum, at the given rate of simple interest, the said amount can be worked out by application of following formula worked out from fundamental concepts of interest yields.

(i) $I = P \times R \times N$

(ii) $A = P + I$

Where,

'I' is the total interest amount accrued in given period.

'P' is the principle amount deposited.

'R' is the rate of interest adopted.

'N' is the period in number of years.

'A' is the Gross Amount including principal sum and total interest.

By use of above formula, we can work out Gross Amount that would accrue after specified period of time at specified rate of simple interest.

1.1 Example – 1 :

A person deposits sum of Rs.5,000/- at 4% simple interest rate, for 5 years period. Calculate Gross Amount receivable after 5 years period including total interest amount at simple interest basis.

Solution :

$$I = P \times R \times N$$
$$= 5000 \times 4/100 \times 5$$
$$= \text{Rs.}1000$$

$$A = P + I$$
$$= 5000 + 1000$$

Gross Amount 'A' = Rs.6,000/- (Receivable after 5 years)

2.0 Compound Interest Amount Working : Gross amount that would accrue at compound interest rate, after a given period of time, can be worked out from following formula. (Also refer to the Table No.7 of Miram's Valuation Tables.)

(i) Total Interest Amount (I) = $(1 + R)^n$

(ii) Gross Amount (A) = $P \times (1 + R)^n$

Where,

'R' = Rate of compound interest.

'n' = number of years.

'P' = Principal Amount,

'A' = Gross Amount receivable at end of given period.

2.1 Example – 2 :

A person deposits Rs.5,000/- in Bank at 4% compound interest rate for 5 years period. Calculate gross amount receivable after 5 years period including total interest amount on compound interest basis.

Solution :

$$A = P \times (1 + R)^n$$
$$= 5,000 \times (1 + 4/100)^5$$
$$= 5,000 \times (1.04)^5$$
$$= 5,000 \times 1.216$$
$$= \text{Rs. } 6,080/-$$

It will be seen that investor gets Rs.80/- extra after 5 years if interest is worked out not on simple interest basis but on compound interest basis.

If you see Mirams Table No.7 compound interest computation 'I' is readily worked out and given. In 5 years period line in 4% rate column, said table 7 shows 'I' value at 1.217 almost same as 1.216 value worked out in this example.

2.2 Example – 3 :

An investor purchased, a machine for Rs.200,000/- and spent Rs.25,000/- on erection, installation and bringing the machine to operation. However, he could only start commercial production after 3 years. Calculate value of the Amount that is blocked up in investment, after 3 years period, on the basis of purchase price and other expenses, by considering 7% compound rate of interest.

Solution : Principal Sum (P) = 200,000 + 25,000 = Rs.2,25,000

R = 7% and N = 3 years

Invested amount (A) after 3 years = 225,000 x $(1 + 7/100)^3$

= 225,000 x $(1.07)^3$

= 225,000 x 1.225

= Rs. 275,625/-

3.0 Present Value of a Rupee : (Refer Table 2 in Mirams Val. Tables) :

Working out present worth of a Rupee receivable after certain period at given rate of compound interest is the reverse mathematical process of the working given in above para 2.0.

Following formula will give present worth of a Rupee and present worth of capital sum receivable at future date.

(i) Present value of a Rupee (PV) $= \frac{1}{(1+R)^n}$

(ii) Present worth of amount receivable (PVA) $= C \times \frac{1}{(1+R)^n}$

Where,

'C' = Capital sum Receivable at future date.

'R' = Rate of interest

'n' = number of years.

This process of working out present reduced amount receivable at some future date, is also known as deferring or discounting of receivable sum at given rate of interest for a given period.

3.1 Example – 4 :

A Lessor will receive back machinery worth Rs.20,00,000/- after 10 years. Calculate its present worth by adopting 6% rate of interest.

Solution : Capital Amount Receivable (C) = Rs.20,00,000/-

R = 6% N = 10 years

Present worth of Receivable Amount (PVA)

$$= C \times \frac{1}{(1+R)^n}$$

$$= 20{,}00{,}000 \times \frac{1}{(1 + 6/100)^{10}}$$

$$= 20{,}00{,}000 \times \frac{1}{(1.06)^{10}}$$

$$= 20{,}00{,}000 \times 1/1.79$$

$$= 20{,}00{,}000 \times 0.558$$

= Rs.11,16,000/-

Note :- If you refer to Mirams Table-2, you will find present Rupee value at 0.5584 in 6% rate column at 10 years period row (line).

3.2 Example – 5 :

What is the present value of the reversion of machinery let for 15 years period. Assume that the value of the machinery at the end of 15 years will be Rs.800,000/- and rate of interest expected is 6%.

Solution : In this example C = 800,000, R = 6% and n = 15 years

$$\therefore PVA = 800,000 \times \frac{1}{(1+0.06)^{15}}$$

$$= 800,000 \times \frac{1}{2.397}$$

$$= 800,000 \times 0.417$$

$$= Rs.333,600/-$$

3.3 Example – 6 :

Find out present amount payable for an instrument which guarantees payment of capital sum of Rs.80,000/- after 5 years. Adopt 7% rate of interest.

Solution : Present Value Amount $= C \times \frac{1}{(1+R)^n}$

$$= 80,000 \times \frac{1}{(1+0.07)^5}$$

$$= 80,000 \times \frac{1}{1.402}$$

$$= 80,000 \times 0.713$$

$$= Rs.57,040/-$$

3.4 Example – 7 :

What is the present value of the right to receive following sums of money, at 6% interest rate, at 5 years intervals as given below.

(i) After 5 years Rs.10,000

(ii) After 10 years Rs.30,000

(iii) After 15 years Rs.50,000

Solution : It will be necessary to compute present value in 3 parts as under :-

(i) Present value of Rs.10,000 $= C \times \frac{1}{(1+R)^n}$

$= 10,000 \times \frac{1}{(1+.06)^5}$

$= 10,000 \times 0.7472$

$=$ Rs.7,472/- ...(a)

(ii) Present value of Rs.30,000 $= 30,000 \times \frac{1}{(1+.06)^{10}}$

$= 30,000 \times 0.5584$

$=$ Rs.16,752/- ...(b)

(iii) Present value of Rs.50,000 $= 50,000 \times \frac{1}{(1+.06)^{15}}$

$= 50,000 \times 0.4173$

$=$ Rs.20,865/- ...(c)

(iv) Present value of right to receive sums in 3 stages at 5 years interval .

= (a) + (b) + (c)

= Rs.7,472/- + Rs.16,752/- + Rs.20,865/- = Rs.45,089/-

## 4.0 Amount of Re.1/Annum working:

( refer Table 6 in Mirams Valuation Table.)

Many a times valuer is required to work out Gross Amount that would accumulate after the given period of time, at the given rate of interest, on the fixed sum receivable every year. Such accumulated sum is worked out by use of following formula.

(i) Accumulated sum for Re.1/year (APA) $= \dfrac{(1+R)^n - 1}{R}$

(ii) Gross Accumulated Sum $= C \times \dfrac{(1+R)^n - 1}{R}$

'R' = Rate of Interest.

'n' = number of years.

'C' = Capital Amount received/Year.

4.1 Example – 8 :

A person saved Rs.1000/- each year and invested this yearly saving each year at 8% interest for 25 years period. What will be gross capital yield at the end of 25 years?

Solution : APA $= \dfrac{(1+R)^n - 1}{R}$

$$= \frac{(1+0.08)^{25} - 1}{0.08}$$

$$= \frac{6.85 - 1}{0.08} = 73.106$$

Gross Capital Sum = C x APA = 1000 x 73.106

= Rs.73,106/-

4.2 Example – 9 :

From the salary of an employee, Rs.500/month is deducted and said sum is invested in provident fund scheme annually at 7% interest. Calculate gross provident fund amount accumulated under the scheme after 20 years service. There are no withdrawals from the fund during this period.

Solution :

$$APA = \frac{(1+0.07)^{20} - 1}{0.07}$$

$$= \frac{3.869 - 1}{0.07} = 40.995$$

Gross P.F. Amount (after 20 yrs) $= C \times APA = 500 \times 12 \times 40.995$

$= \text{Rs.}245,970/-$

5.0 Annual Sinking Fund Working :

(Refer Table-5 of Mirams Valuation Table)

In order to find out depreciated worth of an old existing building, a valuer has to consider Sinking Fund amount that has to be set aside annually by a building owner, at given rate of interest, for the period which is equal to past age of the building. The working of this amount is the reverse process to that adopted (Vide para 4.0 above) for finding out worth of known annual payment after given period of time at given rate of interest. In present working, we have to find out annual payment that is required to be set aside each year in order to receive Re.1 at the end of given period, at given rate of interest. Gross Sinking Fund (G.S.F.) can be worked out from following formula.

(i) $$ASF = \frac{R}{(1+R)^n - 1}$$

(ii) $$\text{Gross S.F.} = C \times \frac{R}{(1+R)^n - 1}$$

Where,

| | | |
|---|---|---|
| ASF | = | Annual Sinking Fund amount to be set aside each year for recouping Re.1 at end of given period, at given interest rate. |
| 'R' | = | Rate of interest |
| 'N' | = | Number of years. |
| 'C' | = | Total capital recoupment expected. |
| 'GSF' | = | Gross Sinking Fund. |

5.1 Example – 10 :

Find out Gross Sinking Fund required to be set aside every year to recoup total capital sum of Rs.400,000/- at the end of 60 years life of building at 4% rate of compound interest.

Solution :

$$ASF = \frac{R}{(1+R)^n - 1}$$

$$= \frac{0.04}{(1+0.04)^{60} - 1}$$

$$= \frac{0.04}{10.519 - 1}$$

$$= \frac{0.04}{9.519} = 0.0042$$

Gross Sinking Fund (GSF) = C x ASF

= 400,000 x 0.0042 = Rs.1680/Year

If you apply the formula given in previous para 4.0, using 1680/year as annual saving ,you will notice that this sum of Rs.1680/- per year accumulates to the gross capital sum of Rs.400,000/- at 4% rate of interest after 60 years period.

5.2 Example – 11 :

An individual has to repay loan amount of Rs.40,000/- after 20 years. What amount should be set aside every year to enable it to repay loan amount with 4% interest ?

Solution :

$$ASF = \frac{R}{(1+R)^n - 1} = \frac{0.04}{(1+0.04)^{20} - 1}$$

$$= \frac{0.04}{2.19 - 1} = \frac{0.04}{1.19}$$

$$= 0.0336$$

$$GSF = C \times ASF$$

$$= 40{,}000 \times 0.0336 = \text{Rs. } 1344/\text{Year.}$$

6.0 Present value of an amount of Re.1/year (Single rate basis) :

(Refer Years Purchase Table-1 in Mirams Valuation Table)

Present worth of future annual income flow, for given period of time, at given single rate of interest compounded could give us present market worth of the asset generating such income. Hence this Y.P. working is very useful to valuers. The income flow is normally a perpetual income for immovable property..

Such single rate of interest being remuneration for capital invested is known as "Remunerative Interest"

As only remunerative rate of interest is considered for the perpetual income in this working, it is known as single rate working. The technique of arriving at years purchase for Re.1 is very simple. We have to separately work out present value of Re.1 receivable after 1st year, P.V. of Re.1 receivable after 2nd year and so on up to Re.1 receivable after given number of years and total up all these sums. This will give us Y.P. value for Re.1/year after given number of years. The formula for working out Years Purchase and value of asset are as under :-

(i) Present value of Re.1/year (Y.P.) = $\dfrac{1 - \dfrac{1}{(1+R)^n}}{R}$

(ii) Value of asset = C x Y.P.

Where,

‘R’ = Rate of interest.

Y.P. = Years Purchase

‘n’ = numbers of years.

‘C’ = Capital income (Annuity) received each year.

6.1 Example – 13 :

A residential house yields net rental income (Annuity) of Rs.3000/- per year. If this income ceases after 80 years (Future life of building), what is present value of this property at 7% rate of interest. (Income receivable for 80 years is as good as perpetual income & hence Single Rate)

Solution :

$$\text{Y P.} = \frac{1 - \frac{1}{(1+R)^n}}{R}$$

$$= \frac{1 - \frac{1}{(1+0.07)^{80}}}{0.07}$$

$$= \frac{1-0.004459}{0.07} = 14.222$$

Present value of property = C x YP = 3000 x 14.222

= Rs.42,666/- Say Rs.43,000/-

6.2 Example – 14 :

What is the present value of an Annuity which would continue yielding income of Rs.2000/month for 60 years period at 4% rate of interest. (Income receivable for 60 years or more is considered as perpetual income. Hence Single Rate)

Solution :

$$\text{Y.P.} = \frac{1 - \frac{1}{(1+R)^n}}{R} = \frac{1 - \frac{1}{(1+0.04)^{60}}}{0.04}$$

$$= \frac{1 - 0.905}{0.04} = 22.623$$

Present value of annuity = C x YP = 2000 x 12 x 22.623

= Rs.542,952/-

7.0 Present value of an amount of Re.1/year (Dual Rate basis) :

(Refer years purchase table – 1 in Mirams Valuation Table) :

It is very essential in number of cases to provide for recoupment of capital sum invested also, in addition to annual yield income from the asset. Whenever income is terminable at future date, dual interest rates have to be considered. As two interest rates are considered for terminable income, this working is known as Dual Rate working. Table used is called dual rate table.

One rate is called remunerative interest rate and it is for the REMUNERATION (yield) for the capital sum invested. Second rate of interest is called Accumulative rate of interest since it is for **ACCUMULATION** of annual sinking fund set aside (Getting back of original capital) of capital invested, for period after which annual income is likely to cease. In this case the income is terminable and hence provision for accumulation of capital (Getting back of capital) has to be made. The accumulative rate of interest is considered at lower rate as because highest security for accumulation of capital is needed.

Remunerative interest rate is higher and accumulative (recoupment) interest rate is minimum. This is nothing but to provide for setting aside Sinking Fund amount each year for full period so as to get back capital sum invested. This is also known as Redemption of Capital. As two interest rates are considered in this working, this is known as Dual Rate. The formula for working out years purchase with redemption of capital and formula to arrive at value of asset are as under.

(i) Present value of Re.1/year (YP) = $\frac{1}{(R+S)}$

(ii) Sinking Fund (S) = $\frac{r}{(1+r)^n - 1}$

(iii) Value of asset = C x YP

Where,

‘R’ = Remunerative Interest Rate.

‘S’ = Sinking Fund

Y.P. = Years Purchase

‘r’ = Interest rate for recoupment of capital i.e, Accumulative rate of interest.

‘n’ = Numbers of year.

‘C’ = Capital income received each year.

7.1 Example –15:

A Lessee took a plot on 60 years lease and on the plot he built a house yielding net income of Rs.15,000/year. After 30 years, he decided to sale the property. Calculate present sale value of the property if expected yield on investment is 8% and rate of redemption of capital is 3%.

Solution : Y.P. $= \frac{1}{R+S}$ unexpired lease period = 60 – 30 = 30 Yr.

$$S = \frac{r}{(1+r)^n - 1} = \frac{0.03}{(1+0.03)^{30} - 1} = 0.021$$

$$Y\,P = \frac{1}{0.08 + 0.021} = 9.90$$

Present value of property = C x YP = 15,000 x 9.9 = Rs.148,500/-

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## II. The Depreciation under Income Tax Act, 1961 as well as Companies Act 2013, Useful lives to compute depreciation as per Schedule II of Companies Act,2013, Factors to be considered for componentization of assets.

### 1. Introduction

**There are two types of assets: Tangible & Intangible**

Most types of tangible property (except, land), such as buildings, machinery, vehicles, furniture, and equipment are **depreciable.**

Likewise, certain intangible property, such as patents, copyrights, and computer software are **depreciable.**

Valuer estimates the cost of reproduction of or replacement for existing structure and the improvements and then deducts all accrued depreciation in the property being valued from the reproduction cost or replacement cost of the structure as of the valuation date.

When the value of the land is separately added to above figure, one would get the total value of the property.

- Depreciation is an income tax deduction that allows a taxpayer to recover the cost or other basis of certain property. It is an annual allowance for the wear and tear, deterioration, or obsolescence of the property.
- Depreciation is a measure of the wearing out, consumption or other loss of value of a depreciable asset arising from use, passage of time or obsolescence through technology and market changes.
- Depreciation is one of the expenditure debited to profit and loss account. It is non-cash expenses.

Purpose of Depreciation: Accounting & Tax purpose

### 2. Various Terminology

*Depreciation:*

It is the systematic allocation of the ***depreciable amount*** of an asset over its ***useful life.***

*Depreciable Amount:*

It is the cost of an asset, or other amount substituted for cost, less its ***residual value.***

*Useful Life:*

- The period over which an asset is expected to be available for use by an entity; or
- The number of production or similar units expected to be obtained from the asset by an entity.

*Carrying Amount:*
It is the amount at which an asset is recognized after deducting any ***accumulated depreciation*** and ***accumulated impairment losses.***

*Impairment Loss:*
It is the amount by which the carrying amount of an asset exceeds its ***recoverable amount.***

*Recoverable Amount:*
It is the higher of an asset 's ***fair value*** less costs to sell and its ***value in use.***

*Fair Value:*
It is the estimated amount that an entity would currently obtain from disposal of the asset, after deducting the estimated costs of disposal, if the asset were already of the age and in the condition expected at the end of its ***useful life***.

*Value in Use:*
The present value of the future cash flows expected to be derived from an asset or cash-generating unit.

*Amortization:*
It is the systematic allocation of the depreciable amount of an ***intangible asset*** over its useful life.

*Gross Book Value*
It is ***historical cost*** or other amount substituted for cost of asset in the books of account or financial statements.

*Net Book Value:*
Gross book value is shown net of accumulated depreciation and impairment loss or accumulated amortization.

*Block of Assets:*
Block of Assets means group of assets falling within a class of assets for which same rate of depreciation is prescribed.
Please refer to the Article on "Depreciation on block of assets under Income Tax Act,1961" by Prof. Prakash E. Humbad, Prof. Ramkrushan More College, Akurdi, Pune published in Vol. 2, Issue 3, March, 2016 of International Research Journal of Multidisciplinary Studies available on http://irjms.in/sites/irjms/index.php/files/article/viewFile/412/380.

*Depreciable Asset:*
An asset which are expected to be used during more than one accounting period and have a limited useful life and are held by the enterprise for use in the production or supply of goods and services.

**3. Depreciation under Income Tax Act, 1961 & Companies Act 2013**

| Sr. No. | Income Tax Act, 1961 | Companies Act, 2013 |
|---|---|---|
| 1 | Based on block of assets | Based on individual asset |
| 2 | Using Written Down Value Method (WDV) method | Using Straight Line Method (SLM), Written Down Value Method (WDV) & Unit of Production (UoP) |
| 3 | Rate of depreciation | Based on useful life |
| 4 | Adoption of lower rate of depreciation is not permitted | Deviation from useful life specified in Schedule II, Part C is permitted provided that the financial statements shall disclose such difference and provide justification in this behalf duly supported by technical advice |
| 5 | Residual value is not prescribed | Deviation from limit of residual value specified in Schedule II, Part C, is permitted provided that the financial statements shall disclose such difference and provide justification in this behalf duly supported by technical advice |
| 6 | 100% depreciation for cost less than Rs. 5000 | Does not specify |
| 7 | Different rate for extra shift | Increase in % for extra shift |
| 8 | Component accounting is not specified or optional | Useful life specified in part C of the schedule is for whole of the asset. Where cost of a part of the asset is significant to total cost of the asset and useful life of that part is different from the useful life of the remaining asset, useful life of that significant part shall be determined separately. |

## 4. Useful Lives as per Schedule II of Companies Act, 2013

| Sr. No. | Name of Plant | Year |
|---|---|---|
| 1 | P&M related to production and exhibition of Motion Picture Films | 13 |
| 2 | P&M except direct fire glass melting furnaces — Recuperative and regenerative glass melting furnaces | 13 |
| 3 | P&M except direct fire glass melting furnaces — Moulds | 08 |
| 4 | Float Glass Melting Furnaces | 10 |
| 5 | P&M used in Telecommunications – Towers | 18 |
| 6 | Telecom transceivers, switching centers, transmission and other network equipment | 13 |
| 7 | Telecom—Ducts, Cables and optical fiber Satellites | 18 |
| 8 | Crude Oil Refineries & its related asset | 25 |
| 9 | Field operations (above ground) Portable boilers, drilling tools, well-head tanks, etc. | 08 |
| 10 | Thermal/ Gas/ Combined Cycle or Hydro or Nuclear Power Generation Plant | 40 |
| 11 | Sinter Plant, Sinter Plant, Coke Oven, Rolling Mill of Steel Plant | 20 |
| 12 | Metal pot line, Bauxite crushing and grinding section, Digester Section, Turbine, Equipments for Calcinations, Copper Smelter, Roll Grinder for non-ferrous metal plant | 40 |
| 13 | Soaking Pit, Annealing Furnace, Rolling Mills, Equipments for Scalping, Slitting , etc. for non-ferrous metal plant | 30 |
| 14 | Reactors, Distillation Columns, Drying equipments/Centrifuges and Decanters, Vessel/storage tanks for pharmaceuticals and chemicals plant | 20 |

## 5. Factors to be taken into consideration for estimation of Useful Life

- Utility
- Physical & working condition
- Status of repair & maintenance
- Availability of raw material
- Availability of spares & parts
- Demand & supply

**6. What is a Componentization of Asset?**

If fixed asset has two or more major components with substantially different useful lives, these assets should be treated as separate components and depreciated over the different useful lives. This is called componentization of Asset.

A part of the machinery is said to be a component which is having a significant value in relation to the total cost of the asset and total useful life of the part is also significantly different from the total useful life of the main asset. The component is treated as a separate asset for treatment of depreciation as well as for capitalization of subsequent expenditure on restoring or replacing.

**7. Factors to be considered for Componentization of Assets**

- Identifiability or Separability
  The component must be identifiable and separable. Any component which is not separable from its parent asset for replacement or maintenance, it cannot be treated as a separate component.
- Identifiable in terms of cost / Measurement of cost from market
  The replacement cost of identified component should be available
- Significant difference in terms of total useful life
  The percentage rate for depreciation is dependent on the total useful life; hence the significant difference in total Useful life for parent asset and component is required to be ascertained.

Example – Componentization of Aircraft
Aircraft has an engine, a body and Electronic System that have very different useful lives. The engine may need to be replaced multiple times over life of the aircraft. The useful life of the body may be 20 years, whereas the useful life of the engine and Electronic System may be 8 years and 5 years respectively. The body would be treated as a separate component and it is depreciated over 20 years, while the engines would be depreciated over 8 years (or perhaps based on the number of flight hours) and Electronic System would be depreciated over 5 years.

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| Sr. No. | Components | Component Amount | Useful Life | Depreciation/ Year |
|---|---|---|---|---|
| | | In INR | In Yr. | In INR |
| **1** | Air frame (with balance unidentifiable assets) | 4,800,000,000 | 20 | 240,000,000 |
| **2** | Engine | 2,560,000,000 | 8 | 320,000,000 |
| **3** | Electronic System | 640,000,000 | 5 | 128,000,000 |
| | Total | 8,000,000,000 | | 688,000,000 |

**Valuation of machine tools, factory and utility equipment**

Three approaches to value applicable to valuation of plant and machinery are also applicable to valuation of machine tools, factory and utility equipment and same have been covered in KPB's book.

It is equally important for valuers of plant and machinery to get familiarise with machine tools, factory and utility equipment and then only he can do proper valuation and therefore same have been covered in this study material.

The technical specifications are vital for machines falling under this category. The technical specifications of machine tools and factory equipment are covered under section IV and technical specification of utility equipment are covered under subject of Industrial Processes.

**III. Machine Tools.**

*by*
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# INDEX

**Prologue:**

A quality production is the fundamental moto of any manufacturing unit. There are certain basic need for a sustained quality production like wel maintained machinary, means an equiped work shop, quick emergency handling (well designed fire fighting & Alarm system) and efficient materials handling and peripharials.

This machine tools & factory equipment is a vast subject with horizon as a limit. There are numerous types of machinary available in the market. The types of machinary and equipment used can vary from one product to another and also from one unit to another. An effort is made to cover and briefly introduce all major types of machine tools used in a factory. Also all important peripharial equipments and systems are discussed.

So much is available on the subject that it has to be compiled in a systematic manner with a target group in mind. This text offers a comprehensive & flexible introduction to the basic machine tools. It is designed specifically for heterogeneous classes. As a matter of fact this subject is being natured for non-engineering background students & hence a special care is taken to avoid design aspects as far as possible. We shall study the basic engineering machines, tools, material handling equipments and some of the popular variance of the standard equipment.

The entire subject is divided in six chapters or units.

- The first unit deals with “Introduction to metal Working”.- i.e. various types of metal working processes are discussed here.
- The second unit – deals with various types of machines and machining operations.
- Third units discusses the tools used in the operation and special equipments thereof.
- Fourth unit “Measuring Equipments” – adapts various measuring equipments deployed for accurate measurements. The Fifth unit being extension of the fourth one deals with various “Non Destructive Testing” procedures & methods.
- The last unit is dedicated to various aspects of “Material Handling” starting with lifting & transport equipments like cranes, conveyors, winch to vehicle like forklifts, tractors, bulldozer, excavators etc. It also overviews the basic Fire & Control equipments and Communication systems.

An effort is made so that after studying all the units, the student will understand the basic working of a factory machine tool work shop and other periphereals services. Having understood the basic working and the type of usage, a valuer can judge the value of the equipment in question by putting his valuation practices in use.

I also wish to put on record the valuable guidance received from Mr. Kirit Budhbhatti to make this work more beneficial to the students.

# CHAPTER-1

## INTRODUCTION TO METALWORKING

Metalworking is the craft and practice of working with metals to create structures or machine parts. The term covers a wide range of work-from large ships, bridges and oil refineries to delicate jewellery and instruments. Consequently, this craft covers a wide range of skills and entails the use of many types of tools.

**History**

Metalworking is a trade, art, hobby and industry that relates to metallurgy - a science, jewelery making - an art and craft, as a trade and an industry with ancient roots spanning all cultures and civilizations. Metalworking had its beginnings millennia in the past. Early humans, we speculate, realized different stones had different properties. These were freed metal ores on the earth's surfaces. We can further speculate that some indigenous groups attributed magical and spiritual significance to them. At some imprecise point humankind discovered that these lustrous rocks were meltable, and ductile and able to be formed into various articles for tools, adornment and practical uses. Humans over the millennia learned to work raw metals into objects of art, adornment, trade and practicality.

Through trial and error, and crude harnessing of the malleability of metals, inquisitions as to the sources of these elements probably began. By the historical periods of the Pharohs in Egypt, the Vedic Kings in India, and the Tribes of Israel, and Mayan Civilization in North America among other ancient populations, precious metals began to have value attached to them, and in some cases rules for ownership, distribution, and trade were created, enforced and agreed upon by respective peoples. By the above periods skills at creating objects of adornment, religious artifacts, and trade instruments of precious metals (non-ferrous), as well as implements of inhumanity, and other weaponry usually of ferrous metals and/or alloys were finely honed and flawlessly executed skills and techniques practised by artisans, blacksmiths, atharvavedic practitioners, alchemists, and other categories of metalworkers around the globe. For example, the ancient technique of granulation is found spontaneously around the world in numerous ancient cultures before the historic record shows people travelled seas or overland to far regions of the earth to share this process still being used, and attempted by metalsmiths today.

As time progressed metal objects became more common, and ever more complex. The need to further acquire and work metals grew in importance. Skills related to extracting metal ores from the earth began to evolve, and metalsmiths became more knowledgable. Metalsmiths became important members of society. Fates and economies of entire civilizations were greatly affected by the availability of metals and metalsmiths.

Today modern mining practices are more efficient, and conversely more damaging to the earth, and the workers that are engaged in the industry. Those that finance the operations are driven by profits per ounce of extracted precious metals and today's gold market which as of the date of this editing, are at a 25 year high.

The metalworker though depends on the extraction of precious metals to make jewelery, build more efficient electronics, and for industrial and technological applications from construction to shipping containers to rail, and air transport. Without metals, goods and services would cease to move around the globe on the scale we know today. More individuals then ever before are learning metalworking as a creative outlet in the forms of jewelery making, hobby restoration of aircraft and cars, blacksmithing, tinsmithing, tinkering, and in other art and craft pursuits. Trade schools continue to teach welding in all of its forms, and there is a proliferation of schools of Lapidary and Jewelers srts and sciences at this- the beginning of the 21st. Century a.c.e./a.d.

**Processes**

- 1.0 Shape modifying by material removal processes
  - 1.1 Milling
  - 1.2 Turning
  - 1.3 Cutting
  - 1.4 Drilling and threading
  - 1.5 Grinding
- 2.0 Shape modifying with material retention processes
  - 2.1 Casting
  - 2.2 Plastic deforming
  - 2.3 Powder forming
  - 2.4 Sheet metal
- 3.0 Joining processes
  - 3.1 Welding
  - 3.2 Hand fabrication
- 4.0 Preparation and validation
  - 4.1 Marking out

## 1.0 Shape modifying by material removal processes

### 1.1 Milling

Milling is the complex shaping of metal (or possibly other materials) parts, by removing unneeded material to form the final shape. It is generally done on a milling machine, a power-driven machine that in its basic form is comprised of a milling cutter that rotates about the spindle axis (like a drill), and a worktable that can move in multiple directions (usually three dimensions [x,y,z axis] relative to the workpiece, whereas a drill can only move in one dimension [z axis] while cutting). The motion across the surface of the workpiece is usually accomplished by moving the table on which the workpiece is mounted, in the x and y directions. Milling machines may be operated manually or under computer numerical control (CNC), and can perform a vast number of complex operations, such as slot cutting, planing, drilling and threading, rabbeting, routing, etc. Two common types of millers are the horizontal miller and vertical miller.

### 1.2 Turning

A lathe is a machine tool which spins a block of material so that when abrasive, cutting, or deformation tools are applied to the workpiece, it can be shaped to produce an object which has rotational symmetry about an axis of rotation, called Solids of Revolution. Examples of objects that can be produced on a lathe include candlestick holders, table legs, bowls, baseball bats, crankshafts or camshafts.

The material may be held in place by a chuck or worked between one or two centers of which at least one can be moved horizontally to accommodate varying material lengths. In a metalworking lathe, metal is removed from the workpiece using a hardened cutting tool which is usually fixed to a solid moveable mounting called the "toolpost", this arrangement is then moved around the workpiece using handwheels and/or computer controlled motors. The main difference between the Milling Machine and the Lathe is that in the Milling Machine the tool is moving but in the Lathe, the work is moving.

### 1.3 Cutting

There are many technologies available to cut metal. Sawing, chisel, shearing, burning by Laser, gas jet and plasma, erosion by water jet or electric discharge, and good old fashioned hand cutting.

**1.4 Drilling and threading**

Drilling is the process of using a drill bit in a drill to produce holes. Under normal usage, swarf is carried up and away from the tip of the drill bit by the fluting. The continued production of chips from the cutting edges pushes the older chips outwards from the hole. This continues until the chips pack too tightly, either because of deeper than normal holes or insufficient backing off (removing the drill slightly [breaking the chip] or totally from the hole [clearing the bit] while drilling). Lubricants (or coolants) (i.e. cutting fluid) are sometimes used to ease this problem and to prolong the tool's life by cooling, lubricating the tip and improving chip flow.

Taps and dies are tools commonly used for the cutting of screw threads in metal parts. A tap is used to cut a female thread on the inside surface of a predrilled hole, while a die cuts a male thread on a preformed cylindrical rod.

**1.5 Grinding**

Grinding uses an abrasive process to remove material from the workpiece. A grinding machine is a machine tool used for producing very fine finishes or making very light cuts, using an abrasive wheel as the cutting device. This wheel can be made up of various sizes and types of stones, diamonds or of inorganic materials.

**2.0 Shape modifying with material retention processes**

These processes modify the shape of the object being formed, without removing any material.

**2.1 Casting**

- Sand casting
- Shell casting
- Investment casting (called Lost wax casting in art)
- Die casting

**2.2 Plastic deforming**

- Forging
- Rolling
- Extrusion
- Spinning

**2.3 Powder forming**

- Sintering

**2.4 Sheet metal**

- Bending :A calculated deformation of the metal from it original shape.
- Drawing
- Pressing
- Spinning
- Flow turning

**3.0 Joining processes**

**3.1 Welding**

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material that cools to become a strong joint, but sometimes pressure is used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the workpieces to form a bond between them.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding can be done in many different environments, including open air, underwater and in space. Regardless of location, however, welding remains dangerous, and precautions must be taken to avoid burns, electric shock, poisonous fumes, and overexposure to ultraviolet light.

**4.0 Marking out**

Marking out (also known as layout) is the process of transferring a design or pattern to a workpiece and is the first step in the handcraft of metalworking. It is performed in many industries or hobbies, although in the repetition industries the need to mark out every individual piece is eliminated.

In the metal trades area, marking out consists of transferring the engineers plan to the workpiece in preparation for the next step, machining or manufacture.

**Exercise:**

1. What is metal working?
2. Describe Processes of metal working.
3. What is Welding?
4. What is the significance of Marking out ?

# CHAPTER - 2

## MACHINES & MACHINING OPERATIONS

**Lathe Machine**

A lathe is a common tool used in machining.

A lathe is a tool which spins a block of material to perform various operations such as cutting, sanding, knurling, drilling or deformation with tools that are applied to the workpiece to create an object which has symmetry about an axis of rotation.

Lathes are used in woodturning, metalworking, metal spinning, and glassworking. A lathe used for working with clay is more commonly known as a potter's wheel. Most suitably equipped metalworking lathes can also be used to produce most solids of revolution, plane surfaces and screw threads or helices. Ornamental lathes can produce three-dimensional solids of incredible complexity. The material is held in place by either one or two centers, at least one of which can be moved horizontally to accommodate varying material lengths. Examples of objects that can be produced on a lathe include candlestick holders, cue sticks, table legs, bowls, baseball bats, crankshafts and camshafts.

**A metal lathe**

In a metalworking lathe, metal is removed from the workpiece using a hardened cutting tool, which is usually fixed to a solid moveable mounting called the "toolpost", which is then moved against the workpiece using handwheels and/or computer controlled motors.

The toolpost is operated by leadscrews that can accurately position the tool in a variety of planes. The toolpost may be driven manually or automatically to produce the roughing and finishing cuts required to turn the workpiece to the desired shape and dimensions, or for cutting threads, worm gears, etc. Cutting fluid may also be pumped to the cutting site to provide cooling, lubrication and clearing of swarf from the workpiece. Some lathes may be operated under control of a computer for mass production of parts.

Metalworking lathes are commonly provided with a variable ratio gear train to drive the main leadscrew. This enables different pitches of threads to be cut. Some older gear trains are changed manually by using interchangeable gears with various numbers of teeth, while more modern or elaborate lathes have a quick change box to provide commonly used ratios by the operation of a lever.

The threads that can be cut are, in some ways, determined by the pitch of the leadscrew: A lathe with a metric leadscrew will readily cut metric threads (including BA), while one with an imperial leadscrew will readily cut imperial unit based threads such as BSW or UTS (UNF,UNC).

The workpiece may be supported between a pair of points called centres, or it may be bolted to a faceplate or held in a chuck. A chuck has movable jaws that can grip the workpiece securely.

**Varieties**

The smallest lathes are "jewelers lathes" or "watchmaker lathes", which are small enough that they may be held in one hand. Although the workpieces machined on a jeweler's lathes are metal, jeweler's lathes differ from all other metal working lathes in that the cutting tools (called "gravers") are hand held, supported by a T-rest, not fixed to a cross slide. The work is usually held in a collet and two spindle bores to receive such collets are common, namely 6 mm and 8 mm. Two patterns of bed are common, the WW (Webster Whitcomb) bed, which is found only on 8 mm Watchmakers lathes which is a truncated triangular prism and the continental D-style bar bed used on both 6 mm and 8 mm lathes by firms such as Lorch and Star. Other designs have been used, e.g. Boley used a triangular prism as bed on some 6.5 mm lathes, and IME used a V edged bed on their 8 mm lathes.

- Lathes that sit on a bench or table are called **"bench lathes".**
- Lathes that do not have additional intergal features for the purposes increased production rates, but rather have individual part production or modification as the primary role, are called **"engine lathes".**
- Lathes with a very large spindle bore and a chuck on both ends of the spindle are called **"oil field lathes."**

- Fully automatic mechanical lathes, employing cams and gear trains for controlled movement, are called **automatic screw machines.**
- Lathes that are controlled by a computer are **CNC lathes.**
- Lathes with the spindle mounted in a vertical configuration, instead of horizontal configuration, are **called vertical lathes or vertical boring machines**. They are used where very large diameters must be turned, and the workpiece is not very long.
- A lathe with a cylindrical tailstock that can rotate around a vertical axis, so as to present different facets towards the headstock (and the workpiece) are **turret lathes.**
- A lathe equipped with indexing plates, profile cutters, spiral or helical guides, etc., so as to enable ornamental turning is an **ornamental lathe**.
- Various combinations are possible: e.g. one could have a "vertical CNC lathe", etc.
- Lathes can be combined with other mechanisms into more complex machines, such as those with an overhead drill or vertical milling unit. These are usually referred to as **combination lathes.**

**SCREW M/C**

A **Screw Machine** is a metalworking machine used in the high volume manufacture of turned components.
In operation, a Screw Machine is similar to a Lathe. Essentially a Screw Machine is an Automated Turret Lathe.

Screw Machines have been replaced by CNC Lathes to some extent. However, for high volume production of turned components nothing is as cost efficient as a Screw Machine.

In the hierarchy of manufacturing machines, the Screw Machine sits at the top when large volume of product is needed. An Engine Lathe sits at the bottom, taking the least amount of time to set-up but the most amount of skilled labor and time to actually produce a part. A turret lathe has traditionally been one step above a Lathe, needing greater set-up time but being able to produce a higher volume of product and usually requiring a lower skilled operator once the set-up process is complete. Screw Machines may require an extensive set-up but once running, a single operator can monitor the operation of several machines.

A Screw Machine may have a single spindle but, in contrast to a lathe, a Screw Machines may have multiple spindles. Each spindle contains a bar of material that is being machined simultaneously. A common configuration is six spindles. The cage that holds these six bars of material indexes after each machining operation is complete. Each station may have multiple tools that cut the material in sequence. The operation of these tools being very similar to that of a turret lathe.

By way of example then: a bar of material is fed forward through the spindle. The face of the bar is machined (facing operation). The Outside of the bar is machined to shape (turning operation). The bar is drilled (boring operation) and finally, the part is cut off (parting operation).

In a single spindle machine, these four operations would most likely be performed sequentially with four cross-slides each coming into position in turn to perform their operation. In a multiple spindle machine, each operation would be performed on each spindle simultaneously, with the material being positioned at each station in sequence.
Screw Machines are mechanically driven, the position of the cutting tool is determined by the shape of a cam that rotates in step with the machine, but at a slower speed.
For the machining of complex shapes, it is common to use a Form Tools.

This contrasts with the cutting that is performed on an Engine Lathe where the cutting tool is usually a Single-Point Tool. A Form Tool has the form or contour of the final part but in reverse, so it cuts the material leaving the desired component shape. A Single-Point Tool is designed to cut on one point at a time and the shape of the component is dictated by the motion of the tool rather than its shape.

The name "Screw Machine" is somewhat of a misnomer since Screw Machines spend most of their time making things that are not screws and are not even threaded. However, threading is frequently performed on a screw machine. Unlike a lathe, single point threading is rarely if ever performed, single point threading is too time consuming for the short cycle times that are typical of Screw machines. A threading die can cut rapidly but it requires the machine to reverse in order to be removed from the work. It is impractical to reverse the rotation of the spindle[s] of the machine so it is necessary to have a cutting tool that can cut in one direction and cut fast and be removed without interrupting the rotation of the machine. Threading is performed with a Die Head - a device that cuts the thread then opens and withdraws rapidly.

**Cutting**

Cutting is the separation of a physical object, or a portion of a physical object, into two portions, through the application of an acutely directed force. An implement commonly used for cutting is the knife or in medical cases the scalpel. However, any sufficiently sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force. Cutting also describes the action of a saw which removes material in the process of cutting.


Cutting is a compressive and shearing phenomenon, and occurs only when the total stress generated by the cutting implement exceeds the ultimate strength of the material of the object being cut. The simplest applicable equation is stress = force/area: The stress generated by a cutting implement is directly proportional to the force with which it is applied, and inversely proportional to the area of contact. Hence, the smaller the area (i.e., the sharper the cutting implement), the less force is needed to cut something.

**Saw**

A saw is a tool for cutting wood or other material, consisting of a serrated blade (a blade with the cutting edge dentated or toothed) and worked either by hand or by steam, water, electric or other power. The teeth of the saw are each bent to specific angle and this angle is called "set". The set of a tooth is dependent on the kind of cut the saw will be making. For example a "rip saw" has a tooth set that is similar to the angle used on a chisel. The idea is to have the teeth rip or tear the fibers of the wood apart.

**Mechanically powered saws**

Mechanically powered saws mechanically move the teeth past the wood while the saw itself is held stationary. This is accomplished in one of three ways: the teeth are along the perimeter of a flat, circular blade; the blade reciprocates up and down rapidly; or the teeth are along one edge of a continuous band. They are more specifically differentiated as follows:

Circular blade saws

- Circular saw, machine-driven for industrial sawing of log and beams, typically found in sawmills - also name given to smaller hand-held saws
- Table saw, circular blade rises through a slot in a table. It is the most common piece of stationary woodworking equipment. The smaller direct-drive versions that can be set on a workbench are called workbench saws. Smaller belt-driven ones generally set on steel legs are often called Contractor's Saws. The heavier, more precise and more powerful, often driven by multiple belts, with an enclosed base stand as an integral part of the saw are called Cabinet saws. A relatively new version, called a hybrid saw, has the lighter weight mechanism of a Contractor saw but with an enclosed base like the Cabinet saw.
- Radial arm saw, versatile machine used mainly for cross-cutting where the blade is pulled on a guide arm through a piece of wood held stationary on the saw's table
- Rotary saw, for making accurate cuts without the need for a pilot hole in wallboard, plywood, and other thin materials, also called a spiral cut saw or a "RotoZip". The latter is a trademark owned by Bosch Tool Corp. who pioneered this type of saw - design is similar to a small wood router, bits are similar to a twist drill, some cut on the upward twist, some cut downwards
- Electric miter saw, (also called chop saw, cut-off saw or power miter box) – for making accurate cross cuts and miter cuts. The basic model has its circular blade fixed at a 90° angle to the vertical, a compound miter saw's blade can be adjusted to other angles. A sliding compound miter saw has a blade which can be pulled through the work similar to the action of a radial arm saw, which gives a greater capacity for cutting wider workpieces.
- Concrete saw, usually powered by an internal combustion engine and used with a Diamond Blade to cut concrete or asphalt pavement.

Reciprocating blade saws

- Jigsaw or saber saw (mainly US), narrow blade for cutting irregular shapes, typically held in one hand with the barrel perpendicular to the saw blade. Historically, the term jigsaw was also commonly used for what is now usually called a scroll saw.
- Reciprocating saw or sabre saw (mainly UK and Australia), action similar to a jigsaw, but much larger, more powerful and with a longer stroke with the blade parallel to the barrel. Normally held in both hands, useful for demolition work or for cutting pipe. Sometimes powered by compressed air.

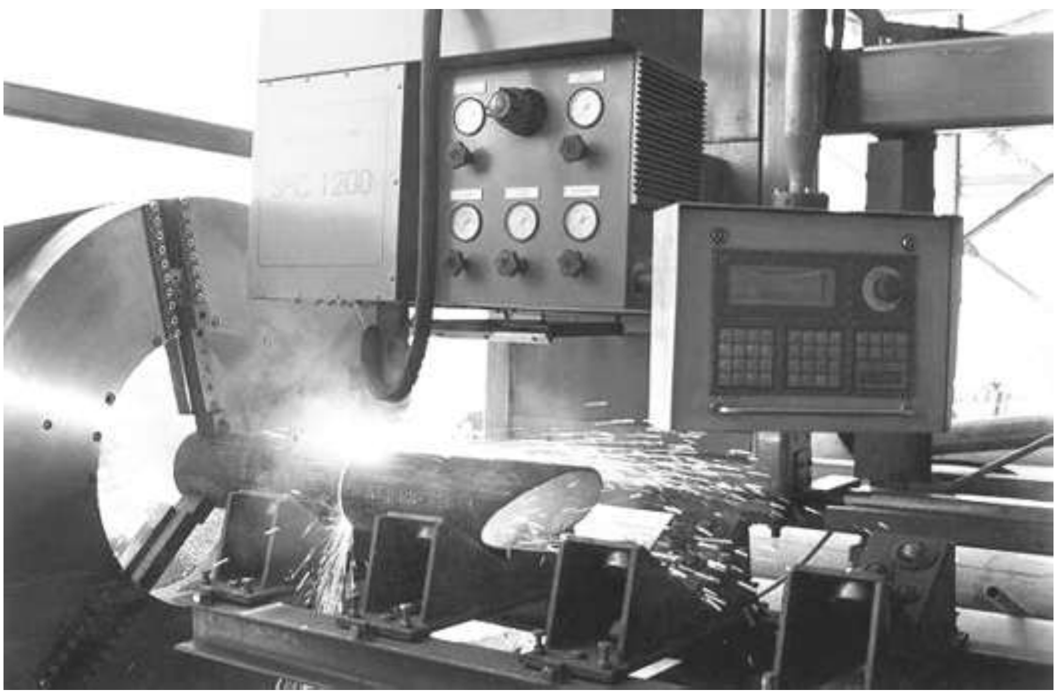
- Scroll saw, saw for making intricate curved cuts (scrolls), the first of which were pedal powered. Traditionally called a jigsaw.
- Dragsaw, internal combustion powered saw used for bucking logs before the advent of the chainsaw.
- Sternal saw, used in surgery to open a patient's sternum.

Continuous band

- Band saw, with motor-driven continuous band

**Metal Cutting Band Saws**

When cutting metals, special band saws are required that include coolant pumps which provide a constant flow of liquid coolant over the blade. The coolant keeps blades cool, adding blade life. They also include a powered wire brushwheel to remove chips and buildup from the blade as it exits the material. Metal cutting band saws are available in vertical and horizontal designs. These units range from manual to semi-automatic and even automatic controls.



**CNC Cutting Machine**

Machine shop bandsaws are horizontal, vertically cutting saws. Small, manual shop saws are usually employ a gravity-fed blade that falls in an arc around a pivot point. The rate of descent is controlled by a shock absorber that has an adjustable rate. When a manual saw is set up for another cut, the operator raises the saw by hand and leaves it in a 45 degree position. The material is unclamped, moved up to hit the part stop (which is then moved out of the way), material reclamped, and the operator hits the rapid advance switch to lower the saw just before the cut begins. The saw's piston is then set to cut advance, and another cut is made.

**Guillotine Shear m/c**

A guillotine is a machine used to accurately cut sheet metal. It may be foot-operated (or less commonly hand-operated), or powered. An angled blade is driven down which slices the metal along the length of the cut, shearing it off very cleanly.

Depending on the capacity of the machine, the angle of the blade may be varied along with the clearance between the upper and lower blades. The thicker the material, the greater the angle and clearance given to the blades.

The angle of the blade is referred to as shear, and this provides a slicing rather than a chopping action; by slicing the material a cleaner cut is produced and less energy is used. This is because the blade contacts only a small area at a time rather than the full length of the cut (which is also how scissors work).

Clearance is defined as the separation between the blades, measured at the point where the cutting action takes place, and perpendicular to the direction of blade movement. It affects the finish of the cut (burr) and the machine's power consumption, and is directly related to the material's composition. The cut of a guillotine is in part a fracturing process; the blade partially penetrates the material but the final separation is due to the material fracturing. Harder materials (such as stainless steel) fracture more readily than softer ones (such as brass).

The design of press tools and guillotine blades is an engineering compromise. A sharp edge is required, along with strength and durability, so to achieve these two objectives the blades for metal work tend to be square-edged rather than knife-edged. The difference between the two angles is called the rake

**Drilling**

Under normal usage, swarf is carried up and away from the tip of the drill bit by the fluting. The continued production of chips from the cutting edges produces more chips which continue the movement of the chips outwards from the hole. This continues until the chips pack too tightly, either because of deeper than normal holes or insufficient backing off (removing the drill slightly or totally from the hole while drilling). Lubricants and coolants (i.e. cutting fluid) are sometimes used to ease this problem and to prolong the tools life by cooling and lubricating the tip and chip flow. Coolant is introduced via holes through the drill shank.

Straight fluting is used for copper or brass, as this exhibits less tendency to "dig in" or grab the material. If a helical drill (twist drill) is used then the same effect can be achieved by stoning a small flat parallel with the axis of the drill bit.
For heavy feeds and comparatively deep holes oil-hole drills can be used, with a lubricant pumped to the drill head through a small hole in the bit and flowing out along the fluting.

**Jig borer**

The jig borer is a type of machine tool invented at the end of World War I to make possible the quick-yet-very-precise location of hole centers.

Before the jig borer was developed, hole center location had been accomplished either with layout (either quickly-but-imprecisely or painstakingly-and-precisely) or with drill jigs (themselves made with painstaking-and-precise layout). The jig borer was invented to expedite the making of drill jigs, but it helped to eliminate the need for drill jigs entirely by making quick precision directly available for the parts that the jigs would have been created for. The revolutionary underlying principle was that advances in machine tool control that expedited the making of jigs were fundamentally a way to expedite the cutting process itself, for which the jig was just a means to an end. Thus the jig borer's development helped advance machine tool technology toward later NC and CNC development. The jig borer was a logical extension of manual machine tool technology that began to incorporate some then-novel concepts that would become routine with NC and CNC control, such as:

- coordinate dimensioning (dimensioning of all locations on the part from a single reference point);
- working routinely in "tenths" (ten-thousandths of an inch, 0.0001") as a fast, everyday machine capability (whereas it formerly was the exclusive domain of special, time-consuming, craftsman-dependent manual skills); and
- circumventing jigs altogether.

**Milling machine**

A milling machine is a power-driven machine used for the complex shaping of metal (or possibly other materials) parts. Its basic form is that of a rotating cutter or endmill which rotates about the spindle axis (similar to a drill), and a movable table to which the workpiece is affixed. That is to say the cutting tool generally remains stationary (except for its rotation) while the workpiece moves to accomplish the cutting action. Milling machines may be operated manually or under computer numerical control.

Milling machines can perform a vast number of complex operations, such as slot cutting, planing, drilling, rebating, routing, etc.Cutting fluid is often pumped to the cutting site to cool and lubricate the cut, and to sluice away the resulting swarf.

**Types of milling machines**

There are two main types of mill: the vertical mill and the horizontal mill. In the vertical mill the spindle axis is vertically oriented. Milling cutters are held in the spindle and rotate on its axis. The spindle can generally be extended (or the table can be raised/lowered, giving the same effect), allowing plunge cuts and drilling. There are several subcategories of vertical mills: the bedmill and the turret mill. Turret mills, like the ubiquitous Bridgeport, are generally smaller than bedmills, and are considered by some to be more versatile. In a turret mill the spindle remains stationary during cutting operations and the table is moved both perpendicular to and parallel to the spindle axis to accomplish cutting. In the bedmill, however, the table moves only perpendicular to the spindle's axis, while the spindle itself moves parallel to its own axis. Also of note is a lighter machine, called a mill-drill. It is quite popular with hobbyists, due to its cheap price. These are frequently of lower quality than other types of machines, however.

A horizontal mill has the same sort of x–y table, but the cutters are mounted on a horizontal arbor across the table. A majority of horizontal mills also feature a +15/-15 degree rotary table that allows milling at shallow angles. While endmills and the other types of tools available to a vertical mill may be used in a horizontal mill, their real advantage lies in arbor-mounted cutters, called side and face mills, which have a cross section rather like a circular saw, but are generally wider and smaller in diameter.

Because the cutters have good support from the arbor, quite heavy cuts can be taken, enabling rapid material removal rates. These are used to mill grooves and slots. Plain mills are used to shape flat surfaces. Several cutters may be ganged together on the arbor to mill a complex shape of slots and planes. Special cutters can also cut grooves, bevels, radii, or indeed any section desired. These specialty cutters tend to be expensive. Simplex mills have one spindle, and duplex mills have two. It is also easier to cut gears on a horizontal mill.

A more complex form of the milling machine is the Universal milling machine, in which the rotating cutter can be oriented vertically or horizontally, increasing the flexibility of the machine tool. The table of the universal machine can be swiveled through a small angle (up to about 15 degrees), enabling tapered cuts to be made over the length of the table.

**Milling machine variants**

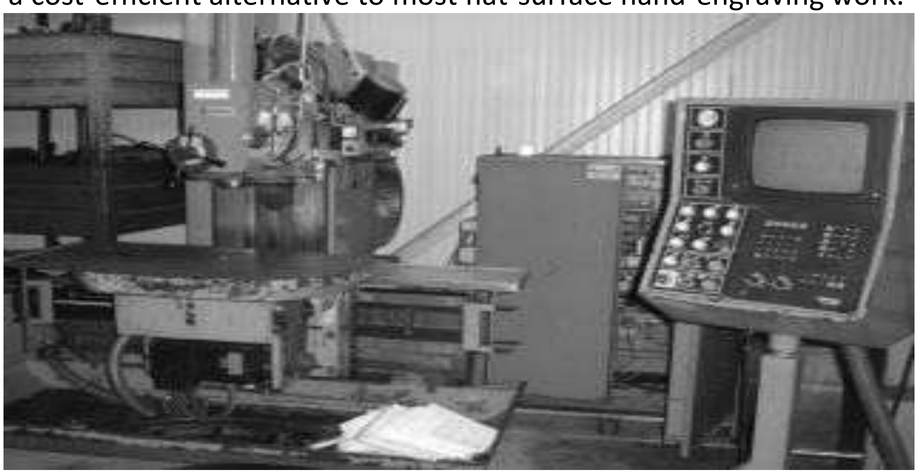
- Box or column mills are very basic hobbyist bench-mounted milling machines that feature a head riding up and down on a column or box way.
- Turret or Vertical ram mills are more commonly referred to as bridgeport-type milling machines. The spindle can be aligned in many different positions for a very versatile, if somewhat less rigid machine.
- C-Frame mills are larger, industrial production mills. They feature a knee and fixed spindle head that is only moble vertically. They are typically much more powerful than a turret mill, featuring a separate hydaulic motor for intergal hydraulic power feeds in all directions, and a twenty to fifty horsepower motor. Backlash eliminators are almost standard equipment. They use large NMTB 40 or 50 tooling. The tables on C-frame mills are usually 18" by 68" or larger, to allow multiple parts to be machined at the same time.
- Knee mill refers to any milling machine that has a vertically adjustable table.
- Bed mill refers to any milling machine where the spindle is on a pendant that moves up and down to move the cutter into the work. These are generally more rigid than a knee mill.
- Jig borers are vertical mills that are built to bore holes, and very light slot or face milling. They are typically bed mills with a long spindle throw. The beds are more accurate, and the handwheels are graduated down to .0001" for precise hole placement.
- Horizontal boring mills are large, accurate bed horizontal mills that incorporate many features from various machine tools. They are predominantly used to create large manufacturing jigs, or to modify large, high precision parts. They have a spindle stroke of several (usually between four and six) feet, and many are equipped with a tailstock to perform very long boring operations without losing accuracy as the bore increases in depth. A typical bed would have X and Y travel, and be between three and four feet square with a rotary table or a larger rectangle without said table. The pendant usually

has between four and eight feet in vertical movement. Some mills have a large (30" or more) intergal facing head. Right angle rotary tables and vertical milling attachments are available to further increase productivity.

- Floor mills have a row of rotary tables, and a horizontal pendant spindle mounted on a set of tracks that runs parallel to the table row. These mills have predominantly been converted to CNC, but some can still be found (if one can even find a used machine available) under manual control. The spindle carriage moves to each individual table, performs the machining operations, and moves to the next table while the previous table is being set up for the next operation. Unlike any other kind of mill, floor mills have floor units that are entirely movable. A crane will drop massive rotary tables , X-Y tables, and the like into position for machining, allowing the largest and most complex custom milling operations to take place.

**CNC milling machines**

Most CNC milling machines or machining centers are computer controlled vertical mills with the ability to move the spindle vertically along the Z-axis. This extra degree of freedom permits their use in engraving applications, and also allows to create 2.5D surfaces such as relief sculptures. When combined with the use of conical tools or a ball nose cutter, it also significantly improves milling precision without impacting speed, providing a cost-efficient alternative to most flat-surface hand-engraving work.



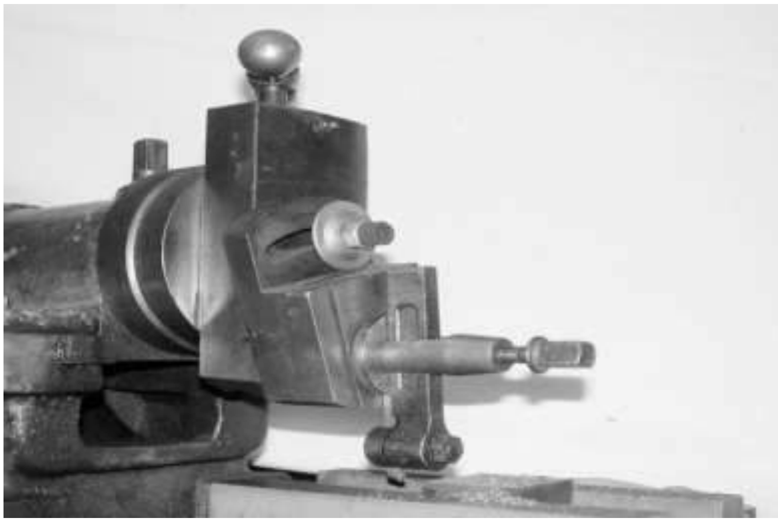
CNC machines can exist in virtually any of the forms of manual machinery, like horizontal mills. The most advanced CNC milling-machines, the 5-axis machines, add two more axes in addition to the three normal axes (XYZ). Horizontal milling machines also have a C or Q axis, allowing the horizontally mounted workpiece to be rotated, essentially allowing asymmetric and eccentric turning. The fifth axis(B-Axis) controls the tilt of the tool itself. When all of these axes are used in conjunction with each other, extremely complicated geometries, even organic geometries such as a human head can be made with relative ease with these machines. But the skill to program such geometries is beyond that of most humans. Therefore, 5-axis milling machines are practically always programmed with CAM.

**Shaper**

A shaper is a machine tool used for shaping or surfacing metal and other materials.

**History**

Shapers have been largely superseded by milling machines or grinding machines in modern industrial practice. They rapidly fell out of favour with modern industry as they were time consuming in operation, the amount of material removal by a single point cutting tool being no match for recent methods, however they are still popular with some amateurs, or where production time is not a factor. The basic function of the machine is still sound and tooling for them is minimal and very cheap to reproduce. They can be invaluable for jobbing or repair shops where only one or a few pieces are required to be produced and the alternative methods are cost or tooling intensive. The mechanically operated machines are simple and robust in construction, making their repair and upkeep easily achievable.



**Types**

They may be vertical or horizontal, with the horizontal arrangement being the most common. Vertical shapers are generally fitted with a rotary table to enable curved surfaces to be machined. The vertical shaper differs to a slotter (slotting machine) as the slide can be moved from the vertical, a slotter is fixed in the one plane.

Very small machines have been successfully made to operate by hand power. Once size increases, up to a potential 36 inch stroke, the power needs increase and it becomes necessary to use an electric motor. This motor drives a mechanical arrangement (using a pinion gear, bull gear and crank) or a hydraulic motor which supplies the necessary movement via hydraulic cylinders.

**Uses**

The most common use is to machine straight, flat surfaces but with ingenuity and some accessories a wide range of work can be done. Other examples of its use are:

- Keyways in the boss of a pulley or gear can be machined without resorting to a dedicated broaching setup.
- Dovetail slides
- Internal splines
- Keyway cutting in blind holes

**Planer**

A metalworking planer is a type of metalworking machine tool, analogous to a shaper but larger and with the entire workpiece moving beneath the cutter (instead of the cutter moving above a stationary workpiece). The work table is moved back and forth on the bed beneath the cutting head by either mechanical means (a rack and pinion gear) or by a hydraulic cylinder.

Planers and shapers were used generally for two types of work: generating accurate flat surfaces and cutting slots (such as keyways). Planers and shapers are now obsolescent, because milling machines have eclipsed them as the machine tools of choice for doing such work. However, they have not yet entirely disappeared from the metalworking world.

Modern planers are used by smaller tool and die shops within larger production facilities to maintain and repair large stamping dies and plastic injection molds. Additional uses include any other task where an abnormally large (usually in the range of 4'×8' or more) block of metal must be squared when a (quite massive) horizontal planing or floor mill is not available, too expensive, or unpractical for the situation. While not as precise as grinding, a planer can remove a tremendous amount of material in one pass and still maintain a high degree of accuracy. Metal planers come in two kinds: double-housing and open-side. The double-housing variety has vertical supports on both sides of its long bed; the open-side variety has a vertical support on only one side, allowing the workpiece to extend beyond the bed. Metal planers can vary in size from a table size of 30"×72" to 20'×62', and in weight from around 20,000 lbs to over 1,000,000 lbs.

**Grinding machine**

A grinding machine is a machine tool used for producing very fine finishes or making very light cuts, using an abrasive wheel as the cutting device. This wheel can be made up of various sizes and types of stones, diamonds or of inorganic materials. For machines used to reduce particle size in materials processing see grinding.

**Construction**

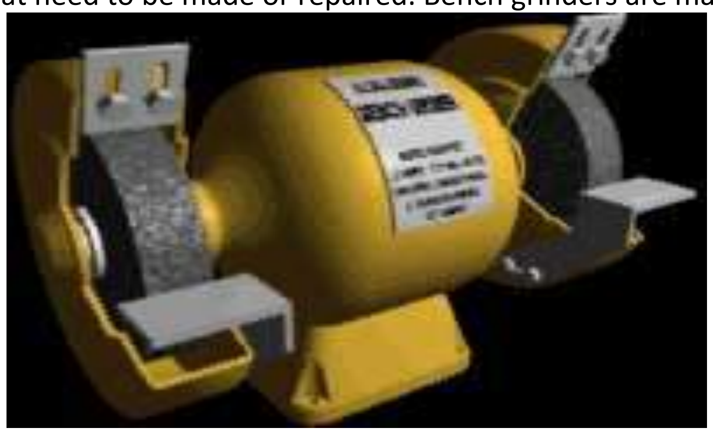
The grinding machine consists of a power driven grinding wheel spinning at the required speed (which is determined by the wheels diameter and manufacturers rating, usually by a formula) and a bed with a fixture to guide and hold the work-piece. The grinding head can be controlled to travel across a fixed work piece or the workpiece can be moved whilst the grind head stays in a fixed position. Very fine control of the grinding head or tables position is possible using a vernier calibrated hand wheel, or using the features of NC or CNC controls.

Grinding machines remove material from the workpiece by abrasion which can generate substantial amounts of heat, they therefore incorporate a coolant to cool the workpiece so that it does not overheat and go outside its tolerance, the coolant also benefits the machinist as the heat generated may cause burns in some cases. In very high-precision grinding machines (most cylindrical and surface grinders) the final grinding stages are usually set up so that they remove about 2/10000mm (less than 1/100000 in) per pass - this generates so little heat that even with no coolant, the temperature rise is negligible.

**Types of grinders**

Belt grinder, which is usually used as a machining method to process metals and other materials, with the aid of coated abrasives. Sanding is the machining of wood, grinding is the common name for machining metals. Belt grinding is a versatile process suitable for all kind of applications like finishing, deburring and stock removal

- Bench grinder, which usually has two wheels of different grain sizes for roughing and finishing operations and is secured to a workbench. It is used for shaping tool bits or various tools that need to be made or repaired. Bench grinders are manually operated.



- Cylindrical grinder which includes the centerless grinder. A cylindrical grinder may have multiple grinding wheels. The workpiece is rotated and fed past the wheel/s to form a cylinder. It is used to make precision rods.


**Cylindrical Grinding Machine**

- Surface grinder which includes the wash grinder. A surface grinder has a "head" which is lowered, and the workpiece is moved back and forth past the grinding wheel on a table that has a permanent magnet for use with magnetic stock. Surface grinders can be manually operated or have CNC controls.
- Tool and Cutter grinder and the D-bit grinder. These usually can perform the minor function of the drill bit grinder, or other specialist toolroom grinding operations.
- Jig grinder, which as the name implies, has a variety of uses when finishing jigs, dies, and fixtures. It's primary function is in the realm of grinding holes and pins. It can also be used for complex surface grinding to finish work started on a mill.

**Forge**

The forge or smithy is the workplace of a smith or a blacksmith. Forging is the term for shaping metal by plastic deformation. Cold forging is done at low temperatures, while conventional forging is done at high temperatures, which makes metal easier to shape and less likely to fracture.

A basic smithy contains a forge, sometimes called a hearth for heating the metals, commonly iron or steel to a temperature where the metal becomes malleable (typically red hot), or to a temperature where work hardening ceases to accumulate, an anvil to lay the metal pieces on while hammering, and a slack tub to rapidly cool, and thus harden, forged metal pieces in. Tools include tongs to hold the hot metal, and hammers to strike the hot metal.

Once the final shape has been forged, iron and steel in particular often get some type of heat treatment. This can result in various degrees of hardening or softening depending on the details of the treatment.

## Forging

Forging is the working of metal by plastic deformation. It is distinguished from machining, the shaping of metal by removing material, such as by drilling, sawing, milling, turning or grinding, and from casting, wherein metal in its molten state is poured into a mold, whose form it retains on solidifying. The processes of raising, sinking, rolling, swaging,drawing and upsetting are essentially forging operations although they are not commonly so called because of the special techniques and tooling they require.
Forging results in metal that is stronger than cast or machined metal parts. This is because during forging the metal's grain flow changes in to the shape of the part, making it stronger. Some modern parts require a specific grain flow to ensure the strength and reliability of the part.

**A Black Smith**

Many metals are typically forged cold but iron and its alloys are almost always forged hot. This is for two reasons: first, if work hardening were allowed to progress, hard materials such as iron and steel would become extremely difficult to work with; secondly, most steel alloys can be hardened by heat treatments, such as by the formation of martensite, rather than cold forging. Alloys that are amenable to precipitation hardening, such as most structural alloys of aluminium and titanium, can also be forged hot, then made strong once they achieve their final shape. Other materials must be strengthened by the forging process itself.

Forging was done historically by a smith using hammer and anvil, and though the use of water power in the production and working of iron dates to the twelfth century CE the hammer and anvil are by no means obsolete. The smithy has evolved over centuries to the forge shop with engineered processes, production equipment, tooling, raw materials and products to meet the exacting demands of modern day society and industry.

In modern times, industrial forging is commonly done either with presses or with hammers powered by compressed air, electricity, hydraulics or steam. These hammers are very large, having reciprocating weights in the thousands of pounds. Smaller power hammers, 500 pounds or less reciprocating weight, and hydraulic presses are common in art smithies as well. Steam hammers are becoming increasingly obsolete.

In industry a distinction is made between open- and closed-die forging. In open-die work the metal is free to move except where contacted by the hammer, anvil, or other (often hand-held) tooling. In closed-die work the material is placed in a die resembling a mold, which it is forced to fill by the application of pressure. A great many common objects, like wrenches and crankshafts, are produced by closed-die forging, which is well suited to mass production. Open-die forging lends itself to very short runs and is appropriate for art smithing and custom work.

Closed-die forging is more expensive for mass production than is casting, but produces a much stronger part, and is therefore used for tools, high-strength machine parts and the like. In particular, forgings are commonly used in automotives, where a high strength requirement is demanded of the part, with a contraint on the mass of the part - in short, a high strength-to-mass ratio. Forged parts are more suitable for mass production. The process of forging a part is becomes cheaper with higher volumes. For these reasons forgings are used in the automotive industry, usually after some machining. One particular variant, drop forging, is often used to mass produce flat wrenches and other household tools.

**Machine press**

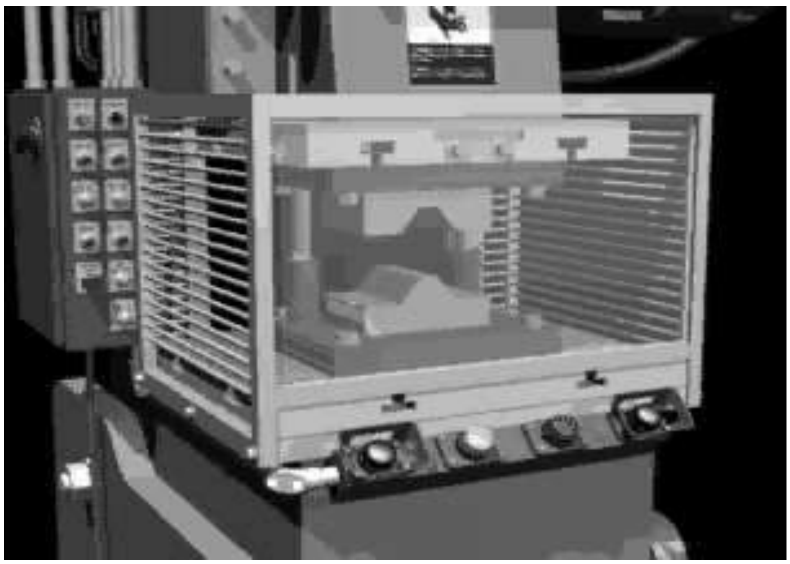
A press, or a machine press is a tool used to work metal (typically steel) by changing its shape and internal structure.

A forge press reforms the workpiece into a three dimensional object—not only changing its visible shape but also the internal structure of the material. A stronger part results from this process than if the object was machined.

Bending is a typical operation performed and occurs by a machine pressing, or applying direct pressure, to the material and forcing it to change shape. A press brake is a typical machine for this operation.

An easy to understand type of machine press is a set of rollers. Metal is fed into the rollers, which are turning to pull the material through. The space between the rollers is smaller than the unfinished metal, and thus the metal is made thinner and/or wider.
Another kind of press is a set of plates with a relief, or depth-based design, in them. The metal is placed between the plates, and the plates are pressed up against each other, deforming the metal in the desired fashion. This may be coining or embossing or forming. A punch press is used for forming holes.

Progressive stamping is a manufacturing method that can encompass punching, coining, bending and several ways of modifying the metal, combined with an automatic feeding system. The feeding system pushes a coil of metal through all of the stations of a progressive stamping die. Each station performs one or more operations until a finished part is made per the requirements on the print. The final operation is a cutoff operation, which separates the finished part from the carrying web. The carrying web, along with metal that is punched away in previous operations, is considered scrap metal.



A Press Brake is a special type of machine press that bends sheetmetal into shape. A good example of the type of work a press break can do is the backplate of a computer case. Other examples include brackets, frame pieces and electronic enclosures just to name a few. Some press breaks have CNC controls and can form parts with accuracy to a fraction of a millimeter. These machines can be dangerous considering the knife-edge bending dies and powerful 100+ ton bending force. However in the hands of a skilled operator the machine presents minimum hazard.

Machine presses are used extensively around the world for shaping all kinds of metals to a desired shape. A typical toaster (for bread) has a metal case that has been bent and pressed into shape by a machine press.

Also remember that machine presses have a high hazardous level , so safety measures must always be taken. Injuries in a press may aways be permanent , since there are over 100s tons on top of a limb. Bimanual controls (both hands need to be on the buttons to make the press work) are a very good way to prevent accidents. Also light sensors that keep the machine from working if the operator is in range of the die (tool that goes inside the press to shape metal), or any limbs is in range.

**Hydraulic press**

A hydraulic press is a hydraulic mechanism for applying a large lifting or compressive force. It is the hydraulic equivalent of a mechanical lever, and is also known as a Bramah press after the inventor, Joseph Bramah. Hydraulic presses are the most commonly-used and efficient form of modern press.

**Guillotine Shear m/c**

A guillotine is a machine used to accurately cut sheet metal. It may be foot-operated (or less commonly hand-operated), or powered. An angled blade is driven down which slices the metal along the length of the cut, shearing it off very cleanly.

Depending on the capacity of the machine, the angle of the blade may be varied along with the clearance between the upper and lower blades. The thicker the material, the greater the angle and clearance given to the blades.

The angle of the blade is referred to as shear, and this provides a slicing rather than a chopping action; by slicing the material a cleaner cut is produced and less energy is used. This is because the blade contacts only a small area at a time rather than the full length of the cut (which is also how scissors work).

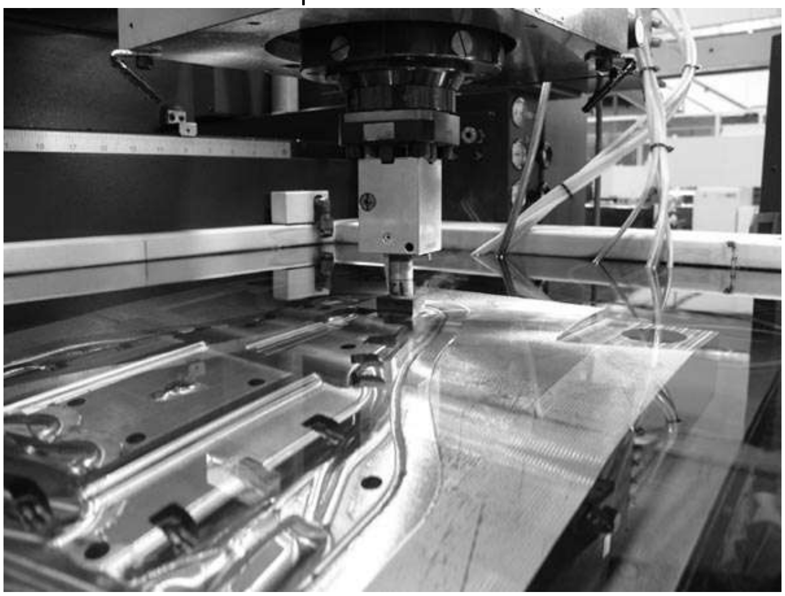
Clearance is defined as the separation between the blades, measured at the point where the cutting action takes place, and perpendicular to the direction of blade movement. It affects the finish of the cut (burr) and the machine's power consumption, and is directly related to the material's composition. The cut of a guillotine is in part a fracturing process; the blade partially penetrates the material but the final separation is due to the material fracturing. Harder materials (such as stainless steel) fracture more readily than softer ones (such as brass).

The design of press tools and guillotine blades is an engineering compromise. A sharp edge is required, along with strength and durability, so to achieve these two objectives the blades for metal work tend to be square-edged rather than knife-edged. The difference between the two angles is called the rake

**Electrical discharge machining**

Electrical discharge machining (or EDM) is a machining method primarily used for hard metals or those that would be impossible to machine with traditional techniques. One critical limitation, however, is that EDM only works with materials that are electrically conductive. EDM can cut small or odd-shaped angles, intricate contours or cavities in extremely hard steel and exotic metals such as titanium, hastelloy, kovar, inconel and carbide.

Sometimes referred to as spark machining or spark eroding, EDM is a nontraditional method of removing material by a series of rapidly recurring electric arcing discharges between an electrode (the cutting tool) and the work piece, in the presence of an energetic electric field. The EDM cutting tool is guided along the desired path very close to the work but it does not touch the piece.



Consecutive sparks produce a series of micro-craters on the work piece and remove material along the cutting path by melting and vaporization. The particles are washed away by the continuously flushing dielectric fluid.

**Engraving**

Engraving is the practice of incising a design onto a hard, flat surface, by cutting grooves into it. The result may be a decorative object in itself, as when silver or gold are engraved, or may provide an intaglio printing plate, of copper or another metal.

**The engraving process**

Engravers use a hardened steel tool called a burin to cut the design into the surface, most traditionally a copper plate. Gravers come in a variety of shapes and sizes that yield different line types. The burin produces a unique and recognizable quality of line that is characterized by its steady, deliberate appearance and clean edges. The angle tint tool has a slightly curved tip that is commonly used in printmaking. Florentine liners are flat-bottomed tools with multiple lines incised into them, used to do fill work on larger areas. Flat gravers are used for doing fill work on letters, as well as most musical instrument engraving work. Round gravers are commonly used on silver to create bright cuts (also called bright-cut engraving), as well as other hard-to-cut metals such as nickel and steel.

Burins are either square or elongated diamond-shaped and used for cutting straight lines. Other tools such as mezzotint rockers, roulets and burnishers are used for texturing effects.

**Laser engraving**

Laser engraving is the practice of using lasers to engrave, etch, or mark an object. The technique can be very technical and complex, and often a computer system is used to drive the movements of the laser head. Despite this complexity, very precise and clean engravings can be achieved at a high rate. The technique does not involve tool bits which contact the engraving surface and wear out. This is considered an advantage over alternative engraving technologies where bit heads have to be replaced regularly.

The impact of laser engraving has been more pronounced for specially-designed "laserable" materials. These include polymer and novel metal alloys.

In situations where physical alteration of a surface by engraving is undesirable, an alternative such as "marking" is available. This is a generic term that covers a broad spectrum of surfacing techniques, including printing and hot-branding. In many instances, laser engraving machines are able to do marking that would have been done by other processes.

**Laser engraving machines**

A laser engraving machine can be thought of as three main parts: a laser, a controller, and a surface. The laser is like a pencil - the beam emitted from it allows the controller to trace patterns onto the surface. The controller (usually a computer) controls the direction, intensity, speed of movement, and spread of the laser beam aimed at the surface. The surface is picked to match what the laser can act on.

There are two main genres of engraving machines: The most common is the X-Y table where, usually, the workpiece (surface) is stationary and the laser moves around in X and Y directions drawing vectors. Sometimes the laser is stationary and the workpiece moves. Sometimes the workpiece moves in the Y axis and the laser in the X axis. The other genre is for cylindrical workpieces (or flat workpieces mounted around a cylinder) where the laser effectively traverses a fine helix and on/off laser pulsing produces the desired image on a raster basis.

The point where the laser (the terms "laser" and "laser beam" may be used interchangeably) touches the surface should be on the focal plane of the laser's optical system, and is usually synonymous with its focal point. This point is typically small, perhaps less than a fraction of a millimeter (depending on the optical wavelength). Only the area inside this focal point is significantly affected when the laser beam passes over the surface.

The energy delivered by the laser changes the surface of the material under the focal point. It may heat up the surface and subsequently vaporize the material, or perhaps the material may fracture (known as "glass" or "glass up") and flake off the surface. This is how material is removed from the surface to create an engraving.

If the surface material is vaporized during laser engraving, ventilation through the use of blowers or a vacuum pump are almost always required to remove the noxious fumes and smoke arising from this process, and for removal of debris on the surface to allow the laser to continue etching.

A laser can remove material very efficiently because the laser beam can be designed to deliver energy to the surface in a manner which converts a high percentage of the light energy into heat. The beam is highly focused and collimated - in most non-reflective materials like wood, plastics and enamel surfaces, the conversion of light energy to heat is more than {x%} efficient {example reference needed}. However, because of this efficiency, the equipment used in laser engraving may heat up rather quickly. Elaborate cooling systems are required for the laser. Alternatively, the laser beam may be pulsed to decrease the amount of excessive heating.

**Exercise:**

1. What is a lathe?
2. Discuss various types of lathe.
3. Name the varients of “cutting m/c”
4. Describe the process of drilling.
5. Describe the types of:-
    a. Milling m/c
    b. Grinding m/c
    c. Engraving

# CHAPTER - 3

## MACHINE TOOLS & EQUIPMENTS

A cutting tool, in the context of metalworking is any tool that is used to remove metal from the workpiece by means of shear deformation. In order to last, cutting tools must be made of a material harder than the material which is to be cut, and they must be able to withstand the heat generated in the metal cutting process. They also must have a specific geometry, designed so that the cutting edge can contact the workpiece without the rest of the tool dragging on its surface. The angle of the cutting face is also important.

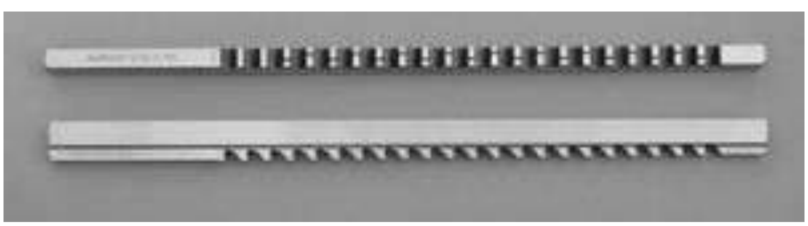
**Types of cutting tools**

- Broach
- Endmill
- Reamer
- Drill bit
- Tool bit (used in a lathe, flycutter, shaper or planer)
- Countersink

There are many other types of cutting tools, but these are a few of the important ones

**Broach**

A broach is a series of progressively taller chisel points mounted on a single piece of steel, typically used to enlarge a circular hole into a larger noncircular shape such as a square or other desired shape.



Another typical use of a broach is to cut splines or a square keyway (see image) on objects such as gears, driveshafts, pulleys etc. The amount of material removed by each broach tooth (or chisel) varies with the material being cut. A broach tooth designed to cut steel might remove only 0.05 mm (0.0025 inch), while a broach tooth designed to cut brass might remove as much as 0.10 mm (0.004 inch). The succession of teeth (chisels) removes the total amount of material required. A broach may also be designed to be pushed or pulled through an existing hole; broaching machines are therefore designed accordingly.

**Wobble or Rotary Broach**

A somewhat different design of tool that can achieve the irregular hole shape of a broach is called a wobble broach. This type of tool is often used on rotating machines such as lathes. The wobble broaching process is also called rotary broaching.

The tool has a contour similar to the desired final shape but the leading edge of the tool is wider than the body. The tool is free to rotate but the axis of rotation is inclined slightly to the axis of rotation of the work. A typical value for this misalignment is 1 degree. As the work rotates, the broach is pressed against it and rotates synchronously with it. However, since the axis of rotation is different, the leading (cutting) edge of the broach "wobbles" with respect to the work.

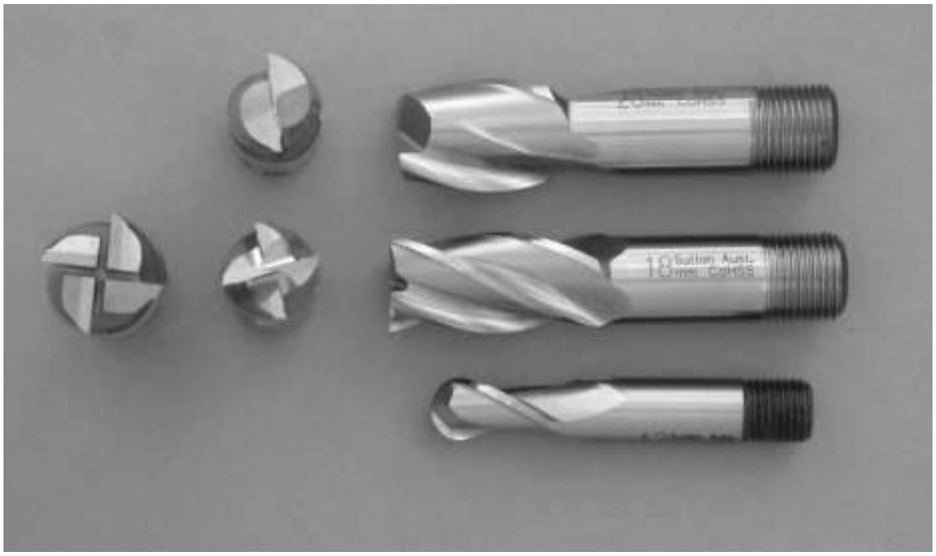
If the tool is inclined at an angle of 1 degree to the work, the sides of the tool must have a 1 degree or greater draft.

Ideally the tool advances at the same rate that it cuts. So a 1/2" diameter tool should advance at 0.009" per revolution. 1/2*sin(1). If it advances any faster than that then the tool becomes choked, if it advances any more slowly then you get an interrupted or zig-zag cut. Since all work material is elastic, you would actually cut a little less than the ideal rate just to release the load on the non-cutting edge of the tool.

There is some spiraling of the tool as it cuts so the bottom of the hole may be rotated with respect to the top of the hole. Spiraling may be undesirable because it binds the body of the tool and prevents it from wobbling freely. One solution to this is to reverse the rotation in mid cut causing the tool to spiral in the opposite direction. If reversing the machine is not practical, then interrupting the cut is another possible solution.
In general, a wobble broach will not cut as accurately as a push or pull broach. However, the ability to use a wobble broach on high production machinery such as a screw machine makes this a desirable manufacturing method.

**Endmill**

An endmill is a type of Milling cutter, a cutting tool used in industrial milling applications. It is distinguished from its cousin, the drill bit, in its application, geometry, and manufacture. The term "endmill" is sometimes considered to be machinist's slang, but has come into standard usage in industry publications, trade magazines, and manufacturers catalogues.



**Types**

A broad category of end and face milling tools exists, such as flat bottom, ball nose, radius, inverted radius, and chamfer tools. Each category may be further divided by specific application and special geometry.

It is becoming increasingly more common for traditional solid endmills to be replaced by more cost-effective inserted cutting tools (which, though more expensive initially, reduce tool-change times and allow for the easy replacement of worn or broken cutting edges rather than the entire tool).

Endmills are sold in both imperial and metric shank and cutting diameters. In the USA, metric is readily available, but not commonly used by machine shops; in Canada, due to the country's proximity to the US, much the same is true. In Asia and Europe, while imperial is readily available, metric diameters are standard.

**Applications**

Endmills are used in milling applications such as profile milling, tracer milling, face milling, and the like. Depending on the material being milled, and what task should be performed, different tool types and geometry may be used. For instance, when milling a material like aluminum, it may be adventageous to use a tool with a very shallow flute depth, and a pre-dulled (but polished) cutting edge.

**Reamer**

A reamer or ream is a tool for enlarging holes and is used in metalworking. It may be used as a hand tool or may have a specialized drive end. For production machine tools the drive will usually be a standard taper. For hand tools the drive will usually be a square drive, intended for use with the same type of wrench used to turn a tap for the cutting of screw threads.

A typical reamer consists of a set of parallel straight or helical cutting edges along the length of a cylindrical body. Each cutting edge is ground at a slight angle and with a slight undercut below the cutting edge. Reamers must combine both hardness in the cutting edges, for long life, and toughness, so that the tool does not fail under the normal forces of use. They should only be used to remove small amounts of material. This ensures a long life for the reamer and a superior finish to the hole.

The spiral may be clockwise or counter-clockwise depending on usage. For example, a tapered hand reamer with a clockwise spiral will tend to self feed as it is used, possibly leading to a wedging action and consequent breakage. A counter-clockwise spiral is therefore preferred even though the reamer is still turned in the clockwise direction.
reamer is still turned in the clockwise direction.

**Drill bit**

Drill bits are cutting tools used to create cylindrical holes. Bits are held in a tool called a drill, which rotates them and provides axial force to create the hole. Specialized bits are also available for non-cylindrical-shaped holes.

**Drill Bits**

This article describes the types of drill bits in terms of the design of the cutter. The other end of the drill bit, the shank, is described in the drill bit shank article. Drill bits come in standard sizes, described in the drill bit sizes article. A comprehensive drill and tap size chart lists metric and imperial sized drills alongside the required screw tap sizes.

The term drill can refer to a drilling machine, or can refer to a drill bit for use in a drilling machine. In this article, for clarity, drill bit or bit is used throughout to refer to a bit for use in a drilling machine, and drill refers always to a drilling machine.

**Metal Drills**

**Twist drill**

The twist drill bit is the type produced in largest quantity today. It can be used to create holes in metal, plastic, wood and stone.

The twist drill bit was invented by Steven A. Morse[1] of East Bridgewater, Massachusetts in 1861. He received U.S. Patent 38119 for his invention on 7 April 1863. The original method of manufacture was to cut two grooves in opposite sides of a round bar, then to twist the bar to produce the helical flutes. This gave the tool its name. Nowadays, the drill bit is usually made by rotating the bar while moving it past a grinding wheel to cut the flutes in the same manner as cutting helical gears.

Tools recognisable as twist drill bits are currently produced in diameters covering the range at least from 0.05 mm to 100 mm. Lengths up to about 1000 mm are available for use in powered hand tools.

The geometry and sharpening of the cutting edges is crucial to the performance of the bit. Users often throw away small bits that become blunt, and replace them with new bits, because they are inexpensive and sharpening them well is difficult.
For larger bits, special grinding jigs are available. A special tool grinder is available for sharpening or reshaping cutting surfaces on twist drills to optimize the drill for a particular material.

Manufacturers can produce special versions of the twist drill bit, varying the geometry and the materials used, to suit particular machinery and particular materials to be cut. Twist drill bits are available in the widest choice of tooling materials. However, even for industrial users, most holes are still drilled with a conventional bit of high speed steel.
The most common twist drill (the one sold in general hardware stores) has a point of 118 degrees. This is a suitable angle for a wide array of tasks, and will not cause the uninitiated operator undue stress by walking or digging in. A more aggressive (pointy) angle, such as 90 degrees, is suited for very soft plastics and other materials. The bit will generally be self-starting and cut very quickly. A shallower angle, such as 150 degrees, is suited for drilling steels and other tougher materials. This style bit requires a starter hole, but will not bind or suffer premature wear when a proper feed rate is set.

Drills with no point angle are used in situations where a blind, flat-bottomed hole is required. These style drills are very sensitive to changes in lip angle, and even a slight change can result in an inappropriately fast cutting drill bit that will suffer premature wear.

The tool geometry is broken down into several areas:

- The **helix**, or rate of twist in the drill, controls the rate of chip removal in a drill. A low helix drill is used in high feed rate applications under low spindle speeds, where removal of a large volume of swarf is required. High helix drills are used in cutting applications where traditionally high cutting speeds are used and the material has a tendency to gall on the drill or otherwise clog the hole, such as aluminum or copper.
- **Point angle** is determined by the material the drill will be operating in. Harder materials require a larger point angle, and softer materials require a more pointed angle. The correct point angle for the hardness of the material controls wandering, chatter, hole shape, wear rate, and a wide array of other characteristics.

- **Lip angle** determines the amount of support provided to the cutting edge. A greater lip angle will cause the drill to cut more aggressively under the same amount of point pressure as a drill with a smaller lip angle. Both conditions can cause binding, wear, and eventual catastrophic failure of the tool. The proper amount of lip clearance is determined by the point angle. A very acute point angle has more web surface area presented to the work at any one time, requiring an aggressive lip angle, where a flat drill is extremely sensitive to small changes in lip angle due to the small surface area supporting the cutting edges.

**Tool bit**

The term tool bit generally refers to a non-rotary cutting tool used in metal lathes, shapers, and planers. Such cutters are also often referred to by the set-phrase name of single-point cutting tool. The cutting edge is ground to suit a particular machining operation and may be resharpened or reshaped as needed. The ground tool bit is held rigidly by a tool holder while it is cutting.

**Materials**

Originally, all tool bits were made of high carbon tool steels with the appropriate hardening and tempering. Since the introductions of high-speed steel (HSS) (early years of the 20th century), sintered carbide (1930s), and ceramic cutters, those materials have gradually replaced the earlier kinds of tool steel in almost all cutting applications. Most tool bits today are either HSS or carbide

**Carbides and ceramics**

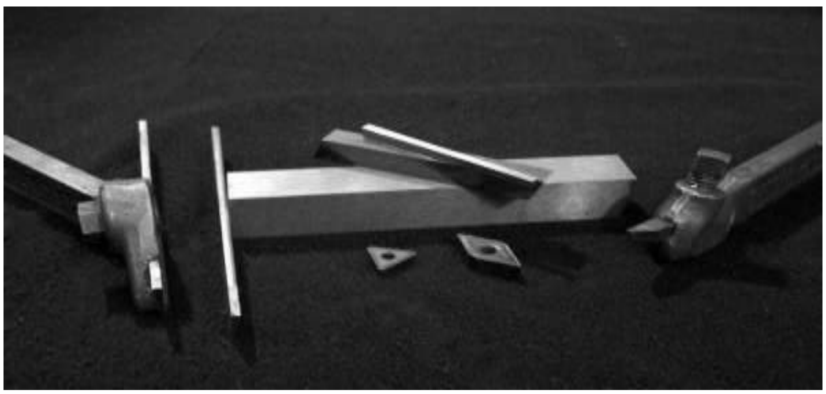
Carbide, ceramics (such as cubic boron nitride), and diamond, having higher hardness than HSS, all allow faster material removal than HSS in most cases. Because these materials are expensive and hard to work with, typically the body of the cutting tool is made of steel, and a small cutting edge made of the harder material is attached. The cutting edge is usually either screwed on (in this case it is called an insert), or brazed on to a steel shank (this is usually only done for carbide).

**Tool holders**

By confining the expensive hard cutting tip to the part doing the actual cutting, the cost of tooling is reduced. The supporting tool holder can then be made from a tougher steel, which besides being cheaper is also usually better suited to the task, being less brittle than the cutting-edge materials.

The tool holders may also be designed to introduce additional properties to the cutting action, such as

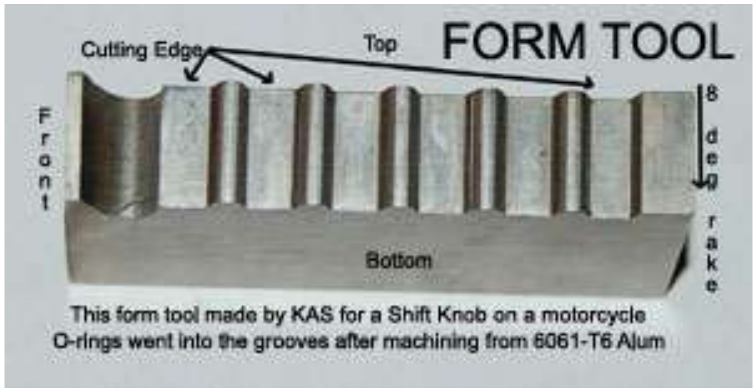
- Angular approach - direction of tool travel.
- Spring loading - deflection of the tool bit away from the material when excessive load is applied.
- Variable overhang - the tool bit may be extended or retracted as the job requires.
- Rigidity - the tool holder can be sized according to the work to be performed.
- Direct cutting fluid or coolant to the work area.



**Inserts**
Almost all high-performance cutting tools use the insert method. There are several reasons for this. First of all, at the very high cutting speeds and feeds supported by these materials, the cutting tip can reach temperatures high enough to melt the brazing material holding it to the shank. Economics are also important; inserts are made symmetrically so that when the first cutting edge is dull they can be rotated, presenting a fresh cutting edge. Some inserts are even made so that they can be flipped over, giving as many as 8 cutting edges per insert.

There are many types of inserts: some for roughing, some for finishing. Others are made for specialized jobs like cutting threads or grooves. The industry employs standardized nomenclature to describe inserts by shape, material, coating material, and size.

**Form tools**
This form tool is for a shift knob on a motorcycle. O-rings went into the grooves after machining from 6061-T6 Aluminum. This tool has an 8-degree rake from top to bottom for clearance. This tool was designed for a 2G Brown & Sharpe screw machine.




A form tool is precision-ground into a pattern that resembles the part to be formed. The form tool can be used as a single operation and therefore eliminate many other operations from the slides (front, rear and/or vertical) and the turret, such as boxtools. A form tool turns one or more diameters while feeding into the work. Before the use of forum tools, diameters were turned by multiple slide and turret operations, and thus more work to make the part. For example, a form tool can turn many diameters and in addition can also cutoff the part in a single operation and eliminate indexing the turret.

For single-spindle machines, bypassing indexing the machine can dramatically increase hourly part production. On long-running jobs it is common to use a ‘roughing tool’ tool on a different slide, or from the turret to remove the bulk of material to reduce wear on the form tool. There are also different types of form tools. Insert tools are the most common for short- to medium-range jobs (50 to 20,000 pcs). Circular form tools are usually for longer jobs, since the tool wear can be ground off the tool tip many times as the tool is rotated in its holder. There is also a skiving tool that can be used for light finishing cuts. Form tools can be made of cobalt, carbide, or high-speed steel. Carbide requires additional care because it is very brittle and will chip if chatter occurs.

A drawback when using form tools is that the feed into the work is usually slow, .0005" to .0012" per revolution depending on the width of the tool. Wide form tools create more heat and usually are problematic for chatter. Heat and chatter reduces tool life. Also, form tools wider than 2.5 times the smaller diameter of the part being turned have a greater risk of the part breaking off. When turning longer lengths, a support from the turret can be used to increase turning length from 2.5 times to 5 times the smallest diameter of the part being turned, and this also can help reduce chatter. Despite the drawbacks, the elimination of extra operations often makes using form tools the most efficient option.

**Mandrel**

A mandrel (pronounced "mandrul", and also transliterated as manderil) is either an object used to shape machined work; a tool component that grips or clamps materials to be machined; or a tool component that can be used to grip other moving tool components.

An example of one type of mandrel is a shaped bar of metal inserted in, or next to, an item to be machined or bent in a certain pattern. Exhaust pipes in automobiles are frequently bent using a mandrel during manufacture. The mandrel allows the exhaust pipes to be bent into smooth curves without undesirable creasing, kinking, or collapsing. Molten glass may be shaped in this way as well. Another example of this type of mandrel is found in jewelry manufacturing, where ring and bracelet mandrels are used to shape metal into a desired size and shape, using a tiny hammer to beat the metal against the mandrel.

Another type of mandrel is the clamp that a lathe uses to hold pieces of wood, metal or plastic to be machined as they are turned. In this way, rods can be threaded, furniture legs are turned to have beautiful patterns, and irregularly-shaped objects can be given a cylindrical or round shape.

The third type of mandrel discussed here is that which is used to hold circular saw blades, buffing wheels (used for polishing), and sanding discs onto drills, circular saws, and similar power tools. A mandrel of this type generally consists of a cylinder, threaded on one end, with a washer brazed onto the threaded end and an accompanying screw and second washer which are used to clamp the circular saw blade, sanding media, or other rotary tool onto the mandrel.

While most mandrels are driven by direct connection to an electric motor or engine, other mandrels are driven by attachment to a bearing-supported, pulley-driven shaft.
In fiber optics, an optical fiber is often wrapped around a mandrel to alter the light travelling in the fiber.

**Chuck**

A Chuck is a specialised type of clamp used to hold rotating tools or materials.

**Collet**

A collet is a sleeve with a (normally) cylindrical inside and a conical outside. The collet has kerf cuts along its length to allow it to expand and contract. A threaded section at the rear of the collet is used to pull it into a matching conical socket. As the collet is pulled into the socket, the collet will contract - gripping the contents of the inner cylinder. Collets are most commonly found on milling machines, lathes, wood routers, and precision grinders. There are many different systems, common examples being the ER and R8 systems. Collets can also be obtained to fit Morse or Brown and Sharpe taper sockets.

Typically collets offer far higher levels of precision and accuracy than self-centering chucks, and have a far shorter setting up time than independent-jaw chucks. The penalty is that most collets can only accommodate a single size of workpiece. An exception are ER collets which typically have a working range of 1 mm (about 0.04 inches).

Collets usually are made to hold cylindrical work, but are available to hold square, hexagonal or octagonal workpieces.

**Drill Chuck**
A drill chuck is a specialised three-jaw chuck used to hold drill bits or related tools.

The image at right shows an assembled keyless chuck at the top. The tightening action of this chuck style is performed by twisting the body using firm hand pressure only.

The lower images show the traditional keyed style of drill chuck with its key. The arbor is shown separately to the right. These chucks require a key to provide the necessary torque to tighten and loosen the jaws. The rotary action of the key turns the outer body which acts on an internal screw; this in turn moves the threaded jaws in or out along a tapered surface. The taper allows the jaws to encompass various sizes of drill shanks. The end view shows the three small jaws that slide within the body.

Some high precision chucks use ball thrust bearings to reduce friction in the closing mechanism and maximizing drilling torque. These chucks are sometimes referred to as "superchucks".

**Special Direct System (SDS)**
Developed by Bosch in 1975 for hammer drills, the SDS uses a cylindrical shank on the tool, with indents to be held by the chuck. A tool is inserted into the chuck by pressing in, and is locked in place until a separate lock release is used – no tightening required. The rotary force is supplied through wedges that fit into two or three open grooves. The hammer action actually moves the bit up and down within the chuck since the bit is free to move a short distance. Two sprung balls fit into closed grooves, allowing movement whilst retaining the bit. SDS relies on a tool having the same shank diameter as the chuck - there are three standard sizes:

- **SDS-Plus** – a 10 mm shank with two open grooves held by the driving wedges and two closed grooves held by locking balls. This is the most common size and takes a hammer up to 4 kg. The wedges grip an area of 75 mm² and the shank is inserted 40 mm into the chuck

- **SDS-top** a 14 mm shank similar to SDS-plus, designed for hammers from 2 to 5 kg. The grip area is increased to 212 mm² and the shank is inserted 70 mm. This size is not common
- **SDS-max** – an 18 mm shank with three open grooves and locking segments rather than balls. It is designed for hammers over 5 kg. The wedges grip an area of 389 mm2 and the shank is inserted 90 mm.

Many SDS drills have a "rotation off" setting, which allows the drill to be used for chiselling. The name SDS comes from the German "Steck – Dreh – Sitz" (Insert – Twist – Stay). German-speaking countries may use "Spannen durch System" (Clamping System), though Bosch uses "Special Direct System" for international purposes.

**Three-jaw Chuck**
A three-jaw chuck is a rotating clamp which uses three interconnected dogs or 'jaws' to hold onto a tool or work piece. Three-jaw chucks are usually self-centering and are best suited to grip circular cross sections, though independent versions can be obtained.
The image shows a three-jaw chuck and key with one jaw removed and inverted showing the teeth that engage in the scroll plate. The scroll plate is rotated within the chuck body by the key, the scroll engages the teeth on the underside of the jaws which moves the three jaws in unison, to tighten or release the workpiece.

The *Griptru™* style of self-centering chuck from Pratt Burnerd Intl., Ltd. has further adjustment screws which can be used to further improve the accuracy of the chuck at any chosen diameter of workpiece.
Three-jaw chucks can be found on lathes and indexing heads.

**Four-jaw Chuck**
A four-jaw chuck is similar to a three-jaw chuck, but with four jaws, each of which can be moved independently. This makes them ideal for gripping non-circular cross sections, but difficult to centre precisely. Four-jaw chucks are almost never used for tool holding. Four-jaw chucks can be found on lathes and indexing heads.

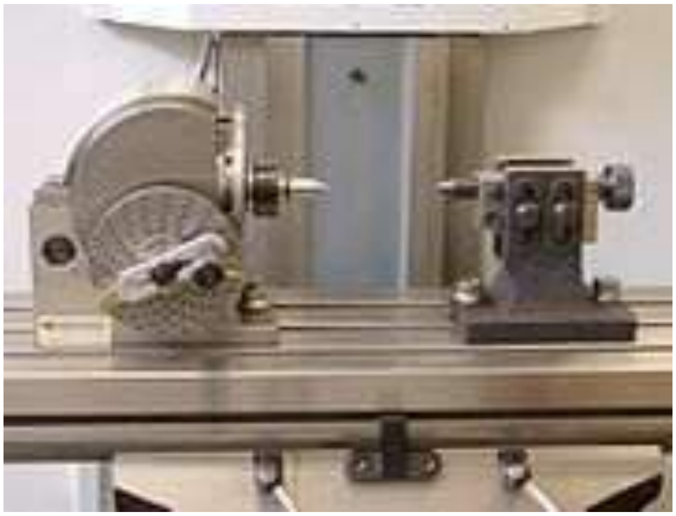
The image shows a four-jaw chuck with the jaws independently set. The key is used to adjust each jaw separately.

**Multi jaw Chuck**
For special purposes, and also the holding of fragile materials, chucks are available with six or eight jaws. These are invariably of the self-centering design, and are built to very high standards of accuracy.

**Self-centering four jaw Chuck**
A four jaw chuck with a mechanism for centering the work piece. Sometimes used to refer to chucks where the jaws are moved in interconnected pairs.

**Magnetic Chuck**
Used only for holding ferro-metallic work pieces, a magnetic chuck consists of an accurately centred permanent magnet face. Electro Magnets or permanent magnets are brought into contact with fixed ferrous plates, or 'pole pieces', contained within a housing. These pole pieces are usuall flush with the housing surface. The part or 'work piece' to be held forms the closing of the magnetic loop or path, onto those fixed plates, providing a secure anchor for the work piece

**Indexing head**



Indexing head and tailstock set up on a milling machines table
An indexing head is a specialized tool that allows a work piece to be rotated to any angle or circular division.
The tool is similar to a rotary table except that it is designed to be adjustable through at least 90 &deg: (in fact it will over travel to approx 95°).

**Indexing plates**

Simple indexing consists of a series of preset holes in a backing plate, these divisions are provided for the most common angles (such as 90 °, 45 °, 30 °, etc). The remaining divisions of a circle are provided by manually rotating the dividing arm using index plates. Tables or calculations are required to use this method.

**Lathe center**

A lathe center (or center) is a tool that has been ground to an included angle of 60 ° and is used to accurately position a workpiece about its axis.

The primary use of a center in metalworking is to ensure concentric work is produced, this allows the workpiece to be transferred between operations without any loss of accuracy. A part may be turned in a lathe, sent off for hardening and tempering and then ground between centers in a cylindrical grinder. The preservation of concentricity between the turning and grinding operations is crucial for quality work. A center is also used to support longer work pieces where the cutting forces would deflect the work. excessively, reducing the finish and accuracy of the workpiece, or creating a hazardous situation.

A center has applications anywhere that a centered workpiece may be used, this is not limited to lathe usage but may include setups in dividing heads, cylindrical grinders, tool and cutter grinders or other related equipment. The term between centers refers to any machining operation where the job needs to be performed using centers.
A center is inserted into a matching hole drilled by a center drill.

**Dead center**

A dead center (one that does not turn freely, ie:- dead) may be used to support the workpiece at either the fixed or rotating end of the machine. When used in the fixed position, a dead center produces friction between the workpiece and center, due to the rotation of the workpiece. Lubrication is therefore required between the center and workpiece to prevent friction welding from occurring. Additionally the tip of the center may have an insert of carbide which will reduce the friction slightly and allow for faster speeds. Dead centers may also be fully hardened to prevent damage to the important mating surfaces taper of the taper and to preserve the 60 ° nose taper.

**Machine taper**

Machine tool operators must be able to install or remove cutting bits or other accessories quickly and easily from the machine tool's powered rotating spindle. A lathe, for example, has a rotating spindle in its headstock, to which one may want to mount a spur drive or work in a collet. Another example is a drill press, to which an operator may want to mount a bit directly, or using a drill chuck.

Several options exist: (1) a threaded spindle, into/onto which accessories are screwed, (2) a permanently mounted chuck (as with some drill presses), or (3) a taper mount.

This simple, low-cost, and versatile tool mounting system involves (A) tool bits or holders with gradually tapered shanks, and (B) a matching hollowed-out spindle. Tools are simply slipped onto or into the spindle; the pressure of the spindle against the workpiece drives the tapered shank tightly into the tapered hole. The friction across the entire surface area of the interface provides a surprisingly large amount of torque transmission, so that splines or keys are not required.

This system is known as a machine taper.

**Magnetic base**

A magnetic base is often used to hold a dial indicator, however its versatility is only limited by the operator's ingenuity.

The vertical post, side arm (as shown in the image at right) and the dial indicator (not shown) are connected by two swivelling connectors. These connectors allow free movement of the arms so that the indicator can be presented to the work in a suitable orientation. The magnetic base may have a "V" cut into the bottom of the base or the back, this "V" allows the base to be attached to a round bar such as the column of a drill press.

The base is made from two blocks of iron, with a round cavity bored through the centre. The halves are joined together with a non magnetic material such as brass or aluminium. A round permanent magnet is inserted into the bored hole and a handle is attached to allow easy rotation of the magnet. This act of rotation changes the direction of the magnetic field so that it is either directed into the two halves, where the iron blocks act as keepers (off position), or directed so that the field traverses the non-magnetic material between the two halves (on position).
In this on position the field is effectively passing across an air gap where it can be made to do work, if this gap is bridged with another piece of iron (or steel in our case) it becomes part of the magnetic field's "circuit" and will be attracted with the full strength of the magnet, this is the work we want it to do — clamping.

**Rotary table**

A rotary table is a precision work positioning device used in metalworking. It enables the operator to drill or cut work at exact intervals around a fixed (usually horizontal or vertical) axis. Some rotary tables allow the use of index plates for indexing operations, and some can also be fitted with dividing plates that enable regular work positioning at divisions for which indexing plates are not available. A rotary fixture used in this fashion is more appropriately called a dividing head.
(indexing head).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The table shown is a manually operated type. Powered tables under the control of CNC machines are now available, and provide a fourth axis to CNC milling machines.

Rotary tables are made with a solid base, which has provision for clamping onto another table or fixture. The actual table is a precision-machined disc to which the work piece is clamped (T slots are generally provided for this purpose). This disc can rotate freely, for indexing, or under the control of a worm (handwheel), with the worm wheel portion being made part of the actual table.

The ratio between worm and table is generally 40:1, but may be any ratio that can be easily divided into 360°. This is for ease of use when indexing plates are available. A graduated dial and, often, a vernier scale enable the operator to position the table, and thus the work affixed to it with great accuracy.
A center hole is usually machined into the table. Most commonly, this hole is machined to admit a Morse taper center or fixture.

**Use**

Rotary tables are most commonly mounted "flat" with the table rotating around a vertical axis, in the same plane as the cutter of a vertical milling machine. If the rotary table can be mounted on its end, so that it rotates about a horizontal axis, a tailstock can be used to hold the workpiece "between centers."

With the table mounted on a secondary table, the workpiece is accurately centered around the rotary table's axis, which in turn is centered around the cutting tool's axis. All three axes are thus coaxial. From this point, the secondary table can be offset in either the X or Y direction to set the cutter the desired distance from the workpiece's center. This allows concentric machining operations on the workpiece. Placing the workpiece eccentrically a set distance from the center permits more complex curves to be cut. As with other setups on a vertical mill, the milling operation can be either drilling a series of concentric, and possibly equidistant holes, or face or end milling either circular or semicircular shapes and conours.

A rotary table can be used:

- To machine spanner flats on a bolt
- To drill equidistant holes on a circular flange
- To cut a round piece with a protruding tang
- To cut complex curves (with proper setup)

**Vise**

A vise (American and Canadian English) or vice (British English) is a mechanical screw apparatus used for holding or clamping a work piece to allow work to be performed on it using other tools, such as saws, planes, drills, mills, screwdrivers, sandpaper, etc. In general, vises have a fixed jaw with another moved in relation to it by the use of the screw.

**Varieties of vise or vice**

Without qualification, "vise" usually refers to a bench vise with flat, parallel jaws, attached to a workbench.

- A woodworker's bench vice is a more or less integral part of the bench.
- An engineer's bench vise is bolted onto the top of the bench.

Other kinds of vise include:

- hand vises (hand-held),
- machine vises - drill vises (lie flat on a drill press bed). Vises of the same general form are used also on milling machines and grinding machines.
- compound slide vises are more complex machine vises. They allow speed and precision in the placement of the work.
- off-center vises,
- angle vises,
- sine vises, which use solving triangles and gauge blocks to set up a highly accurate angle,
- rotary vises,
- diemakers' vises,
- table vises,
- pin vises (for holding thin, long cylindrical objects by one end),
- jewellers' vises and by contrast,
- leg vises, which are attached to a bench but also supported from the ground so as to be stable under the very heavy use imposed by a blacksmith's work.

**Woodworking vises**

For woodworking, the jaws are made of wood,plastic or from metal, in the latter case they are usually faced with wood to avoid marring the work piece. The top edges of the jaws are typically brought flush with the bench top by the extension of the wooden face above the top of the iron moveable jaw. This jaw may include a dog hole to hold a bench dog. In modern metal woodworkers' vises, a split nut is almost universally used. The nut in which the screw turns is in two parts so that, by means of a lever, it can be removed from the screw and the screw and moveable jaw quickly slid into a suitable position at which point the nut is again closed onto the screw so that the vise may be closed firmly onto the work.

**Metalworkers' vises**

For metalworking, the jaws are made of metal which may be hardened steel with a coarse gripping finish. Removable soft jaws are usually kept for use where appropriate, to protect the work from damage.

Metalworking bench vises, known as engineers' or fitters' vises, are bolted onto the top surface of the bench with the face of the fixed jaws just forward of the front edge of the bench. The bench height should be such that the top of the vise jaws is at or just below the elbow height of the user when standing upright. Were several people use the one vise, this is a counsel of perfection but is still a good guide.

The nut in which the screw turns may be split so that, by means of a lever, it can be removed from the screw and the screw and moveable jaw quickly slid into a suitable position at which point the nut is again closed onto the screw. Many fitters prefer to use the greater precision available from a plain screw vise. The vise may include other features such as a small anvil on the back of its body but it is in general, better to separate the functions of the various tools.

**Die head**

A die head is a threading die that is used in the high volume production of threaded components.

 Die Heads 

Die heads are commonly used on lathes, turret lathes, screw machines and CNC lathes. They may be used for either cutting a thread or rolling a thread. They may also be used for internal or external thread cutting.

In operation, there are several moveable chasers that cut the thread then back away from the work to permit rapid removal of the tool. The lower picture at the right shows four sets of chasers. Each set of chasers is designed to cut a different thread. One set of chasers would be used at a time, each chaser is inserted into the die head and the die head is closed bringing the chasers down to their cutting position. When sufficient length of thread has been cut the die head will open allowing for rapid retraction of the head without interference with the newly formed thread.

With most die heads, all that is needed to open the chasers is a reverse load. Simply withdrawing the die head is all that is needed to open it.
The die head shown cuts an outside thread. There are also collapsible die heads that are used to cut an internal thread.

# CHAPTER 4

## WORKSHOP MEASURING EQUIPMENTS

**Caliper**

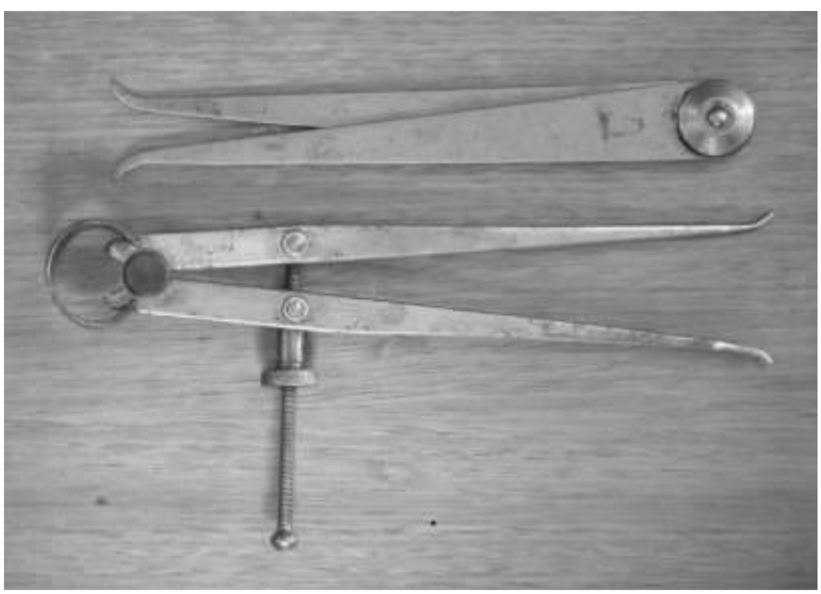
A caliper is a device used to measure the distance between two symmetrically opposing sides. A caliper can be as simple as a compass with inward or outward-facing points. The tips of the caliper are adjusted to fit across the points to be measured, the caliper is then removed and the distance read by measuring between the tips with a measuring tool, such as a ruler.

They are used in the metalworking field of mechanical engineering, and in woodworking and woodturning.

- **1 Types**
    - 1.1 Inside caliper
    - 1.2 Outside caliper
    - 1.3 Divider caliper
    - 1.4 Oddleg caliper
    - 1.5 Vernier calipers
    - 1.6 Dial caliper
    - 1.7 Digital caliper

**Types**

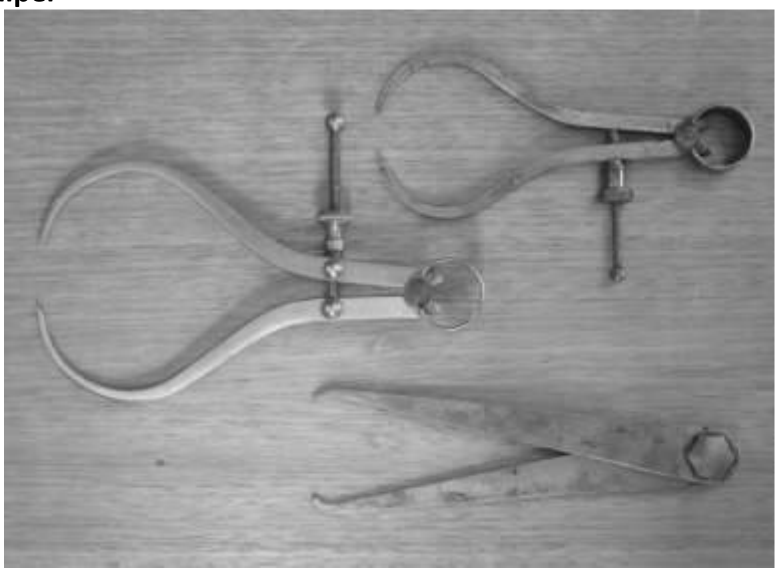
**1.1 Inside caliper**



**Two inside calipers**

• The upper caliper in the image requires manual adjustment prior to fitting, fine setting of this caliper type is performed by tapping the caliper legs lightly on a handy surface until they will almost pass over the object. A light push against the resistance of the central pivot screw then spreads the legs to the correct dimension and provides the required, consistent feel that ensures a repeatable measurement.
• The lower caliper in the image has an adjusting screw that permits it to be carefully adjusted without removal of the tool from the workpiece.

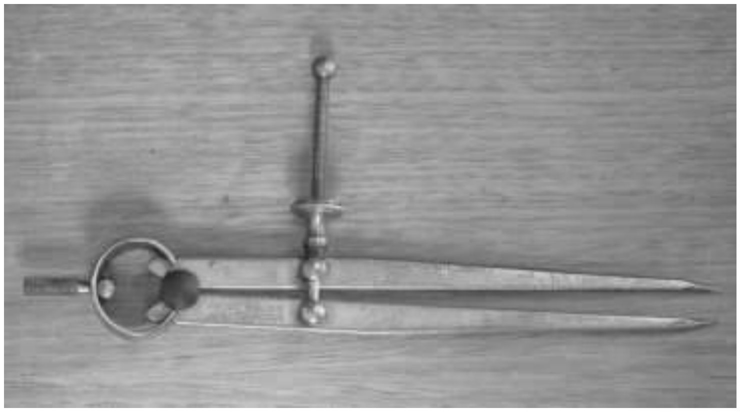
**1.2 Outside caliper**



**Outside calipers**

Outside calipers are used to measure the external size of an object.
The same observations and technique apply to this type of caliper, as for the above Inside caliper. With some understanding of their limitations and usage these instruments can provide a high degree of accuracy and repeatability. They are especially useful when measuring over very large distances, consider if the calipers are used to measure a large diameter pipe. A vernier caliper does not have the depth capacity to straddle this large diameter while at the same time reach the outermost points of the pipes diameter.

## 1.3 Divider caliper



In the metalworking field divider calipers are used in the process of marking out suitable workpieces. The points are sharpened so that they act as scribers, one leg can then be placed in the dimple created by a center or prick punch and the other leg pivoted so that it scribes a line on the workpiece's surface, thus forming an arc or circle.

A divider caliper is also used to measure a distance between two points on a map. The two caliper's ends are brought to the two points whose distance is being measured. The caliper's opening is then either measured on a separate ruler and then converted to the actual distance, or it is measured directly on a scale drawn on the map. On a nautical chart the distance is often measured on the latitude scale appearing on the sides of the map: one minute of arc of latitude is approximately one nautical mile or 1852 metres.

## 1.4 Odd leg calipers

Oddleg calipers, Hermaphrodite calipers or Oddleg jennys, as pictured at left, are generally used to scribe a line a set distance from the edge of workpiece. The bent leg is used to run along the workpiece edge while the scriber makes its mark at a predetermined distance, this ensures a line parallel to the edge.

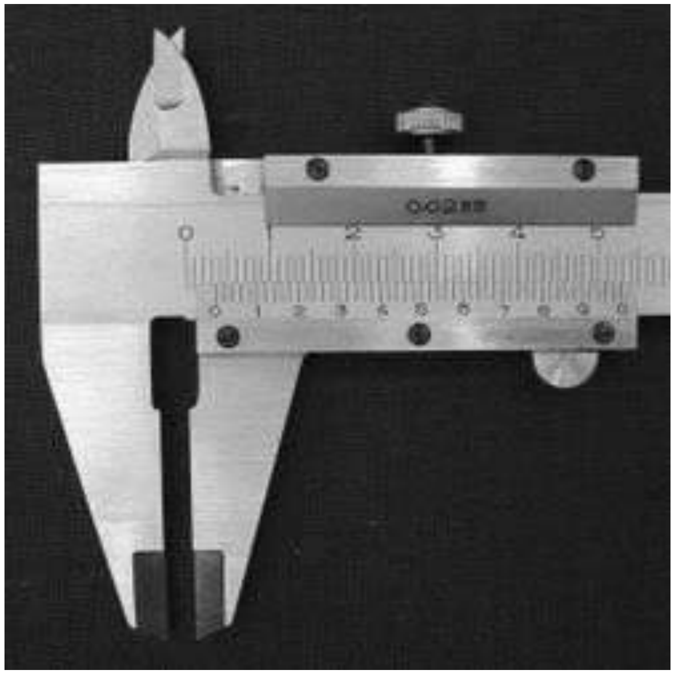
The uppermost caliper has a slight shoulder in the bent leg allowing it to sit on the edge more securely, the lower caliper lacks this feature but has a renewable scriber that can be adjusted for wear, as well as being replaced when excessively worn.

## 1.5 Vernier calipers

Parts of a vernier caliper:

1. Outside jaws: used to measure external lengths
2. Inside jaws: used to measure internal lengths
3. Depth probe: used to measure depths
4. Main scale (cm)
5. Main scale (inch)

6. Vernier (cm)
7. Vernier (inch)
8. Retainer: used to block movable part to allow the easy transferring a measurement




**Using the vernier caliper**

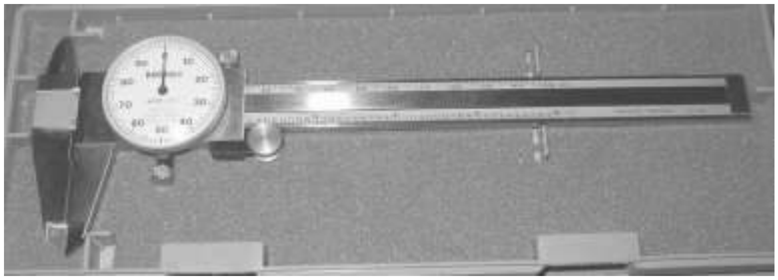
A variation to the more traditional caliper is the inclusion of a vernier scale, this makes it possible to directly obtain an accurate measurement.

Vernier calipers can measure internal dimensions (using the uppermost jaws in the picture at right), external dimensions using the pictured lower jaws, and depending on the manufacturer, depth measurements by the use of a probe that is attached to the movable head and slides along the centre of the body. This probe is slender and can get into deep grooves that may prove difficult for other measuring tools.

The vernier scales will often include both metric and English measurements on the upper and lower part of the scale.

Vernier calipers commonly used in industry provide a precision to a hundredth of a millimetre (10 micrometres), or one thousandths of an inch.
A more accurate instrument used for the same purpose is the micrometer.

**1.6 Dial caliper**



A further refinement to the vernier caliper is the dial caliper.
In this instrument, a small gear rack drives a pointer on a circular dial. Typically, the pointer rotates once every inch, tenth of an inch, or 10 millimetres, allowing for a very accurate and direct reading without the need to interpolate a vernier scale (although one still needs to add the basic inches or tens of millimeters value read from the slide of the caliper). The dial is usually arranged to be rotatable beneath the pointer, allowing for easy "differential" measurements (the measuring of the difference in size between two objects, or the setting of the dial using a master object and subsequently being able to read directly the plus-or-minus variance in size of subsequent objects relative to the master object).

The slide of a dial caliper can usually also be locked at a setting using a small lever; this allows simple go/no-go checks of part sizes.

**1.7 Digital caliper**

A refinement now popular is the replacement of the analog dial with an electronic digital display. This version of the caliper finally allows simply reading the value directly from a single display. Many digital calipers can also be switched between metric and imperial units and all provide for zeroing the display at any point along the slide, allowing the same sort of differential measurements as with the dial caliper but without the need to read numbers that may be upside down.

Digital calipers may also contain some sort of "reading hold" feature, allowing the reading of dimensions even in very awkward locations where the display cannot be directly seen.

Increasingly, digital calipers are offering a serial data output to allow them to be interfaced with a personal computer. This means measurements to be taken and instantly stored in a spreadsheet or similar piece of software, significantly decreasing the time taken to take and record a series of measurements. The output of non name brand calipers is usually 24 bit 90 kHz synchronous. A suitable interface to convert the output to RS232 levels and format can be easily built or purchased.
Like dial calipers, the slide of a digital caliper can usually be locked using a lever or thumb-screw.

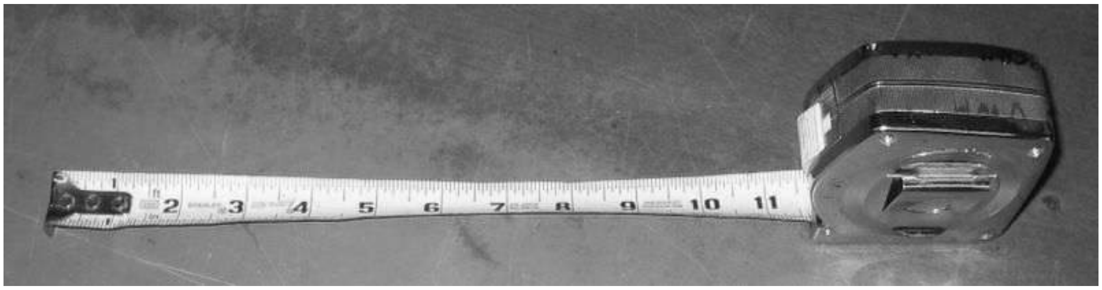
**Use of Calipers**
A caliper must be properly applied against the part in order to take the desired measurement. For example, when measuring the thickness of a plate a vernier caliper must be held at right angles to the piece. Some practice may be needed to measure round or irregular objects correctly.

Accuracy of measurement when using a caliper is highly dependent on the skill of the operator. Regardless of type, a caliper's jaws must be forced into contact with the part being measured. As both part and caliper are always to some extent elastic, the amount of force used affects the indication. A consistent, firm touch is correct. Too much force results in an under indication as part and tool distort; too little force gives insufficient contact and an over indication. This is a greater problem with a caliper incorporating a screw, which lends mechanical advantage.

Simple calipers are un-calibrated; the measurement taken must be compared against a scale. Whether the scale is part of the caliper or not, all analog calipers -- verniers and dials -- require good eyesight in order to achieve the highest precision. Digital calipers have the advantage in this area.

Calibrated calipers may be mishandled, leading to loss of zero. When a calipers' jaws are fully closed, it should of course indicate zero. If it does not, it must be recalibrated or discarded. It might seem that a vernier caliper cannot get out of calibration but a drop or knock can be enough. Sometimes a careful tap is enough to restore zero. Digital calipers have zero set buttons.

Measure Tape



A measuring tape is a ribbon of cloth, plastic, or metal with linear-measure markings, often in both imperial and metric units. Surveyors use tape measures in lengths on the order of hectometres. It is a convenient measuring tool. Its flexibility allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.

Tape measures intended for use in tailoring or dressmaking are typically made of flexible cloth or plastic, while those designed for carpentry or construction often use a stiff, curved metallic ribbon that can remain stiff and straight when extended, but retracts into a coil for convenient storage. This type of tape measure will have a floating tang on the end to aid measuring. The tang will float a distance equal to its thickness, to allow accurate measurement whether the tape is in tension or compression. A tape measure of 25 or even 100 feet can wind into a relatively small container.

For many purposes tape measures are indispensable. Almost any home or shop can be expected to have several of one sort or another.

**Micrometer**

A micrometer is a widely used device in mechanical engineering for precisely measuring thickness of blocks, outer and inner diameters of shafts and depths of slots. Appearing frequently in metrology, the study of measurement, micrometers have several advantages over other types of measuring instruments like the Vernier caliper - they are easy to use and their readouts are consistent.

The first ever micrometric screw was invented by William Gascoigne in the 17th century, as an enhancement of the Vernier; it was used in a telescope to measure angular distances between stars. Its adaptation for the measurement of the small dimension was made by Jean-Louis Palmer; this device is therefore often called palmer in France. In 1888 Edward Williams Morley added to the precision of micrometric measurements and proved their accuracy in a complex series of experiements.

**Types**

There are mainly three common types of micrometers, the names are based on their application:

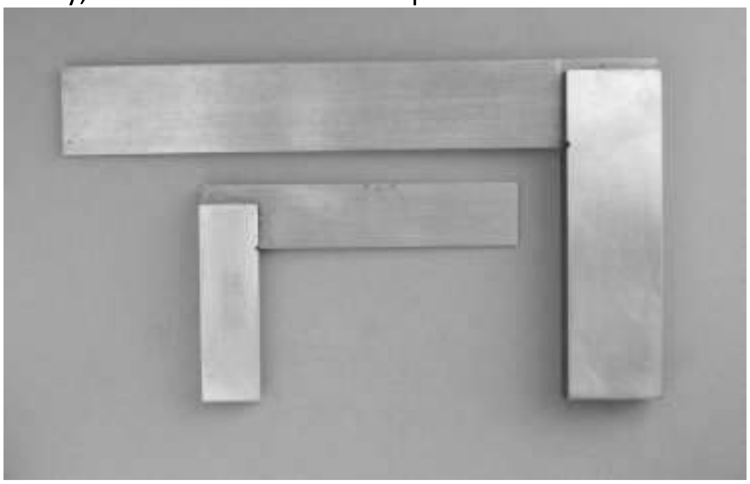
- External Micrometer
- Internal Micrometer
- Depth Micrometer

An external micrometer is typically used to measure wires, spheres, shafts and blocks. An internal micrometer is used to measure the opening of holes, and a depth micrometer typically measures depths of slots and steps.

The precision of a micrometer is achieved by a using a fine pitch screw mechanism.
An additional interesting feature of micrometers is the inclusion of a spring-loaded twisting handle. Normally, one could use the mechanical advantage of the screw to force the micrometer to squeeze the material, giving an inaccurate measurement. However, by attaching a handle that will ratchet at a certain torque, the micrometer will not continue to advance once sufficient resistance is encountered.

**Machinist square**

A machinist square or engineer's square is the metalworkers' equivalent of a try square. It consists of a steel blade inserted and either welded or pinned into a heavier body at an angle of 90°. In the accompanying image, there is evidence of pinning at the intersection of the blade and body, where the heads of two pins are visible as dark circles.



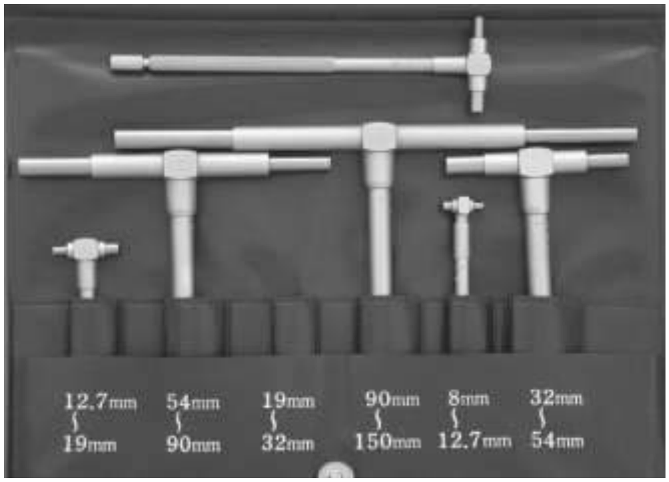
In use the body is aligned against the one edge of the object and the blade is presented to the end or body of the object. If the end is being checked, then a strong light source behind the square will show any mismatch between the blade of the square and the end of the object. The purpose of this action is to either check for squareness or to mark out the body of the workpiece.

**Bore gauge**

A bore gauge is a convenient term for the measuring or transfer tools that are used in the process of accurately measuring holes.

**Telescopic gauges**

These are a range of gauges that are used to measure a bore's size, by transferring the internal dimension to a remote measuring tool. They are a direct equivalent of inside calipers and require the operator to develop the correct feel to obtain repeatable results.




The gauges are locked by twisting the knurled end of the handles, this action is performed to exert a small amount of friction on the telescopic portions of the gauge (the smaller diameter rods found at the T head of the gauge). Once gently locked to a size slightly larger than the bore, the gauges are inserted at an angle to the bore and slowly brought to align themselves radially, across the hole. This action compresses the two anvils where they remain locked at the bores dimension after being withdrawn.
The gauge is then removed and measured with the aid of a micrometer or vernier caliper.

**Small hole gauges**
A set of tools, shown in the image below, which cover the smaller sizes — 3 mm (0.125") to 13 mm (0.5").

They require a slightly different technique to the telescopic gauges, the small hole gauge is initially set smaller than the bore to be measured. It is then inserted into the bore and adjusted by rotating the knurled knob at the base, until light pressure is felt when the gauge is slightly moved in the bore. Measurement is again by external means.

**Dial bore gauge**
Is a Dial indicator type gauge that will measure a range of holes directly. The tool consists of

- A range of interchangeable anvil pieces (for the telescopic part of the gauge) that transfer their movement to a freely moving rod.
- A body that includes a transfer mechanism (the movable rod)
- A dial indicator mounted at the remote end (to measure the axial movement of the rod).

This combination allows the bore size to be accurately read from the instrument with the minimum of effort. The fixed end of the anvil piece has pressure fingers on either side of it that assist correct placement in the bore, this reduces the reliance on feel by the operator, as required when using the telescopic gauge.

**Gauge blocks**
Gauge blocks (also known as gage blocks, Johansson gauges, or slip gauges) are precision ground and lapped measuring standards. They are used as references for the setting of measuring equipment such as micrometers, sine bars, dial indicators (when used in an inspection role).

They are available in various grades depending on their intended use

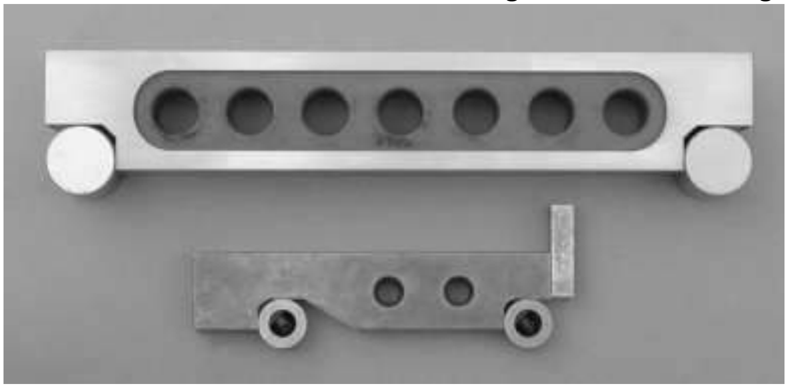
- reference (AAA) — high tolerance (± 0.00005mm or 0.000002")
- calibration (AA) — (tolerance +0.00010mm to -0.00005mm)
- inspection (A) — (tolerance +0.00015mm to -0.0005mm)
- workshop (B) — low tolerance (tolerance +0.00025mm to -0.00015mm)

More recent grade designations include:

- 0.5 — generally equivalent to grade AAA
- 1 — generally equivalent to grade AA
- 2 — generally equivalent to grade A+
- 3 — compromise grade between A and B

**Sine bar**

A sine bar is a tool used to measure angles in metalworking.



It consists of a hardened, precision ground body with two precision ground cylinders fixed at each end. The distance between the centers of the cylinders is precisely controlled, and the top of the bar is parallel to a line through the centers of the two rollers. The dimension between the two rollers is chosen to be a whole number (for ease of later calculations) and forms the hypotenuse of a triangle when in use. The image shows a 10 inch and a 100 mm sine bar.

When a sine bar is placed on a level surface the top edge will be parallel to that surface. If one roller is raised by a known distance then the top edge of the bar will be tilted by the same amount forming an angle that may be calculated by the application of the sine rule.

The hypotenuse is a constant dimension — (100 mm or 10 in in the examples shown).

The height is obtained from the dimension between the bottom of one roller and the table's surface.

The angle is calculated by using the sine rule. $\sin(angle) = \frac{opposite}{hypotenuse}$

Angles may be measured or set with this tool. For precision measurements where the bar must be set at an angle, gauge blocks are traditionally used.

**Types**

**Sine centre**

A special type of sine bar is sine centre which is used for conical objects having male and female parts.it cannot measure the angle more than 45 degree.

**Sine table**

Sine table is used to measure angles of large workpieces

**Compound sine angle**

It is used to measure compound angles of large workpieces.In this case,two sine tables are mounted one over the other at right angles.The tables can be twisted to get the required alignment.

**Feeler gauge**

They consist of a number of small lengths of steel of different thicknesses with measurements marked on each piece. They are flexible enough that, even if they are all on the same hinge, several can be stacked together to gauge intermediate values. It's common to have two sets for imperial units and metric measurements although the pictured set has both measurements recorded on each blade.

A similar device with wires of specific diameter instead of flat blades is used to set the gap in spark plugs to the correct size; this is done by increasing or decreasing the gap until the gauge of the correct size just fits inside the gap.

The lengths of steel are sometimes called *blades*, although they have no sharp edge.

**Feeler gauge**

A feeler gauge is a simple tool used to measure gap-widths. Feeler gauges are mostly used in engineering to measuring the clearance between two parts.

They consist of a number of small lengths of steel of different thicknesses with measurements marked on each piece. They are flexible enough that, even if they are all on the same hinge, several can be stacked together to gauge intermediate values. It's common to have two sets for imperial units and metric measurements although the pictured set has both measurements recorded on each blade.

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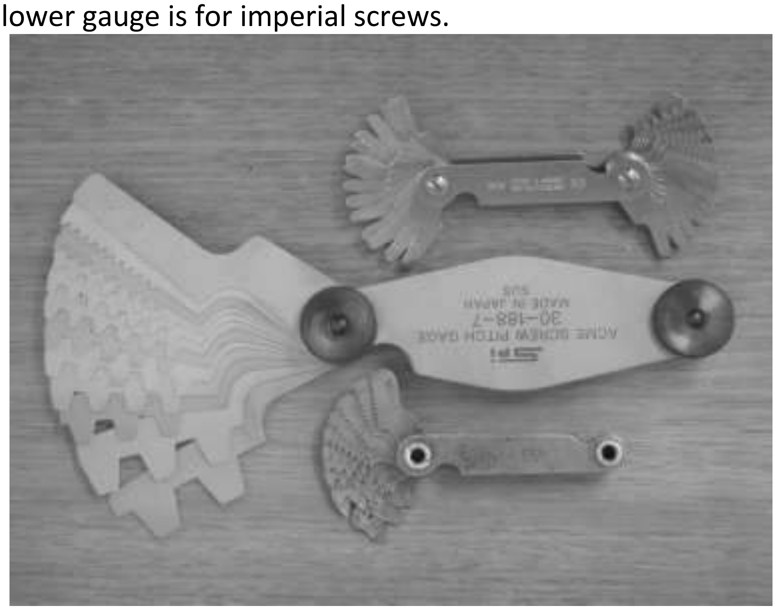
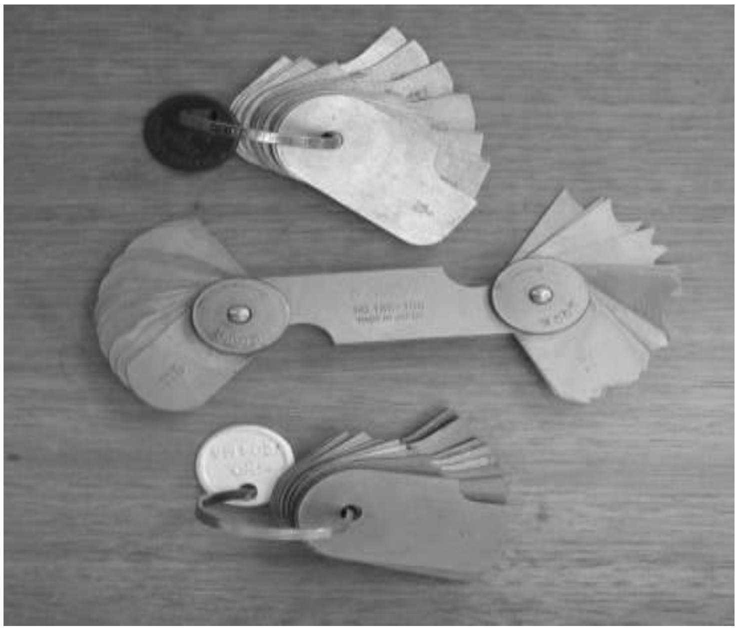
**Thread pitch gauge**

Threading gauges, pictured on the right, are also referred to as pitch gauges and are used to measure the pitch or lead of screw threads. The uppermost gauge in the image is an ISO metric pitch gauge, The larger gauge in the center is for measuring the Acme Thread Form, and the lower gauge is for imperial screws.



Thread pitch gauges are used as a reference tool in determining the pitch of a thread that is on a screw or in a tapped hole. This tool is not used as a precision measuring instrument. This device allows the user to determine the profile of the given thread and quickly categorize the thread by shape and pitch. This device also saves time, in that it removes the need for the user to measure and calculate the thread pitch of the threaded item.

**Radius gauge**



A radius gauge is a tool used to measure the radius of an object.
Radius gauges require a bright light behind the object to be measured. The gauge is placed against the edge to be checked and any light leakage between the blade and edge indicates a mismatch that requires correction.
A good set of gauges will offer both convex and concave sections, and allow for their application in awkward locations.

**Go-NoGo gauge**

A Go NoGo gauge (or Go/no go) refers to an inspection tool used to check a workpiece against its allowed tolerances. Its name derives from its use: the gauge itself has two tests; the check involves the workpiece's having to pass one test(*Go*) and 'fail' the other (*No Go*).

It is an integral part of the quality process that is used in the manufacturing industry to ensure interchangeability of parts between processes, or even between different manufacturers.

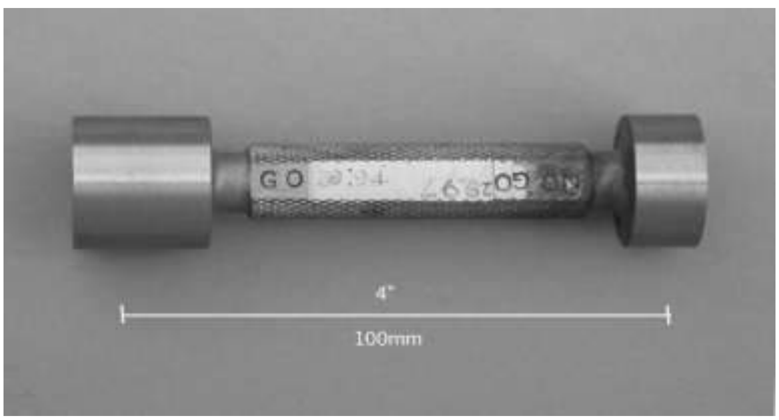
A Go NoGo gauge is a measuring tool that does not return a *size* in the conventional sense, but instead returns a *state*. The *state* is either acceptable (the part is within tolerance and may be used) or it is unacceptable (and must be rejected).

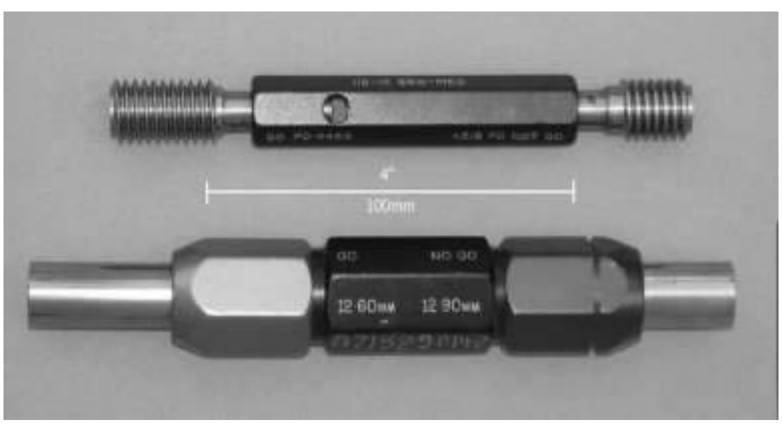
They are well suited for use in the production area of the factory as they require little skill or interpretation to use effectively and have few, if any, moving parts to be damaged in the often hostile production environment.

**Plug gauge**

These gauges are referred to as plug gauges; they are used in the manner of a plug. They are generally assembled from standard parts where the gauge portion is interchangeable with other gauge pieces (obtained from a set of pin type gauge blocks) and a body that uses the collet principle to hold the gauges firmly. To use this style of gauge, one end is inserted into the part first and depending on the result of that test, the other end is tried.

**Hardened and ground plug gauge**

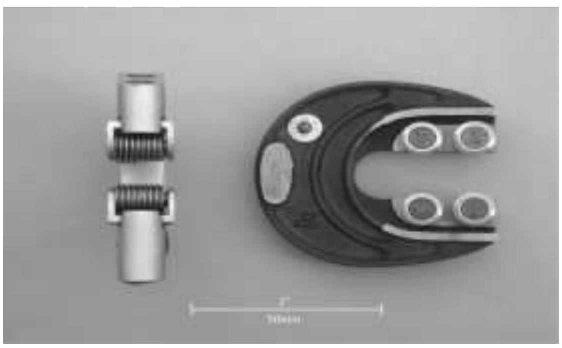


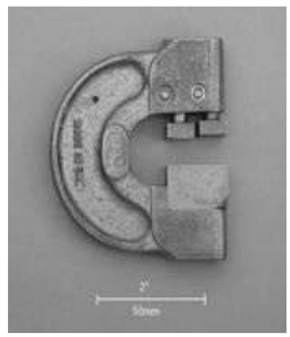



**Replaceable thread and plug gauges**

The lower gauge is a thread gauge that is screwed into the part to be tested, the labeled *GO* end will enter into the part fully, the *NOT GO* end should not. The top image is a plain plug gauge used to check the size of a hole, the green end is the *GO*, red is the *NO GO*. The tolerance of the part this gauge checks is 0.30mm where the lower size of the hole is 12.60mm and the upper size is 12.90mm, every size outside this range is *out of tolerance*.

**Gap gauge**





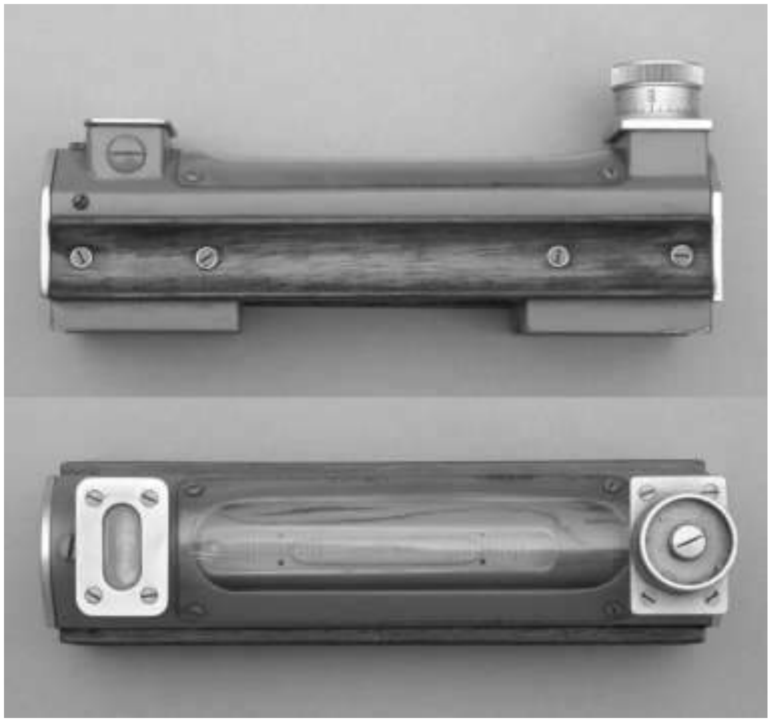
These images illustrate an alternative type of gauge. The gap gauge has four *anvils* or *jaws*, the first one or pair (outermost) are set using the upper limit (tolerance) of the part and the inner set adjusted to the lower limit of the part.

The usage of this gauge may be more intuitive than the plug type. A correctly machined part will pass the first set of jaws and stop at the second — end of test. In this manner a part may be checked in one action, unlike the plug gauge that needs to be used in the correct sequence and flipped to access the second gauge.

The left image is a plain gap gauge used to measure outside distances (diameters), the right hand image shows two views of a thread gap gauge.

**Spirit level**

An **engineers spirit level** is generally used to level machines, although they may be used to level large workpieces on machines such as planers. Spirit levels are also used in building construction, by carpenters and masons.



Both levels have The upper image is a *plain* precision level used in the engineering field to level machines or workpieces, the lower image shows an adjustable precision level that has an accuracy of 1:10000. The adjustable nature of this level can also be used to measure the inclination of an object.

The accuracy of a spirit level can be checked by placing it on any flat surface, marking the bubble's position and rotating the level 180°. The position of the bubble should then be symmetrical to the first reading.
a "vee" groove machined along the base which enables the level to sit on a round bar while remaining parallel with the bars axis. They also have a smaller cross level to enable the second axis to be roughly checked or corrected.

While a precision level may be used to check and correct the twist in a machine (or workpiece), its presence does not necessarily need to be corrected.

- A machine such as a mill or lathe does not have to be perfectly level to operate correctly but may in fact have a known twist introduced to the machines bed. This twist is often introduced to ensure that a worn lathe turns parallel work, by realigning the bed (that is worn) to the spindle axis (unworn).
- Levelling a ships lathe would be pointless due to the nature of the ships base - floating on water. Correcting any twist in the bed however would be essential for accurate work to be reproduced from the lathe.

# CHAPTER 5

## NON DESTRUCTIVE TESTING (NDT)

Non destructive testing (NDT) is one of the important topic in day today life. Though NDT techniques are used in industries, certain techniques like X-ray, ultrasonic testing is used in medical field. It is very interesting to know that X-rays were first used in medical field, later in industry. In this module various NDTs / NDE are listed out but NDTs, which are most commonly used are explained in little detail to familiar with NDTs.

**INTRODUCTION**

The field of Nondestructive Testing (NDT) is a very broad, interdisciplinary field that plays a critical role in assuring that structural components and systems perform their function in a reliable and cost effective fashion. NDT techniques that locate and characterize material conditions and flaws that might otherwise result in failure of pressure vessels, pipelines or machinery components. These tests are performed in a manner that does not affect the future usefulness of the object or material. In other words, NDT allows parts and materials to be inspected and measured without damaging them. Because it allows inspection without interfering with a product's final use, NDT provides an excellent balance between quality control and costeffectiveness.

Generally speaking, NDT applies to industrial inspections. While technologies are used in NDT that are similar to those used in the medical industry, typically nonliving objects are the subjects of the inspections.

**NON DESTRUCTIVE EVALUATION**

Nondestructive Evaluation (NDE) is a term that is often used interchangeably with NDT. However, technically, NDE is used to describe measurements that are more quantitative in nature. NDE method would not only locate a defect, but it would also be used to measure something about that defect such as its size, shape, and orientation. NDE may be used to determine material properties such as fracture toughness, formability, and other physical characteristics.

**NDT / NDE METHODS**

The number of NDT methods that can be used to inspect components and make measurements is large and continues to grow. There are six NDT methods that are used most often. These methods are visual inspection, penetrant testing, magnetic particle testing, electromagnetic or eddy current testing, radiography, and ultrasonic testing. These methods and a few others are briefly described below.

## 1. VISUAL OR OPTICAL TESTING (VT)

Visual inspection involves using an inspector's eyes to look for defects. The inspector may also use special tools such as magnifying glasses, mirrors, boroscopes or fibroscopes to gain access and more closely inspect the subject area. Visual examination involves procedures that range from simple to very complex.

## 2. LIQUID PENETRANT TESTING (LPT)

Liquid penetrant Testing (LPT) is one of the most widely used nondestructive evaluation (NDE) method. Its popularity can be attributed to two main factors, which are its relative ease of use and its flexibility. LPT can be used to inspect almost any material provided that its surface is not extremely rough or porous. Materials that are commonly inspected using LPT include the following:

- Metals (aluminum, copper, steel, titanium, etc.)
- Glass
- Many ceramic materials
- Rubber
- Plastics

LPT offers flexibility in performing inspections because it can be applied in a large variety of applications ranging from automotive spark plugs to critical aircraft components. Penetrant material can be applied with a spray can or a cotton swab to inspect for flaws known to occur in a specific area or it can be applied by dipping or spraying to quickly inspect large areas.

Liquid penetrant inspection is used to inspect of flaws that break the surface of the sample. Some of these flaws are listed below:

- Fatigue cracks
- Quench cracks
- Grinding cracks
- Overload and impact fractures
- Porosity
- Laps
- Seams
- Pin holes in welds
- Lack of fusion or braising along the edge of the bond line

As mentioned above, one of the major limitations of a penetrant inspection is that flaws must be open to the surface.

In LPT, a liquid penetrant (contrast colour dye or fluorescent) is applied over the thoroughly cleaned and dry surface, which is having flows(discontinuities) those are open surface due to capillary action. Sufficient time is allowed so that the penetrant can enter in narrow discontinuities. Excess penetrant is removed by cleaning and developer (a fluffy chalk like powder) is applied over the surface.

Due to blotting nature of the developer, entrapped penetrant in the discontinuities flows out and gives an indication, which can be viewed either in normal light for contrast dye or in “black light” (UV light) for fluorescent dye. The indication is always greater than the discontinuity due to diffusion of the penetrant in the developer.

**ADVANTAGES AND DISADVANTAGES OF LPT**

Like all nondestructive inspection methods, liquid penetrant inspection has both advantages and disadvantages. The primary advantages and disadvantages when compared to other NDE methods are summarized below.

**PRIMARY ADVANTAGES**

- The method has high sensitive to small surface discontinuities.
- The method has few material limitations, i.e. metallic and nonmetallic, magnetic and nonmagnetic, and conductive and nonconductive materials may be inspected.
- Large areas and large volumes of parts/materials can be inspected rapidly and at low cost.
- Parts with complex geometric shapes are routinely inspected.
- Indications are produced directly on the surface of the part and constitute a visual representation of the flaw.
- Aerosol spray cans make penetrant materials very portable.
- Penetrant materials and associated equipment are relatively inexpensive.

**PRIMARY DISADVANTAGES**

- Only surface breaking defects can be detected.
- Only materials with a relative nonporous surface can be inspected.
- Precleaning is critical as contaminants can mask defects.
- Metal smearing from machining, grinding, and grit or vapor blasting must be removed prior to LPT.
- The inspector must have direct access to the surface being inspected.
- Surface finish and roughness can affect inspection sensitivity.
- Multiple process operations must be performed and controlled.
- Post cleaning of acceptable parts or materials is required.
- Chemical handling and proper disposal is required.

### 3. MAGNETIC PARTICLE TESTING (MPT)

MPT is a fast and relatively easy to apply and part surface preparation is not as critical as it is for some other NDT methods. These characteristics make MPT one of the most widely utilized nondestructive testing methods.

MPT uses magnetic fields and small magnetic particles, such as iron filings to detect flaws in components. The only requirement from an inspectability standpoint is that the component being inspected must be made of a ferromagnetic material such iron, nickel, cobalt, or some of their alloys. Ferromagnetic materials are materials that can be magnetized to a level that will allow the inspection to be effective.

Magnetic particle testing (MPT) is a relatively simple concept. It can be considered as a combination of two nondestructive testing methods: magnetic flux leakage testing and visual testing. Consider a bar magnet. It has a magnetic field in and around the magnet. Any place that a magnetic line of force exits or enters the magnet is called a pole. A pole where a magnetic line of force exits the magnet is called a north pole and a pole where a line of force enters the magnet is called a south pole. This NDT method is accomplish by inducing a magnetic field in a ferromagnetic material and then dusting the surface with iron particles (either dry or suspended in liquid). Surface and near-surface imperfections distort the magnetic field and concentrate iron particles near imperfections, previewing a visual indication of the flaw.

### 4. ELECTROMAGNETIC (ET) OR EDDY CURRENT TESTING

Electrical currents are generated in a conductive material by an induced alternating magnetic field. The electrical currents are called eddy currents because they flow in circles at and just below the surface of the material. Interruptions in the flow of eddy currents, caused by imperfections, dimensional changes, or changes in the material's conductive and permeability properties, can be detected with the proper equipment.

### 5. RADIOGRAPHIC TESTING (RT)

X-rays were discovered in 1895 by Wilhelm Conrad Roentgen (1845-1923) who was a Professor at Wuerzburg University in Germany. Working with a cathode-ray tube in his laboratory, Roentgen observed a fluorescent glow of crystals on a table near his tube. He concluded that a new type of ray was being emitted from the tube. This ray was capable of passing through the heavy paper covering and exciting the phosphorescent materials in the room. He found the new ray could pass through most substances casting shadows of solid objects. Roentgen also discovered that the ray could pass through the tissue of humans, but not bones and metal objects.

In 1922, industrial radiography took another step forward with the advent of the 200,000-volt X-ray tube that allowed radiographs of thick steel parts to be produced in a reasonable amount of time. In 1931, General Electric Company developed 1,000,000 volt X-ray generators, providing an effective tool for industrial radiography. That same year, the American Society of Mechanical Engineers (ASME) permitted X-ray approval of fusion welded pressure vessels that further opened the door to industrial acceptance and use.
Radiography involves the use of penetrating gamma or X-radiation to examine parts and products for imperfections. An X-ray generator or radioactive isotope is used as a source of radiation. Radiation is directed through a part and onto film or other imaging media. The resulting shadowgraph shows the dimensional features of the part. Possible imperfections are indicated as density changes on the film in the same manner as a medical X-ray shows broken bones.

**6. ULTRASONIC TESTING (UT)**

Sound in the range of 20 Hz to 18000 Hz is in audible ranges of human ear. Sound beyond this range cannot be heard by human and called as ultrasonic sound. However, some mammals can hear well above this. For example, bats and whales use echo location that can reach frequencies in excess of 100,000Hz.

Ultrasonic testing is based on time-varying deformations or vibrations in materials, which is generally referred to as acoustics. All material substances are comprised of atoms, which may be forced into vibrational motion about their equilibrium positions. Many different patterns of vibrational motion exist at the atomic level, however, most are irrelevant to acoustics and ultrasonic testing. Acoustics is focused on particles that contain many atoms that move in unison to produce a mechanical wave. When a material is not stressed in tension or compression beyond its elastic limit, its individual particles perform elastic oscillations. When the particles of a medium are displaced from their equilibrium positions, internal (electrostatic) restoration forces arise. It is these elastic restoring forces between particles, combined with inertia of the particles, that leads to oscillatory motions of the medium. In solids, sound waves can propagate in four principle modes that are based on the way the particles oscillate. Sound can propagate as longitudinal waves, shear waves, surface waves, and in thin materials as plate waves. Longitudinal and shear waves are the two modes of propagation most widely used in ultrasonic testing.

Ultrasonic testing uses transmission of high-frequency sound waves into a material to detect imperfections or to locate changes in material properties. The most commonly used ultrasonic testing technique is pulse echo, wherein sound is introduced into a test object and reflections (echoes) are returned to a receiver from internal imperfections or from the part's geometrical surfaces.

# CHAPTER- 6

## THE FORMAT FOR COLLECTING TECHNICAL SPECIFICATIONS FOR MACHINES TOOLS & FACTORY EQUIPMENT FROM CLIENTS

**(a) Capstan Lathe:**

| |
|---|
| **Capacity:** |
| **Maximum swing:** |
| Over bed covers and under overhead support bar |
| Over bed within 160 mm of cross slide |
| Close to cross slide |
| Over cross slide |
| **Largest bar admitted by dead length bar chuck:** |
| Round, dia. |
| Hexagon, A/F |
| Square, A/F |
| **Largest bar admitted by geared draw-in chuck:** |
| Round, dia. |
| Hexagon, A/F |
| Square, A/F |
| Maximum length of bar |
| Power of main motor |
| **Spindle:** |
| Diameter of spindle bore |
| Diameter of spindle flange |
| **Saddle and cross slide:** |
| Maximum longitudinal traverse |
| Maximum cross traverse |
| Height of tools for square turret and rear tool post |
| **Capstan slide:** |
| Maximum stroke of capstan slide |
| Diameter of tool holes in hexagonal turret |
| Centre of tool holes to top of capstan slide |
| **Speeds and feeds:** |
| Number of reversible spindle speeds |
| Spindle speeds |
| Number of automatic feeds to saddle and capstan slide |
| Automatic feed rate, per revolution |
| **Miscellaneous:** |
| **Floor space occupied:** |

| |
|---|
| Chuck work machine |
| Bar work machine |
| **Gross weight:** |
| Chuck work machine |
| Bar work machine |

**(b) Centre Lathe:**

| |
|---|
| **Capacity:** |
| Height of centre |
| Type of bed |
| Swing over bed |
| Swing over carriage wings |
| Swing over cross slide |
| Swing in gap |
| Distance between centres |
| **Headstock:** |
| Spindle nose/bore |
| Spindle socket taper |
| Speed range: |
| Forward |
| Reverse |
| **Feeds and Threads:** |
| Feed range longitudinal |
| Feed range cross |
| Lead screw pitch |
| Metric threads |
| Inch threads |
| Module threads |
| **Carriage:** |
| Cross slide travel |
| Top slide travel |
| Tool shank size |
| **Tailstock:** |
| Sleeve diameter/ taper |
| Sleeve travel |
| **Power of main motor** |

**(c) Combination Turret Lathe:**

| |
|---|
| **Capacity:** |
| **Maximum Swing:** |
| Under overhead support bar |
| Over saddle |
| Over cross slide |
| **Spindle flange to hex-turret face:** |
| Maximum |
| Minimum |
| Diameter of spindle bore |
| Diameter of spindle flange |
| Main spindle motor power |
| Quick power traverse motor |
| **Saddle and cross slide:** |
| Stroke of turret slide |
| Diameter of tool holes in turret |
| Centre of tool holes to top of turret slide |
| Turret face size |
| **Speeds and feeds:** |
| Number of spindle speeds |
| Range of spindle speeds |
| Number of automatic feeds to saddle and turret slide |
| **Automatic feed rate per rev.:** |
| Fine feed range |
| Coarse feed range |
| **Miscellaneous:** |
| Minimum floor space occupied |
| Minimum floor space for machine with bar guard |
| Gross weight of machine |

### (d) CNC High Performance Vertical Lathe:

| |
|---|
| **Capacity:** |
| Table diameter |
| Maximum swing |
| Maximum turning diameter |
| Maximum turning height |
| Maximum weight of workplace |
| Maximum torque of table |
| Maximum cutting force |
| **Table speed:** |
| No. of range |
| **Speed range:** |
| Low |
| High |
| **Cross-rail:** |
| Height under cross-rail |
| Maximum |
| Minimum |
| Crossrail positioning step |
| **Tool head:** |
| Vertical travel |
| Horizontal travel: |
| To right from table centre |
| To left from table centre |
| Tool holder shank size |
| Ram size (square) |
| **Feeds:** |
| Feed |
| Feed rate |
| **Traverse rate:** |
| Rapid traverse |
| **Elevating speed of cross-rail:** |
| 50 Hz |
| 60 Hz |

(e) **CNC Turn Mill Centre:**

| |
|---|
| **Capacity:** |
| Type of bed |
| Swing over carriage wins |
| Maximum turning dia. over cross slide |
| Distance between centres |
| Maximum turning dia. of chucking job |
| Maximum turning length |
| **Spindle:** |
| Spindle nose |
| Hole through spindle |
| Spindle socket taper |
| Spindle indexing |
| **Speeds and feeds:** |
| Spindle speed range |
| Selection of speeds |
| Type of spindle drive |
| **Longitudinal feed drive:** |
| Feed range |
| Rapid traverse rate |
| Stroke |
| **Cross feed drive:** |
| Feed range |
| Rapid traverse rate |
| Stroke |
| **Tailstock:** |
| Tailstock spindle dia. |
| Spindle stroke (HYD) |
| Spindle taper |
| **Turrent:** |
| No. of tools (external/internal) |
| Turret indexing positions |
| Turning tool shank size |
| Turret actuation |
| Maximum boring bar size |
| **Capacity of driven tools:** |
| No. of rotating tools on turret |
| Maximum tool capacities on steel for: |
| a. Drilling |
| b. End milling |

| |
|---|
| c. Face milling |
| d. Tapping |
| **Speed and Power** |
| Maximum speed |
| Type of tool drive |
| Spindle drive motor |
| Hydraulic power pack motor |
| Coolant pump motor |
| Input supply to voltage stabiliser |
| Total connected load |
| **CNC System** |
| **Accuracies** |
| Positioning |
| Repeatability |

**(f) Shaping machine:**

| |
|---|
| Maximum length of stroke |
| Maximum horizontal traverse of table |
| Maximum vertical traverse of table |
| Maximum distance table to ram |
| Minimum distance table to ram |
| Length and width of table top |
| Depth of table side |
| Floor space |
| No. of speeds to ram |
| Range of speeds |
| Range of table feed |
| No. of table feeds |
| Power of driving motor |
| 'T' slot size on table top |
| Net weight of the machine |

**(g) Planing machine:**

| |
|---|
| **Capacity:** |
| Width of planing |
| Length of planing |
| Height of planing |
| Clamping surface of table (width * length) |
| Stroke of toolpost slide |

| |
|---|
| Number of infeed and reverse speeds |
| **First version:** |
| Range of infeed and reverse speeds from 5 to 25 m/min |
| Maximum draw through force |
| Output of the machine motor |
| **Second version:** |
| Range of infeed and reverse speeds from 6.3 to 31.5 m/min |
| Maximum draw through force |
| Output of the machine motor |
| **Third version:** |
| Range of infeed and reverse speeds from 8 to 40 m/min |
| Maximum draw through force |
| Output of the machine motor |
| **Feeds, weight and load:** |
| Feeds of cross-rail heads |
| Feeds of side heads |
| Feeds of tool post slides |
| Output of the motor for cross-rail rapid traverse |
| Output of the motor for rapid traverse of heads |
| Weight of the machine with standard equipment/length of planing |
| Weight of 1 m of the length of planing |
| Volumetric content of boxes for 1 m length of planing |
| Maximum load to table by work piece per 1 m length of planing |
| Maximum load to cross-rail head |
| Maximum load to side head |
| Maximum length of planing |
| Maximum speed |
| Floor space occupied by machine/ length of planing |

**(h) Radial Drilling Machine:**

| |
|---|
| **Maximum size of hole drilled:** |
| Maximum size of hole drilled without pre-drilling in steel of 60 kp per sq.mm tensile strength |
| Maximum size of hole drilled in cast iron of 25 kp per sq.mm tensile strength |
| Maximum size of hole bored in steel of 60 kp per sq.mm tensile strength |
| Maximum thread size cut in steel of 60 kp per sq.mm tensile strength |
| Maximum thread size cut in cast iron of 25 kp per sq.mm tensile strength |
| **Main dimensions:** |
| Maximum distance between spindle axis and outer column |
| Minimum distance between spindle axis and outer column |

| |
|---|
| Maximum pitch circle of holes drilled |
| Minimum pitch circle of holes drilled |
| Maximum and minimum distance between spindle and base |
| Outer column dia. |
| Vertical travel of arm along column |
| Horizontal travel of headstock on arm |
| Range of arm swivel on column |
| **Spindle:** |
| Spindle nose dia. |
| Inner taper in spindle |
| Spindle dia. |
| Spindle travel |
| **Spindle speeds and feeds:** |
| No. of speeds |
| Speed range, standard |
| Speed range, increased |
| No. of feeds |
| Feed range |
| **Base:** |
| Clamping area |
| Base height |
| Number, width and distance of clamping slots |
| **Drive:** |
| Spindle driving motor |
| Clamping motor |
| Coolant pump motor |
| **Dimensions:** |
| Overall length |
| Overall width |
| Overall height |
| Overall weight |
| Overall input of machine |

CVSRTA

### (i) Horizontal Boring and Milling Machine:

| |
|---|
| **Type** |
| **Headstock:** |
| Diameter of work spindle |
| Taper in spindle (CSN 22 0429) |
| Protrusion of work spindle |
| External diameter of connecting of hollow spindle (CSN 22 0431) |
| Vertical adjustment of headstock |
| Horizontal protrusion of head stock |
| Range of speed of work and hollow spindle in 26 steps (in line R 20/2) |
| Output and speed of motor for spindle drive |
| Maximum torsional moment on hollow spindle |
| **Horizontal headstock feeds:** |
| 1st Range- steplessly |
| 2nd Range- steplessly |
| Rapid traverse of headstock in horizontal direction |
| **Work spindle feeds in horizontal direction and headstock feeds in vertical direction:** |
| 1st Range- steplessly |
| 2nd Range- steplessly |
| Rapid traverse of work spindle and headstock |
| Minimum distance of spindle centre line from bed guiding surfaces |
| Output and speed of motor of hydraulic set for feed drive |
| **Upright:** |
| Upright traverse along the bed |
| Length of standard bed |
| **Upright feeds:** |
| 1st Range- steplessly |
| 2nd Range- steplessly |
| Rapid traverse |
| Output of all installed motors |

## (j) Hacksaw:

| |
|---|
| **Capacity:** |
| Size |
| Cuts round material upto maximum |
| Cuts square material upto maximum |
| Length and breadth of saw blade |
| Angular cuts at 45 degree |
| Stroke per minute |
| Length of the stroke |
| Load |
| Weight |

## (k) Circular Saw:

| |
|---|
| **Capacity:** |
| Maximum diameter |
| Saw blade |
| Table size |
| Height of the table |
| Spindle speed |
| Power required |

## (l) Cylindrical Grinding Machine:

| |
|---|
| **Capacity:** |
| Height of centre |
| Swing over table |
| Distance between centres |
| Maximum grinding length |
| **Grinding wheel:** |
| Maximum diameter |
| Minimum diameter |
| **Work Head:** |
| Taper bore in spindle |
| **Tail stock:** |
| Centre |
| Quill movement |
| **Table head:** |
| Maximum table traverse |
| Swivel of table in either direction |

| |
|---|
| **Wheel head:** |
| Cross travel of wheel head |
| Wheel feed/ revolution of hand wheel |
| Wheel spindle speed (single) |
| Work spindle speed (single) |
| Steps of speed for table traverse |
| **General:** |
| Wheel head motor |
| Work head motor |
| Table drive motor |
| Machine overall dimensions |
| Weight of the machine |

**(m) Tool and Cutter Grinder:**

| |
|---|
| **Capacity:** |
| Centre distance maximum |
| Centre height maximum |
| Movement of table maximum |
| Angle adjustment |
| Axial adjustment of grinding wheel |
| Vertical adjustment of grinding support |
| RPM of grinding wheel |
| Swing of grinding support to right and left |
| Diameter of grinding wheel |
| Grinding motor power requirement |
| Table motor power requirement |
| Power requirement for suction motor |
| Power requirement for water cooling |
| Net weight of machine |
| **Indexing plate:** |
| No. of Index |

CVSRTA

### (n) EDM Machine (spark erosion machine):

| |
|---|
| **Table Tank:** |
| Table size |
| Travel size |
| Tank size |
| Job weight |
| Linearity of movement |
| **Work hesad:** |
| Vertical travel |
| Platen |
| **Platen to table:** |
| Maximum |
| Minimum |
| Electrode weight (maximum) |
| Linearity of movement |
| **Dielectric:** |
| Reservoir |
| Pump |
| Filter |
| Feed system |
| **Generator:** |
| Output voltage (volts) |
| Output current (maximum amps) |
| Pulse time (microseconds) |
| Pause time (microseconds) |

### (o) Lift:

| |
|---|
| Load capacity |
| Operating speed |
| Platform size |
| Hoist way opening available |
| Landings |
| Openings |
| Operation |
| Car enclosure |
| Car gate opening |

(p) **Electric overhead travelling crane:**

| |
|---|
| **Safe working load:** |
| Main |
| Auxiliary |
| Span Auxiliary |
| Height of lift |
| **Speeds:** |
| Main hoist |
| Auxiliary hoist |
| Cross travel |
| Long travel |
| **Wire rope:** |
| Diameter: |
| Main |
| Auxiliary |
| Rope drum dia. (Main) |
| Length |
| Material of construction |
| Rope drum dia. (Aux.) |
| Length |
| Material of construction |
| **Wheel:** |
| C.T./ DD dia. |
| Rail size |
| L.T./ DD dia. |
| Rail size |
| **Motors:** |
| **Main hoist:** |
| HP |
| Rating |
| RPM |
| Type |
| Insulation |
| **Long travel:** |
| HP |
| Rating |
| RPM |
| Type |
| Insulation |
| **Cross travel:** |

| |
|---|
| HP |
| Rating |
| RPM |
| Type |
| Insulation |
| **Auxiliary hoist:** |
| HP |
| Rating |
| RPM |
| Type |
| Insulation |
| **Brake:** |
| Hoist |
| Cross travel |
| Long travel |
| Auxiliary hoist |
| **Hook block:** |
| **Main hoist:** |
| Falls |
| Capacity |
| **Auxiliary hoist:** |
| Falls |
| Capacity |
| **Gearboxes:** |
| **Main hoist:** |
| Size |
| Ratio |
| Type |
| **Cross travel:** |
| Size |
| Ratio |
| Type |
| **Long travel:** |
| Size |
| Ratio |
| Type |
| **Auxiliary hoist:** |
| Size |
| Ratio |
| Type |

**(q) Belt conveyor:**

| |
|---|
| Type |
| Horizontal portion |
| Inclined portion |
| Height |
| Height at discharge end |
| Belt |
| Speed |
| **Drive** |
| **Gearbox:** |
| Type |
| Ratio |

**(r) Bucket elevator for lifting and conveying:**

| |
|---|
| Type |
| Bulk density and size |
| Conveying rate |
| Height- centre to centre |
| Speed |
| Bucket size |
| Bucket spacing |
| Type of bucket |
| Bucket plate thickness |
| Chain |
| Sprocket |
| Head sprocket shaft dia. |
| Boot sprocket shaft dia. |
| **Materials of construction:** |
| Bucket |
| Pin and bush |
| Links |
| Sprocket |
| Shaft |
| **Casing:** |
| Type |
| Size |
| Thickness of head and boot section |
| Thickness of mid-section |
| Inlet |

| |
|---|
| Outlet |
| **Materials of construction:** |
| Head and boot section |
| Mid-section |
| **Drive** |
| **Gearbox:** |
| Type |
| Ratio |
| Coupling guard |
| Type of take up |

**IV. Factory Equipment - material handling -fire protection etc.**

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**Lifting & Transport Vehicles**

In day to day manufacturing, right from the stage of raw material "Inward" to the product "dispatch" , the material is required to be handled in various ways. In this chapter we will discuss the lifting & transportation arrangements being used in the industry. In the first part you will be introduced to some of the "Lifting" devices. The later part deals with the "Engineering Vehicles"

**Crane**

A crane is a tower or derrick equipped with cables and pulleys that can be used both to lift and lower materials and to shift them horizontally. Cranes are commonly employed in the construction industry and in manufacturing heavy equipment. Construction cranes are usually temporary structures, either fixed to the ground or mounted on a purpose-built vehicle. Cranes may either be controlled from an operator in a cab that travels with the crane, by a pushbutton pendant control station, or by infrared or radio control. Where a cab operator is employed, workers on the ground will communicate with the operator through a system of standardised hand-signals or, in larger installations, radio systems; an experienced crew can position loads with great precision using only these signals.

Listed under are the types of cranes used. Please note that the list includes some of the ancient cranes also. Though these cranes are not used now a days, however they are briefly discussed here for acadamic interest.

**1 Types of cranes**

1.1 Ancient Greek cranes
1.2 Ancient Roman cranes
1.3 Railroad cranes
1.4 Mobile crane
1.5 Telescopic crane
1.6 Tower crane
1.7 Truck-mounted crane
1.8 Rough terrain crane
1.9 Crawler crane
1.10 Loader crane
1.11 Gantry crane
1.12 Overhead crane

1.13 Stacker crane
1.14 Floating crane
1.15 Aerial crane
1.16 Winch (Crane for special purpose)

**Ancient Greek cranes**

The crane for lifting heavy loads was invented by the ancient Greeks in the late 6th century BC.

[1] The archaeological record shows that no later than c.515 BC distinctive cuttings for both lifting tongs and Lewis irons begin to appear on stone blocks of Greek temples. Since these holes point at the use of a lifting device, and since they are to be found either above the centre of gravity of the block, or in pairs equidistant from a point over the centre of gravity, they are regarded by archaeologists as the positive evidence required for the existence of the crane.

[2] The introduction of the winch and pulley hoist soon lead to a widespread replacement of ramps as the main means of vertical motion. Although the exact circumstances of the shift from the ramp to the crane technology remain unclear, it has been argued that the volatile social and political conditions of Greece were more suitable to the employment of small, professional construction teams than of large bodies of unskilled labour, making the crane more preferable to the Greek polis than the more labour-intensive ramp which had been the norm in the autocratic societies of Egypt or Assyria.

**Ancient Roman cranes**

The heyday of the crane in ancient times came under the Roman Empire, when construction activity soared and buildings reached enormous dimensions. The Romans adopted the Greek crane and developed it further. We are relatively well informed about their lifting techniques thanks to rather lengthy accounts by the engineers Vitruvius and Heron of Alexandria.

The simplest Roman crane, the Trispastos, consisted of a single-beam jib, a winch, a rope, and a block containing three pulleys. Having thus a mechanical advantage of 3:1. Heavier crane types featured five pulleys (Pentaspastos) or, in case of the largest one, a set of three by five pulleys (Polyspastos) and came with two, three or four masts, depending on the maximum load. In case the winch was replaced by a treadwheel, the maximum load even doubled at only half the crew, since the treadwheel possesses a much bigger mechanical advantage due to its larger diameter.

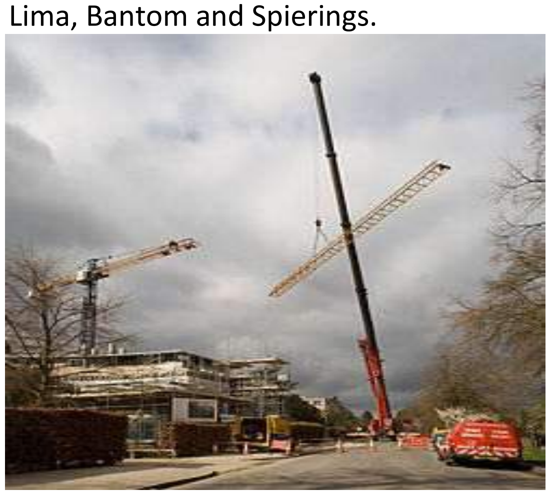
Cranes in the Middle Ages were used to build Europe's cathedrals. The crane would be fixed on top of a wall as it was being constructed and was powered by men running inside two large wheels on each side. Also cranes were used in Medieval ports and shipyards e.g. Żuraw in Gdańsk, Poland.

**Railroad cranes**
A railroad crane is a crane that is mounted on a railroad car or on a flatcar.

**Mobile crane**
The most basic type of crane consists of a steel truss or telescopic boom mounted on a mobile platform, which may be rail, wheeled (including "truck" carriers) or caterpillar tracks. The boom is hinged at the bottom, and can be raised and lowered by cables or by hydraulic cylinders. A hook is suspended from the top of the boom by cables and pulleys.

The cables are operated by whatever prime movers the designers have available, operating through a variety of transmissions. Steam engines, electric motors and internal combustion engines (IC) have all been used.

International Manufacturers include: Koehring, Manitowoc, American Hoist and Derrick, NCK-Rapier, Bucyrus-Erie, Ruston-Bucyrus, Jones, Sumitomo, Hitachi, Mannesman Dematic (Demag), Liebherr, Sennebogen, Northwest, Lorain, Grove, P&H, PPM, Terex, Favelle Favco, Link Belt, Lima, Bantom and Spierings.



**Telescopic crane**
A type of crane whose boom consists of a number of tubes fitted one inside the other. A hydraulic mechanism extends or retracts the tubes to increase or decrease the length of the boom. is used on many constuction projects

**Tower crane**

The tower crane is a modern form of balance crane. Fixed to the ground, tower cranes often give the best combination of height and lifting capacity and are used in the construction of tall buildings. To save space and to provide stability the vertical part of the crane is often braced onto the completed structure which is normally the concrete lift shaft in the center of the building. A horizontal boom is balanced asymmetrically across the top of the tower. Its short arm carries a counterweight of concrete blocks, and its long arm carries the lifting gear. The crane operator either sits in a cabin at the top of the tower or controls the crane by radio remote control from the ground, usually standing near the load. In the first case the operator's cabin is located at the top of the tower just below the horizontal boom. The boom is mounted on a slewing bearing and is rotated by means of a slewing motor. The lifting hook is operated by a system of pulleys.

A tower crane is usually assembled by a telescopic crane of smaller lifting capacity but greater height and in the case of tower cranes that have risen while constructing very tall skyscrapers, a smaller crane will sometimes be lifted to the roof of the completed tower to dismantle the tower crane afterward. A self-assembling tower crane has been demonstrated, which lifts itself off the ground using jacks, allowing the next section of the tower to be inserted at ground level.

**Truck-mounted crane**

A crane mounted on truck carrier which provides the mobility for the crane. Outriggers that extend horizontally and vertically are used to level and stabilize the crane for hoisting.

**Rough terrain crane**

A crane mounted on an undercarriage with four rubber tires that is designed for pick-and-carry operations and for off-road and "rough terrain" applications. Outriggers that extend horizontally and vertically are used to level and stabilize the crane for hoisting. These telescopic cranes are single-engine machines where the same engine is used for powering the undercarriage as is used for powering the crane, similar to a crawler crane. However, in a rough terrain crane, the engine is usually mounted in the undercarriage rather than in the upper, like the crawler crane.

**Crawler crane**

A crawler is a crane mounted on an undercarriage with a set of tracks that provide for the stability and mobility of the crane. Crawler cranes have both advantages and disadvantages depending on their intended use. The main advantage of a crawler is that they can move on site and perform lifts with very little set-up, as the crane is stable on its tracks with no outriggers. In addition, a crawler crane is capable of moving with a load. The main disadvantage of a crawler crane is that they are very heavy, and cannot easily be moved from one job site to the next without significant expense. Typically, a large crawler must be disassembled or moved by barge in order to be transported.

**Loader crane**

Almost invariably called a "Hiab" by its operators, this is a hydraulically-powered articulated arm fitted to a trailer, used to move goods onto or off of the trailer. Unlike most cranes the operator must move around to be able to view his load; hence he will have a portable cabled or radio linked control system. The numerous jointed sections can be folded into a small space when the crane is not in use. One or more of the sections may be telescopic. Often the crane will have a degree of automation and be able to unload or stow itself without an operator's instruction. Manufacturers of loader cranes include the Swedish company Hiab (Hydrauliska Industri AB) and the Danish company HMF .

**Gantry crane**

A Gantry crane has a hoist in a trolley which runs horizontally along gantry rails, usually fitted underneath a beam spanning between uprights which themselves have wheels so that the whole crane can move at right angles to the direction of the gantry rails. These cranes come in all sizes, and some which are extremely large for use in shipyards or industrial installations can move very heavy loads. A special version is the Portainer crane for loading and unloading ship-borne containers of freight.


Gantry cranes at Harbour

**Overhead crane**

These are widely used in large factory manufacturing or assembly area.

Also known as a "suspended crane", this type of crane works in the same way as a gantry crane but without uprights. The hoist is on a trolley which moves in one direction along one or two beams, which move at right angles to that direction along elevated tracks, often mounted along the side walls of an assembly area in a factory. Some of them can lift very heavy loads.

**Stacker crane**

A crane with a forklift type mechanism used in automated (computer controlled) warehouses (known as an automated storage and retrieval system (AS/RS)). The crane moves on a track in an aisle of the warehouse. The fork can be raised or lowered to any of the levels of a storage rack and can be extended into the rack to store and retrieve product. The product can in some cases be as large as an automobile. Stacker cranes are often used in the large freezer warehouses of frozen food manufacturers. This automation avoids requiring forklift drivers to work in below freezing temperatures every day.

**Floating crane**

Floating cranes are used mainly in bridge building and port construction, but they are also used for occasional loading and unloading of especially heavy or awkward loads on and off ships. Some floating cranes are mounted on a pontoon, others are specialized crane barges with a lifting capacity exceeding 10,000 tonnes and have been used to transport entire bridge sections. Floating cranes have also been used to salvage sunken ships.

Crane vessels are often used in offshore construction. The largest revolving cranes can be found on SSCV Thialf, which has two cranes with a capacity of 7100 metric tons each

**Aerial crane**

Aerial cranes usually extend from helicopters to lift large loads. Helicopters are able to travel to and lift in areas that are more difficult to reach by a conventional crane. Aerial helicopter cranes are most commonly used to lift units/loads onto shopping centers, multi-story buildings, highrises, etc. However, they can lift basically anything within their lifting capacity, (i.e. cars, boats, swimming pools, etc.). They also work as disaster relief after natural disasters for clean-up, and during wild-fires they are able to carry huge buckets of water over fires to put them out.

**Mechanical principles of Crane**

There are two major considerations that are taken into account in the design of cranes. The first is that the crane must be able to lift a load of a specified weight and the second is that the crane must remain stable and not topple over when the load is lifted and moved to another location.

**Lifting capacity**

Cranes illustrate the use of one or more simple machines to create mechanical advantage.

•***The lever.*** A balance crane contains a horizontal beam (the lever) pivoted about a point called the fulcrum. The principle of the lever allows a heavy load attached to the shorter end of the beam to be lifted by a smaller force applied in the opposite direction to the longer end of the beam. The ratio of the load's weight to the applied force is equal to the ratio of the lengths of the longer arm and the shorter arm, and is called the mechanical advantage.

•***The pulley.*** A jib crane contains a tilted strut (the jib) that supports a fixed pulley block. Cables are wrapped multiple times round the fixed block and round another block attached to the load. When the free end of the cable is pulled by hand or by a winding machine, the pulley system delivers a force to the load that is equal to the applied force multiplied by the number of lengths of cable passing between the two blocks. This number is the mechanical advantage.

•***The hydraulic cylinder.*** This can be used directly to lift the load (as with a HIAB), or indirectly to move the jib or beam that carries another lifting device.

Cranes, like all machines, obey the principle of conservation of energy. This means that the energy delivered to the load cannot exceed the energy put in to the machine. For example, if a pulley system multiplies the applied force by ten, then the load moves only one tenth as far as the applied force. Since energy is proportional to force multiplied by distance, the output energy is kept roughly equal to the input energy (in practice slightly less, because some energy is lost to friction and other inefficiencies).

**Stability of crane**

In order for a crane to be stable the sum of all moments about any point such as the base of the crane must equate to zero. In practice the magnitude and combination of anticipated loads is increased so that a crane should have a factor of safety against toppling of about ten times. As an accessor one has to be very careful about the safety factors in such criticle equipments.

**Winch (Crane for special purpose)**

A winch is a mechanical device that is used to wind up a rope or wire rope (also called "cable"). In its simplest form it consists of a spool and attached crank. More elaborate designs have gear assemblies and can be powered by electric, hydraulic, pneumatic or internal combustion drives. Some may include a solenoid brake and/or a mechanical brake or ratchet that prevents it from unwinding.

Besides industrial applications (e.g. in cranes), winches are used for towing cars, boats, or gliders. There are several winches on almost every boat or ship where they are used to pull anchor or mooring lines, halyards, and sheets.

The rope is usually stored on the winch, but a similar machine that does not store the rope is called a capstan.

Winches are frequently used as elements of backstage mechanics to move scenery in large theatrical productions. Winches are often embedded in the stage floor and used to move large set pieces on and off.

**Bulk material handling**

Bulk Material Handling is an engineering field that is centred around the design of equipment (civil, structural, mechanical, electrical and control) used for the transportation of materials such as ores and cereals in loose bulk form. It can also relate to the handling of mixed wastes.

Bulk material handling systems are typically comprised of moveable items of machinery such as conveyors, stackers, reclaimers, shiploaders, unloaders and various shuttles, hoppers and diverters combined with storage facilities such as stockyards, storage silos or stockpiles.

The purpose of a bulk material handling facility is generally to transport material from one of several locations (i.e. a source) to an ultimate destination. Providing storage and inventory control and possibly material blending is usually part of a bulk material handling system.

Bulk material handling systems can be found on mine sites, ports (for loading or unloading of cereals, ores and minerals) and processing facilities (such as iron and steel, coal fired power stations refineries).

In ports handling large quantities of bulk materials continuous ship unloaders are replacing gantry cranes.

**Conveyor belt**

A conveyor belt or belt conveyor consists of two pulleys, with a continuous loop of material that rotates about them. The pulleys are powered, moving the belt and the material on the belt forward. Conveyor belts are extensively used to transport industrial and agricultural materials, such as grain, coal, ores, etc. Material flowing over the belt may be weighed in transit using a beltweigher. Belts with regularly spaced partitions, known as elevator belts, are used for transporting loose materials up steep inclines. Conveyor belts are used in self-unloading bulk freighters and in live bottom trucks. This technology is also used in conveyor transport such as moving sidewalks or escalators, as well as on many manufacturing assembly lines. Stores often have conveyor belts at the check-out counter to move shopping items. Ski areas also use conveyor belts to transport skiers up the hill. A wide variety of conveying machines are available, different as regards principle of operation, means and direction of conveyance, including screw conveyors, the moving floor system, which uses reciprocating slats to move cargo, and roller conveyor system, which uses a series of powered rollers to convey boxes or pallets. This is widely used in industries for movement of work in progress or finished goods to storage area.


The longest conveyor belt in the world is in Western Sahara. It is 100 km long, from the phosphate mines of Bu Craa to the coast south of El-Aaiun. The longest single belt conveyor runs from Meghalaya in India to Sylhet in Bangladesh. It is 17 km long and conveys limestone and shale.

Conveyor mechanisms are used as components in automated distribution and warehousing. In combination with computer controlled pallet handling equipment this allows for more efficient retail, wholesale, and manufacturing distribution. It is considered a labor saving system that allows large volumes to move rapidly through a process, allowing companies to ship or receive higher volumes with smaller storage space and with less labor expense.

**Engineering vehicles**

Engineering vehicles are heavy-duty vehicles, specially designed for executing engineering tasks.

These vehicles can be put under various catagories depending on where the material is handled or how it is handled.

- Caterpillar vehicles
- Excavators
- Forklift truck
- Tractors

**Caterpillar vehicles**

The Caterpillar vehicle group includes the Bulldozers, JCBs etc which are used for earth moving, excavation or bulldozing use.

For use in a rough or hazadous tarrien, these combat engineering vehicles combine the earth moving capabilities of the bulldozer with armor which gives the vehicle and its operator protection when operating in or around a combat situation. In most cases they are civilian models that have been modified by the addition of armor and military equipment but there have been cases where a tank has been stripped of its armament and fitted with a dozer blade as in the British Centaur of the Second World War which were used at the Normandy landings alongside armored versions of the Caterpillar D8 bulldozer. Tanks have been fitted with bulldozer blades while retaining their armament but this does not make them armored bulldozers as such.

**Bulldozer**
A bulldozer is a very powerful crawler (caterpillar tracked tractor) equipped with a blade. The term "bulldozer" is often used to mean any heavy engineering vehicle, but precisely, the term refers only to a tractor (usually tracked) fitted with a dozer blade. That is the meaning used herein.

The first bulldozers were built by a man by the name of William "Willy" Kern. It was his love for engines and their inability to perform under the harsh "hole-digging" presure that he put on them that eventually gave Willy the push to adapt farm Holt tractors that were used to plough fields into what we today call "bulldozers", Their versatility in soft ground for logging and road building lead directly to them becoming the armoured tank in the first war.

By the 1920s, tracked vehicles became common, particularly the Caterpillar 60. To dig canals, raise earth dams, and do other earthmoving jobs, these tractors were equipped with a large thick metal plate in front. This thick metal plate (it got its curved shape later) is called a "blade". The blade peels layers of soil and pushes it forward as the tractor advances. Several specialised blades have been developed: for high volume loads such as coal, rakes to remove only larger boulders, or blades with razor sharp edges to cut tree stumps. In some early models the driver sat on top in the open without a cabin. These attachments, home built or by small equipment manufacturers of attachments for wheeled and crawler tractors and trucks, appeared by 1929, widespread acceptance of the bull-grader does not seem to appear before the mid-1930's, and the addition of powered down force made them the preferred excavation machine for large and small contractors alike by the 1940's, by which time the term "bulldozer" referred to the entire machine and not just the attachment.

Over the years, when engineers needed equipment to complete large scale earthworks, firms like the CAT, Komatsu, Fiat-Allis, John Deere, International Harvester, Case, Liebherr, Terex and JCB started to manufacture large tracked-type earthmoving machines. They were large, noisy, and powerful, and therefore nicknamed "bulldozer".

Through the years, bulldozers got bigger, more powerful, and more sophisticated. Important improvements include more powerful engines, more reliable drive trains, better tracks, raised cabins, and hydraulic (instead of early models' cable operated) arms that enable more precise manipulation of the blade and automated controls. As an option, bulldozers can be equipped with a rear ripper claw to loosen rocky soils or to break up pavement (roads).

**Description**

Most often, bulldozers are large and powerful tracked engineering vehicles. The tracks give them excellent ground hold and mobility through very rough terrain. Wide tracks help distribute the bulldozer's weight over large area (decreasing pressure), thus preventing it from sinking in sandy or muddy ground. Extra wide tracks are known as 'swamp tracks'. Bulldozers have excellent ground hold and a torque divider designed to convert the engine's power into dragging ability , letting the bulldozer use its own weight to push very heavy things and remove obstacles that are stuck in the ground. The Caterpillar D9, for example, can easily tow tanks that weigh more than 70 tons. Because of these attributes, bulldozers are used to clear areas of obstacles, shrubbery, burnt vehicles, and remains of structures.

Sometimes a bulldozer is used to push another piece of earthmoving equipment known as a "scraper". The towed Fresno Scraper, invented in 1883 by James Porteous, was the first design to enable this to be done economically, removing the soil from the cut and depositing it elsewhere on shallow ground (fill). Many dozer blades have a reinforced center section with this purpose in mind, and are called "bull blades."
The bulldozer's primary tools are the blade and the ripper.

**Compact excavator**

A compact hydraulic excavator is a tracked or wheeled vehicle with an approximate operating weight of 6 metric tons (13,228 lbs). It generally includes a standard backfill blade and features independent boom swing. The compact hydraulic excavator is also referred to as a mini excavator.

The compact hydraulic excavator is somewhat unique from other construction equipment in that all movement and functions of the machine are accomplished through the transfer of hydraulic fluid. The compact excavator's work group and blade are activated by hydraulic fluid acting upon hydraulic cylinders. The excavator's slew (rotation) and travel functions are also activated by hydraulic fluid powering hydraulic motors.

In recent years, hydraulic excavator capabilities have expanded far beyond excavation tasks. With the advent of hydraulic powered attachments such as breakers, clamps, augers and compactors, the excavator is frequently used in many applications other than excavation and actually serves as an effective attachment tool carrier. Many excavators feature quick-attach mounting systems for simplified attachment mounting, dramatically increasing the machine's utilization on the jobsite.

**Loader**

A loader, also called a front end loader, bucket loader, scoop loader or shovel, is a type of tractor, usually wheeled, that uses a wide square tilting bucket on the end of movable arms to lift and move material. The loader assembly may be a removable attachment or permanently mounted. Often the bucket can be replaced with other devices or tools—like forks to lift heavy pallets or shipping containers, hydraulically-opening "clamshell" bucket allows a loader to act as a light dozer or scraper. The bucket can also be augmented with devices like a bale grappler for handling large bales of hay/ straw.

Large loaders, such as the Caterpillar 950G/966G, Volvo L120E or Hitachi ZW310 usually have only a front bucket and are called Front Loaders, whereas small loader tractors are often also equipped with a small backhoe and are called backhoe loaders or loader backhoes.

Loaders are used mainly for uploading materials into trucks, laying pipe, clearing rubble, and digging. A loader is not the most efficient machine for digging as it cannot dig very deep below the level of its wheels, like a backhoe can. Their deep bucket can usually store about 3-6 cubic meters (exact number varies with the model) of earth.

The front loader's bucket capacity is much bigger than a bucket capacity of a backhoe loader. Loaders are not classified as earthmoving machinery, as their primary purpose is other than earthmoving.

In construction areas loaders are also used to transport building materials - such as bricks, pipe, metal bars, and digging tools - over short distances.

Loaders are also used for snow removal, using their bucket or a snowbasket but usually they use a snowplow attachment. They clear snow from streets and highways and also parking lots. They sometimes load the snow into dump trucks which haul it away.
Unlike most bulldozers, some loaders are wheeled and not tracked. However, track loaders do exist. They are sucessful where sharp edged materials or nails in construction debris would damage rubber wheels. Wheels provide better mobility and speed and do not damage paved roads as much as tracks, but this comes at the cost of reduced traction.

Unlike backhoes or standard tractors fitted with a front bucket, many large loaders do not use automotive steering mechanisms. Instead, they steer by a hydraulically actuated pivot point set exactly between the front and rear axles. This is referred to as "articulated steering" and allows the front axle to be solid, allowing it to carry a heavier weight. Articulated steering also gives reduced turning radius (and therefore higher maneuverability) for a given wheelbase. Since the front wheels and attachment rotate on the same axis, the operator is able to "steer" his load in an arc after positioning the machine, which can come in handy. The problem is that when the machine is "twisted" to one side and a heavy load is lifted high, it has a bigger risk of turning over to the "wide" side.

**Forklift truck**

A forklift truck, a lift truck or a forklift is a powered industrial truck used to lift and transport materials, normally by means of steel forks inserted under the load. Forklifts are most commonly used to move loads stored on pallets. The forklift was developed in the 1920s by various companies including the transmission manufacturing company Clark (today known as Clark Material Handling Company) and the hoist company Yale & Towne Manufacturing (Today known as Yale Materials Handling Corporation)[1]. It has since become an indispensable piece of equipment in manufacturing and warehousing operations.

Following is the list of the more common truck types, from the smallest to the biggest:

- Hand pallet truck
- Walkie low lift truck
- Rider low lift truck
- Towing tractor
- Walkie stacker
- Rider stacker
- Reach truck
- Electric counterbalanced truck
- IC counterbalanced truck
- Telescopic handler
- Slip Sheet machine
- Walkie Order Picking truck
- Rider Order Picking truck

The names of the trucks themselves are indicative of the type. All the description given under, singularly or collectively can describe a typical forklift:

- The truck proper, which is a motive machine with wheels and/or tracks powered through a drive train
- An LPG, gasoline or diesel fueled internal combustion engine, or an electric motor(s) either Direct Current or Alternating Current powered by either a battery or fuel cells.
- The mast, which is the vertical assembly that does the work of raising, lowering, and tilting the load; the mast is either hydraulically operated consisting of one or cylinder(s) and interlocking rails for lifting and lowering operations and for lateral stability, or it may be chain operated with a hydraulic motor providing motive power.
- The carriage, which comprises flat metal plate(s) and is moved along the mast either by means of chains, or by being directly attached to the hydraulic cylinder.
- The cab, which may contain a seat for the operator, along with the control pedals, steering wheel, levers, and switches for controlling the machine and a dashboard containing operator readouts. The cab may be open, or closed, but is bounded by the cage-like overhead guard assembly.
- Counterbalance machines have a counterweight, which is a heavy iron mass attached to the rear of the machine, necessary to compensate for the load. In an electric forklift, the large lead-acid battery itself may serve as part of the counterweight.

**Control and capability**

Forklift trucks are available in many variations and load capacities. In a typical warehouse setting most forklifts used have load capacities of around one to five tons, though machines of over 50 tonnes capacity have been built and operated.

In addition to a control to raise and lower the forks (also known as blades or tines), the operator can tilt the mast to compensate for a load's tendency to angle the blades toward the ground and risk slipping off the forks. Tilt also provides a limited ability to operate on non-level ground. Some machines also allow the operator to move the tines and backrest laterally(side-shift), allowing easier placement of a load. To aid the handling of skids that may have become excessively tilted and other specialty material handling needs, some forklifts are fitted with a mechanism that allows the tines to be rotated. In addition, a few machines offer a hydraulic control to move the tines together or apart, removing the need for the operator to get out of the cab to manually adjust for a differently sized load.

Roll and Barrel Clamp attachments for handling barrels, kegs, or paper rolls also have a control to operate the Clamp pads that grab the load, such attachments also usually have a rotate function so that a vertically stored paper roll can be inserted into the horizontal intake of a printing press.

Another variation, used in some manufacturing facilities, utilizes forklift trucks with a clamp attachment that the operator can open and close around a load, instead of forks. Products such as cartons, boxes, etc., can be moved with these trucks. The product to be moved is squeezed, lifted, and carried to its destination. These are generally referred to as "clamp trucks".

**Tractor**

A tractor is a device intended for drawing, towing or pulling something which cannot propel itself and, often, powering it too. Most commonly the word is used to describe a vehicle intended for pulling some other vehicle or object.

In Britain and India the word "tractor" usually means "farm tractor", and the use of the word "tractor" to mean other types of vehicles is familiar to the vehicle trade but unfamiliar to much of the general public. In Canada and the US the word is also used to refer to a road tractor .

The word comes from the Latin trahere "to pull". A conflicting history of the name suggests that steam tractors were originally referred to as traction engines, with the word "tractor" eventually deriving from a contraction of 'traction' and 'motor'.

**Farm tractor**

The most common use of the term is for the vehicles used on farms. The farm tractor is used for pulling or pushing agricultural machinery or trailers, for plowing, tilling, disking, harrowing, planting, and similar tasks.

The classic farm tractor is a simple open vehicle, with two very large driving wheels on an axle below and slightly behind a single seat (the seat and steering wheel consequently are in the center), and the engine in front of the driver, with two steerable wheels below the engine compartment. This basic design has remained unchanged for a number of years, but enclosed cabs are fitted on almost all modern models, for reasons of operator safety and comfort.

There are also lawn tractors. Cub Cadet, Husqvarna, John Deere, Massey Ferguson and Toro are some of the better known brands.

Farm implements can be attached to the rear of the tractor by either a drawbar or a three-point hitch. The three-point hitch was invented by Harry Ferguson and has been standard since the 1960s. Equipment attached to the three-point hitch can be raised or lowered hydraulically with a control lever. The equipment attached to the three-point hitch is usually completely supported by the tractor. Another way to attach an implement is via a Quick Hitch, which is attached to the three-point hitch. This enables a single person to attach an implement quicker and put the person in less danger when attaching the implement.

**Engineering tractors**

The durability and engine power of tractors made them very suitable for engineering tasks. Tractors can be fitted with engineering tools such as dozer blade, bucket, hoe, ripper, and so on. The most common attachments for the front of a tractor are dozer blade or a bucket. When attached with engineering tools the tractor is called an engineering vehicle.

A bulldozer is a track-type tractor attached with blade in the front and a rope-winch behind. Bulldozers are very powerful tractors and have excellent ground-hold, as their main tasks are to push or drag things.

Bulldozers have been further modified over time to evolve into new machines which are capable of working in ways that the original bulldozer can not. One example is that loader tractors were created by removing the blade and substituting a large volume bucket and hydraulic arms which can raise and lower the bucket, thus making it useful for scooping up earth, rock and similar loose material to load it into trucks.
A front-loader or loader is a tractor with an engineering tool which consists of two hydraulic powered arms on either side of the front engine compartment and a tilting implement. This is usually a wide open box called a bucket but other common attachments are a pallet fork and a bale grappler.

Other modifications to the original bulldozer include making the machine smaller to let it operate in small work areas where movement is limited. There are also tiny wheeled loaders, officially called Skid-steer loaders but nicknamed "Bobcat" after the original manufacturer, which are particularly suited for small excavation projects in confined areas.

**EPA tractor**

During World War II there was a shortage of tractors in Sweden and this led to the invention of a new type of tractor called the EPA tractor (EPA was a chain of discount stores and it was often used to signify something lacking in quality). An EPA tractor was simply an automobile, truck or lorry, with the passenger space was cut off behind the front seats, equipped with two gearboxes in a row. When done to an older car with a ladder frame, the result was not dissimilar to a tractor and could be used as one.

**Other types of tractors**

**Road tractors or tractor units**

Heavy-duty vehicles with large engines and several axles. These tractors are designed to pull long semi-trailers, most often for the transport of freight of some kind over a significant distance (see also semi-trailer truck). In England this type of "tractor" is often called an "artic cab".

**Locomotive tractors (engines) or Rail car movers**

The amalgamation of machines, electrical generators, controls and devices that comprise the traction component of railway vehicles. In large industrial units these are deployed for movement of railway wagons in the yard.

**Artillery tractors**

Vehicles used to tow artillery pieces of varying weights. For movement of large equipments and crane booms, these tractors are used in industries.

**Fire Control & Alarm Equipments**

**Fire extinguisher**

A fire extinguisher is an active fire protection device to extinguish or control a fire, often in emergency situations. Typically a fire extinguisher consists of a handheld cylindrical pressure vessel containing an agent that when discharged, can extinguish a fire.


In order to use a packaged commercial fire extinguisher, you must first make sure it is suitable to the type of fire. If it is not a suitable type, it may not be effective or it may cause additional dangers. For example, water on a kitchen oil fire might splash the flaming oil over a wide area. Water on an active electrical fire might create a shock danger.

If the fire extinguisher is suitable, the typical steps to use it are:
(P) Pull the safety pin
(A) Aim the nozzle at the base of the fire, from a safe distance (about six feet away)
(S) Squeeze the handle
(S) Sweep the extinguisher from side to side while aiming at the base of the fire
Since the fire might try to start up again, make SURE it stays out!

According to the standard BS EN 3, fire extinguishers in the United Kingdom are predominately red, and a band or circle of a second color covering at least 5% of the surface area of the extinguisher indicates the contents. Before 1997, the entire body of the fire extinguisher was colour coded according to the type of extinguishing agent.

| Type | Old Code | BS EN 3 Colour Code | Fire Class |
|---|---|---|---|
| Water | Signal Red | Signal Red | A |
| Foam | Cream | Red with a Cream panel above the operating instructions | A, B and sometimes E |
| Dry Powder | French Blue | Red with a Blue panel above the operating instructions | A, B, C,E/B,C,E |
| Carbon Dioxide $CO_2$ | Black | Red with a Black panel above the operating instructions | A(Limited),B,E |
| Halon | Emerald Green | Pre-03- Signal red with a green panel | A,B,E |
| Wet Chemical | No F Class | Red with a Canary Yellow panel above the operating instructions | A, F |
| Class D Powder | French Blue | Red with a Blue panel above the operating instructions | D |

The UK recognizes six fire classes. Class A fires involve organic solids such as paper and wood. Class B fires involve flammable liquids. Class C fires involve flammable gases. Class D fires involve metals, Class E fires involve live electrical items and Class F fires involve cooking fat and oil. Fire extinguishing capacity is rated by fire class using numbers and letters such as 13A, 55B.

**Chemistries**

A fire extinguisher may emit a solid, liquid, or gaseous chemical.

**Water**

Water is the most common chemical for class A fires and if available in sufficient volume can be quite effective. Water extinguishes flame by cooling the fuel surfaces and thereby reduces the pyrolysis rate of the fuel. The effectiveness against the combustion sustaining effect of burning gases is minor for extinguishers, but water fog nozzles used by fire departments creates water droplets small enough to be able to extinguish flaming gases as well. The smaller the droplets, the greater the effectiveness water has against burning gases.

Most water based extinguishers also contain traces of other chemicals to prevent the extinguisher from rusting. Some also contain surfactants which help the water penetrate deep into the burning material and cling better to steep surfaces.

Water may or may not help extinguish class B fires. It depends on whether or not the liquid's molecules are polar molecules. If the liquid that is burning is polar (such as alcohol), then water can be an effective means of extinguishment. If the liquid is nonpolar (such as large hydrocarbons, like petroleum or cooking oils), the water will merely spread the flames around.

Similarly, water sprayed on an electrical fire (US: Class C, UK: Class E) increases the likelihood that the operator will receive an electric shock. However, if the power can be reliably disconnected and a carbon dioxide or halon extinguisher is not available, clean water actually causes less damage to electrical equipment than will either foam or dry powders. Special spray nozzles called fog nozzles, equipped with tiny rotating devices called spiracles replace the continuous water jet with a succession of droplets, greatly increasing the resistivity of the jet. These should however be used by skilled personnel, since these complex nozzle assemblies may difficult to use effectively without training.

**Foams**

**fighting a petrol fire with a foam extinguisher**

Foams are commonly used on class B fires, and are also effective on class A fires. These are mainly water based, with a foaming agent so that the foam can float on top of the burning liquid and break the interaction between the flames and the fuel surface. Ordinary foams work better if "poured" but it is not critical.

A "protein foam" was used for fire suppression in aviation crashes until the 1960s development of "light water", also known as "Aqueous Film-Forming Foam" (or AFFF). Carbon dioxide (later sodium bicarbonate) extinguishers were used to knock down the flames and foam used to prevent re-ignition of the fuel fumes. "Foaming the runway" can reduce friction and sparks in a crash landing, and protein foam continue to be used for that purpose, although FAA regulations prohibit reliance upon its use for reduction of the risk of ignition in gear up landing.

AFFF in concentrations less than 3% is not acceptable to the FAA for use on airports. The 1% concentrate that is available should not be used in ARFF applications because of the difficulty in consistently providing an accurate mixture. Any attempt to use 1% foam would necessitate the installation of a computer-controlled system and each load would have to be checked carefully.

Ordinary foams are designed to work on nonpolar flammable liquids such as petrol (gasoline), but may break down too quickly in polar liquids such as alcohol or glycol. Facilities which handle large amounts of flammable polar liquids use a specialized "alcohol foam" instead. Alcohol foams must be gently "poured" across the burning liquid. If the fire cannot be approached closely enough to do this, they should be sprayed onto an adjacent solid surface so that they run gently onto the burning liquid.

Alcohol type foams are typically used by city and industrial fire departments because they are effective on both hydrocarbons, such as gasoline, and polar solvents such as alcohol. Most fire department will only carry only one type of foam on their trucks if they use alcohol type foams.

**Dry Powder ("Dry Chemical" in the US)**

For classes B and C, a dry powder is used. There are two main dry powder chemistries in use:

- BC powder is either sodium bicarbonate or potassium bicarbonate, finely powdered and propelled by carbon dioxide or nitrogen. Similarly to almost all extinguishing agents the powders acts as a thermal ballast making the flames too cool for the chemical reactions to continue. Some powders also provide a minor chemical inhibition, although this effect is relatively weak. These powders thus provide rapid knockdown of flame fronts, but may not keep the fire suppressed. Consequently, they are often used in conjunction with foam for attacking large class B fires. BC extinguishers are often kept in small vehicles since they provide good knockdown of a rapidly flaring class B fire, from a small package. BC Powder has a slight saponification effect on cooking oils & fats due to its alkalinity & sometimes used to be specified for kitchens prior to the invention of Wet Chemical extinguishers.

Where an extremely fast knockdown is required potassium bicarbonate (Purple K) extinguishers are used. A particular blend also containing urea (Monnex) decrepitates upon exposure to heat increasing the surface area of the powder particles and providing very rapid knockdown.

- ABC powder is monoammonium phosphate and/or ammonium sulphate. As well as suppressing the flame in the air, it also melts at a low temperature to form a layer of slag which excludes the gas and heat transfer at the fuel surface. For this reason it can also be effective against class A fires. ABC powder is usually the best agent for fires involving multiple classes. However it is less effective against three-dimensional class A fires, or those with a complex or porous structure. Foams or water are better in those cases.

Both types of powders can also be used on electrical fires, but provide a significant cleanup and corrosion problem that is likely to make the electrical equipment unsalvageable.

**Wet potassium salts ("Wet Chemical")**

Most class F (class K in the US) extinguishers contain a solution of potassium acetate, sometimes with some potassium citrate or potassium bicarbonate. The extinguishers spray the agent out as a fine mist. The mist acts to cool the flame front, while the potassium salts saponify the surface of the burning cooking oil, producing a layer of foam over the surface. This solution thus provides a similar blanketing effect to a foam extinguisher, but with a greater cooling effect. The saponification only works on animal fats and vegetable oils, so class F extinguishers cannot be used for class B fires. The misting also helps to prevent splashing the blazing oil.

**Carbon dioxide**

**Carbon dioxide extinguisher**

Carbon dioxide ($CO_2$) also works on classes B and C/E and works by suffocating the fire. Carbon dioxide will not burn and displaces air. Carbon dioxide can be used on electrical fires because, being a gas, it does not leave residues which might further harm the damaged equipment. (Carbon dioxide can also be used on class A fires when it is important to avoid water damage, but in this application the gas concentration must usually be maintained longer than is possible with a hand-held extinguisher.) Carbon dioxide extinguishers have a horn on the end of the hose. Due to the extreme cold of the carbon dioxide that is expelled from an extinguisher, it should not be touched.

**Halons**

Halons are very versatile extinguishers. They will extinguish most types of fire except class D & K/F and are highly effective even at quite low concentrations (less than 5%). Halon is a poor extinguisher for Class A fires, a nine pound Halon extinguisher only receives a 1-A rating and tends to be easily deflected by the wind. They are the only fire extinguishing agents that are quite suitable for discharge in aircraft (as other materials pose a corrosion hazard to the aircraft). Halon fire-suppression systems are also incorporated into some armored fighting vehicles, such as the M1 Abrams tank. The major extinguishing effect is by disturbing the thermal balance of the flame, and to a small extent by inhibiting the chemical reaction of the fire. Halons are chlorofluorocarbons causing damage to the ozone layer and are being phased out for more environmentally-friendly alternatives. Halon fire extinguishers may cost upwards of Rs 50000 due to production and import restrictions.

Halon extinguishers used to be widely used in vehicles and computer suites. It is mildly toxic in confined spaces, but to a far less extent than its predecessors such as carbon tetrachloride, chlorobromomethane and methyl bromide.

Since 1992 the sale and service of Halon extinguishers has been made illegal in Canada due to environmental concerns except for in a few rare cases, as per the Montreal Protocol.

In the UK and Europe Halons were made illegal at the end of 2003, except for certain specific aircraft and law enforcement uses. This appears to be at least partially in response to the Montreal Protocol and effort by the United Nations Environment Programme (UNEP) to combat release of quantities of harmful chemicals into the atmosphere.

**Phosphorus tribromide**

Like Halon, phosphorus tribromide is a flame chemistry poison, marketed under the brand name PhostrEx. PhostrEx is a liquid which needs a propellant, such as compressed nitrogen and/or helium, to disperse onto a fire. As a fire extinguisher, PhostrEx is much more potent than Halon, making it particularly appealing for aviation use as a lightweight substitute. Unlike Halon, PhostrEx reacts quickly with atmospheric moisture to break down into phosphorous acid and hydrogen bromide, neither of which harms the earth's ozone layer.

High concentrations of PhostrEx can cause skin blistering and eye irritation, but since so little is needed to put out flames this problem is not a significant risk, especially in applications where dispersal is confined within an engine compartment. Any skin or eye contact with PhostrEx should be rinsed with ordinary water as soon as practical. PhostrEx is not especially corrosive to metals, although it can tarnish some. The U.S. EPA and FAA both approved PhostrEx, and the substance will find its first major use in Eclipse Aviation's jet aircraft as an engine fire suppression system.

**Fluorocarbons**

Recently, DuPont has begun marketing several nearly saturated fluorocarbons under the trademarks FE-13, FE-25, FE-36, FE-227, and FE-241. These materials are claimed to have all the advantageous properties of halons, but lower toxicity, and zero ozone depletion potential. They require about 50% greater concentration for equivalent fire quenching.

**Specialised materials for Class D**

Class D fires involve extremely high temperatures and highly reactive fuels. For example, burning magnesium metal breaks water down to hydrogen gas and excites the fire; breaks halon down to toxic phosgene and fluorophosgene and may cause a rapid phase transition explosion; and continues to burn even when completely smothered by nitrogen gas or carbon dioxide (in the latter case, also producing toxic carbon monoxide). Consequently, there is no one type of extinguisher agent that is approved for all class D fires; rather, there are several common types and a few rarer ones, and each must be compatibility approved for the particular hazard being guarded. Additionally, there are important differences in the way each one is operated, so the operators must receive special training. Some example class D chemistries include:

- Granulated sodium chloride and graphite applied by a shaker, scoop or shovel. Suitable for sodium, potassium, magnesium, titanium, aluminium, and most other metal fires.
- Powdered graphite, applied with a long handled scoop, is preferred for fires in fine powders of reactive metals, where the blast of pressure from an extinguisher may stir up the powder and cause a dust explosion. Graphite both smothers the fire and conducts away heat.
- Finely powdered copper propelled by compressed argon is the currently preferred method for lithium fires. It smothers the fire, dilutes the fuel, and conducts away heat. It is capable of clinging to dripping molten lithium on vertical surfaces. Graphite can also be used on lithium fires but only on a level surface.
- Other materials sometimes used include powdered sodium carbonate, powdered dolomite and argon gas.
- As a very poor last resort dry sand may be used to smother a metal fire if nothing else is available, applied with a long-handled shovel to avoid the operator receiving flash burns. Sand is, however, notorious for collecting moisture, and even the smallest trace of moisture may result in a steam explosion, spattering burning molten metal around.

**Fire sprinkler**

Fire sprinklers are an active fire protection measure subject to stringent bounding. They are connected to a fire suppression system that consists of overhead pipes fitted with sprinkler heads throughout the coverage area. Fire sprinkler systems for high-rises are usually also equipped with a fire pump, and a jockey pump and are tied into the fire alarm system. Although historically only used in factories and large commercial buildings, home and small building systems are now available at a relatively cost-effective price.

Each sprinkler head is held closed independently by heat-sensitive seals. These seals prevent water flow until a design temperature is exceeded at the individual sprinkler heads.

Each sprinkler activates independently when the predetermined heat level is reached. The design intention is to limit the total number of sprinklers that operate, thereby providing the maximum water supply available from the water source to the point of fire origin.

Typical "wet" systems are simple and passive. They have water already pressurized in the pipes held back by the sprinkler head. These systems require no manual controls to activate, so long as adequate water supplies are provided.

Specialty systems called "dry" systems, designed for unheated spaces, have a low "maintenance" air pressure in the pipes. Water is fed into the system when the sprinkler "fuses" allowing the maintenance air pressure to reach the minimum pressure point. "Pre-action" systems are highly specialized for locations where accidental activation is unacceptable such as museums with rare art works, manuscripts, or books. Pre-action valves are connected to fire alarm initiating devices such as smoke detectors or heat detectors and virtually eliminate the possibility of accidental water flow.

"Deluge" systems are "pre-action" systems that have open sprinklers, i.e. the fusible link is removed, so that every sprinkler served by the system will discharge water. This ensures a large and simultaneous application of water over the entire hazard. These systems are used for special hazards where rapid fire spread is a concern.
Other specialty systems may have foam instead of water suppression agents for fire protection in occupancies with flammable liquids, such as airport hangars. "Clean agent" gaseous systems, such as Argon/CO2/Nitrogen mixtures can be used in very small spaces where water cannot be used for suppression.

A sprinkler activation will do less damage than a fire department hose, as the fire department's hose streams provide around 250 US gallons per minute (15 L/s) whereas an activated sprinkler head generally discharges around 23 US gallons per minute (1.5 L/s). In addition, the sprinkler will activate immediately; whereas a fire appliance takes some time to reach an incident. This delay can result in substantial damage from the fire before the appliance arrives and will the fire will be much larger; requiring much more water to extinguish.

Most sprinkler systems installed today are designed using an area and density approach. First the building use and building contents are analyzed to determine the level of fire hazard. Usually buildings are classified as light hazard, ordinary hazard group 1, ordinary hazard group 2, extra hazard group 1, or extra hazard group 2. After determining the hazard classification, a design area and density can be determined by referencing tables in the National Fire Protection Association (NFPA) handbooks. The design area is a theoretical area of the building representing the worst case area where a fire could burn.

The design density is a measurement of how much water per square foot of floor area should be applied to the design area. For example, in an office building classified as light hazard, a typical design area would be 1500 square feet and the density would be 0.1 gallons per minute per square foot or a minimum of 150 gallons per minute applied to the 1500 square foot design area. Another example would be a warehouse classified as ordinary hazard group 2 where a typical design area would be 1500 square feet and the density would be 0.2 gallons per minute per square foot or a minimum of 300 gallons per minute applied to the 1500 square foot design area.

After the design area and density have been determined, calculations are performed to prove that the system can deliver the required amount of water to the required design area. These calculations account for all of the pressure that is lost or gained between the includes pressure that is lost due to friction inside the piping, pressure that is lost or gained due to elevation differences between the source and the discharging sprinklers, and sometimes momentum pressure from water velocity inside the piping is also calculated.

**Fire alarm system**

Fire alarm systems have devices connected to them to detect the fire/smoke or to alert the occupants of an emergency. Below is a list of common devices found on a fire alarm.

- **Manual pull stations/manual call points** - Devices to allow people to manual activate the fire alarm. Usually located near exits.
  A fire alarm pull station is an active fire protection device, usually wall-mounted, that, when activated, initiates an alarm on a fire alarm system. In its simplest form, the user activates the alarm by pulling the handle down, which completes a circuit and locks the handle in the activated position, and sending an alarm to the fire alarm control panel. Fire alarm pull station are often reset using a key, which allows the handle to go back up to its normal position.
  Many fire alarm pull stations are single action and only require the user to pull down the handle. Other fire alarm pull stations are dual-action, and as such require the user to perform a second task before pulling down, such as lifting up or pushing in a panel on the station, or shattering a glass panel. The Fire-Lite BG-10 and the Cerberus Pyrotronics (Siemens) MS-501 are examples of this design. Perhaps the most recognizable pull station is the T-bar style pull. The style is so named because the handle is shaped like the letter "T". This style was first manufactured by Simplex, and is now manufactured by many other companies.

- **Manual call points**
  In Europe, a manual call point, usually referred to as an MCP within the fire protection industry, and as a "break glass" in the UK, is used to allow building occupants to signal that a fire or other emergency exists within the building. They are usually connected to a central fire alarm panel which is in turn connected to an alarm system in the building, and often to a local fire brigade dispatcher as well. The first MCP (as we know it) arrived in Europe in 1972 and was invented by KAC. [1]
  MCP's would historically be printed with FIRE as a title above a glass element, where the element would be glass which would be covered with plastic. This element design would be the old British Standard. The new European Standard EN54 says that the title should be the House Flame symbol, and the glass would appear differently. The glass will still be covered with plastic on the printed side.
- **Smoke detectors –** Smoke detectors, as the name suggest, detects the smoke in the vicinity and sends signal to the control panel. There are many types in use. Main types being - Spot type: Photoelectric and Ionization; Line type: Projected Beam Smoke Detector; Air-Sampling type: Cloud Chamber
- **Water Flow Switches –** On receipt of comand from the control panel, if there is a sprinkler system, the water flow switch will be activated. It detects & controls the water flowing through the fire sprinkler system
- **Rate-of-Rise and Thermostat (heat) Detectors -** Detect heat changes. These are used in addition to smoke detectors. Heat generated may be prior to full fledge fire can also be detected by this units. On sensing a predetermined heat, a signal is sent to control
- **Valve Position Switch -** Indicates that a fire sprinkler system valve that is required to be open, is now closed (off-normal).
- **Carbon Monoxide Detectors –** In case of fire, there is all possibility that the fire may starve of oxygen. This lack of oxygen will result in production of Carbon Monoxide gas (instead of Carbon Dioxide) This is highly poiseneous gas. It is more dangerous because it is without any colour or odour (smell). The CO detectors detects poisonous carbon monoxide gas and gives alarm.
- **Horns/Strobes -** Visual and Audible devices to alert people of system activation.
- **Magnetic Door Holder -** Doors are allowed to close when the fire alarm is activated.
- **Control Panel -** The control panel is the main analysing and commanding unit of the system. It receives signal from various sensor devices and actuating devices listed above. On recept of this signal, it gives out appropriate command for various acts like – audiable / visual alarm, activation of automatic fire fighting system like sprinklers, closure of doors for isolation of effected area for prevention of spreading of fire etc. The control panel also gives repeat alarm to area panels situated in stratagic locations like medical unit, control room, HODs office etc.

**Telecommunication**

Telecommunication is the transmission of signals over a distance for the purpose of communication. In modern times, this process almost always involves the sending of electromagnetic waves by electronic transmitters

The basic elements of a telecommunication system are:

- a transmitter that takes information and converts it to a signal for transmission
- a transmission medium over which the signal is transmitted
- a receiver that receives and converts the signal back into usable information

Signals can either be analogue or digital. In an analogue signal, the signal is varied continuously with respect to the information. In a digital signal, the information is encoded as a set of discrete values (e.g. 1's and 0's). Telecommunications devices convert different types of information, such as sound and video, into electrical or optical signals. Electrical signals typically travel along a medium such as copper wire or are carried over the air as radio waves. Optical signals typically travel along a medium such as strands of glass fibers. When a signal reaches its destination, the device on the receiving end converts the signal back into an understandable message, such as sound over a telephone, moving images on a television, or words and pictures on a computer screen

A collection of transmitters, receivers or transceivers that communicate with each other is known as a network. Digital networks may consist of one or more routers that route data to the correct user. An analogue network may consist of one or more switches that establish a connection between two or more users. For both types of network, a repeater may be necessary to amplify or recreate the signal when it is being transmitted over long distances. This is to combat attenuation that can render the signal indistinguishable from noise.

In a conventional telephone system, the caller is connected to the person they want to talk to by the switches at various exchanges. The switches form an electrical connection between the two users and the setting of these switches is determined electronically when the caller dials the number based upon either pulses or tones made by the caller's telephone. Once the connection is made, the caller's voice is transformed to an electrical signal using a small microphone in the telephone's receiver. This electrical signal is then sent through various switches in the network to the user at the other end where it transformed back into sound waves by a speaker for that person to hear. This person also has a separate electrical connection between him and the caller which allows him to talk back.

Today, the fixed-line telephone systems in most residential homes are analogue — that is the speaker's voice directly determines the amplitude of the signal's voltage. However although short-distance calls may be handled from end-to-end as analogue signals, increasingly telephone service providers are transparently converting signals to digital before converting them back to analogue for reception. The advantage being that digitized voice data can travel side-by-side with data from the Internet and that digital signals can be perfectly reproduced in long distance communication as opposed to analogue signals which are inevitably impacted by noise.

Mobile phones have had a significant impact on telephone networks. Mobile phone subscriptions now outnumber fixed-line subscriptions in many markets. Sales of mobile phones in 2005 totalled 816.6 million with that figure being almost equally shared amongst the markets of Asia/Pacific (204 m), Western Europe (164 m), CEMEA (Central Europe, the Middle East and Africa) (153.5 m), North America (148 m) and Latin America (102 m). In terms of new subscriptions over the five years from 1999, Africa has outpaced other markets with 58.2% growth. Increasingly these phones are being serviced by digital systems such as GSM or W-CDMA with many markets choosing to depreciate analogue systems such as AMPS.

There have also been dramatic changes in telephone communication behind the scenes. Starting with the operation of TAT-8 in 1988, the 1990s saw the widespread adoption of systems based upon optic fibres. The benefit of communicating with optic fibres is that they offer a drastic increase in data capacity. TAT-8 itself was able to carry 10 times as many telephone calls as the last copper cable laid at that time and today's optic fibre cables are able to carry 25 times as many telephone calls as TAT-8This drastic increase in data capacity is due to several factors. First, optic fibres are physically much smaller than competing technologies. Second, they do not suffer from crosstalk which means several hundred of them can be easily bundled together in a single cableLastly, improvements in multiplexing have lead to an exponential growth in the data capacity of a single fibreAssisting communication across these networks is a protocol known as Asynchronous Transfer Mode (ATM) that allows the side-by-side data transmission mentioned in the first paragraph. The importance of the ATM protocol is chiefly in its notion of establishing pathways for data through the network and associating a traffic contract with these pathways.

The traffic contract is essentially an agreement between the client and the network about how the network is to handle the data, if the network cannot meet the conditions of the traffic contract it does not accept the connection. This is important because telephone calls can negotiate a contract so as to guarantee themselves a constant bit rate, something that will ensure a caller's voice is not delayed in parts or cut-off completely. Now a days Multiprotocol Label Switching (MPLS) is better option than ATM.

**Multiprotocol Label Switching** (MPLS) is a type of data-carrying technique for high-performance telecommunications networks. MPLS directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table.

## V. Utility Equipment used as engineering services in an Industry

***by***

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**Utility Equipment used as engineering services in an Industry**

**Prologue:**

The effort here is to learn about basic study of utility equipment used as engineering services in an industry. We shall study the basic principal of engineering and some of the popular variance of the standard equipment.

The entire subject is divided in five sections or units.

The first unit deals with “Energy Generation”.- i.e. how energy is generated for utilization in an industry. It broadly covers various types of boilers. heaters, fittings and devices associated with boilers,

The second unit – “ Energy Consuming Devices” discuses some of the important equipment like different types of pumps, compressors and prime movers.

Third unit “Energy Utilisation” – adapts various equipment deployed for utilization of the energy generated earlier. It covers the systems to condition (heat or cool) the mediums, humidifiers / de humidifiers, circulating and distributing equipment like ducts, diffusers, grills, dampers, fans, air cleaning system etc.

The fourth unit is dedicated to various aspects of “Electrical Installations” starting with what is electricity, basic theory of electricity, basic machines and distribution network. It also overviews the basic control, application & protection equipment like switchgear, motors, drives etc. It also deals with various statutory requirements (including that for boilers)

An effort is made so that after studying all the four units, the student will understand the basic plant installation and the machinery installed in it. Having understood the basic working and the type of usage, a valuer can judge the value of the equipment in question by putting his valuation practices in use. The fifth unit deals with some typical practical aspects of valuations.

I wish to put on record the valuable guidance received from Mr Kirit Budhbhatti to make this work more beneficial to the students. I also thank Prof Oza & Prof AM Shaikh for suggestions to improve contents & Mr Muni Bhatt for checking the language part.

**Hemant Vasavada**

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# INDEX

# UNIT 01

## ENERGY GENERATION

**PROCESS BOILERS AND PIPEWORK INSTALLATIONS**

**Definition of a Boiler**

A boiler is an enclosed vessel that provides a means for combustion heat to be transferred into water until it becomes heated water or steam. The hot water or steam under pressure is then usable for transferring the heat to a process. Water is a useful and cheap medium for transferring heat to a process. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment that must be treated with utmost care.

The process of heating a liquid until it reaches its gaseous state is called evaporation. Heat is transferred from one body to another by means of

(1) Radiation, which is the transfer of heat from a hot body to a cold body without a conveying medium,
(2) Convection, the transfer of heat by a conveying medium, such as air or water and
(3) Conduction, transfer of heat by actual physical contact, molecule to molecule.

**Boiler Specification**

The heating surface is any part of the boiler metal that has hot gases of combustion on one side and water on the other. Any part of the boiler metal that actually contributes to making steam is heating surface. The amount of heating surface of a boiler is expressed in square meters. The larger the heating surface a boiler has, the more efficient it becomes.

The quantity of the steam produced is indicated in tons of water evaporated to steam per hour.

Maximum continuous rating is the hourly evaporation that can be maintained for 24 hours.

F & A means the amount of steam generated from water at 100 °C to saturated steam at 100 °C.

**Indian Boiler Regulation**

The Indian Boilers Act was enacted to consolidate and amend the law relating to steam boilers. Indian Boilers Regulation (IBR) was created in exercise of the powers conferred by section 28 & 29 of the Indian Boilers Act.

**Typical Boiler Specification**
**Boiler Make & Year** : XYZ & 2003
**MCR**(Maximum Continuous Rating) : 10TPH (F & A 100°C)
**Rated Working Pressure** : 10.54 kg/cm2(g)
**Type of Boiler** : 3 Pass Fire tube
**Fuel Fired** : Fuel Oil

**IBR Steam Boilers** means any closed vessel exceeding 22.75 liters in capacity and which is used expressively for generating steam under pressure and includes any mounting or other fitting attached to such vessel, which is wholly, or partly under pressure when the steam is shut off.

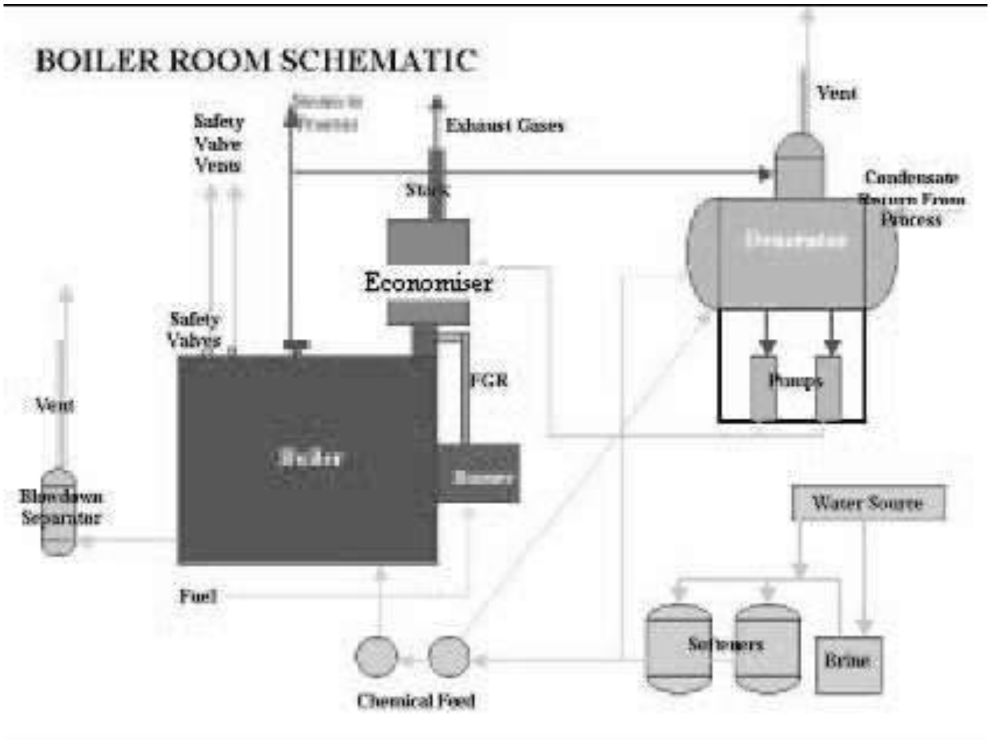
**IBR Steam Pipe** means any pipe through which steam passes from a boiler to a prime mover or other user or both, if pressure at which steam passes through such pipes exceeds 3.5 kg/cm2 above atmospheric pressure or such pipe exceeds 254 mm in internal diameter and includes in either case any connected fitting of a steam pipe.

**Boiler Systems**

The boiler system comprises of: feed water system, steam system and fuel system.
The **feed water system** provides water to the boiler and regulates it automatically to meet the steam demand. Various valves provide access for maintenance and repair.

The **steam system** collects and controls the steam produced in the boiler. Steam is directed through a piping system to the point of use. Throughout the system, steam pressure is regulated using valves and checked with steam pressure gauges.

The **fuel system** includes all equipment used to provide fuel to generate the necessary heat. The equipment required in the fuel system depends on the type of fuel used in the system. A typical boiler room schematic is shown in Figure




The water supplied to the boiler that is converted into steam is called **feed water**.

The two sources of feed water are:
(1) **Condensate** or condensed steam returned from the processes and
(2) **Makeup water** (treated raw water) which must come from outside the boiler room and plant processes. For higher boiler efficiencies, the feed water is preheated by economizer, using the waste heat in the flue gas.

**Boiler Types and Classifications**

There are virtually infinite numbers of boiler designs but generally they fit into one of two categories:
**1. Fire tube** or “fire in tube” boilers: contain long steel tubes through which the hot gasses from a furnace pass and around which the water to be converted to steam circulates.

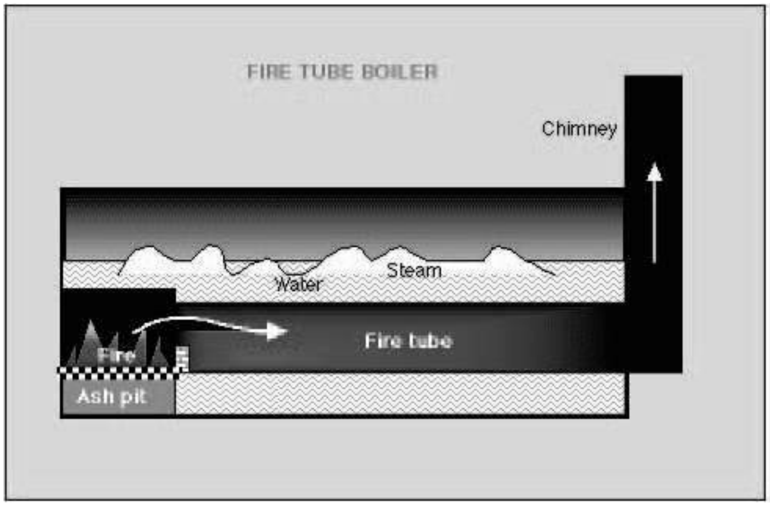


**Fig: Fire Tube Boiler**

Fire tube boilers, typically have a lower initial cost, are more fuel efficient and easier to operate, but they are limited generally to capacities of 25 tons/hr and pressures of 17.5 kg/cm2.

**2. Water tube** or "water in tube" boilers: in which the conditions are reversed with the water passing through the tubes and the hot gasses passing outside the tubes

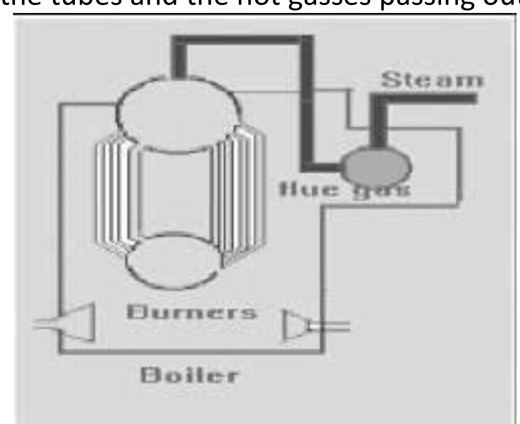


**Fig: Water Tube Boiler**

These boilers can be of single- or multiple-drum type. These boilers can be built to any steam capacities and pressures, and have higher efficiencies than fire tube boilers. **Packaged Boiler:** The packaged boiler is so called because it comes as a complete package. Once delivered to site, it requires only the steam, water pipe work, fuel supply and electrical connections to be made for it to become operational.

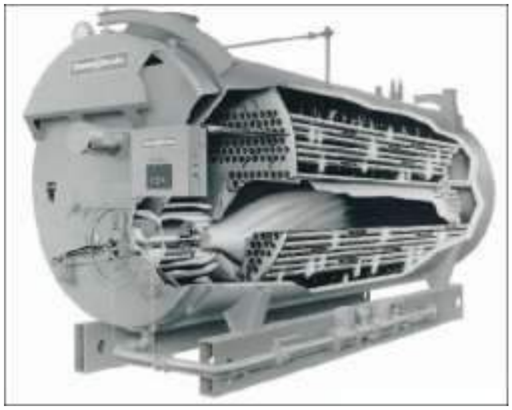


**Fig: Package Boiler**

Package boilers are generally of shell type with fire tube design so as to achieve high heat transfer rates by both radiation and convection.

The features of package boilers are:

- Small combustion space and high heat release rate resulting in faster evaporation.
- Large number of small diameter tubes leading to good convective heat transfer.
- Forced or induced draft systems resulting in good combustion efficiency.
- Number of passes resulting in better overall heat transfer.
- Higher thermal efficiency levels compared with other boilers.

These boilers are classified based on the number of passes – the number of times the hot combustion gases pass through the boiler. The combustion chamber is taken, as the first pass after which there may be one, two or three sets of fire-tubes. The most common boiler of this class is a three-pass unit with two sets of fire-tubes and with the exhaust gases exiting through the rear of the boiler.

Boilers can be classified in various ways, by its:

(1) Type of construction : cast-iron and steel boilers

(2) Fuel of combustion (or means of heating) : gas, oil, coal, waste fuel (such as wood waste and biogases) and electricity

(3) Heat transfer medium : hot water, steam and organic fluids

For the study purpose let us classify the boilers by its type of construction. The classifications are as follows:

**A. Cast-iron Boilers**

(i) Sectional boilers (vertical)

(ii) Sectional boilers (horizontal)

**B. Steel Boilers**

(i) Fire-tube boilers
The products of combustion pass through the inside of tubes with water surrounding the tubes.

(ii) Water-tube boilers
The water passes through the tubes and the products of combustion pass around the tubes.

(iii) Other and special application boilers including electric boilers, hot water high temperature systems, waste heat boilers, waste fuel boilers and fluidized bed boilers (and a subsection on pulverized coal firing)

**C.** Under **Pipe work Installations,** the study has considered the various fittings, connections or devices that are attached directly to the boiler so that the units can be operated safely and efficiently, as well as auxiliary equipment to the system:

(i) Safety valves

(ii) Water columns, gauge classes and gauge cocks

(iii) Valves and piping

(iv) Steam traps

(v) Pressure gauges

(vi) Feed water heaters and other devices

(vii) Auxiliary equipment including bag house filters, gas scrubbers and electrostatic precipitators

**A. Cast Iron Boilers:**

The cast-iron boiler is basically a water tube boiler because the water is inside the cast sections (There are no tubes and the products of combustion are on the outside)

Cast-iron is a term applied to many iron-carbon alloys, which can be cast in a mould to make a particular shape. But for cast-iron boilers, grey cast iron is generally used.

Cast-iron process boilers are built to various shapes and sizes, but can be grouped into the two following broad classifications:

1. Sectional boilers (vertical) consist of sections assembled front to back, with sections standing vertically and assembled by means of push nipples or screwed nipples to form waterway passages.
2. Sectional boilers (horizontal) consist of assembled sections stacked like pancakes. Here, each section is laid flat in relation to the base. This type of vertical stacking may be supplemented by having three vertically stacked boilers side-by-side and interconnected to gain additional capacity.

   These sections can be connected to build a boiler up to 1.8MW capacity.

They require refractory combustion chambers and insulated/air or water cooled hearths designed to limit boiler house floor temperatures to a max. of 65°C. They also require adequate suction in the combustion chamber provided by chimney or induced draught fan. Designs are now produced with fully water-cooled combustion chambers requiring no brickwork and these are independent of chimney draught to some extent. Such later designs are at present taken up to ratings of 4MW and are suited to solid, liquid or gaseous fuel firing.

**Fig: Cast Iron Boiler**

All such boilers can be installed in sites with limited access and can be extended to meet future requirements. They are suitable for LTHW (low temperature hot water) systems and low-pressure steam up to maximum gauge pressure of 4 bar. Certain units can withstand a gauge pressure of 10 bar.

**B. Steel Boilers:**

**(I) Fire-tube boilers**

Type and Arrangements

Fire-tube boilers are classified into horizontal return – tubular (HRT), economic type, locomotive firebox-type, scotch-marine-type, vertical tubular and vertical tubeless boilers. The scotch marine (SM) design is the dominant fire tube type for both heating and industrial process use up to 35,000 lb/hr capacity and 300psi pressure. Above this capacity water tube boilers are generally used.

***Horizontal-Return-Tubular Boilers***

The HRT boiler consists of a cylindrical shell, fusion-welded, with tubes of identical diameter running the length of the shell throughout the water space.

The HRT boiler is simple in construction, has a fairly low initial cost and is a good steamer. It is more economical than the vertical tubular or locomotive types, but the scotch marine boiler, is replacing it.

Horizontal-return-tubular boilers are not very practical in shell sizes over 96” in diameter or for pressure exceeding 200psi.

***Economic Boiler***

The economic boiler is an adaptation of the HRT boiler, giving somewhat greater heating surface per square foot of floor space. An added advantage is that the required amount of brickwork is much less since the boiler is self-supporting in its special casing. But this type has the same size and pressure limitations as the HRT boiler.

The economic-type boiler is considered to be an externally fired, fire-tube design because its steel-encased combustion chamber is not a pressure part of the boiler. They are compact in design and are usually shipped as a unit.

***Locomotive Firebox Boilers***

The locomotive firebox boiler, like the vertical tubular and scotch-marine types, is an internally fired fire-tube unit. But, its shell is horizontal and the firebox is not contained within the cylindrical portion of the boiler.

The locomotive firebox boiler is limited as to pressure and capacity, just as the HRT boiler.

**Scotch Marine Boilers**

The largest number of boilers in use today for commercial and small industrial plants is the scotch marine (SM) boilers. This boiler was originally used for marine service because the furnace forms and integral part of the boiler assembly, permitting very compact construction that requires a small space for the capacity produced. The SM boiler is sold as a package consisting of the pressure vessel, burner, controls, draught fan, draught controls and other components assembled into a fully factory-fire-tested unit.

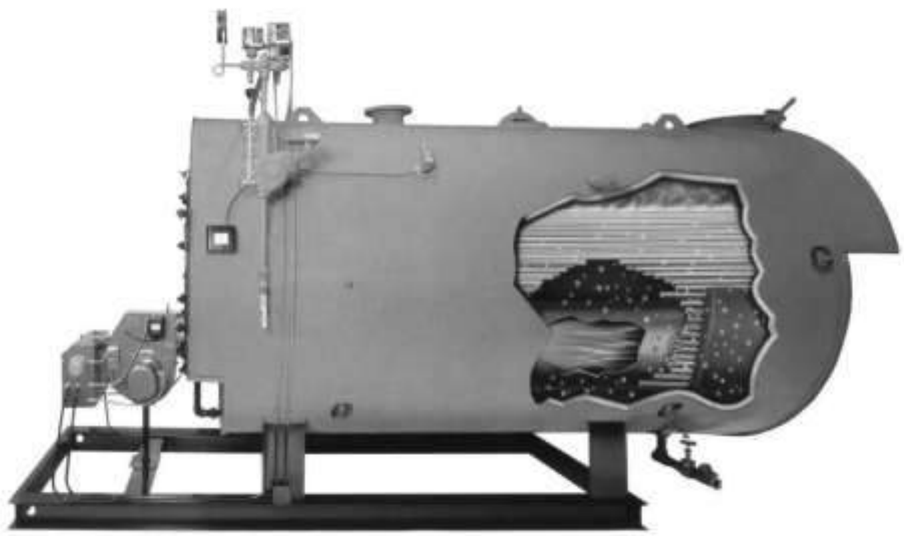


**Fig. Scotch Marine Boilers**

The SM boiler is built either as a wetback furnace or as a dry-back. It consists of an outer cylinder shell, a furnace; front and rear tube sheets and a crown sheet. The hot gases from the furnaces pass into a refractory-lined combustion chamber at the back and are returned through the fire tubes to the front of the boiler and then to the uptake. This boiler is suitable for coal, gas and oil firing.

In the wetback design, the shell, tube and furnace combustion are similar to the dry-back type, but the combustion chamber, being inside the shell, is surrounded by water. Thus, no outside setting or combustion-chamber refractory is needed. The dry-back type is a quick steamer because of its large heating surface. It is also compact and easily set up and shows fairly good economy.

The SM boiler may be by far the largest in diameter of any fire-tube boiler, being built up to about 15 feet diameter. In boilers of large diameter, it is the practice to use more than one furnace. Two, three or even four furnaces are used in the large boilers of this type

**Vertical Tubular Boiler**

The vertical fire-tube boiler is used where floor space is at a premium and the pressure and capacity requirements come within the scope of this type of boiler. The vertical tubular (VT) boiler is an internally fired fire-tube unit. It is a self-contained unit requiring little or no brickwork. It is popular for portable service, such as cranes, pile drivers, hoisting engines, and similar construction equipment. Vertical tubular boilers are used for stationary service where moderate pressures and capacity are required for process work, such a pressing, drying-roll applications in various small laundries in the plastics industry.

The coil-type water-tube boiler is a competitor of the VT boiler for small capacities and lower pressures to 150psi. But the VT boiler is limited in capacity and pressure even more than the horizontal fire-tube boiler. For this reason, most VT boilers of the fire-tube type seldom exceed 300hp or about 10,000 1b/hr capacity with a maximum pressure of 200psi.

The advantages of VT fire-tube boilers are:

1. Compactness and portability
2. Low initial cost
3. Very little floor space required per boiler horsepower
4. No special setting required
5. Quick and simpler installation

The disadvantages are:

1. The interior is not easily accessible for cleaning, inspection or repair
2. The water capacity is small, making it difficult to keep a steady steam pressure under varying load.
3. The boiler is liable to prime (carry over with steam) when under heavy load because of the small steam space
4. The efficiency is low in smaller sizes because hot gases have a short, direct path to the stack, so much of the heat goes to waste.

**Lancashire and Cornish Boilers**

These boilers are very rarely in use nowadays. They are essentially fire-tube boilers, but unlike the conventional ones, they do not have tubes within the boiler. Its construction is quite basic, comprising a pressure vessel with two furnaces normally fired by either gas or coal fuel. The rating of these boilers is in the range of 5,000 – 10,000 lb/hr at 100psi. These boilers can still be found in use for supplying hot water to pit head baths in coal mines and for process drying in old cotton and yarn manufacturing textile processing house. It has also found it's application, in dairy industry. In dairy industry, the cleanliness and sterilization is an integral & essential part of the manufacturing. These boilers are used for providing steam to sterilize milk in autoclaves.

**(ii) Water-Tube Boilers**

As mentioned earlier, water tube boilers are normally rated above 35,000 lb/hr capacity and 300psi pressure.

**Bent Tube Water Tube Boilers**

The Sterling boiler was one of the first types of bent-tube boilers to come into common use. Boilers of this general type were usually designed for pressures from 160 to 1000psi and capacities ranging from 7500 to 350,000 lb/hr of steam.

Modern bent tube boilers come in packaged units and typical example is the "Combustion Engineering" VU steam generator. It is cross drum bent-tube boiler with self-contained furnace. Great flexibility of operation, as well as compactness and high efficiency, is afforded by the ample combustion space and adequate heating surfaces offered to the radiant heat. This boiler is designed especially to burn fuels in suspension with interfuse-type burners.

**Coal-Fired Packaged Boilers**

Stoker-fired, water-tube boilers generally are built up to about the 250,000 lb/hr rating. Above this rating, pulverized-coal and cyclone-fired units are generally used. Modern stoker-fired boilers are usually of the two-drum type. Long-drum and cross-drum designs are used with bent tubes. On a long drum boiler, the flue gases flow lengthwise to the drums, while on a cross drum, they flow across or perpendicular to the drum.

**Coil Boilers**

Coil boilers, were developed to satisfy industry's needs for a compact, fast-steaming, factory-assembled packaged boiler. They find special application where a process requires high-pressure steam in one part of the process flow and the capacities required are moderate. A packaged unit is placed where the load need exists and this makes it unnecessary to operate large, centralized boilers at reduced capacity during periods of operation when other parts of the plant may have low demand. Several packaged boilers can be placed close to the steam loads of a plant at widely separate locations, thus avoiding long steam-line losses that may exist with a centralized steam plant.

Coil-type boilers are used over packaged fire-tube types when high pressure and capacities may be required. Pressures up to 900psi are possible with coil-type water tube boilers. Capacities generally are below 10,000 1b/hr, but units of greater size are available.

**Utility Boilers**

Utility boilers are used to generate electric power at the lowest heat rate possible, which is generally defined as the net Btu of fuel needed to generate one kilowatt of electricity. The trend has been to install single-boiler steam turbine arrangements that include a need to coordinate boiler-turbine start-up and loading.

Depending on the design for pressure, capacity and final temperature, a modern, large steam generator will have water walls, super heater, economizer, reheater and air-heater tubes. The basic purpose of these tubes is to extract all possible heat from the fuel input, thus lowering the exit temperature going up the stack. Utility boilers are classified as sub critical and supercritical, and are determined by whether a unit is operated above or below the critical pressure of 3206.2psia. Further classification is also made to indicate whether the boiler has natural circulation or forced (controlled) circulation.

**(iii) Other and Special Application Boilers**

**Electric Boilers**

Two basic types of electric boilers are available. First, units for low capacity and voltage generally consist of the resistance type. In the resistance type, current generates heat by flowing through resistance elements. This is wire, encased in an insulated metal sheath and these are submerged in water to generate usually moderate pressure steam at low capacities. These types do not depend on the conductivity or resistance of the water for generating heat. Second, in electrode boilers, the current flows through the water and not through wires. The liquid in the boilers converts electric energy to heat energy.

The energy crisis and air pollution regulations have created a demand for higher-output electric boilers above the 10,000 lb/hr ratings. A high voltage unit is classified as boilers with energy input between 2,300 Volts and 15,000 Volts.

Electrode boilers are packaged and they come fully equipped with controls and safety devices. Most boilers have controllers to maintain conductivity within the manufacturer's limits by monitoring the water and adding prescribed chemicals as needed, as well as blowing down the boiler when necessary.

**High -Temperature Hot-Water Boilers**

A high-temperature hot-water (HTHW) system is a heat utilization boiler that uses water at an elevated temperature, usually over 300°F with no specific pressure limitations. The HTHW system usually is not designed for temperatures exceeding 500°F. Operating temperatures within the range of 350° to 450°F are the most frequently encountered. Above 500°F, other fluids are used to obtain high temperature, such as Dowtherm and similar organic fluids.

At these temperatures, water in its liquid form can exist only at pressures above the corresponding saturation pressures.

The HTHW systems have widespread use for supplying the heating needs of large airports, military bases, office buildings, hospitals, colleges and other large multi building complexes. The application of HTHW systems has been extended to many industrial processes in the fields of chemistry, plastics, rubber, metal plating, paper and textiles.

**Advantages of HTHW Systems**

For many applications, HTHW systems are claimed to have distinct advantages over steam systems. The major advantages are:

1. Because of its large heat-storage capacity, an HTHW system permits very close control of temperature, which is important with many process applications.
2. The large quantity of heat in the system forms a heat reserve so that fluctuating loads have a minimal effect on the boiler, permitting use of a lower capacity boiler unit.
3. The absence of return-line corrosion in HTHW system, which is frequently a problem in a steam system is advantageous.
4. No traps, pumps, receivers, vents or other condensate-return equipment are needed on HTHW systems, thus producing lower initial cost, less maintenance and no steam losses.
5. A small amount of make-p is required; thus there is no need for an expensive feed water treatment system.

**Disadvantages of HTHW Systems**

There are several disadvantages, one of the most important being the large water content of the system. This produces the following disadvantages:

1. The system takes longer to heat up initially.
2. More time is needed for cool down when a repair or alteration has to be made and much water has to be discharged.
3. If a pipe or pressure-vessel break occurs, the water content, being above the atmospheric boiling point, will partly flash into steam with a powerful disruption effect. Even a relatively small leak can result in considerable water damage before the system can be depressurized.

Both fire-tube and water-tube boilers are used for HTHW systems. The main advantage of fire-tube boilers for this application is that they are generally less expensive in the smaller sizes below 600hp. Above this size, water tube boilers are used.

Water tube hot water generators are available in packaged ratings up to 150 million Btu/hr for water temperatures up to 650°F. The combustion equipment used is the same as that used for steam boilers. All types of fuels can be used.

**High Temperature Heat-Transfer Liquid and Vapour Organic Fluids**

Thermal fluids such as oils, silicates, glycols and similar liquids with high boiling points are used where higher temperatures are demanded by process requirements but at low operating pressures. Uses include drying of fabrics, clay, wood, paint, etc., which previously many have been done by direct firing of natural gas. Temperature up to 1000°F is now practical with thermal fluids.

Where HTHW systems can be used, they are preferred to thermal liquids, because they have about twice the heat capacity, do not deteriorate in use and are cheap.

Thermal-liquid systems also can be used in conjunction with steam systems. Plants that require high-pressure steam for specific applications can apply thermal liquids economically for other uses as well by installing a thermal liquid-to-steam heat exchanger and use part of its output to generate steam. This eliminates installation of a separate gas or oil-fired boiler.

When an organic substance is in the liquid state, the heating unit is referred to as a heater and if it is vapourised, it is called a vapouriser. The heating may be performed in a electric-fired units, up to about 1 million Btu/hr, with units above this size generally being fired by gas, oil and even coal. Units are generally packaged for automatic operation to a maximum capacity of 30 million Btu/hr. Multiple units are used for greater capacities as a rule.

The systems used can be classified as follows:

1. Vapour systems are generally of the fire-tube type using either gravity returns or pumped condensate return
2. Liquid systems use water-tube boilers with either natural circulation or the more pronounced forced circulation,

Among the organic fluids used are Dowtherm, Avoclor, Therminol FR and Tetralin. Since many of these fluids are hydrocarbons, a tube failure can create a fire hazard in the unit. Some fire insurance inspection departments require a steam smothering device or an inert-gas smothering system to be installed to smother a fire in the unit from a leaking pressure part. Safety controls should include a high-temperature cutout, pressure cutout and safety relief valves set to the maximum allowable pressure of the unit.

**Waste-Heat, Combined-Cycle and Co-Generation Systems**

**Waste-Heat Boilers**

There are a number of manufacturing processes that give off considerable quantities of high-temperature gases. Common among these are the exhaust from gas turbines or diesel engines. The value of heat recovery depends primarily on three considerations:

1. The cost of producing an equivalent amount of heat by other means
2. The cost of heat recovery equipment
3. The operating and maintenance cost of the waste heat recovery equipment

Steam boilers may be designed to use waste heat as all or part of the steam-generating medium. Since the gas temperature is usually 500 to 800°F, whereas combustion products in the conventionally fired installation may enter generating passes at about 2000°F, some means of compensating for the lower gas temperature must be employed. Otherwise, to have an appreciable steam generating capacity, the boiler would have to be beyond all reason in size. Other factors to consider besides pressures and temperatures of available waste gasses are the physical and chemical properties of the gas, their effect on boiler parts, the effect on the heat recovery system by plant-process disturbances and similar considerations involving continuity of service. Recovery of exhausted heat from industrial processes and combustion equipment can often reduce overall plant fuel consumption with minimal capital investment.

Supplementary firing is used when the waste-heat gases do not have sufficient heat to produce the desired final pressure or temperature of the steam.

Depending on the properties of the waste gases and the pressure and capacity needed, the following waste-heat boilers are used:

1. Fire-tube boilers, both the vertical and horizontal types, if waste gas is relatively clean.
2. Straight-tube water-tube boilers, for clean or moderately dust-laden waste gas
3. Water tube of the bent-tube type for very heavy dust loadings
4. Positive circulation boilers, for clean, low temperature gases
5. Pressurised or supercharged boilers, for gas turbine exhaust (Velox type).

Special material and other design factors are considered in the application of a waste-heat boiler because waste gases quite often have inert gases and solid entrapped particles in the mixture.

A Combined-Cycle generating system which utilizes a gas turbo generator or diesel with the exhaust heat going to either an unfired or a partially fired waste-heat boiler can be used to recover sensible heat and thus lower the Btu's required to generate one kilowatt of electricity. The boilers that can be used are generally water tube type of either natural or forced circulation design. Cogeneration produces electric power from a combined cycle usually, but also provides for process steam needs with the use of an extraction steam turbine.

**Waste-Fuel Boilers**

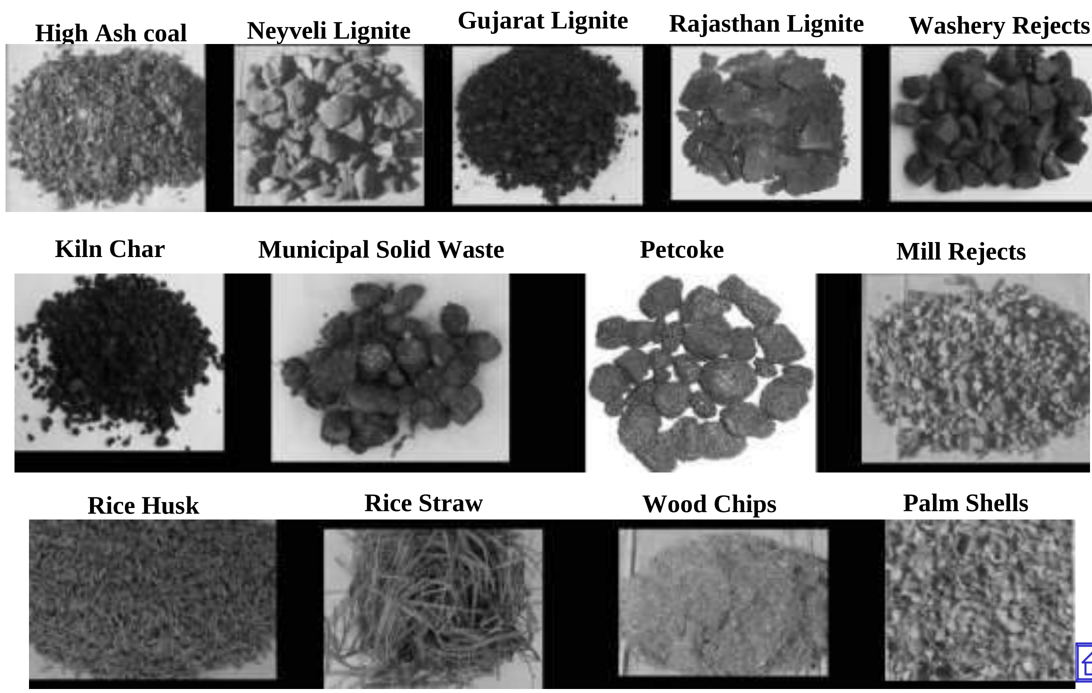
Escalating fuel costs and shortages that may develop in the future have caused industry and governments to re-examine the potential of waste-fuels of all types as a combustive alternate to the once-plentiful supply of fuels such as oil and gas.

Solid fuels in this category of waste fuels are many. Among them are wood chips, sawdust, hulls from coffee and nuts, corncobs, bagasse (waste product from sugar cane), coal char (residue from low-temperature carbonization of coal) and petroleum coke (final solid residue from a refinery). Each product must be handled in a special manner because of differences in moisture content, consistency, specific weight and heat content.

The furnace rather than the steam generator is affected when these special fuels are used. Products like bagasse, which has about 50 percent moisture, require a Dutch oven. The Wad furnace is a popular design for bagasse. Here, bagasse is partly dried and burned in refractory cells below a radiant arch. The combustion of gases is completed above the arch. Spreader stokers can also be used.

In refining sugar from cane, the juice squeezed out of the cane eventually is processed into sugar. The remaining fibrous, tenacious and bulky crushed cane is called bagasse. It is also moist. Depending on where it is grown and efficiency of the juice extractor, bagasse contains 30 to 50 percent wood fiber and 40 to 60 percent water. Heating value is 8000 to 8700 Btu/1b as a dry solid, with a yield of about 4500 Btu/1b at around 45 percent moisture content.

**Fuel Samples**




The steel industry has large quantities of gaseous by-product energy available. Heat content varies from less than 100 Btu/ft$^3$ for blast-furnace gas to 525 to 600 Btu/ft$^3$ for coke-oven gas. The main problem is getting this gas clean enough to avoid fouling the burners.

Oil refineries (catalytic cracking of crude petroleum) produce large volumes of gas as a by-product of catalytic regeneration. This gas contains 5 to 8% CO (carbon monoxide) about twice that much $CO_2$ (carbon dioxide) and air. The gas temperature is around 500°F, with a heat content of about 145 Btu/1b. Increasingly, refineries reclaim this energy by burning the gas together with oil or gas and additional air, in a carbon monoxide steam generator.

Liquid fuels in this category of waste fuels, include residue from chemical processes such as tar and pitch. These can be handled in conventional oil burners, but for satisfactory results, they must be heated to maintain viscosity at the proper level. Filtration is also required to remove and solid contaminants. High moisture can be poured off (decantation) or emulsified.

**Black-Liquor Boilers**

Black liquor is a by-product of wood pulp processing in the papermaking industry. Chips of wood are cooked in steam in a solution of sodium sulphide and sodium hydroxide in a large tank known as a “digester”. Strong liquor from the digester flows to a storage tank where it is joined by weak liquor from pulp washers. In order that this liquor may sustain combustion, it is then concentrated by evaporation and crushed salt cake is added until if contains over 58 percent solids.

The concentrated liquor is pumped at about 220°F through oscillating burners which spray it onto the furnace walls; deposits of combustible char build up until they are heavy enough to drop to the furnace floor, where combustion is assisted by primary air nozzles. The gases and a small percentage of fuel particles rise to the upper part of the furnace where secondary air is admitted to complete the combustion process.

A considerable percentage of chemicals, a form of soda ash is recoverable from the ash of this process. Thus, the combustion of this black liquor is twofold, namely, steam generation and for soda-ash recovery. The capacity of a black-liquor recovery boiler is also expressed in the amount of tons of dry solids it can burn in 24 hours. As an example, a nit designed for 1600 psi with a capacity of 392,000 lb/hr of steam is rated at the same time as being able to burn 800 tons/day of black liquor. The major manufacturers are Babcock Energy, NEI International Combustion and Foster Wheeler.

The deposited liquor dries, forms char and falls to the hearth where sodium chemicals are smelted and the char are turned to gas which burns in the furnace. The smelted chemicals drain down the sloping floor through the water-cooled spout and then into the dissolving tank. The bottom of the furnace in the unit is flat and is called a decanting furnace. Most other boiler details are similar for the two manufacturers’ design.

The black liquor recovery boiler is used in the paper making industry where hydrogen sulphide is used as the chemical to break up the lignin in wood that is cooked in digesters. The process is considered alkaline. Another process is called the red-liquor acid process. Red liquor with a concentration of about 50 percent solids is fired with steam-atmoizing burners. The red liquor burns in suspension and forms little or no slag in the furnace.

Magnesium oxide ash is removed from the furnace floor as well as from the flue gas. Sulphur dioxide is also recovered from the fuel gas by passage of the flue gas through absorption towers where magnesia oxide slurry absorbs the sulphur dioxide. The result is a cooking acid that is reused in the digesters.

Black and red liquors do not burn alike; thus, the steam generators used are not alike. Black liquor in the kraft process is very difficult to burn. Large furnaces are needed to keep the temperature relatively low because the liquor has a high content of low-fusion temperature ash. Smelt collects on the refractory sloping hearth, and a reducing atmosphere must be maintained in the lower part of the furnace or chemical conversion. Also, since super-heater and boiler surfaces have a tendency to coat with slag, they operate at low absorption rates i.e. reducing the efficiency. Thus frequent soot blowing and hot cleaning of heating surfaces is necessary.

Red liquor in the MgO (magnesia oxide) process on the other hand burns completely in suspension, making little or no slag. Thus a smaller steam generator can be used for an equivalent amount of steam production.

**Fluidized-Bed Boilers**

Fluidized-bed boilers are developed to take advantage of the large coal deposits that exist as well as overcome the pollution problem that exists in burning coal. The merits in using fluidised-bed combustion are the following:

1. High-sulphur fuels can be burned without resorting to flue-gas treatment. This is accomplished by injecting limestone into the bed, which absorbs the sulphur dioxide;
2. Higher combustion efficiencies are obtainable in fluidized-bed burning;
3. Lower combustion temperatures are possible which minimize nitrogen oxide and furnace slag formation;
4. The waste product formed at a lower bed temperature is easier to handle and dispose.
5. Low quality, high moisture content fuel can be burnt efficiently.

These are combination water-tube and fire-tube boiler designed for fluidised-brd burning. Particles being carried by the flue gas can be captured by conventional electrostatic precipitators or bag house filters. Fluidised-bed burning boilers approach the oil burning boiler in size because the former have heat-release rates of 100,000btu/(hr/ft$^3$) whereas, a conventional coal-fired steam generator has a heat release rate of around 20,000bt/hr/ ft$^3$).

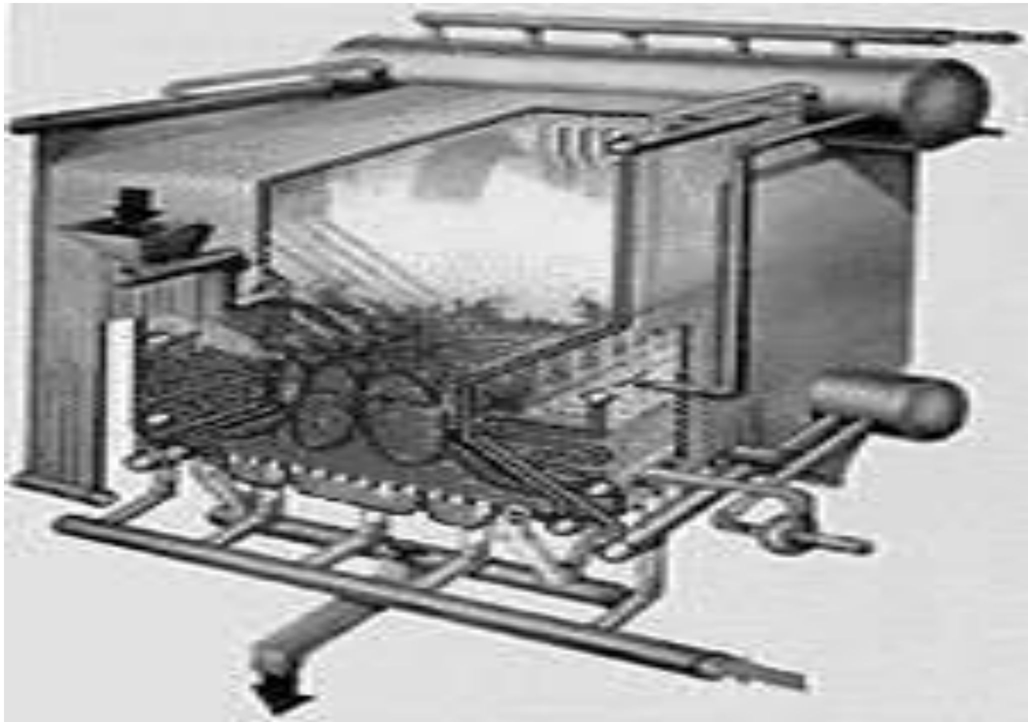


**Fig. Fluidised Bed Boiler**

**Pulverized Coal Firing**

Pulverized coal firing is the most widely used method for burning coal in large boilers. The system requires coal to pass from feed bunkers through scales or feeders to the pulverizer. The grinding of the coal exposes the fuel elements in the coal to rapid oxidation (burning) as the ignition temperature is reached. More complete burning is thus possible than with fuel-bed burning.

In general, pulverizers (sometimes called mills) may be classified as attrition or impact types. To these might be added the shearing type, which is a form of the attrition type, impact type or both. The impact mills generally have some attrition action. And conversely, while attrition may be the primary action of a mill, impact is usually present as a secondary action. Thus we have impact mills, including ball mills and hammer mills and attrition mills, including bowl mills and ball and race mills.

C. Pipe Work Installations, Mountings & Accessories:

Under pipe work installation, we shall consider various fittings, connections or devices that are attached directly to the boiler so that the units can be operated safety and efficiently, as well as other auxiliary equipment to the system. The mountings are primarily attached on the body of the boiler for smooth & safe operation with ease of controls. The Accessories are attached to increase the efficiency of the boilers.

**(i) Safety Valves**

The function of a safety valve is to prevent excessive pressure from building up in a steam boiler. The safety valve is set at or below the maximum safe working pressure for the boiler it protects.

**(ii) Water Columns, Gauge Glasses and Gauge Cocks**

The gauge glass and gage cocks are essential appliances for indicating the level of the boiler water. The water column is installed between the gauge glass and the boiler. It serves to eliminate excessive fluctuations of water-level indication in the glass due to rapid boiler circulation or ebullition and thus acts as a steadying medium.

**(iii) Valves and Piping**

Valves on boilers include steam valves on the main headers, feed valves on the water feed to a boiler; drain valves on water columns, gauge glass and drain connections; blow down valves for both surface blow off and bottom sediment blow off; check and valves on feed lines; and non return valves on steam mains. Materials for power plant piping are mostly carbon steels or stainless steel. Electrical Heat Traced piping is an electrical means of supplying heat to the piping and thus aid the flow of fluids through the piping to various equipment. Insulation can be provided to piping to reduce heat loss via the piping to the environment, thus maintaining the temperature of the fluids at a certain temperature.

**(iv) Steam Traps**

Steam traps are installed in lines wherever condensation must be drained, as rapidly as it accumulates and wherever condensate must be recovered for heating, for hot-water needs, or for return to boilers. They are a “must” for steam piping, separators and all steam-heated or steam operated equipment. Now a days steam traps are also viewed as an energy saving device.

**(v) Pressure Gauges**

Pressure gauges are used to indicate pressure in a system. The two main types of pressure gauges used are Bourdon tube and the diaphragm type.

**(vi) Feed water Heaters and Other Devices**

Feed water Heaters are used to bring feed water nearer to the temperature of the boiler water. Each 10°F in feed water temperature, increases the overall boiler efficiency by about 1 percent, owing to savings in fuel that would have been required to heat the boiler water an equal amount. An added advantage is that temperature stresses in the boiler may be avoided.

Evaporators are used to remove solids from feed water by use of heat. The evaporator is one in which raw (impure) water is evaporated into steam. This steam is condensed into pure condensate for feed water.

Deaerators are also an important section of the boiler. Air, oxygen, carbon dioxide or other such entrained gases are carried by water into a boiler. These may come from raw water, from leakages within a system or by chemical reactions of water and metals in a boiler loop system. The deaerator's main function is to remove these gases from the boiler water so as to prevent corrosion of metal parts in the boiler loop. Water de-ionising units are used to soften hard water by removing certain types of salt impurities in the water.

Pressure reducing valve, sometimes known as pressure regulators, are used to supply steam at a desired constant pressure lower than that of the supply. Their applications include supply for manufacturing processes, low-pressure feed water or fuel oil heaters and other auxiliaries.

**(vii) Auxiliary Equipment to the System**

Coal burning and other solid fuel burning boilers require auxiliary equipment to remove fly ash and other particulates being emitted to the surrounding atmosphere. The equipment commonly used includes the following:

1. Bag house employing fabric filters now usually made of fiberglass that can withstand flue-gas temperatures of 275 to 550°F.
2. Scrubbers that wash particulate emissions such as sulphur dioxide out of the flue gas and form a sludge that is disposed of in a landfills. They are economical only for large industrial and power plants. The fuel gas, after being cleaned in the precipitator, enters the bottom of the scrubber tower and passes up through the limestone slurry, which is being sprayed into the tower from above. The chemical reaction removes the $SO_2$ from the flue gas. The sludge formed must be disposed of in approved landfill sites.
3. Electrostatic precipitators. Induced / forced-draught fans are necessary to keep steam generators operating. The forced-draught fan supplies air for combustion of fuel as well as draught, while the I.D. fan pulls the flue gas out of the boiler and into a stack. Centrifugal and axial fans are used for F.D. & I.D. fans, gas recirculation and primary air fans.

**Exercise :**

1. Define a boiler.
2. Describe significance of "Boiler Specifications"
3. What is IBR ? Where it is applicable.
4. Describe the classification of boilers by the type of construction.
5. Write note & describe the following :
    a. Fire Tube Boilers
    b. Scotch Marine Boilers
    c. Lancashire Boilers.
    d. Utility Boilers.
    e. High temperature Hot Water Boilers with Advantages & Dis advantages.
    f. High temperature heat transfer methods.
    g. Waste Heat Boilers.
    h. Waste fuel Boilers.
    i. Fluidised Bed Boilers.
6. Describe the components of pipe work installations for boilers.

# UNIT – 02

## ENERGY CONSUMING DEVICES

**Pumps & Compressors**

In any industry, pump is essential and vital equipment. It's basic function is to transportation / movement of fluid from one location to another in a system. Increasing the pressure from one level to another does this. Depending on various factors the increase in pressure can be from fraction of a bar in laboratory equipment to tens of thousands in a hydrocarbon industry.

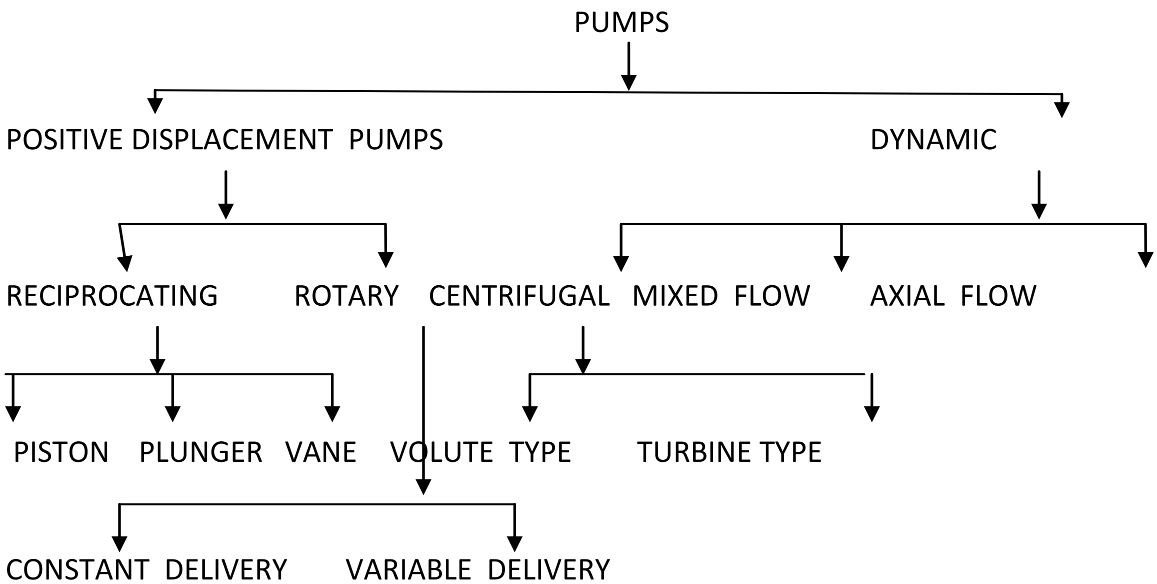
The fluid to be handled can be in liquid form or vapour / gas form. All machines, which handle liquid for transportation, are termed as pumps while as the compressors handle vapours.

While as the basic principal of the construction is similar in both the cases, the design and the internal components change due to :

- The volume handled. Compressor handles a huge volume as compared to the pump since vapour occupies large space. E.g. 1 cubic ft of water at room temperature becomes 1700 cubic feet of vapor at same temperature
- Due to difference in density and volume, the backpressure while the volume is being pressed varies. This calls for variation in clearances.
- The possibility of leakage is different in both the cases and hence the components to check and arrest leaks like seals or gland are different.

**Pumps:**

As we know, there are various types of liquids, which are to be handled in various industries. Also the parameters like temperature, pressure, head, flow etc etc vary from industry to industry and even within same industry it can vary from case to case. There are several types of pumps available for various applications.



The selection of the right type of pump for a particular application is very essential. Following are some of the important technical factors :

- SERVICE (WATER/HYDROCARBON/ACID………)
- DRIVER (MOTOR/TURBINE)
- CAPACITY NORMAL / RATED
- DUTY CONDITIONS (CONTINUOUS/INTERMITTENT
- DIFFERENTIAL HEAD
- SUCTION PRESSURE/TEMPERATURE
- VISCOSITY / SPECIFIC GRAVITY (DENSITY)
- SEAL TYPE

After careful consideration of all the factors, a particular pump is considered for a select application.
For our study purpose, we will find out how the most popular of them, i.e. centrifugal pump works & what are the important parts involved.

**Centrifugal Pumps: Basic Concepts of Operation,**
**Introduction to Working Mechanism of a Centrifugal Pump**

A centrifugal pump is one of the simplest pieces of equipment in any process plant. Its purpose is to convert energy of a prime mover (a electric motor or a turbine) first into velocity or kinetic energy and then into pressure energy of a fluid that is being pumped. The energy changes occur by virtue of two main parts of the pump, namely, the impeller and the volute or diffuser. The impeller is the rotating part that converts driver energy into the kinetic energy. The volute or diffuser is the stationary part that converts the kinetic energy into pressure energy.

**Note:** All of the forms of energy involved in a liquid flow system are expressed in terms of feet of liquid i.e. head.

**Generation of Centrifugal Force**

The process liquid enters the suction nozzle and then into eye (center) of a revolving device known as an impeller. When the impeller rotates, it spins the liquid sitting in the cavities between the vanes outward and provides centrifugal acceleration. As liquid leaves the eye of the impeller a low-pressure area is created causing more liquid to flow toward the inlet. Because the impeller blades are curved, the fluid is pushed in a tangential and radial direction by the centrifugal force. This force acting inside the pump can be better explained by an analogy. This force is the same one that keeps water inside a bucket that is rotating at the end of a string. Figure 1 below depicts a side cross-section of a centrifugal pump indicating the movement of the liquid inside and also the major components of the pump.

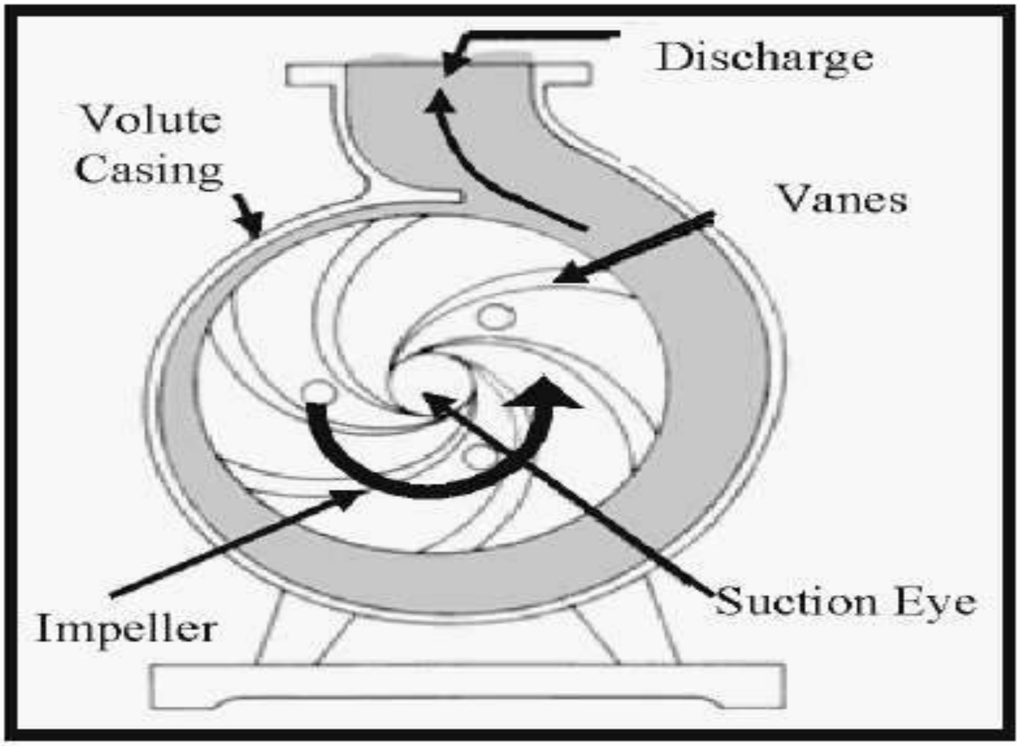



**Figure : Liquid flow path inside a centrifugal pump**

**Conversion of Kinetic Energy to Pressure Energy**

The key idea is that the energy created by the centrifugal force is *kinetic energ*y. The amount of energy given to the liquid is proportional to the *velocity* at the edge or vane tip of the impeller. The faster the impeller revolves or the bigger the impeller is, then the higher will be the velocity of the liquid at the vane tip and he greater the energy imparted to the liquid.

This kinetic energy of a liquid coming out of an impeller is harnessed by creating a *resistance* to the flow. The first resistance is created by the pump volute (casing) that catches the liquid and slows it down. In the discharge nozzle, the liquid further decelerates and its velocity is converted to pressure according to Bernoulli's principle. Therefore, the head (pressure in terms of height of liquid) developed is approximately equal to the velocity energy at the periphery of the impeller.

One fact that must always be remembered: A pump does not create pressure, it only provides flow. Pressure is a just an indication of the amount of resistance to flow.

**General Components of Centrifugal Pumps**

A centrifugal pump has two main components:

I. A rotating component comprised of an impeller and a shaft

II. A stationary component comprised of a casing, casing cover, and bearings.

The general components, both stationary and rotary, are depicted in Figure below. The main components are discussed in brief below. These parts are also shown on a photograph of a pump in the field.

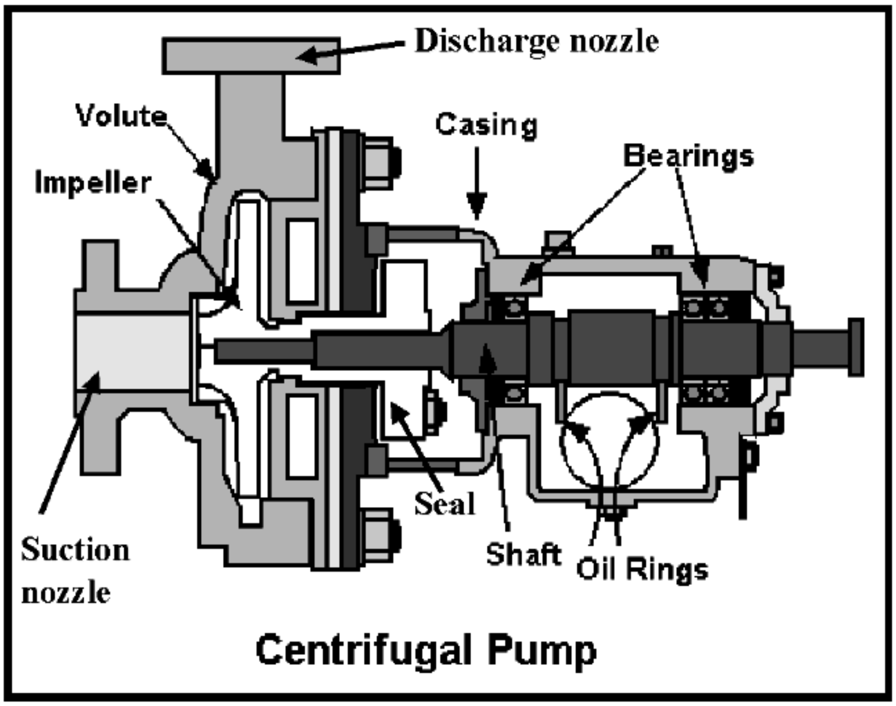



**Figure: General components of Centrifugal Pump.**

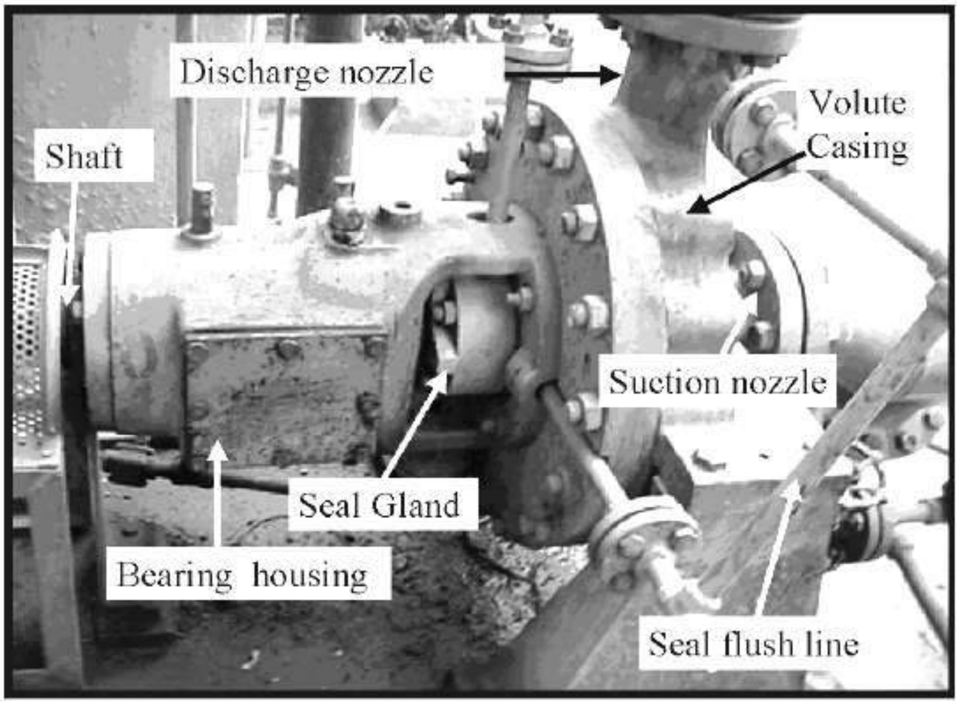



**Figure: General components of a Centrifugal Pump – A photograph of Stationary Components**

**Casing**

Casings are generally of two types: volute and circular. The impellers are fitted inside the casings.

***Volute casings*** build a higher head; *circular casings* are used for low head and high capacity.

* A *volute* is a curved funnel increasing in area to the discharge port. As the area of the cross-section increases, the volute reduces the speed of the liquid and increases the pressure of the liquid..

**Circular casing** have stationary diffusion vanes surrounding the impeller periphery that convert velocity energy to pressure energy. Conventionally, the diffusers are applied to multi-stage pumps.

* The casings can be designed either as solid casings or split casings.

**Solid casing** implies a design in which the entire casing including the discharge nozzle is all contained in one casting or fabricated piece.

**Split casing** implies two or more parts are fastened together. When the casing parts are divided by horizontal plane, the casing is described as horizontally split or axially split casing. When the split is in a vertical plane perpendicular to the rotation axis, the casing is described as vertically split or radially split casing.

**Suction and Discharge Nozzle**

The suction and discharge nozzles are part of the casings itself. They commonly have the following configurations.

1. *End suction/Top discharge*
2. *Top suction Top discharge nozzle*
3. *Side suction / Side discharge nozzles*

**Rotating Components**

**1. Impeller**

The impeller is the main rotating part that provides the centrifugal acceleration to the fluid. They are often classified in many ways.

- Based on major direction of flow in reference to the axis of rotation
  - Radial flow
  - Axial flow
  - Mixed flow
- Based on suction type
  - Single-suction: Liquid inlet on one side.
  - Double-suction: Liquid inlet to the impeller symmetrically from both sides.
- Based on mechanical construction **(Ref Figure below**)
  - Closed: Shrouds or sidewall enclosing the vanes.
  - Open: No shrouds or wall to enclose the vanes.
  - Semi-open or vortex type.

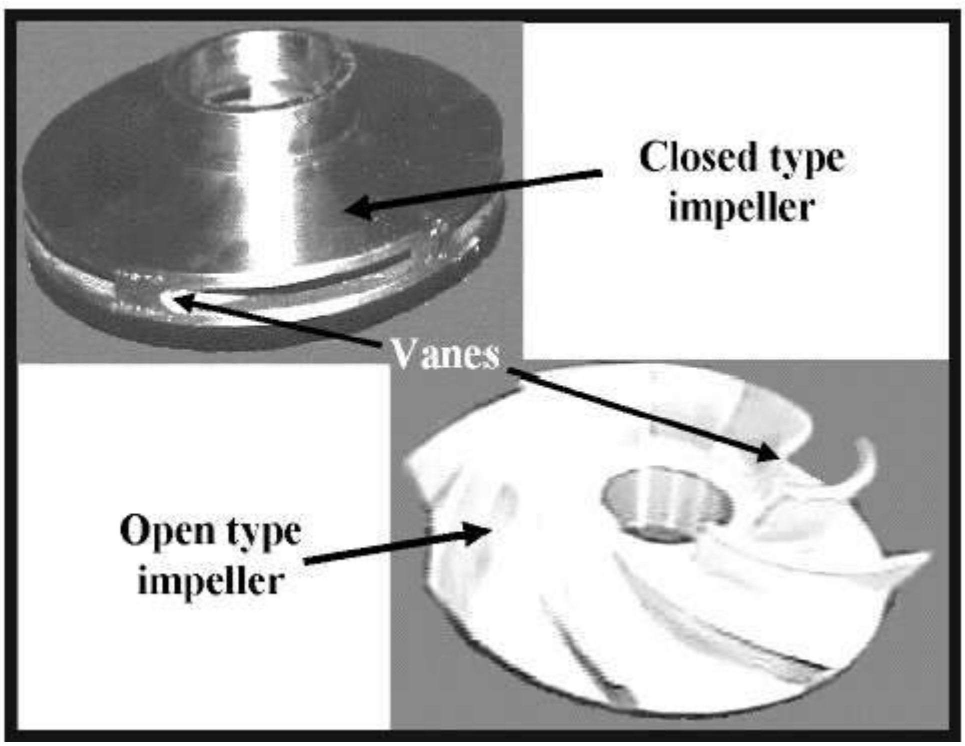



**Figure: Impeller Type**

**2. Shaft**

The basic purpose of a centrifugal pump shaft is to transmit the torques encountered when starting and during operation while supporting the impeller and other rotating parts. It must do this job with a deflection less than the minimum clearance between the rotating and stationary parts.

**Definition of Important Terms**

The key performance parameters of centrifugal pumps are capacity, head, BHP (Brake orse power), BEP (Best efficiency point) and specific speed. The pump curves provide the operating window within which these parameters can be varied for satisfactory pump operation. The following parameters or terms are discussed in detail in this section.

**Capacity**

Capacity means the flow rate with which liquid is moved or pushed by the pump to the desired point in the process. It is commonly measured in either gallons per minute (gpm) or cubic meters per hour (m 3 /hr). The capacity usually changes with the changes in operation of the process. For example, a boiler feed pump is an application that needs a constant pressure with varying capacities to meet a changing steam demand.

**Head**

Significance of using the ***"head"*** term instead of the ***"pressure"*** term

The pressure at any point in a liquid can be thought of as being caused by a vertical column of the liquid due to its weight. The height of this column is called the static head and is expressed in terms of feet of liquid.

Imagine a pipe shooting a jet of water straight up into the air, the height the water goes up would be the head.

**Power and Efficiency**

**Brake Horse Power (BHP)**

The work performed by a pump is a function of the total head and the weight of the liquid pumped in a given time period.

*Pump input or brake horsepower (BHP)* is the actual horsepower delivered to the pump shaft.

*Pump output or hydraulic or water horsepower (WHP)* is the liquid horsepower delivered by the pump.

***Pumps can pump only liquids, not vapors***

The satisfactory operation of a pump requires that vaporization of the liquid being pumped does not occur at any condition of operation. This is so desired because when a liquid vaporizes its volume increases very much. For example, 1 cubic-ft of water at room temperature becomes 1700 cubic-ft of vapor at the same temperature. This makes it clear that if we are to pump a fluid effectively, it must be kept always in the liquid form.

**Two Basic Requirements for Trouble-Free Operation of Centrifugal Pumps**

Centrifugal pumps are the ultimate in simplicity. In general there are two basic requirements that have to be met at all the times for a trouble free operation and longer service life of centrifugal pumps.

The **first** requirement is that no cavitation of the pump occurs throughout the broad operating range and the **second** requirement is that a certain minimum continuous flow is always maintained during operation.

There are number of unfavorable conditions, which may occur separately or simultaneously when the pump is operated at reduced flows. Some include:

- Cases of heavy leakages from the casing, seal, and stuffing box
- Deflection and shearing of shafts
- Seizure of pump internals
- Close tolerances erosion
- Separation cavitation
- Product quality degradation
- Excessive hydraulic thrust
- Premature bearing failures

Each condition may dictate a different minimum flow requirement. Both the pump user and the manufacturer take the final decision on recommended minimum flow after careful “techno-economical” analysis.

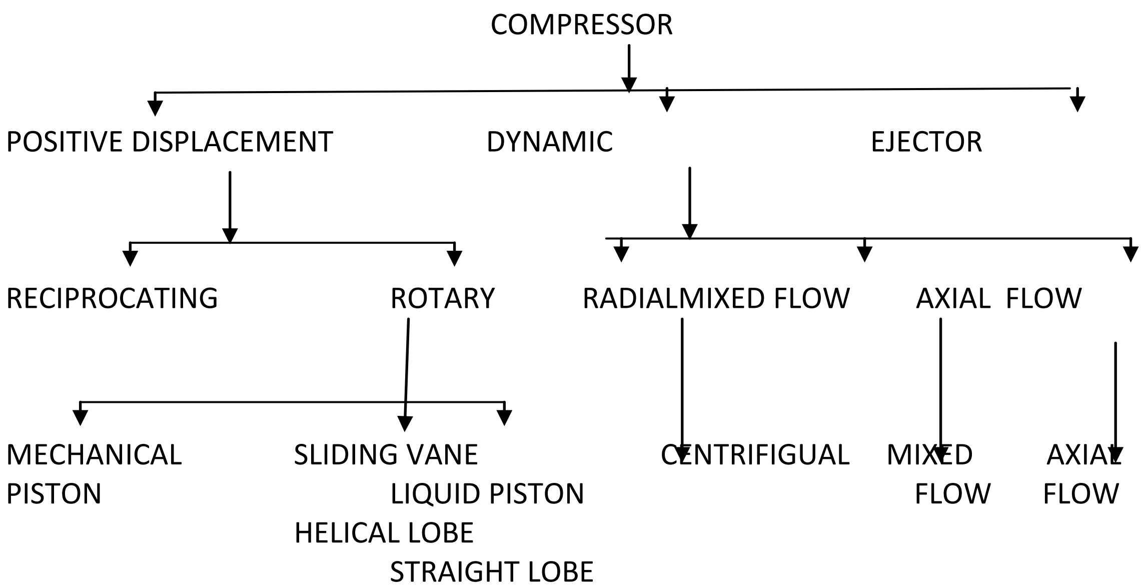
The consequences of prolonged conditions of cavitations and low flow operation can be disastrous for both the pump and the process. **Such failures in hydrocarbon services have often caused damaging fires resulting in loss of machine, production, and worst of all, human life.** Thus, such situations must be avoided at all cost whether involving modifications in the pump and its piping or altering the operating conditions. Proper selection and sizing of pump and its associated piping can not only eliminate the chances of cavitations and low flow operation but also significantly decrease their harmful effects.

As stated earlier, ***Pumps can pump only liquids, not vapours.*** *In an industry there are numerous stages where vapors is required to be handled In following chapter we will be discussing basic aspects of the equipment used in handling vapors.*

## COMPRESSORS:

A compressor is a device used to increase the pressure of a compressible fluid. The inlet pressure level can be nay value from a deep vacuum to a high positive pressure. The discharge pressure can range from sub atmospheric level of high values in tens of thousands of ponds per square inch. The inlet & outlet pressure are related corresponding with the type of compressor and its configuration. Application of compressed gas varies from consumer products, such as home refrigerator to large complex petrochemical plant installation.

COMPRESSOR CLASSIFICATION:




Basically two simple methods are used to compress gas.

- The first one is: Trap a volume of gas and displace it by positive action of a piston or a rotary member. This type of compressors is termed as Positive Displacement Compressors.
- The second method uses dynamic compression. It is accomplished by the mechanical action of contoured blades, which impart velocity and hence pressure to gas. Thus in other words, The Dynamic compressors are machines in which air / gas is compressed by dynamic action of rotating vane or impellers, imparting velocity and pressure to flowing gas. The velocity head is converted in to pressure by partially in rotating element and partially in the stationary diffuser or blades. Two most popular variations are Centrifugal & Axial Flow type.

Positive Displacement Compressor:

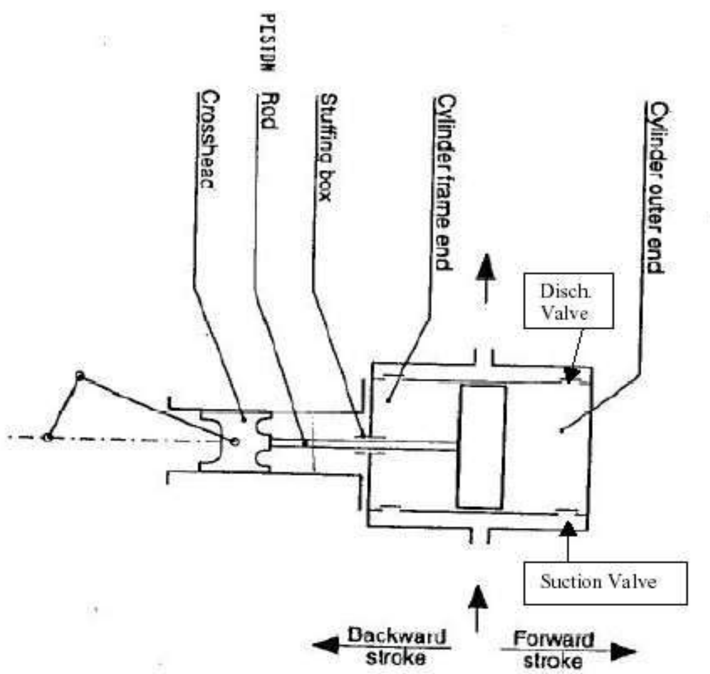
The reciprocating compressor is probably the best known and the most widely used of all compressors. It consists of a mechanical arrangement where reciprocating motion is transmitted to piston, which is free to move in a cylinder.

These are considered for applications where gas flow rate is about 30 ACFM or less i.e. they are favored for low flow and high-pressure services.

The maximum compressor ratio per stage is usually about 3:1 to 4:1. Higher compression ration can result in reduced volumetric & mechanical efficiency. Also, the outlet temperature limits the compression ratio. When multiple cylinders on a common frame are connected in series, usually through a cooler, the arrangement is referred as a multistage compressor.

**Positive Displacement compressors:**
Positive displacement type compressors are machines in which successive volumes of air or gas are confined within a closed space. The pressure is increased as the volume of the closed space is decreased. Four general types, broken down according to the constructional method used to carry out compression are as under:

***Reciprocating compressors***:
The machines in which the compressing element is a piston following a reciprocating motion in a cylinder. Figure below indicates the schematics of a reciprocating compressor.




**Main Parts of a Reciprocating Machine**

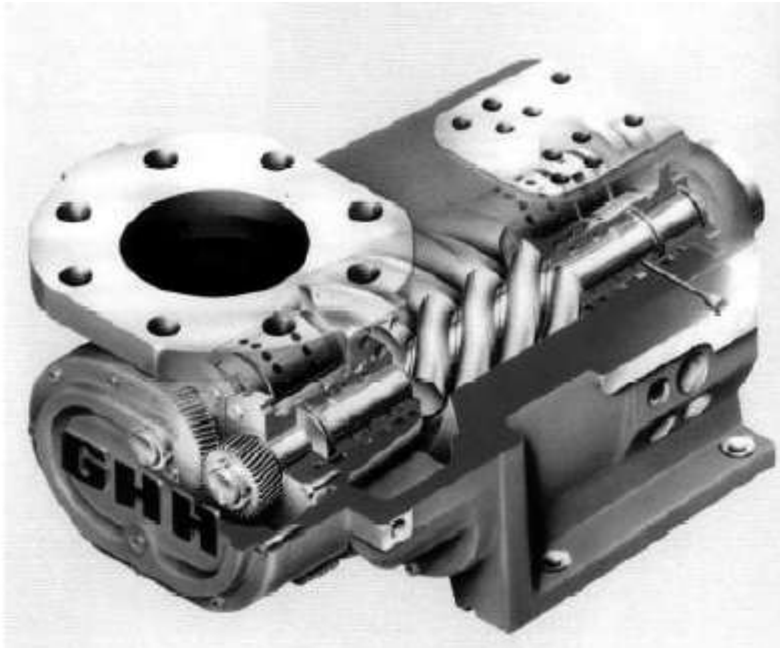
Rotary Compressor:

***Rotary lobe compressors:***
The machines in which two mating lobe impellers revolve within a cylinder and are prevented from making a contact with each other by timing gears mounted outside the cylinder. The gas is trapped by the lobes, which displace it from intake to discharge.

***Rotary slide-vane compressors*** :
The machines in which longitudinal vanes slide radially in a rotor mounted eccentrically in cylinder. Gas gets trapped in the sliding vanes and is compressed and finally discharged as the rotor moves in the casing having suitable ports.

***Rotary liquid piston compressors*** :
The machines in which water or other liquids are used usually in a single rotating element to compress and to displace the air or gas handled. Although each of the positive displacement types will vary from the other somewhat, they can be grouped together as single class of machines for the purpose of compression with dynamic type compressors.

**Rotary Helical Lobe (Screw Compressor):**
This compressor type is generally available up to 250 lb/in2 and for volume of 800 to 20,000 ACFM. The helical & spiral lobe compressor are generally similar and use two intermeshing helical or spiral lobes to compress gas between the lobes and the rotor chamber of casing. The gas is moved axially along the rotor to the discharge part where gas is discharged in to the discharge nozzle of casing. The volume of the trapped gas is decreased as it moves towards the outlet. Helical lobe compressor is further divided in to a dry and a flooded form. The dray form uses timing gears to hold a prescribed timing to the relative motion of the rotors, whereas the flooded form uses a liquid medium to keep the rotors from touching.




**Photograph of a Screw Compressor**

**Sliding Vane Compressor:**

It uses a single rotating element. The rotor is mounted eccentric to the center of the cylinder position of casing and is slotted and fitted with vanes. The vanes are free to move in and out within the slots as the rotor revolves. Gas is trapped between a pair of vanes as the vanes cross the inlet port. Gas is moved and compressed circumferentially as the vane pair moves towards the discharge port. The sliding vane compressor is widely used as a vacuum pump as well as a compressor, with the largest volume approximately 6000 cfm. Sliding vane compressor are available up to 150 lg/nc2 (G).

***Centrifugal Compressor:***

Centrifugal compressors are extensively used in modern chemical & allied industries. These are basically large volume machines. They are available for pressure of up to over 5000 lb/In$^2$ and handle volumes of 1000 to 15000 ACFM. Because there are no rubbing surfaces, they do not contaminate the compressed gas with lubricating oil their efficiency is in the range of 68-76. the capacity can be controlled by speed variation, reducing the suction pressure or by inlet vane control.

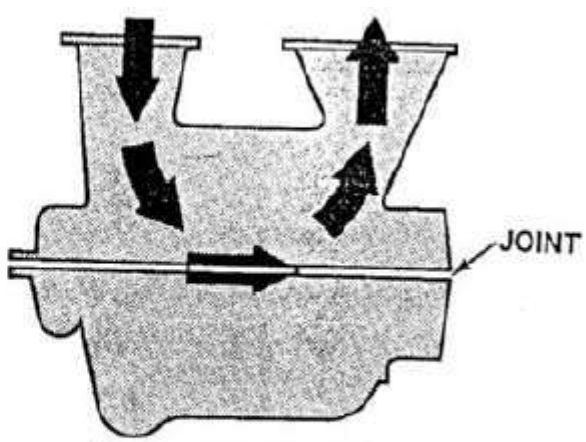
Centrifugal compressors are employed in numerous fields, chemical and petrochemical industries, refineries, fertilizer plants, nuclear reactors and air separation plants, iron and steel plants, production of liquefied natural gas (LNG) and substitute natural gas (SNG), cryogenic and refrigeration plants, mining, transportation and storage of gas, on-shore and off-shore installations. Combining these centrifugal compressors with other compressor type such as axial flow or reciprocating compressors can expand the range of application still further.

The wide range of processes in which centrifugal compressors are employed makes varying demands on these machines. Compressor demand is dependent on such factors as fluid handled, pressure ratio, the volume flow, the number of inter stage coolers, injection and extraction of the medium, and the type of shaft sealing. Taking all this factsors into consideration, the major compressor manufacturers have developed series of centrifugal compressors offering optimum engineering solution implemented by the use of standard components. These series include the two basic types, distinguished by horizontally or vertically split casing, compressors with two or three pairs of main nozzles, and compressors with additional side stream nozzles. Horizontally split casing permits simple removal of rotor and facilitates the checking of labyrinth clearances and o-rings. As pressure level rise and gas molecular becomes smaller, vertical split casings are employed.

**Horizontal Split Centrifugal:**

Centrifugal compressors with horizontally split casing can permit pressures of 70 bar and volume flow rates of up to 3 lac m3/hr at low pressures. Drive ratings can be as high as 30 MW.

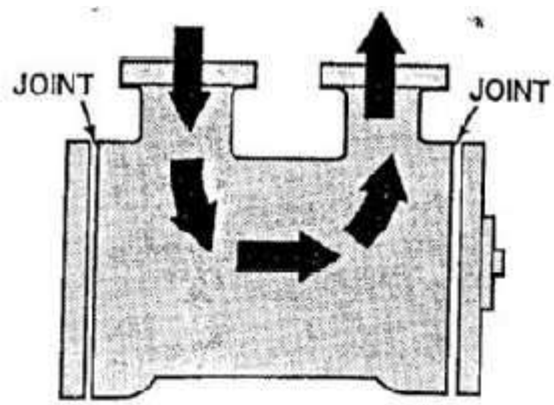
The two halves of casing are sealed and bolted together. The rigid structure is supported at the centerline, thus preventing vertical shifting of the compressor shaft as result of thermal expansion. For erection and dismantling purposes, the top half of the casing, complete with the associated stationary components, can be handled as a single unit. All types of drives, like, gas turbines, steam turbines, and electric motors. can be employed




HORIZONTALLY SPLIT

**Vertically Split Compressors:**
Vertically split (barrel type) centrifugal compressors are the preferred, and sometimes are mandatory design for high pressure or for compressing gases rich in hydrogen. The cylindrical casing ensures good stress distribution and extremely good gas tightness. Unlike the casing, the stationary internal components of the compressors, with the exception of the seal components, are horizontally split. During the assembly of the compressor they are mounted together with the rotor and are inserted axially into the casing. The shear ring segments retain the end covers. Some designs have bolted end covers.

VERTICALLY SPLIT



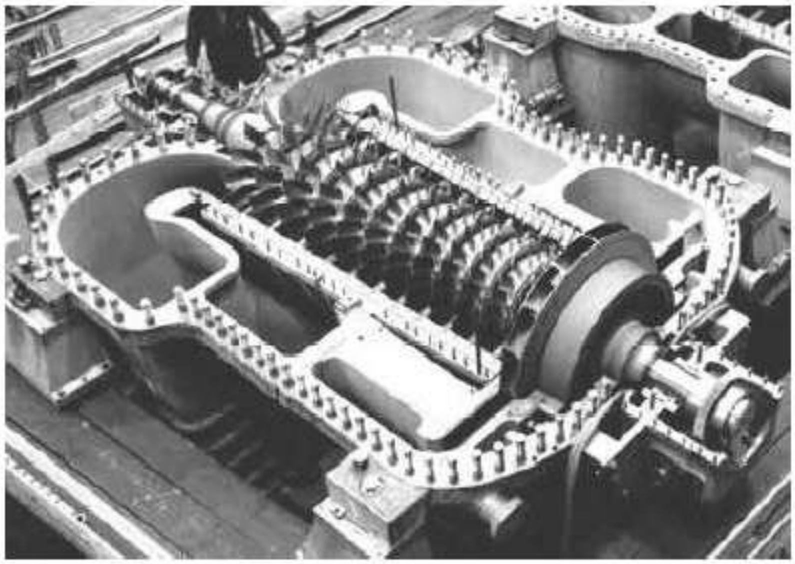

**Compressor Trains:**
Large pressure ratios cannot be handled by one single casing alone. Similarly it is not possible to split the compression cycle into more than two or three stages within one casing. The major compressor manufacturers therefore build compressor trains that may consist of up to four separate casings. Couplings interconnect these separate compressors, which need not be of same type,; they can be powered by a common driver. When additional timing gearing is used, the compressors casings may also be run at different speeds.

**Axial Flow Compressors:**
In axial flow compressor, a massive rotor with several rows of blades rotates in a casing, containing rows of stationary blades. Gas is drawn into an intake nozzle and passed in an axial direction through a series of moving and stationary rows of blades and is fully discharged through a discharge nozzle. Axial compressors are generally driven by electric motors, steam or gas turbines.

Axial compressors are large volume compressors that are characterized by the axial direction of the flow passing through the machine. The energy from the rotor is transferred to the gas by blades.

Axial compressors are most suited for higher capacity and comparatively low-pressure applications. These offer higher efficiency, smaller foundation requirements in weight and space and more efficient drive selection because of its higher speed and lower power requirements. The axial compressor is usually a single inlet, un-cooled machine consisting essentially of blades mounted on the horizontally split casing. The stationary blades can be either fixed or movable. The movable allows for better control of and increased flexibility in operations.

An open view of Axial Flow Compressor



**Geared Centrifugal Compressor:**

A multistage, multi-shaft integral gear compressor consists of individual scroll casings flanged to the gearbox and connected by piping. This compressor type needs fewer stages for a given pressure ratio than a multistage, single shaft turbo compressors. The reduced number of stages, i.e. the increased stage pressure ratio, results from the open-type impeller design, which can be used here as well as from the higher speeds which are achieved with this design. The resulting compact manner of construction, which involves considerable savings in terms of weight and space required, is an interesting aspect for investment planning. Not only are the investment costs reduced in comparison to single shaft compressor, the operating costs are lower as well, since all stages can be operated in their optimum efficiency range by selecting the appropriate pinion shaft speed.

Further plus points of gear compressors are:

- The medium can be cooled following each stage
- Intermediate side streams and extraction are possible following each stage (Multi service operation)
- Can be easily adapted to modify operating conditions by means of a timesaving exchange of impellers.
- Each stage can easily be equipped with inlet guide vane control and adjustable diffuser vane control, thus enabling the control elements to become effective for the entire compressor.

**Lubricating System:**

Compressor bearings are generally lubricated by either splash lubrication or forced lubrication system. Forced lubrication system consists of main oil pump (MOP) and an auxiliary oil pump (AOP). Pressurized oil from pump passes through the inter cooler (optional) and lube oil filter (preferably duplex) and finally supplied to bearings, coupling etc.

**Exercise:**

1. What is a pump & what is a compressor?
2. What are different parts of pumps?
3. Describe a Centrifugal pump with construction and working details.
4. Define :
    a. Capacity of a pump.
    b. Head
    c. BHP
5. What are two basic requirements for trouble free operation of a centrifugal pump? Explain in details.
6. Write note on classifications of compressors.
7. Draw a sketch and describe Reciprocating Compressor.
8. Write notes on following :
    a. Fans & Blowers
    b. Centrifugal Compressor

**PRIME MOVERS**

Prime movers are the equipment which converts external power in to a energy which ultimately drives the material handling equipment like pumps, compressors etc. An economic balance between installation and operating cost always dictates the choice.

Many options are available for selection of prime movers. The prime movers can be any one of the following:

- Electric motor
- Steam Turbines
- IC Engines.

**Electric Motor:**

Electric motors are the versatile, economical, compact and low maintenance prime mover. It operates at a speed

N = f*50*2 / P where
N is Speed in RPM
F is frequency of the supply
P is number of poles of motor.

Thus speed of a given motor for a standard supply gets fixed and can not be varied unless either gear box or variable drive is used.

The motor drivers have following advantages:

- Low initial investment cost
- The compression train always operate at the same speed, which reduces notably, the risk of mechanical stability problems.
- Extreme reliability due to age old proven design.

The functioning of variable drive is discussed in the electrical section of the book.

**Steam Turbines:**

Selection of steam turbine as driver is generally dictated by steam availability and speed variation required. Many of the process plan, have exothermic chemical reactions, which can produce steam Thus due to in plant steam generation, the steam availability increases. This can be a driving force for the selection of a steam turbine.

From the point of view of compression group, steam turbine drivers have three advantages:

- Possibility of direct drive, which avoids the introduction of gearbox, which is always a critical item.
- The facility of regulating the speed of the turbine by inter locking the parameters with the governor, one can vary the turbine speed for maintaining the operating level.

- The turbine can be started with a gradual speed increase, which can avoid requirement of high inertia torque.

In addition the steam turbines are popular for variety of equipment as prime movers because:

- It can give high rotational speed.
- It's ability to utilize high pressure and high temperature steam available in the plant.
- It can give very high Break Horse Power. Thus it can run giant size machines like generators.
- Good efficiency.

**Diesel Engine / Gas Engine –Internal Combustion (IC) Engines**

**Introduction**

All engines in which the combustion of fuel occurs in the cylinders are termed as internal combustion engines.

Classification of I.C. Engine:

These engines are classed into the following important categories.

1) According to the type of fuel used
    - Petrol engine
    - Diesel engine
    - Gas engine
2) According to the method of ignition
    - Spark ignition engine
    - Compression ignition engine
3) According to the number of strokes:
    - Two stroke engine
    - Four stroke engine
4) According to the method of fuel injection:
    - Air injection
    - Airless or solid injection
5) According to the cycle of operation:
    - Otto cycle engine
    - Diesel cycle engine
    - Dual combination cycle engine

**Four stroke cycle diesel engine (compression ignition engine):**

The diesel engine has three valves, i.e. air inlet valve, exhaust valve and fuel injection valve. It differs from petrol engine because in this case, no spark plug is provided. The air

Injecting the fuel into the engine cylinder containing air compressed to a very high pressure ignites fuel mixture. The following are the four strokes of the piston of a diesel engine.

**1) Suction stroke:**

During the first out stroke of the piston, the exhaust and fuel injection valves are closed, changed of any air is drawn in the cylinders through the inlet v/v. the pressure inside the cylinder is below the atmospheric.

**2) Compression stroke:**

The piston moves upward from bottom dead center. The air drawn during the suction stroke is now compressed to a pressure of about 35 $kg/cm^2$. The air compressed is at a very high temperature, which is sufficient to ignite the fuel. Now the fuel injection v/v is opened just before the point of maximum compression.

**3) Working or expansion stroke:**

As soon as the fuel is injected into the cylinder, it is ignited by the heat of compression, and applies pressure on the piston to drive the engine.

**4) Exhaust stroke:**

Air and fuel v/vs are closed and the exhaust v/v is open. The piston moves upward from the bottom dead center. The exhaust products leave through the exhaust v/v.
This completes the one cycle of the engine.

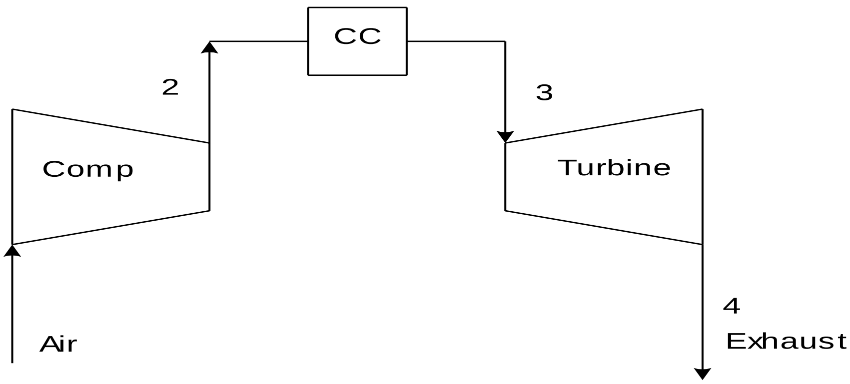
**Gas Turbine:**

In the following para we will examine the working of a gas turbine prime mover. Along with this we will also learn its association with power generation in Gas Turbine Generators.

***Gas Turbine has following advantages:***

- Capital cost is less.
- Fewer auxiliaries.
- Less erection time.
- Less area.
- Higher thermal efficiency when operated in combined cycle mode.
- Quick start.
- Fuel flexibility ( Liquid / Gas )
- Very compact system.
- Black start facility.
- Suitable for Base load / Peak load / Part load operation.
- No/Less environmental Hazards.
- Control reliability.

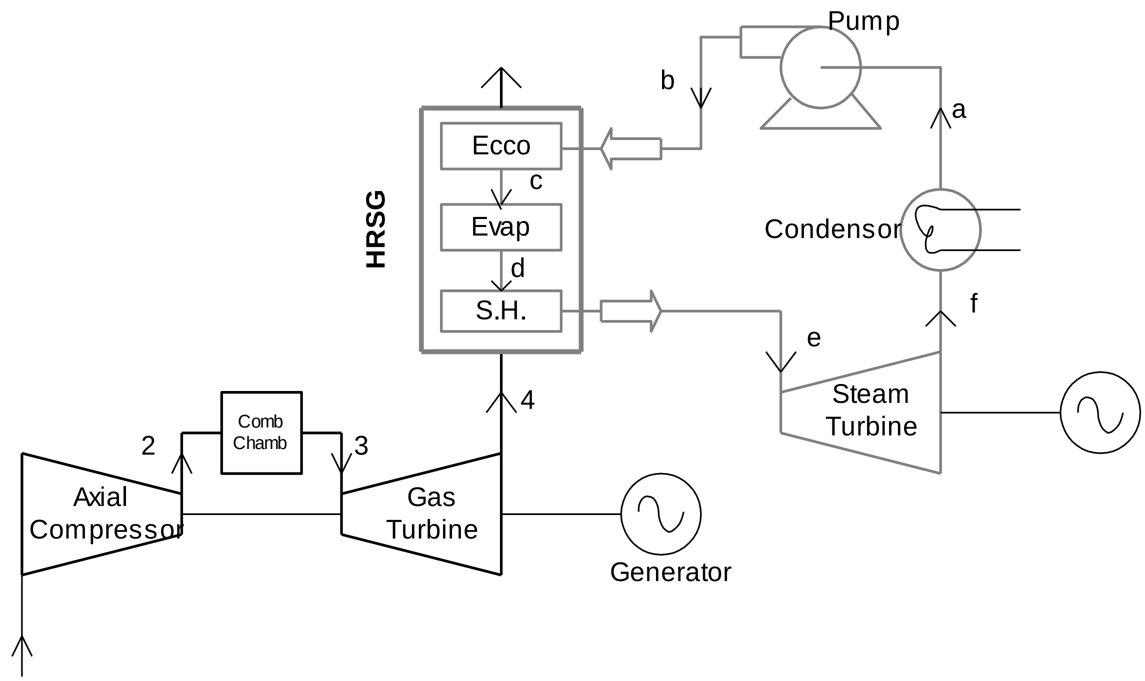
Gas Turbine is Modern Power generating equipment.




**Schematic diagram of a Gas Turbine Generator**

It takes the air from atmosphere, compresses it to sufficiently high pressure, same pressurized air is then utilized for combustion , which takes place in combustion chamber by addition of fuel , there by hot combustion products are generated which are expanded in the turbine where heat energy of hot combustion products is converted in to mechanical energy of shaft which in turn utilized for generating power in Generator.

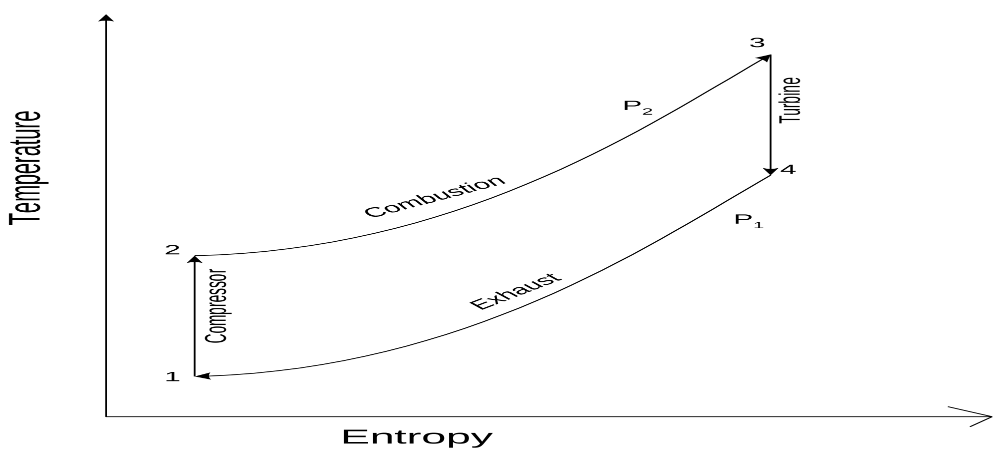
Compression is carried out by Axial Flow compressor, Heat addition is done by Fuel in combustion chambers, Expansion of hot combustible gases is carried out in Turbine and Burnt Gases are exhausted to atmosphere or utilized for steam generation in GTs. All of these four processes are carried out in Only one Factory assembled Unit which is called Gas Turbine. Drawing shows the Typical Brayton cycle and also shows the components of Gas Turbine.




**Schematic Diagram of Gas Turbine with Heat Recovery Boiler**

Gas Turbine operates on Brayton Cycle. Brayton cycle is having divided in four segments namely Compression , Heat addition , Expansion and Exhaust.

Process is explained in following diagram on T-S curve.




In modern days Gas Turbine Based power plants are becoming more and more popular mainly because of it's Higher efficiency, Reliability, Quick response.

In the modern Power Plants Gas Turbine Exhaust is connected to Heat Recovery Steam Generator where the steam is generated from hot gases and Steam is utilized for running the Steam Turbine such system is known as combined cycle power plants and where steam is utilized for various processes such system is called as Co-generation system .

Normally combined cycle power plant efficiency is around 48-50 % and co-generation system efficiency is around 80 % depending up on application.

**Exercise:**

1. What is Prime Mover? Describe them.
2. What are the advantages of Electric Motor as a prime mover?
3. What are the advantages of Steam Engine as a prime mover?
4. What is IC engine? What are it’s important categories.
5. Write note on Gas Turbine.

# UNIT - 03

## ENERGY UTILISATION

**Air Conditioning Installation**

Objectives:

By the end of this chapter it is intended that the student will have fairly good idea about the working, various components used and the basic technology behind the air conditioning installations.

Most of the air-conditioning installations in common use are partial air conditioning systems. That is, the system is designed for heating, humidifying, cleaning and distribution; or it is designed for cooling, dehumidifying, cleaning and distribution.

**Why air is to be conditioned?**

The basic question is as to why at all the air in a specific location is to be conditioned?

The reasons are:

- To control temperature
- To control humidity
- Dust free atmosphere
- Chemical fumes free air

In any given installation, there can be need of control of one or more of the above parameters. In a complete air conditioning installation, one would expect to find the following equipment:

(i) Basic air conditioning systems (both heating and cooling units)
(ii) Humidifiers
(iii) Dehumidifiers
(iv) Circulating/distributing equipment
(v) Air cleaning equipment

***Basic Air Conditioning Systems***

Raising the ambient temperature:

In cold regions where ambient may drop to sub zero temperature, it is essential to raise the temperature. Very low temperature can cause problem in lubricating system, circulation system and also the human working. The temperature is raised to a level so that above factors can be eliminated.

**Gravity Warm Air Furnace – Fuel Gas Atmospheric Burner**

Fuel gas controlled by a pressure regulator, is fed to the burner in this heating system, Fuel is under constant low pressure. An atmospheric – type burner is used. Fuel may be natural gas, propane, LP gas or artificial gas.

The thermostat controls the operation of the burner by means of the gas burner control. Products of burning, carbon dioxide and water vapour, flow through the stack into the chimney. An air break helps keep constant pressure in the combustion chamber.

The heat generated in the combustion chamber is conducted through the chamber wall and is carried or radiated into the air surrounding the chamber. This air is heated up and naturally rises and flows through the warm air ducts into the rooms through warm air registers. As air cools, it becomes heavier and flow down through the cost air duct and back into the bottom of the furnace.

A high-limit control (for safety) is located in the bonnet of the furnace. (The bonnet is a sheet-metal chamber where heat collects before being distributed). The high-limit control will automatically shut off the gas if the bonnet temperature goes higher than the high-limit control temperature setting.

A room thermostat checks the room temperature and responds as needed. The thermostat operation keeps the temperature of the room within about 2°F (1.1°C) of the desired temperature.

**Forced Warm Air – Fuel Gas Power Burner**

This heating system is essentially similar to that of the gravity warm air furnace except that the fuel gas is burned in a power-type burner in this case. The other difference is that as soon as the bonnet temperature is high enough, the fan in the cold air duct return starts and moves air through the heating system. This air is drawn from the cold air register in the floor, above, through the air filter, and then through the furnace. Warm air is then distributed through the various warm air ducts and warm air registers or diffusers into the space to be heated.

**Fuel Gas atmospheric Burner – Hydraulic Systems**

The ignition system of this heating system is similar to that of gravity warm air furnace. In this heating system the room thermostat controls the operation of the water pump. The pump circulates the warm water through the room radiators and returns it to the boiler.

The water temperature is controlled by temperature and pressure – sensing element in the top of the boiler. An expansion tank is used to take care of expanding (warm) or contracting (cool) water. Air in the tank acts as a cushion.

### Oil Burner – Forced Warm Air

Where fuel oil is the heat source, a gun-type oil burner throws a flame into a firepot lined with refractor (fire resistant) material. Fuel oil is stored in a tank, either inside or outside the building. Fuel oil is stored in a tank, either inside or outside the building. It is pumped into the burner under pressure. When heat is required, the thermostat sets the burner into operation. A high voltage transformer then sets sparks to ignite the atomized fuel vapour at the burner nozzle.

The blower or fan in the cold-air duct will start as soon as the bonnet temperature reaches its desired setting to distribute warm air through the ducts.

### *Oil burner – Hydraulics*

The ignition system of this heating system is similar to that of forced warm air oil burner type. Where a high voltage transformer set sparks to burn atomized oil vapour at the burner nozzle. Heat from the combustion chamber is conducted through the boiler wall into the water. The room thermostat sets the circulating pump running to distribute the warm water once desired water temperature is reached.

### Forced Warm Air – Electric Resistance Heat

In this heating system Fig 3.6, the room thermostat turns on the electric resistance heating elements when heat is needed. When desired temperature is reached, the same thermostat turns off the power to the heating units.

Warm air distributed by a blower which forces through the resistance unit where it picks heat. Heated air then distributed to the registers.

A filter is placed between the cold-air duct and blower. A humidifying device is usually placed in the warm air duct and operates whenever the blower is running.

There is an advantage of heating forced air with an electric resistance element. This furnace does not require a stack or chimney.

### Hydraulics – Electric Resistance Heat

In hydraulic systems, the electrical resistance-heating units are inside the boiler. A high limit and safety control attached to the boiler chamber automatically turns on one or all three stages or resistance heating units when temperature of the water at the top of the boiler drops below a minimum setting. It also turns off electric heating units when the temperature of the water reaches the upper setting. The same control becomes a safety device, shutting off heating elements if no water is circulating through the radiators.

The room thermostats control the operation of the pump or pumps, which force the warm water through the room radiators. More than one pump can be used in this system and separate thermostat controls the temperature at the space served by each pump.

**Room Heating Units – Electrical Resistance**

Individual electric resistance units are installed in each room in this system. Electrical power is connected to the units from a electric power panel. One advantage of this system is that its own thermostat regulates the temperature of each room.

**Air Conditioner, Cooling – Window or through The Wall**

Window or through-the wall air conditioners consist of three basic parts:

1. A hermetic compressor
2. Condenser
3. Evaporator using a capillary tube refrigerant control.

When the system operates, liquid refrigerant at the bottom of the condenser is drawn through the capillary tube into low-pressure evaporator. Here the refrigerant vapourises thus absorbing heat from the evaporator surface. Air from the room is drawn into air conditioner through a filter. The air is then forced over the evaporator and cooled before going back into the room. The low-pressure vapour in the evaporator is then drawn through the suction line into the compressor, where it is then compressed to the high-side pressure and sent into the condenser to be cooled and condensed to a liquid. The cycle then repeats.

The condenser and compressor are in the part of the unit, which is outside the building. The condenser fan draws outdoor air in to cool the condenser and discharges it outside.

Air flowing through the evaporator is cooled and dehumidified. Moisture that collects on the evaporator surface is drained to drip pan under the evaporator. In some machine, it flows into a pan in the compressor compartment, which in evaporating, helps to cool the compressor and condenser.

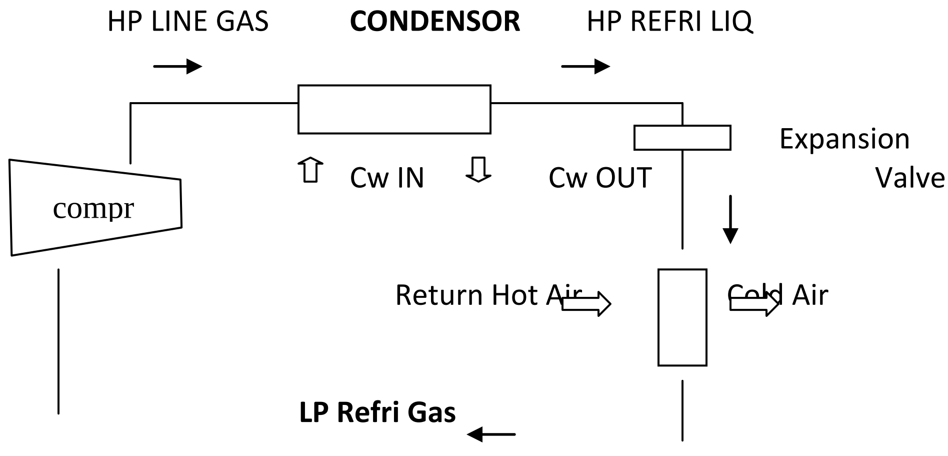
LOWERING THE AMBIENT TEMPERATURE: (COOLING THE AIR)

*In most of the Indian states where ambient temperature during most part of the year is on higher side of the comfort zone, it is essential to lower down the temperature. Refrigeration and air handling do this. There are two basic type of the system of refrigeration or air conditioning. This is differentiated by the means of transfer of heat.*

***Types of Central A/C system***

- Vapour compression system OR DX type
- Chilled water type

In the A/C system, the refrigerant is compressed and then suddenly expanded. This will result in drop of temperature of the refrigerant. This chilled refrigerant is then passed through a coil, through which the heat is transferred to the other media. When the heat transfer is directly taken place between refrigerant & air, it is termed as DX (Direct Expansion) type. In some of the case where the distance between the a/c plant and the volume to be cooled is more or divergent, a intermediate media is cooled first. This media is normally water. This chilled water is then circulated through the coil and a blower passes the air over this coil.  This in direct method of cooling is known as Chilled water system. The system of cooling and the flow chart is indicated in the given figure.




***A/C Refrigeration Cycle Flow Chart***

**Cooling Through–Window or Wall (Window Air Conditioning)**

The window air conditioner is some times fitted with electric resistance heating units for cold weather use.  The units are available up to 3 TR capacity.

During cold weather:

1. The refrigerating mechanism is turned off
2. The electric resistance heating units are turned on
3. The room air fan is turned on.  The same circulates warm air in cold weather and cooled air in warm weather.

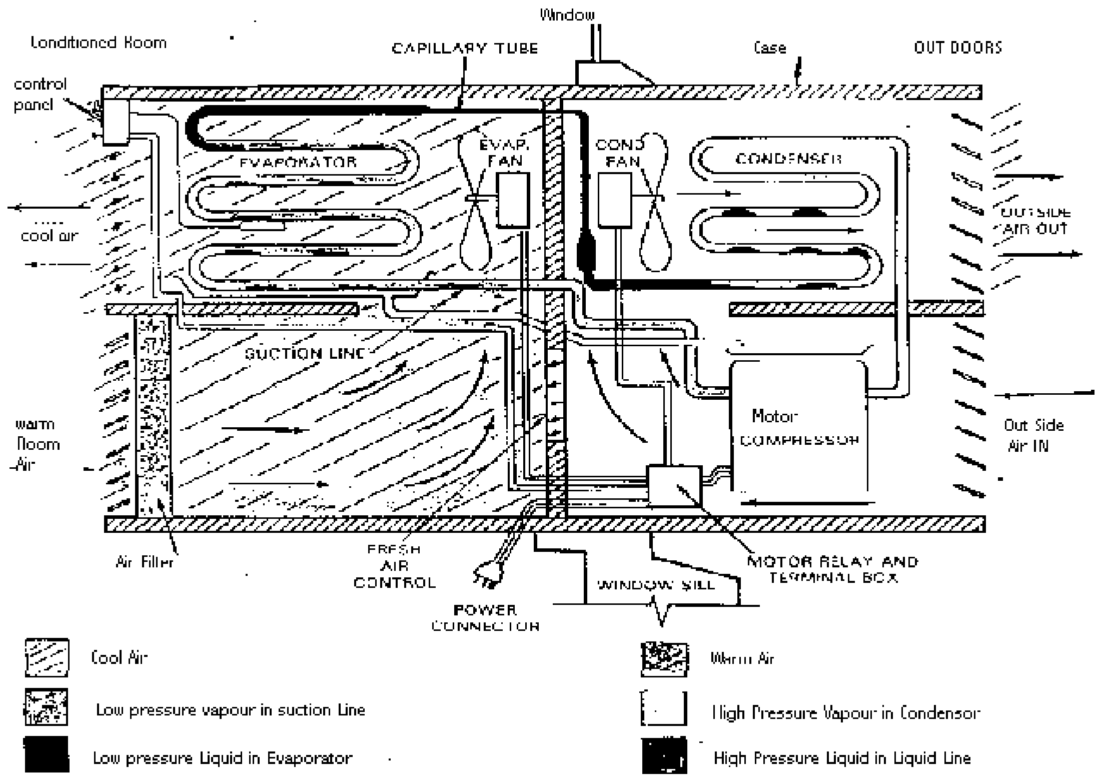



**Fig : Window A/C System**

Central Air Conditioner, Complete System –
Gas Heating, Compression System and Cooling with Humidity Control
This is an industrial type of system to condition the air. The heating is accomplished with gas. This is to increase the air temperature in winter season.

The cooling in summer season is accomplished by compressor system; this brings down the air temperature to a required level.

Fuel gas, burned in an atmospheric burner, is used for heating in this air conditioning system. A compression system using a A-frame evaporator in the furnace plenum chamber provides cooling.

The condensing unit is located outside the building. A single combination heating and cooling thermostat is often used. A humidistat controls the relative humidity in the conditioned space.

In winter, a humidifier in the plenum chamber adds moisture to the heated spaces. Summer humidity is controlled by condensation of moisture on the evaporator. A drain removes this moisture.

A blower forces warm air from the furnace into the rooms. This is located beneath the filter in the cold air return. The electrical power is turned on or off depending on the predetermined setting.

In summer, when cooling is required; the same airflow is used for cooling. However, instead of forced air passing through a heated chamber, passes across the cooled evaporator. This lowers the temperature of the air and also removes source moisture to reduce the humidity. The filter in the incoming air duct does air cleaning before air reaches the blower.

**Absorption Cycle**

Most large absorption air conditioning systems use water as the refrigerant and a Li Br (lithium bromide) water solution as the absorber.

Steam or hot water heats the water and lithium bromide solution. The water turns into water vapour, which is then condensed by a water-cooled condenser, the water then flows into the evaporator where it evaporates (under near vacuum pressure) and is absorbed by the lithium bromide at the absorber.

Three pumps maintain the pressure difference. First moves the solution, which is strong in Li Br back to the absorber and removes more strong Li Br solution from the concentrator. Second recycles water not evaporated in the evaporator back to the spray heads in the evaporator. Third moves the solution which is weak in Li Br up to the concentrator. Cooling water leaves the evaporator at 7°C and travels through the cooling coils located in the rooms to be air-conditioned. The water then returns to the evaporator at 12°C. The LiBr solution always stays in liquid form; the condenser cooling water also cools the absorber.

**Evaporative Condenser**

Many air conditioning systems use water-cooled condensers. An evaporative condenser may be used to cool the condenser vapour. The system comprises a conventional motor compressor, evaporator, thermostatic expansion valve, liquid receiver and evaporative condenser. The hot compressed refrigerant vapour is piped to the evaporative condenser (normally outside the building). Water supply is connected to a float controlled holding tank and pump circulates the water to spray over the condenser. A fan draws in air from the side of the condenser housing and forces it upwards through the top. This cools the water droplets by evaporation which then flows over the condenser to cool the refrigerant vapour into liquid. Some water is used up in evaporation and it is replaced (make up water) automatically using a holding tank and float mechanism.

**Cooling Tower**

As mentioned earlier, water-cooled condensers are common in many refrigeration and air conditioning systems as they are efficient and do not occupy much space. Often tap water are used to circulate over condensers and then discharged into sewers. This can use up large amounts of water (in some places, may be prohibited) and may be expensive. Economics apart, it is a national waste also.

In such cases, a cooling tower can be used to cool the water. Water is re-circulated through the condenser and sometimes the outer shell compressor. Some water has to be replaced due to loss in evaporation.

The cooling tower is a housing or shed in which air is drawn. It has a water spray arrangement and baffles. The fan forces air to cool the sprayed water, which is then collected in the holding tank. In the process, the heat from the water is transferred to air and the temperature of the water is lowered. The water is then circulated through the water-cooled refrigerant condenser. A float mechanism connected to the water spray maintains constant water level in the tank.

**Room Humidifiers:**

The function of a humidifier is to add and control moisture (relative humidity) in heated air for environmental comfort and reduce static electricity conditions. Most humidifiers in warm air systems are part of the furnace or the ductwork.

Humidifiers can easily the added to warm air-heating systems. Hot water, steam and most electric heating systems, however, require a separate cabinet type humidifier.

Various cabinet type humidifiers are used in the industry viz:

1. Plate type humidifier (low capacity)
2. Rotating drum type (for restricted space)
3. Rotating disk type
4. Fixed filter type
5. Fan type
6. Plenum/warm air duct humidifier (slings the water)
7. Plenum/duct electric type
8. Ultrasonic (piezoelectric) type

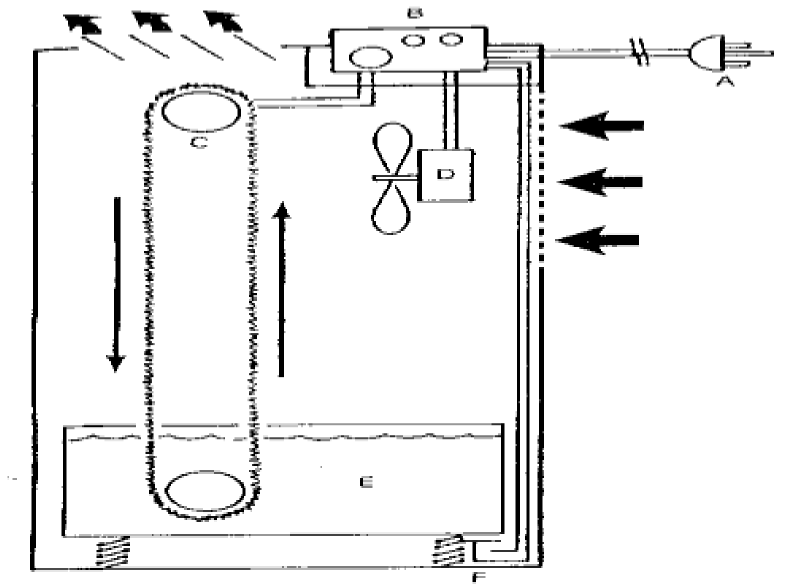
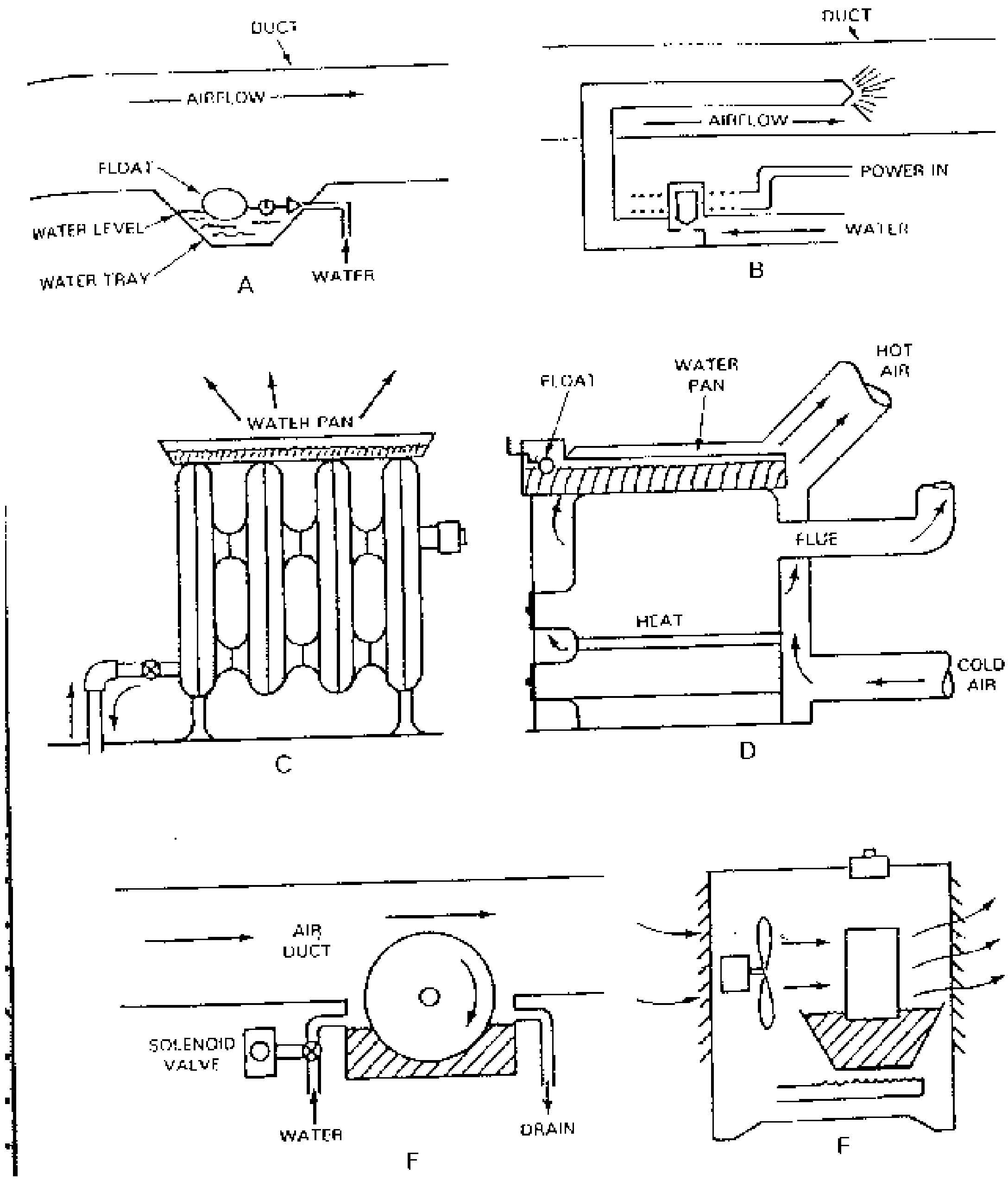


**Fig. Cabinet Type Humidifier**




***Types of Humidifiers***

A – Open water tray in warm air duct
B – Spray nozzle in warm air duct
C – Water pan on radiator
D – Water pan in top of warm air furnace
E – Wetted revolving screen in warm air duct
F – Space humidifier (by electric heat)

**Dehumidifiers:**

A dehumidifier is equipment, which removes moisture from the air by drawing air over a cold coil to condense the moisture in the air. It is usually a small hermetic refrigerating system that has both a condenser and evaporator in a cabinet. Air is drawn over the evaporator. Air moisture is condensed in the evaporator surface and collected in a pan and drained. The cooled air then moves over the condenser to reheat the air to a reasonable relative humidity. The device is used to 'dry' the air in damp places like basements etc.

In some installations, chemicals are used to absorb moisture from the air and then it is heated to remove absorbed moisture. The moisture is then exhausted out side and the chemicals are re-used.

**Circulating / Distributing Equipment:**

**Air Ducts**

Air ducts act as air carriers to deliver air to the conditioned space.
Ducts work on the principle of air pressure difference. If a pressure different exists, air will move from the higher-pressure area to the lower pressure places. The greater the pressure difference, the faster air will flow.

There are three common classifications of ducts:

1. Conditioned air ducts
2. Recirculating air ducts
3. Fresh air ducts

Ducts commonly used for carrying air are round, square or rectangular. Round ducts are more efficient based on volume of air handled per perimeter distance. That is, less material is needed for the same capacity as a square or rectangular duct. Resistance to airflow is also less. In addition, the round duct has a less outside area than a rectangular duct of equivalent capacity; it will have a much lower heat loss or gain.

The square or rectangular ducts conforms better to building construction. It fits into walls and ceilings better than round ducts. It is easier to install rectangular ducts between joists and studs.

**Types of Duct Systems**

There are several types of supply duct systems:

1. Individual round pipe system
2. Extended plenum system
3. Reducing trunk system

Return air systems are usually of two types:

1. Single return system
2. Multiple return system

The return systems can also be combinations of the two systems.
Duct systems may be installed in basements, in crawl spaces and just below ceiling level. Ducts may be made of galvanized sheet steel, aluminium sheet, glass fibre and plastic. Sheet lead is used when the duct must carry corrosive gases. Insulated ducts made from fiberboard have also been developed.

**Diffusers, Grilles and Registers**

Room openings to ducts have several different devices. They are used to control the airflow and to keep large objects out of the duct
There are many devices like Diffusers , Grilles or Registers
Diffusers deliver widespread fan-shaped flows of air into a room. Some diffusers cause the duct air to mix with some room air in the diffuser.
Registers are used to deliver concentrated air streams into a room. It may be one way or two-way adjustable air stream deflectors.

Grilles have an aesthetic purpose also in addition it control the distance, height and spread of air throw as well as the amount of air. Grilles have many different designs. Some are fixed and can direct the air only in one direction. Others are adjustable and can be set to send air in different directions. Fixed type grilles and usually used as covers for the return air duct.

**Dampers**

To ensure even air distribution in forced air systems, dampers are used to balance airflows or they can shut off or open certain ducts for zone control.

There are three types of dampers, some located in the diffuser or grille, some are in the duct itself. They are Butterfly , Multiple blade and Split damper

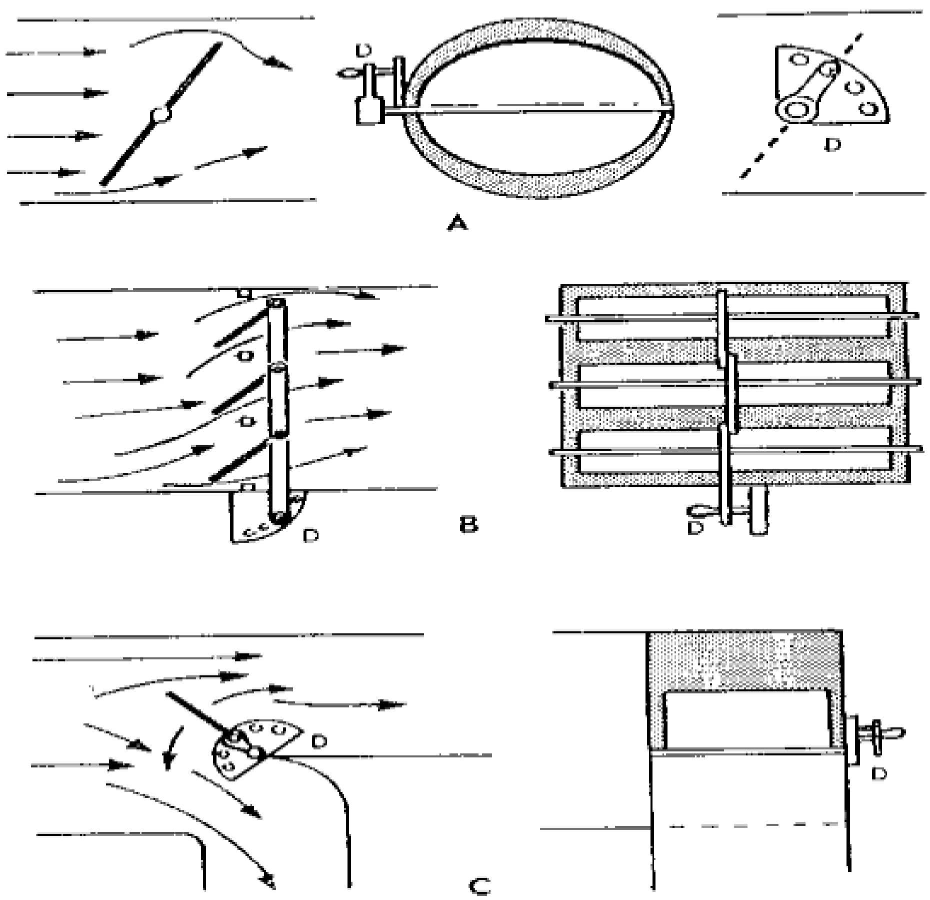



**Fig. Types of Duct Air Flow Controls**

**(Types of Dampers)**

**Air Circulation**

In air heating, three basic systems are used to circulate the air: They are Gravity, Intermittent forced air or Continuous forced air

The first type i.e. gravity system is no longer popular. Due to heavy energy lost before the air gets to the room being heated. The second type is widely used i.e. intermittent forced air system. A thermostat in the furnace plenum chamber is used to control the fan. Now a days the third type is becoming more popular i.e. continuous blower system. It provides a more constant temperature in rooms.

Systems designed to provide cooling as well as heating need additional capacity to move air. This is because a cubic foot of cooled air will not change the room temperature as much as the same amount of warmed air. In average conditions, a 30 to 50 per cent air flow increase is required.

## FANS AND BLOWERS:

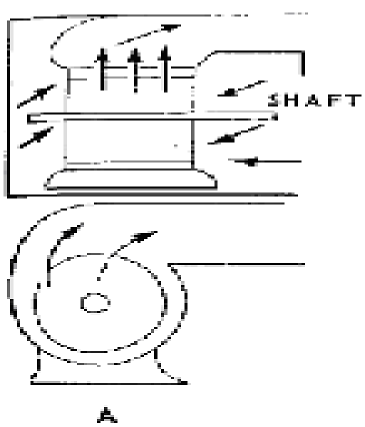
While discussing circulation, it would only be appropriate to briefly cover fans and blowers. Though essentially belonging to the compressor family of machines, they generally differentiate from compressors in their nomenclature. This is most likely due to the fact that the pressure development is marginal and does not affect much of volume reduction.

### Fans:

Fans are used for low pressure , generally the delivery pressure is less than 0.5 lbs/m2. Fans can also be either centrifugal, axial or mixed flow types. Fans are generally used to handle very large flow rates and low pressure. Main applications consist of Combustion Air, Draft, Cooling Towers and Fin Coolers, Drying Units, Ventilation System etc. While centrifugal fans would have axial entry and radial exit, the axial fans are of propeller design having axial entry as well as discharge. Unlike centrifugal fans, axial flow fans would not have ducts.

### Fans in Air Conditioner

Air movement is usually produced by some type of fan. Usually fans are located in the inlet of the air conditioner. There are several types of fans, but the two most popular types are: Axial flow (propeller) & Radial flow (squirrel cage)



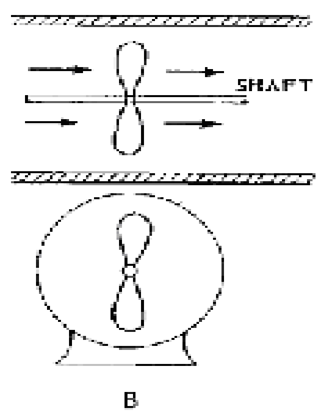




***Fig. Principal Types of Fans***

A – Radial flow & B – Axial flow

The fan construction tells which type it is. If air flows along the direction the axle is pointing, it is called axial flow. If the flow is at right angles to the axle (radius), it is called the radial flow.

The axial flow fan is usually direct driven by mounting the fan blades on the motor shaft. The radial flow fan is most often used on large installations. It is either directly driven or belt-driven.

**Blowers:**
Blowers develop little higher pressure in comparison to fans. They are used for pressure below 1.65 Psi. The centrifugal blower produces energy in the air stream by the centrifugal force and a velocity to the gas by the blades. The scroll shaped volute diffuses the air and creates an increase in the static pressure by reducing the gas velocity.

The performance of a centrifugal fan varies with change in conditions like temperature, speed and density of the gas being handled. Corrections must be applied to manufacturing standards with respect to operating conditions.

**Air cleaning Equipment:**
With air pollution as a growing problem, increasingly cleaning the air has become an important part of air conditioning.

Air may be cleaned in many ways, depending on the foreign matter contaminating it. The means of doing this is as under :

1. To remove solids such as dust, soot and smoke, one may use:
   (a) Centrifugal force (for large particles)
   (b) Washing the air (for particles that are wettable)
   (c) Screens (to block the larger particles)
   (d) Adhesives. The air impinges on a sticky surface and the dirt particles in the air stick to the adhesive.
   (e) Electrostatic (electrically charging the particles and adhering these particles to an opposite charge surface). Most of these cleaners have a screen to trap large particles, an electronic unit to remove particles as small as 0.001 micron, and a mat to trap the electron-treated particles. This uses hot water to wash the unit through a spray manifold. Water is released into the manifold and forced through a series of spray jets. The dirt is flushed off and drains to the bottom of the unit.

2. To remove liquids:
   (a) Liquid absorbents (chemicals to absorb or react with liquid)
   (b) Deflector plates
   (c) Settlement chambers

3. To remove gases and vapours (these are molecular size particles)
   (a) Condensation (cool the contaminant gas to its dew point and remove as a liquid).
   (b) Chemical reaction (to react with the gas)

(c) Some odors are removed by oxidation and by ultraviolet ray treatment. Ultraviolet lamp fixtures can be installed across the full cross section of the duct to do so.

4. Dilution: Activated carbon filters made from various substances including carbon from refining petroleum and coconut shells are used to adsorb odors. This carbon will adsorb (hold on the surface) as much as 50 per cent of its weight in foreign gases. It is possible to remove almost 100 per cent of the contaminants in the air, but to do so is expensive. Removal of 90 to 95 per cent is much more common and practical.

Exersise :

1. What is air conditioning? What one would expect to find in an a/c installation?
2. Where a/c system for raising ambient temperature is used? Name the systems for raising ambient temperature. Describe one of them.
3. What are the basic parts of a/c cooling system? Describe the cooling cycle
4. Draw and describe refrigeration cycle.
5. Describe an absorption cycle.
6. Write short note on:
   a) Window a/c
   b) Cooling Tower
   c) Room Humidifiers
   d) Air Ducts
   e) Dampers
   f) Types of fans
   g) Air Cleaning System

CVSRTA

# UNIT - 04

## ELECTRICAL INSTALLATIONS

***ELECTRICITY & ELECTRIC CURRENT***

It is comparatively easy to describe what electricity can do than to give a simple and direct answer to the question: - “ What exactly is meant by electricity? ” Electricity has become such a universal medium for transmission and utilization of energy that almost every one is familiar with its innumerable uses right from the earlier childhood. Electric energy is utilized for lighting, transportation, communication, heating, refrigeration, and various types of machine tools.

Turning back to the question regarding the nature of electricity, it may be noted that ancient Greeks were the first to observe that when amber is rubbed against a piece of silk cloth, it attracts light objects like pieces of paper etc. The Greek name of amber is “Electron” and thus the name “Electricity” was derived.

The field of electrical engineering is vast and diverse one. Often included under the general title of electrical engineering are the fields of electronics, semiconductors, computer science, power, lighting and electro-magnetic. The focus of this class and the notes is on professionals whose responsibility includes judging and evaluating an electrical machine in the right perspective of engineering.

The following chapter provides a brief review of basic concepts, which serves as background for the professionals in the field of valuation. A thorough understanding of these concepts, while helpful, is not essential to understanding the remaining part.

***ELECTRICAL UNITS :***

Table 1.1 and the following texts provide definitions of the basic electrical quantities.

**Table 1.1 Electrical Quantities in MKS units.**

| Quantity | Symbol | Definition | Unit |
|---|---|---|---|
| Force | f | Push or pull | Newton |
| Energy | wh | Ability to do work | Wh or KWH |
| Power | p | Energy/unit time | Watt |
| Charge | q | Integral of current | Coulomb |
| Current | I | Rate of flow of charge | Ampere |
| Voltage | v | Energy/unit charge | Volt |
| Magnetic Flux Density | H | Force /unit charge momentum | Tesla |
| Magnetic flux | ∅ | Integral of magnetic flux density | Weber |

**"Force":** A force of 1 newton is required to cause a mass of 1 kilogram to change it's velocity at a rate of 1 meter per second per second.

**"Energy":** Energy in a system is measured by the amount of work, which the system is capable of doing. The joule or watt-second is the energy associated with an electromotive force of 1 volt and the passage of one coulomb of electricity.

**"Power":** Power measures the rate at which energy is transferred or transformed. The transformation of 1 joule of energy in 1 second represents an average power of 1 watt.

**"Charge":** Charge is a "Quantity" of electricity .The coulomb is defined as the charge on 6.24 x $10^{18}$ electrons or as the charge experiencing a force of 1 newton in an electric field of 1 volt per meter or as the charge transferred in 1 second by a current of 1 ampere.

**"Current":** The current through an area is defined by the eloctric charge passing through per unit of time. The current is the net rate of flow of positive charges. In a current of 1 ampere, charge is being transferred at the rate of 1 coulomb per second.

**"Voltage":** The energy transfer capability of a flow of electric charge is determined by the potential difference or voltage through which the charge moves. A charge of 1 coulomb receives or delivers an energy of 1 joule in moving through a voltage of 1 volt.

**"Magnetic Flux Density":** around a moving charge or current exists a region of influence called a "Magnetic Field"." The intensity of the magnetic effect is determined by the magnetic flux density which is defined by the magnitude and direction of a force exerted on a charge moving in the field with a certain velocity. A force of 1 newton is experienced by a charge of 1 coulomb moving with a velocity of 1 meter per second normal to a magnetic flux density of 1 tesla.

**"Magnetic Flux":** Magnetic flux quantity I, in Weber, am obtained by integrating magnetic flux density over an area.

**The idea of electric potential & current: -**

***The Voltic Cell***

The figure here indicates a simple voltic cell. One copper plate and one zinc rod are immersed in dilute $H_2SO_4$.

Flow of electrons

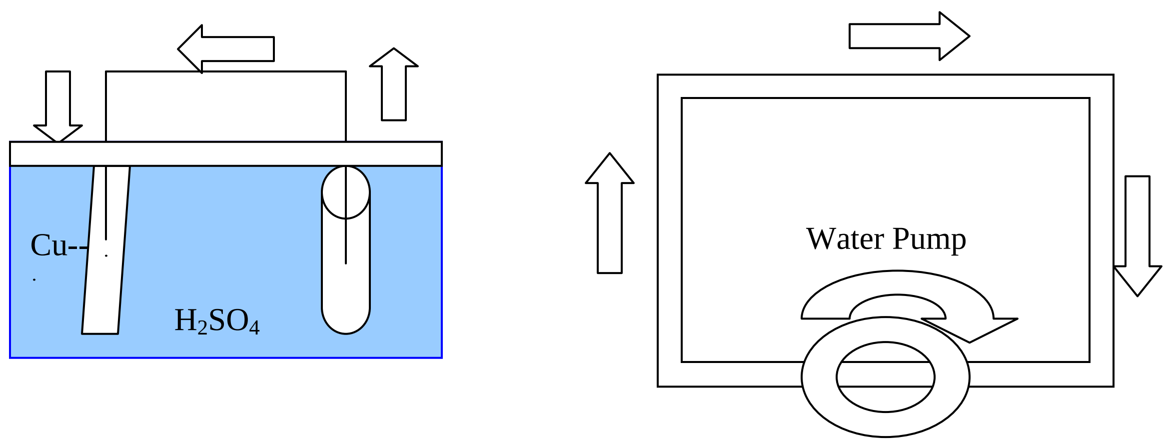



**Figure 1.1 Voltic cell & it's analogy**

Due to chemical reaction the electrons are removed from copper plate and deposited on zinc rod. Thus Cu becomes positive and Zn becomes negative charged. As large number of electrons gets deposited on zinc, they are being attracted by anode but due to the force setup by chemical reaction, they cannot take internal route. Now if a conductor connects the two electrodes, then the electrons will travel from Zn to Cu via this route. This flow is continuous due to continuous chemical reaction and the balance is maintained between the levels of electrons. The direction of current is the direction of positive charge i.e. from Cu to Zn.

This phenomena is similar to that of water pump, which while working maintain continuous flow(current) through pipe.

This principle of electric current production is used in storage battery.

Let us understand some basic rules of electricity :
RESISTANCE: -
If a battery is connected with a wire to make a complete circuit, a current will flow.(Refer figure 1.2) The current that flows is observed to be proportional to the applied voltage .The constant that relates the voltage and the current is called “resistance”. The relation can be expressed by an equation :

**V=R I** where

**v** – volts, **I** – current in amperes and & **R** – resistance in Ω ( Ohms)

This expression is called **Ohm’s Law.**

Since voltage is the energy per unit charge and current is the charge per unit time, the basic expression for electrical energy per unit time or power is:

$$P = VI = I^2R$$

The resistance is also defined as a measure of the ability of a device to dissipate (in the form of heat) power.

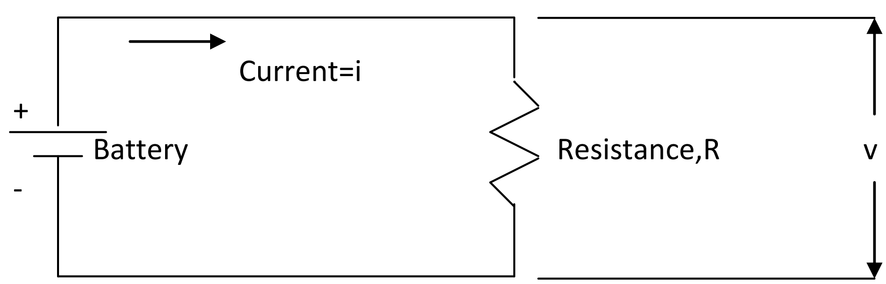



Figure 1.2 OHM’S LAW

**CAPACITANCE :-**
Now let’s connect the battery to two flat plate separated by a small air space between them. (Refer figure 1.3) When a voltage is applied, it is observed that positive charge appears on the plate connected to positive terminal of the battery and negative charge appears on the plate connected to the negative terminal of the battery. If the battery is disconnected the charge persists. Such a device, which stores charge, is called a capacitor.

If a device called signal generator, which generates an alternating voltage, is connected in place of the battery, the current is observed to be proportional to the rate of change of voltage. This relationship can be expressed in the form of a equation as: **I = c.dv/dt**

Where “c ” is a constant called “capacitance” ( Measured in farads ) and dv/dt represents the rate of change of volts.

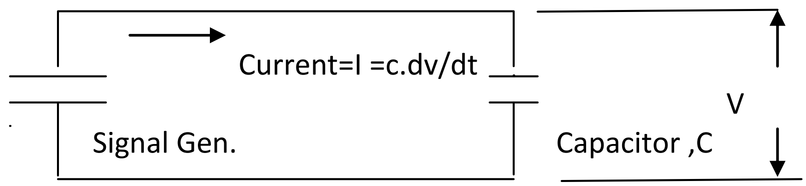



Figure 1.3 CAPACITANCE LAW

**INDUCTANCE :-**

If the signal generator is placed in a circuit in which a coil of wire is present, it is observed that only a small voltage is required to maintain a steady current. (refer figure 1.4 ) However to produce a rapidly changing current, a relatively large voltage is required. The voltage is observed to be proportional to the rate of change of the current and can be expressed as:

**V = L . di/dt**

Where “L” is the constant called “ inductance ” (measured in henrys-H ) and di/dt is the rate of change of current.

Additionally it is observed that, when a direct current is removed from an inductor the resulting magnetic field collapses thereby “ inducing “ a current in an attempt to maintain the current flow. Inductance is the measure of the ability of a device to store energy in the form of a magnetic field.

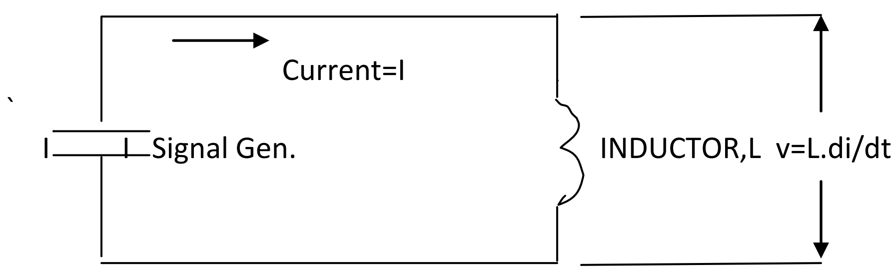



**Figure 1.4 INDUCTANCE LAW**

EXERCISE :

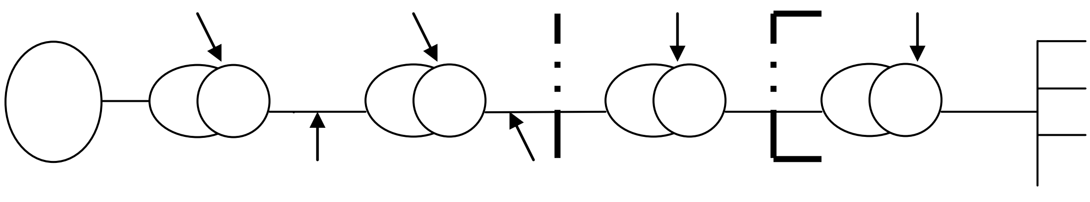
1. Define the terms
   Force, Energy, Power, Voltage & Current
2. Describe Voltic cell and it’s analogy with water pump.
3. What is Ohm’s Law. Explain in brief the relation between Voltage applied, Current passing through and the resistance.

**Transmission & Distribution**

**General layout of the system**

The conductor system by means of which electric power is conveyed from a generating station to the consumer's premises may, in general, be divided in to two distinct parts namely transmission & distribution network. This would be made-up of elements shown in the single line diagram below:

11/132KV 132/33KV Receiving 6.6KV/415V
step up step down Station 33/11 KV (or 6.6KV)
Distribution
transformer transformer (RS) Transformer
transformer **Consume**r



**Generator** Primary Secondary Primary
Transmission Transmission
Distribution

**Fig 1 : Typical Power System Diagram**

The power generated at a generating station is usually at 11 KV level. For economics of transmission it is stepped up to 66KV or 132 KV.at generating station itself. From here it is transmitted over a long distance through overhead lines. This is called a primary transmission. The electricity company set up a receiving station near the utility point, where this Extra High voltage is stepped down to High Voltage (the diagram above show this stepping down in two phases but it may be in one phase also) This high voltage is carried to the users door step. This is secondary transmission. The user industry (for small industries the electricity company in the vicinity) steps down this voltage to Low Tension (415V) This distribution is called primary distribution. Large industries may use both the levels of voltage i.e. 6.6 KV (6600V) & 415 V. Small scale units use only LT supply i.e.415V.

It has to be realized that one or more of these elements may be missing in any particular system.

The transmission voltage to a large extent is determined by economic considerations. High voltage transmission requires conductor of smaller cross section resulting in saving of copper or aluminum. But the cost of insulation, transmission structures & substation equipment increases. Hence the economical voltage of transmission is one, which balances these two aspects. As a rough thumb rule 1000volts per mile of line length is considered.

**Power Flow Concept:**

Power flowing is analogous to water flowing in a pipe. To supply several small water users, a large pipe serves the plant at a high pressure. Several branches from the main pipe service various loads. Pressure reducing stations lower the main pressure to meet the requirement of each user. Similarly, a large feeder at a high voltage serves a plant. Through switchgear breaker, the main feeder is distributed into smaller feeders. The switchgear breakers serves as a protector for each of the smaller feeders. Transformers are used to lower the voltage to the nominal value needed by the user.

**How to design a single line diagram:**

An overall one-line diagram indicates where loads are located and how they are fed.

- The first step is to establish loads and their locations by communicating with the various engineers.
- The next step is to determine the incoming voltage level based on available voltages from the utility company and the distribution voltage within the plant.

(a) For single buildings and small complexes without heavy equipment loads, incoming voltage levels may be 230 or 415 volts. For small industrial plants to 10,000 KVA, voltage levels may be1100, 3300, 6600 or 11.0KV.

(b) For medium plants 10,000 KVA to 20,000 KVA voltage levels may be 11.0 KV.

(c) For large plants above 20,000 KVA, 11.KV or 33 KV are typical values.

(d) For mega size plants, 132 KV voltage level is becoming popular

The advantages with the higher voltage levels are:

(a) Feeders and feeder breakers can handle greater loads , since for a given power, as the voltage goes up the current reduces. The capacity of a conductor is to carry current. Hence as the voltage goes up the system can carry higher load power. Of course the higher voltage means higher insulation level, which also costs. (More economical at certain loads.)

(b) For feeders which serve distant loads, voltage drops are not as noticeable on the higher voltage system.

- The third step is to establish equipment types, sizes and ratings.
- The last step is to determine the system reliability required. The type of process and plant requirements is the deciding factors. The number of feeds and the number of transformers determine the degree of reliability of a system.

**Types of Primary Distribution System**

The three commonly used primary distribution systems for industrial plants are the simple radial, primary selective, and secondary selective systems.

- The Simple Radial System is the most economical. As Figure 2 indicates, it is comprised of one feed and one transformer.

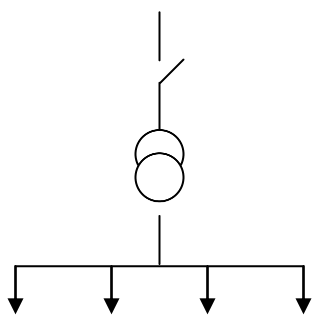


**Figure 2: Simple Radial System**

- The Primary Selective System is comprised of two feeds and two disconnect switches. for primary transformer See Figure.3.

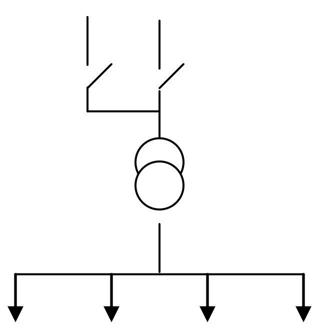


**Figure 3: Primary Selective System**

- The Secondary Selective System is the most reliable and the most expensive. As Figure 4 indicates, it is comprised of two complete substations joined by a tie breaker.

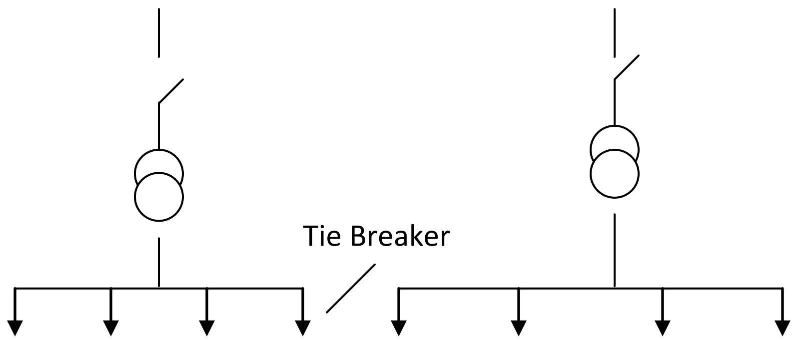



**Figure 4: Secondary Selective System**

**General Tips for Distribution System:**

- Always size unit substations with growth capacity (25% growth Capacity for transformers is common practice).
- A transformer with fans increases its rating. A 1000 KVA dry-type transformer with fans is good for 1333 KVA (33% increase). For an oil-type transformer a factor of 25% is used. Fans should only be considered for emergency conditions or for expanding existing plants.
- The question comes up as to where to locate equipment. Incoming Switchgear is usually located near the property line so that the utility company can gain easy access to the equipment. Substations and motor control centers are usually located indoor in electrical rooms.

**Electrical Rooms:**

The electrical engineer should keep in mind the following when specifying electrical room requirements.

- Do not allow roof penetrations. Any roof opening increases the risk of fluid entering the electrical equipment.
- Do not allow other trades to use electrical room space.
- General ambient temperature should be 40°C. (Special equipment, such as computers, may require air conditioning.)
- Lay out electrical rooms with the following in mind.
  - (a) Sufficient aisle space and door clearances should be provided to allow for maintenance and replacing of damaged transformers and breakers. Use the recommended clearances established by the vendor.
  - (b) Double doors of adequate height (usually 8 feet) should be provided at exists in order to remove equipment.

While designing the electrical lay out, one must keep certain statutory requirement in mind. The Indian Electricity Act specifies the safety aspects for all electrical equipment. In the following Chapter The basic scope and some of the important provisions are indicated in brief. These provisions are important for loss assessors to decide the non-compliance of the statutes.

EXERCISE :

1. Draw and describe the general electrical distribution diagram.
2. Explain the power flow concept in electrical engineering. Explain the same giving analogy.
3. What atr the advantages of higher transmission voltage ?
4. Describe the types of primary distribution system.
5. What are the requirement of electrical sub station room ?
6. Write short notes on :
    a. Design a single line diagram of an electrical system
    b. Secondary selective distribution system
    c. Tips for distribution system

*Main Switchgear for Industrial Installation*

The power received at the doorstep of the unit is required to be distributed throughout the facility for utilization. Here we will be discussing some of the equipment used for the purpose and the safe ways of doing so. We shall also see selection & lay out of equipment for distribution like Circuit Breaker, Motor Control Centre etc.

*Electrical Equipment*

Electrical equipment commonly specified is as under:

- **Switchgear Breaker –** used to distribute power and provide over current protection for high voltage applications.
- **Unit Sub Station -** The high voltage received is stepped down to a usable voltage level at unit s/s. It consists of high voltage dis-connect switch, transformer & low voltage breakers.
- **Motor Control Centre -** is a sheet steel structure which houses starters, circuit breakers or fuses for motor control. It consists of following:
  - ✓ Thermal over load relays which guards against motor over load.
  - ✓ Fuse Disconnect Switch OR breaker, which protects cable or / and motor from over load / short circuit and also can be used as dis connecting device.
  - ✓ Contactors whose contacts are capable of opening or closing the power to motor.
- **Panel board / Switchboard –** breakers used to distribute power & provide over current protection to motor control centers, lighting receptacles and miscellaneous power circuits within the building.

**High Voltage Breakers:**

In a typical medium-duty installation, the incoming supply of 11KV rating can go through an oil or gas filled ring main unit before the step-down transformer.

Oil immersed circuit breakers are located in oil-filled ring main units. These breakers can be further classified by its operating mechanism:

- Manual operation,
- Solenoid operation,
- Motor spring operation and
- Handspring operation.

The capacity rating of these units is three phase 11KV, 650 to 1250 amps normal current capacities and 20 to 25KA fault current levels. The circuit breakers are housed in cubicles.

In a gas filled ring main unit, SF6 (sulphur hexafluoride) gas circuit breakers are used and they are housed in cubicles. Their operating mechanism is of either handspring or motor spring types. Their fault current levels 20 to 40KA.

Other high voltage circuit breakers are the air blast and vacuum types. These circuit breakers can be fitted in main switchboards. Air blast circuit breakers come in either 'plug in' or withdraw able cassette units in three or four pole configuration. Their operating mechanisms are like that of oil-immersed circuit breakers. Normal current capacities range from 800 to 4000amps and fault current level up to 50KA.

Vacuum type circuit breakers are housed in cubicles and their operating mechanisms are either of manual solenoid, motor spring or handspring. Normal current capacities of VCBs are up to 2500 amps and fault current level up to 40KA.

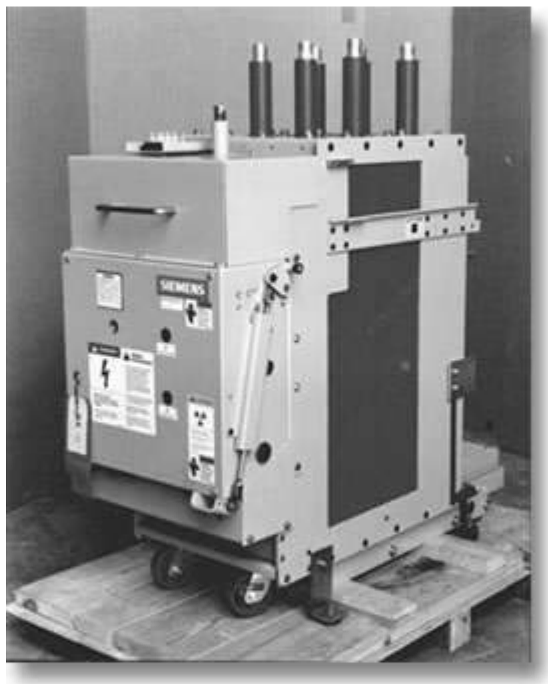



**Fig : Vacuum Circuit Breaker**

All four types of circuit breakers can also be located in main switchboards, Air-blast, oil immersed and vacuum breakers are commonly found in older installations. Although SF6 circuit breakers have been in use in primary distribution (i.e. from electric generating plants to various transformers in the National Grid) for a long time, its use in secondary distribution, i.e. within industrial installation, is relatively new. Increasingly, the use of air-blast and oil-immersed types is being phased out as air types are relatively expensive and due to its flammability, oil-immersed types pose fire risks. Both the vacuum and SF6 circuit breakers, considered as dry-type, are favored due to its safety in use. Once the supply has passed through the circuit breakers without triggering any faults, it goes into the step-down transformer.

**Transformers:**

The transformers used in industrial plants are either of liquid filled or dry types. The liquid-filled types are suitable for use outdoors in hostile environments and for arduous duty cycles. They can come into different forms such as ground / floor mounting, pole mounting and unit substation (known as packaged substations) transformers in a typical range from 500KVA to 5MVA and voltage levels up to 33KV. Liquid cooled transformers are used for a wide variety of applications for both AC and DC supply, typical examples of which are: furnace heating, mining, electro-plating, cathodic protection, thruster drives and converters. Cooling for these transformers is normally with both oil and air circulating by natural convection (ONAN). Improved cooling can be obtained by the use of fans (ONAF), oil pumps (OFAN) or both (OFAF). In locations where fire risks must be greatly reduced, oil is replaced by silicone liquid or other synthetic fluids (LNAN).

Dry-type transformers are available as resin cast transformers and aramid insulated transformers. Resin cast transformers covers voltages from 11 to 35KV and a ratings from 500KVA to 15MVA. Forced air-cooling systems can be fitted to increase continuous ratings by 40 to 50%. These transformers are also suitable for rectifier applications and other special purposes, such as, rapid transit systems and air and iron core reactors. The aramid-insulated transformers operate at 11KV primary voltage with rated power output of 500KVA to 2.5MVA. This type of transformer is suitable for medium voltage distribution needs. Dry-type transformers have a major advantage for installation in hazardous areas, as they do not contain any materials that might add to a fire or pollute the environment.

**Fig: Power Transformer**

The function of the transformers at this stage is to step down the incoming supply of 11KV to the required voltage level commonly to 415V into the main switchboards. In some cases such as electric are furnaces; the supply is stepped down to 3300V.

One of the important accessories of transformer is a Tap Changer. Tap changer is a switch, which either adds or cuts off a section of the winding. This is achieved by taking out different leads of winding and connecting only the required section By doing this, the voltage at secondary side can be increased or decreased.

The cost of the transformer is mainly contributed to copper, as it is active part in the winding. The other parts are insulation, oil and the tap changer. The life of a transformer is very long since there is no wear and tear of any of the components. (Except tap changer). Also due to heavy copper content, the scrape value of the transformer is high.

***Open-Type Switchboards***

An open-type switchboard is one, which has exposed current-carrying parts on the front of the switchboard. It is rarely used in low voltage installations due to safety hazards. It is normally confined to extra low-voltage installations.

**Protected Type Switchboards**

A protected switchboard is one where all of the conductors are protected by metal or other enclosures. They may consist of metal cubicle panel, or an iron frame upon which is mounted metal-clad switchgear, They usually consist of a main isolator, bus bars, circuit breakers or fuses controlling outgoing circuits, power transformers, power correction factor correction panels, motor control and metering equipment. Depending on the equipment they control they can be called as Motor Control Centre (MCC) or Power Control Centre (PCC)

**Power Factor Correction**
The power factor is the ratio of the True power, i.e. the power consumed by a circuit, to the apparent power, i.e. the power supplied to the circuit. When the current and voltage in a circuit are in phase, the true power equals the apparent power and the power factor is 100%.

If the current and voltage go out of phase, electrical energy is fed back to the source and is not consumed by the motor. Power supplied at a low lagging power factor requires a larger current than is necessary for the same power at a higher power factor. A large cable (and therefore larger and more expensive switchgear and transformers) is needed to carry the current, and therefore the capital required by the utility to supply power is higher and charges to the consumer increase accordingly. Therefore consumers install equipment to correct the power factor, viz:

(a) Static capacitors
(b) Phase advancer
(c) Synchronous motors

The metering equipment involved in measuring the power factor variation would include kilovolt-ampere and kilowatt-hour meters.

**Rising Mains Busbar System:**
Rising mains bus bar systems are frequently used for vertical rising mains power distribution. They are rarely encountered in industrial plants except for flatted factory units and multi-storey buildings. The system comprises copper or aluminium bus bars of capacities of 100A to 800A with two, three or four conductors. These are usually metal clad and are made in various lengths up to 4 meter sections. All insulated rising bus bar systems are also available.

Tap-off boxes with fuse links or fuse switches are provided for distribution to various distribution boards. The fuse switches can be of various maximum current ratings from 20A to 800A in SPN, DP, TP and TPN configurations, the fuses used are generally of HBC or circuit breaker types.

**Distribution Boards**
Definition: A unit comprising one or more protective devices against over current and ensuring the distribution of electrical energy to the circuits.

Distribution boards are normally selected to provide plenty of wiring space and with terminals of adequate size to accommodate the cables, which will be connected to them. This is to ensure that when larger than would normally by required cables are installed, in order to limit voltage drop, they would be adequately accommodated.

**Types of Distribution Boards**

There are three types of distribution boards, segregated by the way it is clearing the short circuit, namely:

(i) Those fitted with rewire-able fuse links
(ii) Those fitted with HBC (high breaking capacity) or HRC fuse links
(iii) Those fitted with miniature circuit breakers

i) The rewire-able fuse is now rarely used for main distribution boards as the most common case of overheating and breakdown of switchgear is due to the fittings of incorrect sizes of fuse wire. It is unreliable as it deteriorates, due to oxidation and scaling, resulting in a reduction of its carrying capacity. Other disadvantages include a low rupturing capacity and cannot be relied upon to clear heavy faults. The only advantage it has is its relative cheapness. It costs practically nothing to renew.

ii) Distribution boards fitted with HRC fuse links are popular as they give discriminate protection against over current and will also clear short-circuit currents rapidly and safely up to their rated capacity. This means that the fuse will blow off if the current (or load) increases the rating. The time of blowing (or the time it can sustain the over load) is inversely proportional to the extent of over load. Higher the current, faster it clears the fault. In case of short circuit, the current is very high and hence the time required to clear this short circuit fault is very less. (It is almost instantaneous)

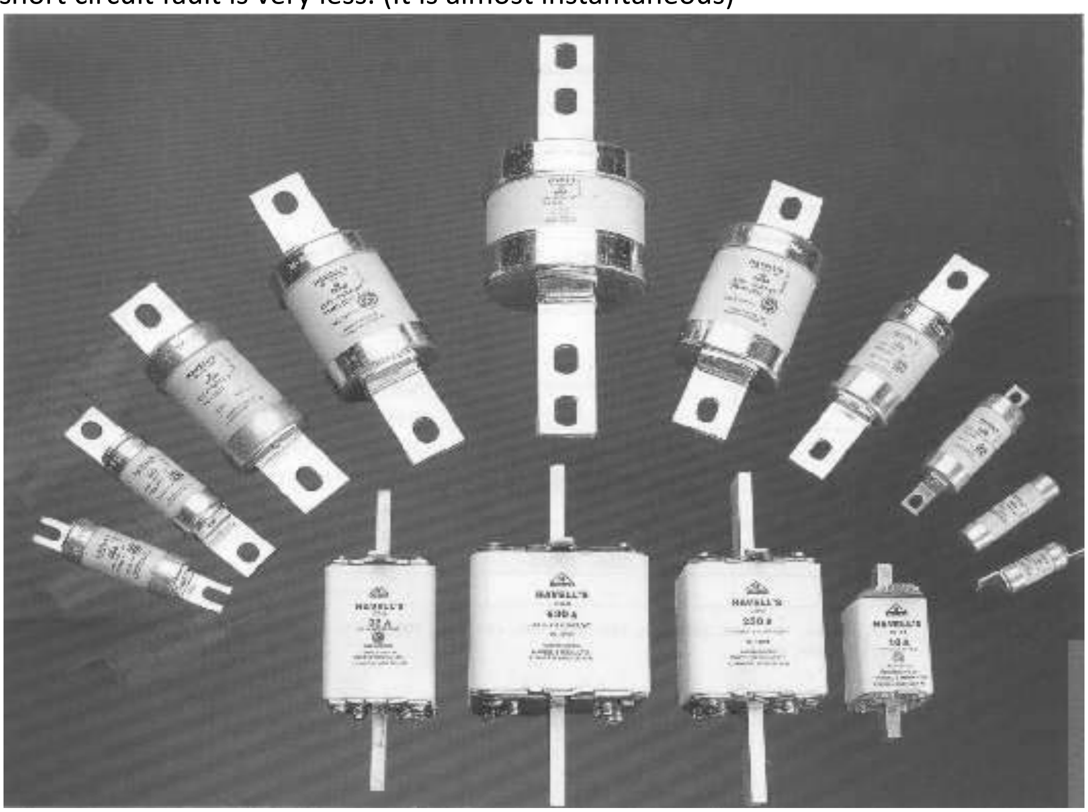


**Fig: Various Types of HRC Fuse Links**

HRC fuse links, are designed so that they will withstand as much as 10 times full load current for a few seconds, by which time the fault will probably be cleared by a final circuit protective device or a local control gear. When main HRC fuses are carefully selected and graded so as to function with discrimination, the final circuit protective device will take care of all normal overloads and main HRC fuse will operate only when the short circuit is of such magnitude that there is possibility of a dangerous build up of a heavy short circuit current, or in the event of cumulative load of the final circuits exceeding the rating of the main fuses.

iii) Distribution boards fitted with miniature circuit breakers are more expensive in their initial cost, but, they have much to commend them, especially as they can incorporate an earth leakage trip.

Modern circuit breakers are designed to handle safely, heavy short circuit currents in the same manner as HRC fuses. The circuit breaker has several advantages over any type of fuse. Briefly these are:

1. In the event of an overload or fault, all poles are simultaneously disconnected from the supply.
2. Some types are capable of remote control by means of emergency stop buttons
3. Some types have overloads capable of adjustment within proper limits
4. Circuits can be closed again quickly
5. They can be used in place of switches to control lights

Miniature circuit breakers are obtainable in ratings from 0.5A to 60A, all of which are of the same physical size, and are therefore, easily interchangeable (not to be interchanged without ensuring that the cables they protect are of the correct rating).

Distribution boards can be classified into four configurations, namely:

(i) single pole and neutral (SPN)
(ii) double pole (DP)
(iii) triple pole (TP)
(iv) triple pole and neutral (TPN)

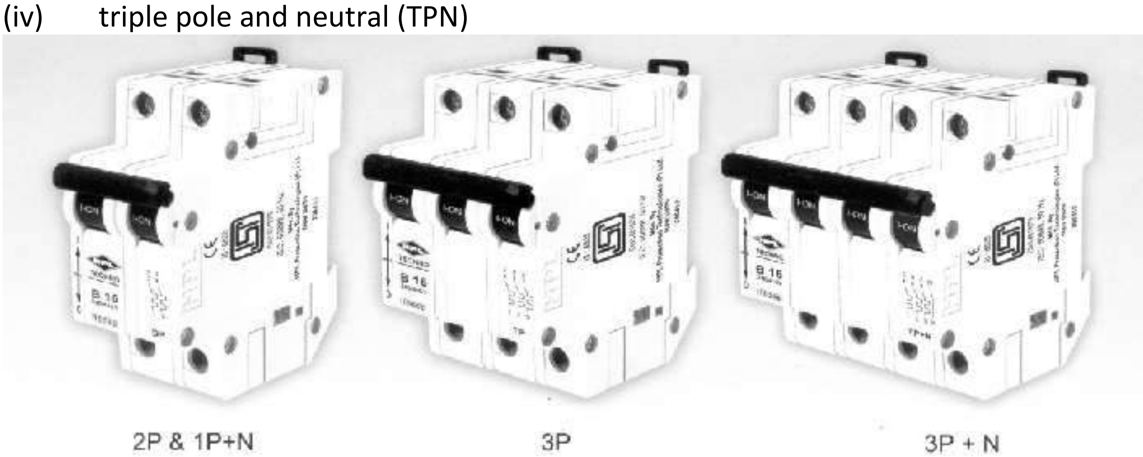



**Fig: Miniature Circuit Breakers**

Within each of these configurations, the number of ways available in it can further describe by the number of ways available in it and the maximum rated current per way. The distribution boards can be described, for instance in “___ way x ___ Amp triple pole and neutral distribution board”.

The fuse boards cover a range from 20A to 200A: The 20A and 32A up to 12 ways in SPN, DP and TPN configurations; 63A up to 10 way, 100A up to 8 way in SPN and TPN configurations; and 200A up to 6 ways in TPN only.

From the distribution boards, cables are drawn to feed various motors that drive various machines and the means of isolation could be either the switch fuses in the distribution boards or isolator boxes or switches at the motors. Isolators are important for the purpose of mechanical maintenance, as it ensures that all voltage is cut off from the machine, which is being worked on.

EXERCISE:

1. Explain the working principle and application of the following :
    a. Switchgear Breaker
    b. Unit s/s
    c. Motor Control Centre (MCC)
    d. Transformer
    e. Types of switch boards
2. What is Power factor Correction ? Why it is done ?
3. Describe all three types of Distribution boards.
4. Explain the advantages of circuit breaker over fuse.
5. What is MCB?

**BATTERY & BATTERY CHARGER:**
In an electrical s/s, DC supply is used as a control supply for switchgear. The main idea of having separate ind independent supply is to cope an eventuality of total power failure. If control supply is taken from normal supply then at the time of emergency we may not get any power to restore back the supply.

**Introduction:**
Station battery charger is used to supply the control power to the electrical switch gear like breakers, etc. which need the DC supply for its operation and in case of failure of electrical power the control power continue to be fed by the battery. Generally when the electrical power is available, the charger develops DC power through rectifier and feeds the load and at the same time it also keeps battery in charging, thus maintaining the battery healthy.

Charging Equipment:

Battery charging equipment consists of
1) Float Charger & 2) Boost charger

Battery charging equipment comprises of float charger and float cum boost charger. Float charger is one which keeps the charged battery in healthy condition by supplying small amount of charge to the battery. It also feed to the DC load (or station load)

Float cum boost charger has two modes of operation, constant voltage mode and constant current mode. In constant voltage mode it works as float charger and in constant current mode it works as boost charger. After getting battery discharged during input power failure, when AC power is restored, the battery needs to be charged. Boost charging is being done off line. For charging the battery or when giving equalizing charge to the battery, float cum boost charger is used in its constant current mode. During boost charging the battery tap which is connected the load through a blocking diode maintains DC continuity on load, in case of failure of input power while batteries are on boost charging, float charger is also kept `ON'. Float charger supplies the station load.

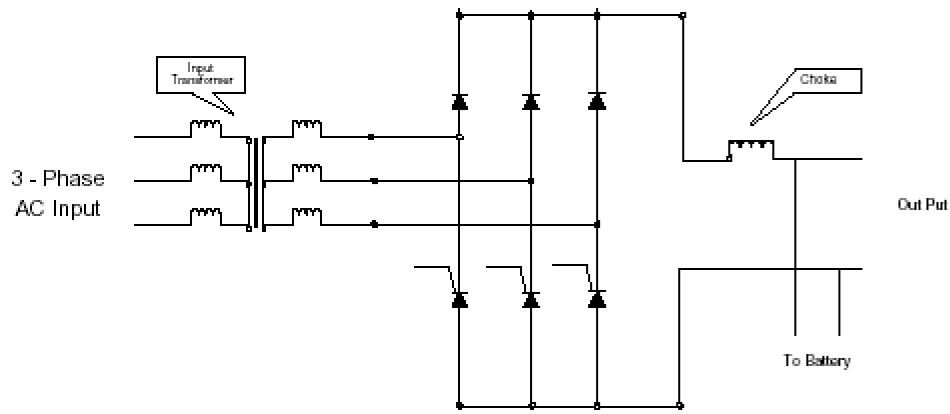
Basically there are two types of rectifiers used in the battery charger. Namely:
□□Full-wave half controlled rectifier. & □□Full-wave fully controlled rectifier.

We will try to understand some basic working of the charger. Though an effort is made to explain in as simple a way as possible, due to basic electronics involved, it may be difficult for a student who do not have a science background, to understand it. As a valuer, the in side working knowledge is surely helpful in analysys, however, lack of it will not be a hindrance.

**Full Wave Half Controlled Rectifier:**

In half controlled rectifier 3 nos. SCRs and 3 nos. Diodes are used for 3 phase rectifier bridge. Similarly in 1 phase rectifier bridge 2 nos. SCRs and 2 nos. Diodes are used. In half controlled rectifier bridge one half cycle cannot be controlled and thus control is limited to some extent.

3 - Phase Full wave Half Controlled Rectifier




**3.1 Operation of three phase Full-Wave Half controlled rectifier Bridge**

When the charger is connected to the an appropriate AC voltage source, the voltage is connected to the primary of the main transformer through a 3 pole contactor and fuses or 3 pole circuit breaker. The transformer steps the voltage up or down as required for the specific DC output voltage and provides galvanic isolation between battery and input supply. The transformer‘s secondary is connected to the full wave bridge rectifier assembly.

The bridge is the heart of the power circuit. This assembly is a standard three phase full-wave half controlled silicon bridge. The voltage control is accomplished by the application of a positive pulse to the gate terminals of the SCR at the desired time. Before the “pulse” is applied, the SCR is “open”, and no current flows in the circuit. However, as soon as the SCR is fired, it operates as a standard silicon diode until the forward current is reduced to almost zero. Charger output control can therefore be accomplished by changing the firing angle.

The bridge rectifier provides a variable DC voltage at its output.
The quick acting fuse protects the bridge in case of accidental short circuits at the output.

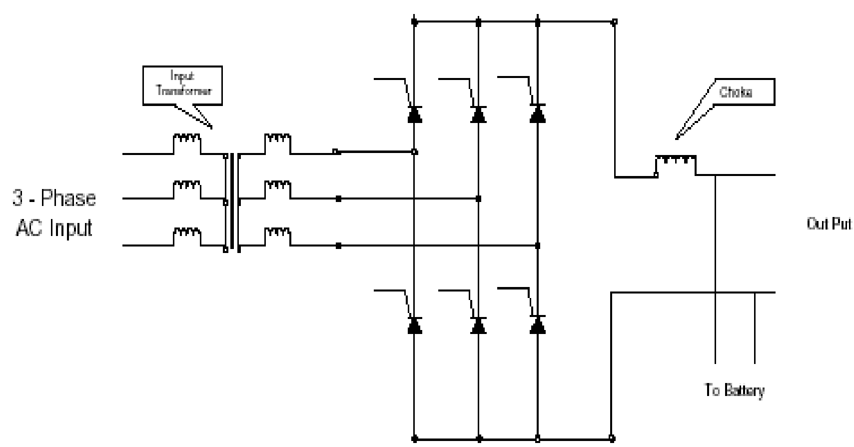
The different function, protection and sensing is done by various electronics circuits for the proper functioning of the charger. The general description and constructional detail are given below.

**Protection:**
The charger is protected by the following:

* * AC input fuses.
* * AC input overload relay.
* * DC output fuse (or Breaker)
* * AC surge suppresser.
* * Snubber.( RC circuit)
* * Automatic current limiting.
* * Reverse battery protection.

**Fully Controlled Rectifiers:**
In full controlled rectifier 6 nos. SCRs are used for 3-phase rectifier bridge. Similarly in 1 phase rectifier bridge 4 nos. SCRs are used. In full controlled rectifier bridge both the cycles can be controlled and hence better regulation is possible. So normally full controlled rectifiers are used for the applications where the accuracy is main criteria. Also better ripple reduction is possible in fully controlled rectifier than the half controlled rectifier.

3 - Phase Full wave Full Controlled Rectifier




**SCR Controllers for 3 phase Fully Controlled Bridge:**
This controller is designed for complete control of the fully controlled SCR bridge rectifier consisting of six SCRs (Thyristors)

The controller senses both the voltage and current of the bridge rectifier, processes both these signals and provides appropriately phase shifted trigger pulses for the six thyristors, so that the required control is achieved.

**Float Charger:**
The charger is fed from three phase, AC supply and gives a DC stabilized output at rated full load current. The float charger is used to maintained the battery in charged condition. The out put voltage of the float charger is slightly higher then the battery, so very small current will continuously flow through the battery and keep the battery charged.

**Boost Charger:**

During power failure, the load is fed from battery and as a result the same gets drained. To bring the battery to its normal "ready to meet next emergency " mode we have to give additional charge to battery. Boost Charger does this boosting of the charge. Here the out put voltage of the charger is considerably higher and hence the battery gets back to normal in a short time.

In the event of the float charger going defective, the boost charger will take over the load in constant voltage mode. During transition period battery will supply the load.

**Battery:**

There are two types of battery cells:

- Primary Battery &
- Secondary battery

**Primary Battery:**

Primary battery is basically zinc-anode base system. Recently significant advances in energy density have been achieved, together with improvement in other areas like as low temperature performance and storage capability, through the development of lithium - anode-based systems and Specialist couples using anodes materials such as cadmium, magnesium and indium-bismuth.

There is no battery system that has every advantage over all the other system, and therefore a procedure for selecting the most suitable system is necessary. The factors involved in selection of primary batteries suitable to meet a particular requirement are extremely complex. So it is essential to consult manufacturer to ensure that the characteristics of the battery and equipment are matched so that the user of the equipment obtains the best possible performance from both.

There are three basic applications for which primary batteries are used:

- Miniature equipment.
- Equipment that is portable in use.
- transportable equipment and standby systems.

**Secondary Battery:**

In order to increase gravimetric density, the gravimetric and volumetric densities, the open circuit and on load cell E.M.F values and the minimum and maximum operating temperature secondary batteries are used. Following are the various batteries used.

- Sealed lead acid.
- Unsealed lead acid.
- Silver cadmium.
- Sealed nickel cadmium.
- Vented nickel cadmium.
- Nickel zinc.
- Alk mg rechargeable.
- Silver zinc.
- Nickel hydrogen.
- Silver hydrogen.
- Zinc chlorine.
- Zinc air.
- Sodium sulfur.
- Lithium-chlorine.
- Lithium-sulfur.

Out of these, two types of secondary rechargeable batteries, which are lead -acid and nickel-cadmium, are generally used in the industries.

The lead acid battery is a primary cell. The rubber or SAN container is filled with sulphuric acid. The active material in negative electrod is metallic lead in spongey form and the in positive electrod is lead dioxide. These electrodes are placed alternatively in the container. Due to the chemical reaction between the acid and the lead, the flow of electron is established.

**Characteristic Voltage:**
The nominal voltage of the lead acid cell is 2.0volts, which remains unaltered by the number of plates or their capacity. In practice, the voltage of a cell does vary slightly according to the state of the charge, the cell temperature, the charge or discharge current, and the age of the cell.

**Capacity:**
The capacity of the battery will vary according to current at which it is discharged. The higher the current being taken out of the battery, the lower the available capacity. For example, if a battery of 500AH capacity ids discharged at the 5hour rate, it will give 100 amperes for 5 hours. The same battery discharged at 200 amperes, however, will give current for only 2 hours, thereby providing capacity of 400 AH at the 2hour rate of discharge. This is because, at higher rate, the voltage drop is more rapid and the final voltage is reached more quickly.

**Maintenance Free Lead Acid Battery:**
Any battery, when overcharged, will liberate hydrogen and oxygen gases as water is decomposed. For a battery to be maintenance free, it is necessary to retard gas liberation, otherwise the electrolyte would be depleted prematurely and catastrophic failure would result. There are two principles types of maintenance free Lead Acid battery.

1) The type featuring calcium lead alloys and immobilized Sulphuric acid electrolyte, which reduces but does not completely eliminate gassing, i. e. there is electrolyte volume reduction. Such cells are usually manufactured containing a reserve of electrolyte so that topping up is not required during battery life.

2) The type in which complete recombination of electrolysis gases occurs,i.e. virtually no electrolyte loss occurs.

**Nickel Cadmium (NiCd) Battery:**
Normally now a days using Nickel Cadmium pocket plate battery for AC and DC UPS and Vented type Lead Acid type battery for station battery charger has become a practice.

CVSRTA

The storage battery consists of a number of individual cells connected in series to produce the required voltage. Each cell contains positive plates (containing nickel hydroxide as the active constituent) and negative plates (containing cadmium hydroxide) immersed in a solution of potassium hydroxide in deionised water with lithium hydroxide as an additive. The voltage produced is dependent upon the chemical composition of the active materials contained in the plates. In the nickel cadmium cell the active constituents are cadmium in the negative plates and nickel in the positive plates. The electrolyte is a solution of potassium hydroxide in deionized water with lithium hydroxide as an additive. Low impurity content is specified to minimize losses and the constituent parts of the positive and negative electrodes are insoluble in the electrolyte. The resulting electrochemical reaction produces a nominal discharge voltage of 1.2 volts per cell.

**Advantages:**

The major advantages of pocket plate nickel cadmium batteries are total reliability combined with extremely long life. This superiority is due to chemical and mechanical characteristics unique to pocket plate nickel cadmium batteries. Nickel cadmium batteries can withstand electrical abuse to a very high degree. They can be deep discharge,

- Over charging even for a pro-longed period, is tolerated by nickel cadmium batteries.
- The high rate performance of nickel cadmium batteries is excellent, and the voltage recovery after high power discharge is almost instantaneous.

The mechanical strength of nickel cadmium batteries is unsurpassed. The reason is the all steel internal construction and the high impact plastic or steel used in the container.

- The support material in nickel cadmium batteries is corrosion free. Thus these batteries do not suffers from the problem of sudden death, which is the usual end of life for most other types of industrial batteries.
- The end of the life cycle of nickel cadmium batteries is predictable. The aging process is very slow and is determined by slightly decreasing performance that allows the user to plan battery replacement years ahead.

**Applications:**

The nickel cadmium pocket plate battery is available in different designs optimized with regard to the required discharge time. Though these batteries are much costlier then Lead acid battery, due to its reliability it is widely used in critical applications like control supply for switch gear system, emergency lighting, telecommunication & fire alarm systems.

EXERCISE:

1. Explain Trickle (or Float) and Boost charging in a battery.
2. What is meant by Primary battery? List the basic application of primary battery.
3. Describe the construction and electro chemistry of lead acid battery.
4. What is MF (Maintenance Free) battery? List the types of MF battery.
5. What is meant by characteristics voltage of a lead acid battery?
6. Explain NiCd battery giving advantages.

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## THE PHILOSOPHY OF PROTECTIVE RELAYING

**What is Protective Relaying?**

We usually think of an electric power system in terms of its more impressive parts–the big generating stations, transformers, motors, high-voltage lines, etc. While these are some of the basic elements, there are many other necessary and fascinating components. Protective relaying is one of these.

It is evident that in spite of all the precautions taken during design and installation of the system, there is every possibility of arising of an abnormal conditions or faults, some of which like short circuit may prove extremely damaging to not only the faulty component but to the neighboring components and to the power system as a whole. It is of vital importance to limit the damage to a minimum by speedy isolation of the faulty section, without disturbing the working of the rest of the system.

The role of protective relaying in electric-power-system design and operation is explained by a brief examination of the over-all background. There are three aspects of a power system that will serve the purposes of this examination. They are

A. Normal operation
B. Prevention of electrical failure.
C. Mitigation of the effects of electrical failure.

The term "normal operation" assumes no failures of equipment, no mistakes of personnel, nor "acts of God." It involves the minimum requirements for supplying the existing load & a certain amount of future load. Some of the considerations are:

The provisions for normal operation involve the major expense for equipment and operation, but a system designed according to this aspect alone could not possibly meet present-day requirements. Electrical equipment failures would cause intolerable outages.

**Faults:**

The flow of current towards an undesirable path or abnormal stoppage of current are termed as fault. As mentioned earlier these faults may prove extremely damaging for the faulty components and also to the neighboring components. Faults can also cause interruption in power supply to other equipment.

There must be additional provisions to minimize damage to equipment and interruptions to the service when failures occur. Two recourses are open:

(1) to incorporate features of design aimed at preventing failures, and
(2) to include provisions for mitigating the effects of failure when it occurs.

Modern power-system design employs varying degrees of both recourses, as dictated by the economics of any particular situation. Notable advances continue to be made toward greater reliability. But also, increasingly greater reliance is being placed on electric power. Consequently, even though the probability of failure is decreased, the tolerance of the possible harm to the service is also decreased. But it is futile-or at least not economically justifiable-to try to prevent failures completely. Sooner or later the law of diminishing returns makes itself felt. Where this occurs will vary between systems and between parts of a system, but, when this point is reached, further expenditure for failure prevention is discouraged. It is much more profitable, then, to let some failures occur and to provide for mitigating their effects.

The type of electrical failure that causes greatest concern is the short circuit, or "fault" as it is usually called, but there are other abnormal operating conditions peculiar to certain elements of the system that also require attention. If we disconnect or isolate the faulty system in a fast manner, the damage can be limited.

**Features for promptly disconnecting the faulty element.**

1. Protective relaying.
2. Circuit breakers with sufficient interrupting capacity.
3. Fuses.

Thus, protective relaying is one of several features of system design concerned with minimizing damage to equipment and interruptions to service when electrical failures occur.

**The Functions Of Protective Relaying:**

The function of protective relaying is to cause the prompt removal from service of any element of a power system when it suffers a short circuit, or starts to operate in any abnormal manner that might cause damage or otherwise interfere with the effective operation of the rest of the system. The relaying equipment is aided in this task by circuit breakers that are capable of disconnecting the faulty element when they are called upon to do so by the relaying equipment. Circuit breakers are generally located so that each generator, transformer, bus, transmission line, etc., can be completely disconnected from the rest of the system. These circuit breakers must have sufficient capacity so that they can carry momentarily the maximum short-circuit current that can flow through them, and then interrupt this current; they must also withstand closing in on such a short circuit and then interrupting it according to certain prescribed standards.

Fusing is employed where protective relays/circuit breakers are not economical. Although the principal function of protective relaying is to mitigate the effects of short circuits, other abnormal operating conditions arise that also require the services of protective relaying. This is particularly true of generators and motors.

To sum up the above, we can say that the protective relaying system should sense the fault and perform following four functions:

1. To operate the correct circuit breakers so as to disconnect only the faulty equipment from the system as quickly as possible thus minimizing the trouble and the damage caused by faults when they do occur.
2. To operate the correct circuit breakers to isolate the faulty section from the healthy system
3. To clear the fault before the system become unstable.
4. To give indication as to where the fault has occurred.

Let us consider for the moment only the relaying equipment for the protection against short circuits.

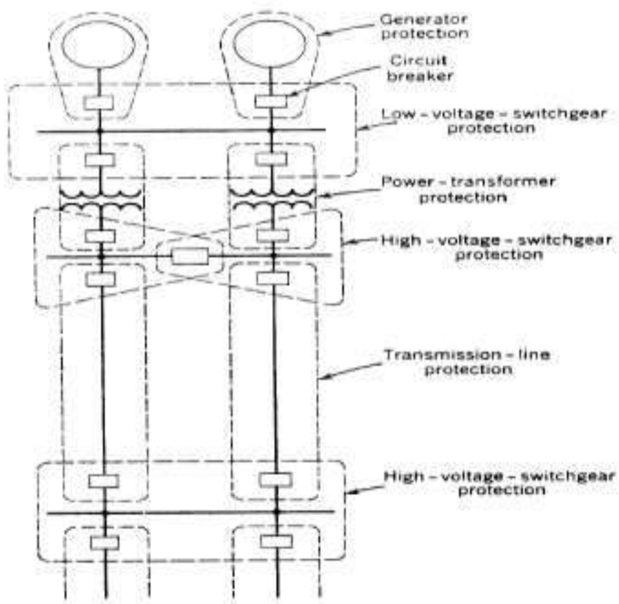



Fig. 1. One-line diagram of a portion of an electric power system illustrating primary relaying.

Figure 1 illustrates relaying. The first observation is that circuit breakers are located in the connections to each power element. This provision makes it possible to disconnect only a faulty element. Occasionally, a breaker between two adjacent elements may be omitted, in which event both elements must be disconnected for a failure in either one.

Finally, it will be observed that adjacent protective zones of Fig. 1 overlap around a circuit breaker. This is the preferred practice because, for failures anywhere except in the overlap region, the minimum number of circuit breakers needs to be tripped. When it becomes desirable for economic or space-saving reasons to overlap on one side of a breaker, as is frequently true in metal-clad switchgear the relaying equipment of the zone that overlaps the breaker must be arranged to trip not only the breakers within its zone but also one or more breakers of the adjacent zone, in order to completely disconnect certain faults.

**Primary & Back up Relaying:**
Main or primary protective schemes are used as the first line of defense. There must be a second line of defense, which will clear the fault in the eventuality of failure of primary system to do it due to any reason.

Though technically possible, normall back-up relaying is employed only for protection against short circuits. Because short circuits are the preponderant type of power failure, there are more opportunities for failure in short primary relaying. Experience has shown that back-up relaying for other than short circuits is not economically justifiable. It is highly desirable that back-up relaying be arranged so that anything that might cause primary relaying to fail will not also cause failure of back-up relaying. It will be evident that this requirement is completely satisfied only if the back-up relays are located so that they do not employ or control anything in common with the primary relays that are to be backed up. So far as possible, the practice is to locate the back-up relays at a different station.

**Requirements of Protective System:**

1. **Reliability:** That protective-relaying equipment must be reliable is a basic requirement. When protective relaying fails to function properly, the allied mitigation features are largely ineffective. Therefore, it is essential that protective-relaying equipment be inherently reliable, and that its application, installation, and maintenance be such as to assure that its maximum capabilities will be realized. Inherent reliability is a matter of design based on long experience, and is much too extensive and detailed a subject to do justice to here.

2. **Selectivity:** This is the property by which only the faulty element of the system is isolated and remaining healthy system are left intact.

3. **Speed:** It is obvious that faster the speed of operation of elements of the protective system (relay and breakers) less is the damage to the equipment. As such the equipment are short time rated for high fault currents and therefore there will be practically no damage to the equipment if the relay and breakers operate fast enough. The time setting of the relay has to be decided on the basis of this short time ratin of the equipment to be protected.

4. **Discrimination:** Protective system should be able to discriminate between fault and load conditions even when the minimum fault current is less then the maximum load current. A relay must be able to distinguish between a fault and an overload.

5. **Stability:** It is the quality of protective system by virtue of which it remains inoperative under specified conditions associated with high value fault current. i.e. it has to remain inoperative under what ever condition of fault current, if the fault is out side their own zone.

6. **Sensitivity:** Sensitivity refers to the minimum level of fault current at which the operation occurs.

***Fundamental Relay – Operating Principles:***

Protective relays are the "tools" of the protection engineer. As in any craft, an intimate knowledge of the characteristics and capabilities of the available tools is essential to heir most effective use. Therefore, we shall spend some time learning about these tools

**General Considerations:**

All the relays that we shall consider operate in response to one or more electrical quantities either to close or to open contacts. We shall not bother with the details of actual mechanical construction except where it may be necessary for a clear understanding of the operation. One of the things that tend to dismay the novice is the great variation in appearance and types of relays, but actually there are surprisingly few fundamental differences. Our attention will be directed to the response of the few basic types to the electrical quantities that actuate them.

**Operating Principles:**

There are really only two fundamentally different operating principles: (1) electro- magnetic attraction, and (2) electromagnetic induction. Electromagnetic attraction relays operate by virtue of a plunger being drawn into a solenoid, or an armature being attracted to the poles of an electromagnet. Such relays may be actuated by d-c or by a-c quantities. Electromagnetic-induction relays use the principle of the induction motor whereby torque is developed by induction in a rotor; this operating principle applies only to relays actuated by alternating current.

**Definitions Of Operation:**

Mechanical movement of the operating mechanism is imparted to a contact structure to close or to open contacts. When we say that a relay "operates," we mean that it either closes or opens its contacts-whichever is the required action under the circumstances. Most relays have a "control spring," or are restrained by gravity, so that they assume a given position when completely de-energized; a contact that is closed under this condition is called a "closed" contact, and one that is open is called and "open" contact. When a relay operates, we say that it "picks up," and the smallest value of the actuating quantity that will cause such operation, as the quantity is slowly increased from zero, is called the "pickup" value. When a relay operates to close, or to move to a stop, we say that it "resets"; and the largest value of the actuating quantity at which this occurs, as the quantity is slowly decreased from above the pickup value, is called the "reset" value.

**Operation Indicators:**

Generally, a protective relay is provided with an indicator that shows when the relay has operated to trip a circuit breaker. Such "operation indicators" or "Flags" are distinctively colored elements that are actuated either mechanically by movement of the relay's operating mechanism, or electrically by the flow of contact current, and come into view when the relay operates. They are arranged to be reset manually after their indication has been noted, so as to be ready for the next operation. Electrically operated flags are generally preferred because they give definite assurance that there was a current flow in the contact circuit. Mechanically operated flags may be used when the closing of a relay contact always completes the trip

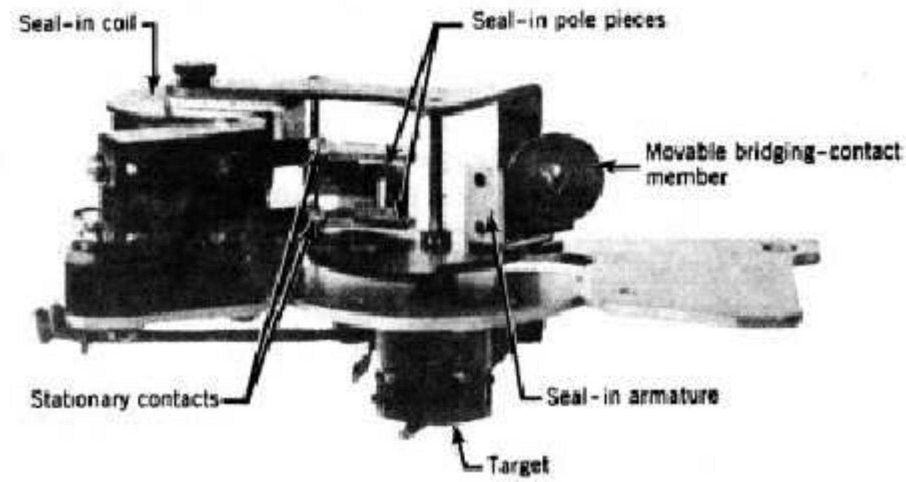



**Fig: Contact element showing target & seal in arrangement**.

**Protective Device Numbering:**

Every protective relay has an associated number. These are unique numbers and are adopted universally. Some of the standard designated numbers are: Over Current Relay – 51, Under Voltage Relay – 27, Time Delay Starting – 2, Interlocking Relay – 3, Over Speed Device – 12 etc. There are 94 numbers already allotted (with provision for future use). The number 95 to 99 is for specific use when none of the pre designated match.

**Static & Microprocessor Relays:**

Electromechanical relays have a long history of application. They are very rugged and reliable. They are still used in power system protection. But as these system have moving parts, there are problems of friction, wear & tear, low torque, high power consumption (for auxiliary relay) etc. With the advent of IC & chips, the static protective relays are coming up very fast. They have many advantages like low burden, precise, compact size etc. The only prohibitive factor is the cost.

It costs nearly 50 % higher at present, however like any other electronic device, the cost is bound to reduce over a period of time, when it may take over the entire protective functioning.

**EXERCISE:**

1. Describe the Function of Protective Relaying
2. What is meant by "Normal operation of a system " when we are talking about the protection ?
3. What are the Features for prompt disconnection of an faulty element?
4. What does Primary OR Secondary Relaying mean? Explain with illustrative figure.
5. Describe the operation of a Induction Type of Relay.
6. Detail the General Consideration of protection.
7. What are operation indicators? How does it help the user?

In this chapter so far we have tried to understand the basic technology of electrical engineering i.e. from what is electricity to how it is generated & distributed. We have also seen how the protection system works. Now we move forward and will try to understand the means of power flow i.e. cables, the basic machine or the prime mover without which the industry will come to a stand still i.e. motors and its drives. At the end we shall see some of the essential statutory compliance for electrical installations.

## *TRANSMISSION OF POWER*

**Cabling & Wiring:**

Having generated a power in a generating station, it has to be transmitted to the user. As seen earlier, the electricity boards (or distribution company) transmit this power from generating stations to the actual user. This transmission of power is normally done with overhead conductors. These o/h conductors are laid on steel / RCC towers. The conductors in this o/h system are generally un insulated. This is the reason why the tower height increases with higher voltage level.

As a plant engineer, we shall be concentrating on the distribution of power within the complex. The power within the complex is generally transmitted through cables.

**What is CABLES?**

Cables are current carrying conductors. Various types of insulated compound insulate this conductor. Some times, steel wire layer protects insulation & conductor. This is called as ARMOURING. While selecting a cable, one has to select the type of insulation and the material of conductor. Various factors play an important role in selection of the cable. A careful consideration is to be given to following factors:

**Power Cable :**

Following are some of the key factors that influence the choice of power cable:

- System voltage rating.
- Current loading requirements.
- External thermal conditions such as ambient temperature, proximity of other cables, adjacent sources of heat, thermal conductivity of soil, etc.
- Voltage drop considerations.
- Special conditions, such as the presence of corrosive agents, flexibility, and flame resistance.

**Voltage Rating**

The system voltage on which the cable is to operate determines the required cable voltage rating. Cables rated 5 kV and above are separated into two classifications: grounded neutral service (100 percent insulation level), and ungrounded neutral service (133 percent insulation level). In case of a phase to ground fault, it is possible to operate ungrounded systems for up to one hour with one phase conductor at ground potential. This condition results in full line-to-line voltage stress across the insulation of each of the other two-phase conductors. For this reason each phase conductor of such a cable has additional insulation.

Cables designed for use on grounded systems take advantage of the absence of this full line-to-line voltage stress across the insulation and use thinner insulation. The direct result of such a design is lower cost & reduced cable diameter.

**Conductor Size**

Conductor size is based principally on three considerations:

- Current-carrying capacity (ampacity).
- Short-circuit current.
- Voltage drop.

Primarily the permissible operating temperature of its insulation affects the current-carrying capacity of a cable. Higher the operating temperature of the insulation, the higher the current carrying capacity of a given conductor size.

The temperature at which a particular cable will operate is affected by the ability of the surrounding material to conduct away the heat. Therefore, the current-carrying capacity is materially affected by the ambient temperature as well as by the installation conditions.

When cables are run close together the presence of the other cables, in effect, increases the ambient temperature, which decreases the ability of the cable to dissipate its heat. As a result, many conditions must be known before an accurate current-carrying capacity can be assigned to a particular cable installation.

CVSRTA

**Short Circuit Current**
A second consideration in selection of conductor size is that of the short circuit current which the cable must carry. The construction of cable is such that its mechanical strength is high and it can handle short-circuit currents without any mechanical difficulty. From a thermal standpoint, however, there is a limit to the amount of short-circuit current which can be carried.

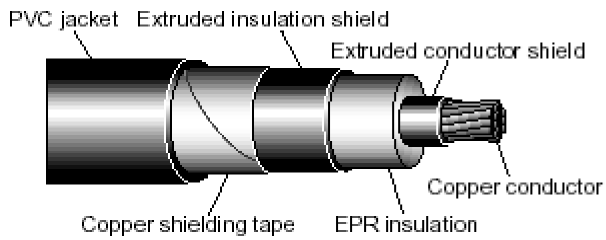



**Figure 1–Typical tape shielded 11 kV power cable**

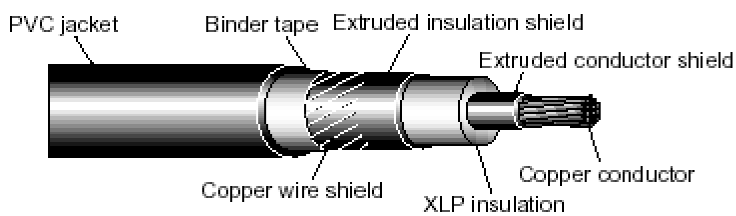



**Figure 2–Typical wire shielded 11 kV power cable**

**Voltage Drop Considerations**
Cable conductor size is sometimes governed by voltage drop rather than by heating. Generally, conductor size on long, low-voltage lines is governed by voltage drop; on short, high-voltage lines by heating. Due to voltage drop considerations, it might be necessary to increase conductor size, even though a smaller size conductor adequately handles the current load.

**Special Conditions**
The following are only a few of the many special conditions, which may affect cable selection:
• The presence of large sources of heat (boilers, steam lines, etc.).

In conditions where ambient temperature is higher (Boilers, Furnace room eyc.), special heat resistant insulation is used such as Mineral or Butyl or Silicon.

• The effect of magnetic materials such as pipes or structural members close to large cables carrying heavy current loads.

In such a condition, magnetically screened cables are used to eliminate the effect of magnetization.

• The presence of corrosive reagents in the soil or other locations in which the cable is installed.

In conditions where the cables are exposed to corrosive atmosphere like acids or alkalis, the insulation is selected to be of PVC.

• The interference that may occur in telecommunication circuits because of adjacent power cables.

To avoid interference, copper screened cables are used.
• Flame and radiation resistance.
• Mechanical toughness.

For mechanical strength armoured cable is used.
• Moisture resistance.

For humid area, PVC / or MI/PVC cable is used.
All special conditions should be carefully investigated, and the advice of competent engineers obtained, before proceeding with an important cable installation.

**Cable with Aluminum Conductors**
Multi core, sheathed cables with Aluminum conductors is sometimes used instead of copper conductors, as they are cheap and not very heavy. The current carrying capacity of Al conductor is 78% of the rating for copper conductors. Thus the size of an Aluminum cable will be higher then the copper one for same current rating.

The use of aluminum conductors presents some problem, which require certain precautions to be taken. Aluminum, when exposed to air, quickly forms an oxide film which is a poor conductor of electricity, If allowed to remain, this can cause a high resistive joint and may result in overheating and eventually failure of cable. The second problem is due to different co-efficient of thermal expansion of Aluminum and copper. This causes problem when the two metals are joined with each other.

CVSRTA

**Armored Power and Control:**

Armored cables comprise a group of cables that are designed to withstand severe mechanical and chemical environments. Armour PVC insulated cables are now being used very extensively for main and sub main cables and also for wiring in industrial installations. The armour are a galvanized steel wire protective layer under the outer insulation. This protects the conductor from external abuse. Their advantages over earlier PILC (Paper Insulated Lead Cover) are that:

- They are more pliable.
- They can be bent to a radius of 8 times the diameter as compared to 12 times in PILC cables.
- They are much lighter and easier to handle and the sealing of the end is much simpler.

Their main disadvantages are that:

- Thermoplastic insulation will sustain serious damage if subject to a prolonged exposure to temperature above 70* C.
- The insulation will become harden and brittle in temperature below 1* C and in freezing temperature the insulation may split.

**Paper Insulated Lead Cover (PILC) Cables**:

Paper Insulated Lead Cover Cables are generally protected by steel tape or steel wire armouring and served overall with hemp or PVC. The serving protects the steel armouring against oxidation and corrosion.

**Mineral Insulated (MI) Cables:**

These cables have an insulation of highly compressed magnesium oxide (MgO) powder between copper core and sheath. Generally MI cables need no additional protection as copper is corrosion resistant.

**Cross Linked Poly Ethylene (XLPE) Cables:**

With advancement in the insulation and hydrocarbon industry, a new compound named Cross Link Poly Ethylene is widely used in cable industry. This XLPE cables have an advantage of high temperature withstand capacity. This gives advantage in cable rating. A similar cross section of conductor can safely carry higher current in XLPE cables then PVC cables, or in other words, we can use a size lower XLPE cable then PVC cables for a same current. Also, under combined heat and mechanical pressure XLPE suffers less deformation compared to PVC or Paper insulated cables.

EXERCISE:

1. Explain the key factors influencing the selection of a power cable
2. What are the functional advantages of armoured cable ?

## *MOTORS & VARIABLE SPEED DRIVES*

**Basic Theory Of Induction Motor:**

In many commercial, industrial, and utility applications electric motors are used to transform electrical energy into mechanical energy. Those electric motors may be part of a pump or fan, or they may be connected to some other form of mechanical equipment such as a conveyor or mixer. The electric motors are broadly divided in two types namely DC motors & AC motors.

This division is based on the type of electric supply being fed to the motor i.e. Direct Current (DC) or Alternating Current (AC).

While there are only three general types of DC motors, there are many different AC motor types. This is because each type is confined to a narrow band of operating characteristics. These characteristics include torque, speed, and electrical service (single-phase or polyphase). These operating characteristics are used to determine a given motor's suitability for a given application.

The three-phase motor is probably the simplest and most rugged of all electric motors. To get a perspective on how important the three-phase motor is, all you need to know is that this motor is used in nine out of ten industrial applications

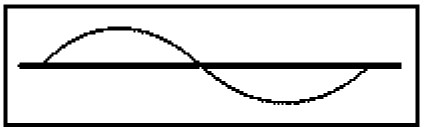
**What makes an AC motor different from a DC motor?**
In a DC motor, electrical power is conducted directly to the armature through brushes and a commutator. An AC motor does not need a commutator to reverse the polarity of the current, as AC changes polarity "naturally."

Also, where the DC motor works by changing the polarity of the current running through the armature (the rotating part of the motor), the AC motor works by changing the polarity of the current running through the stator. (The stationary part of the motor).

In simple words, what it means is that the construction of AC motor is much simpler then the DC motor.

The many types of AC motor may be split into two main groups: single-phase and polyphase.

**Single Phase:**
A single-phase power system has one coil in the generator. Therefore, one alternating voltage is generated. The voltage curve of a single-phase AC generator is shown in Figure

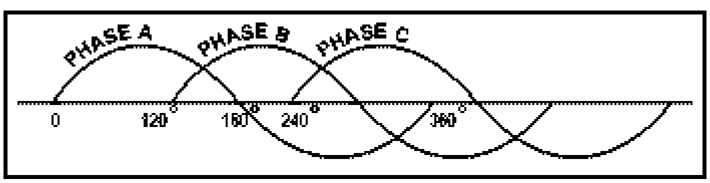


Single-phase motors are generally motors with KW ratings of one or below. (These are generally called fractional KW motors.) They are generally used to operate mechanical devices and machines requiring a relatively small amount of power.

Types of single-phase motors include: shaded-pole, capacitor, split-phase, repulsion, series (AC or universal) and synchronous.

However, the single-phase motor is generally not used because it is inefficient, expensive to operate, and is not self starting.

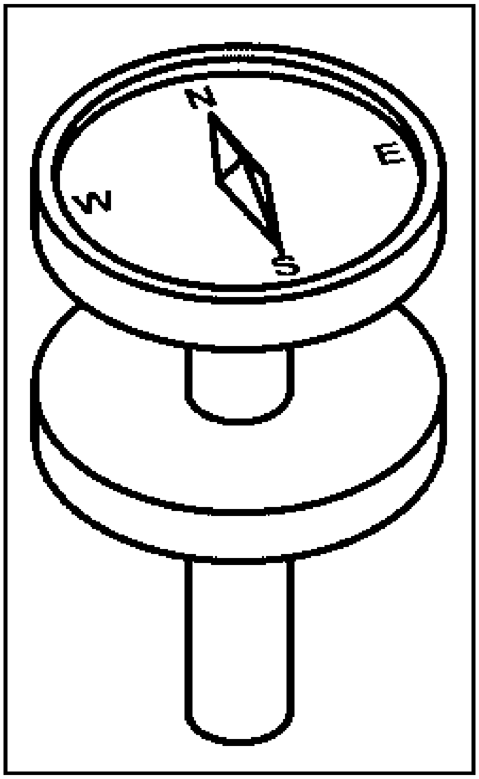
**Three-Phase:**

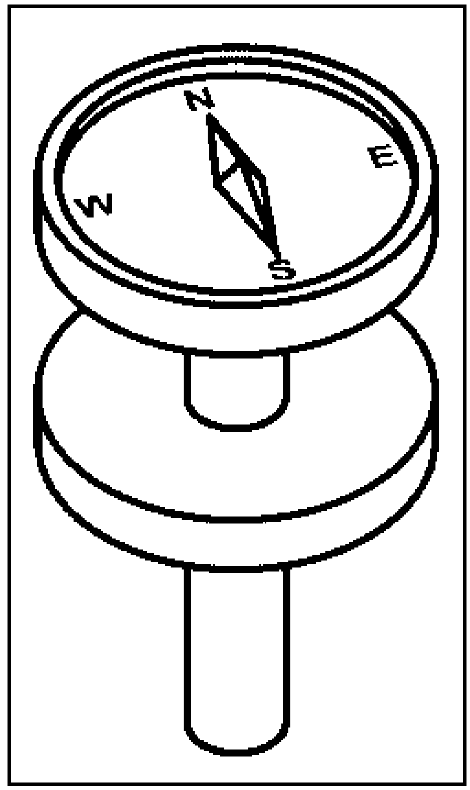



Three-phase or polyphase motors run on three-phase power. A three-phase power system has three coils in the generator. Therefore, three separate and distinct voltages will be generated. The voltage curve is shown in Figure
Types of three-phase motors include: induction (squirrel-cage or wound), rotor types, commutator, and synchronous.

**The Squirrel Cage Induction motor:**
Induction refers to electrically charging a conductor by putting it near a charged body.

**Induction Principle:**
Arago first discovered the principle of the induction motor in 1824. He observed that if a non-magnetic metal disk and a compass are pivoted with their axes parallel, so that one (or both) of the compass poles are located near the edge of the disk, spinning the disk will cause the compass needle to rotate. The direction of the induced rotation in the compass is always the same as that imparted to the disk.




You can prove it to yourself if you like. Mount a simple copper or aluminum disk and a large compass on a vertical stem, so that each may be rotated on its own bearing,

You can prove it to yourself if you like. Mount a simple copper or aluminum disk and a large compass on a vertical stem, so that each may be rotated on its own bearing, independently of the other. Spin the disk, and watch the compass needle. There is no more effective way to demonstrate the principle of induction.

**Applying the Induction Principle to AC Motor-**
So, how do we apply the concept of induction to a motor?
Recall that the AC motor works by changing the polarity of the current running through the stator (the stationary part of the motor). The stator plays the role of the metallic disk described above. A rotating magnetic field is established in the stator.

The conductor, called the Rotor, “follows” the rotating magnetic field by beginning to rotate, just like the compass needle described above.

The induction motor uses a rotor of a special design. It resembles a cage used for exercising squirrels. This is why it is called a squirrel cage rotor.

The rotor consists of circular end rings joined together with metal bars. Note that the metal bars are placed directly opposite each other and provide a complete circuit within the rotor, regardless of the rotor's position. Rotors normally have several bars, but only a few are shown here for clarity.

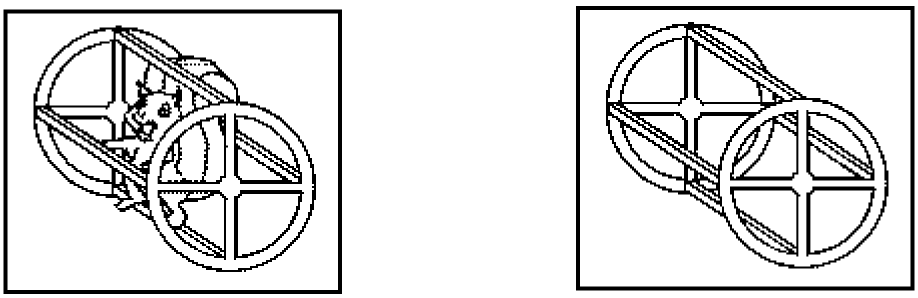


**FIGURE: THE ROTOR OF A SQUIRREL CAGE INDUCTION MOTOR**

Squirrel cage motors are usually chosen over other types of motors because of their simplicity, ruggedness and reliability. Because of these features, squirrel-cage motors have practically become the accepted standard for AC, all-purpose, constant speed motor applications. Without a doubt, the squirrel-cage motor is the workhorse of the industry.

**The Squirrel Cage Induction Motor has certain advantages over the DC motor.**

- **There are only two points of mechanical wear on the squirrel cage motor: the two bearings.**
- **Because it has no commutator, there are no brushes to wear. This keeps maintenance minimal.**
- **No sparks are generated to create a possible fire hazard**.

**Three- Phase Motor:**

An induction motor depends upon an electrically rotating magnetic field, not a mechanically rotating one. (A mechanically rotating field would work, but an electrically rotating magnetic field has significant advantages.) How is an electrically rotating field obtained? It all starts with the phase displacement of a three-phase power system.

Three-phase power can be thought of as three different single-phase power supplies. They are called A, B, and C. In the three-phase motor, each phase of the power supply is provided with its own set of poles, located directly across from each other on the stator, and offset equally from each of the other two phases' poles.

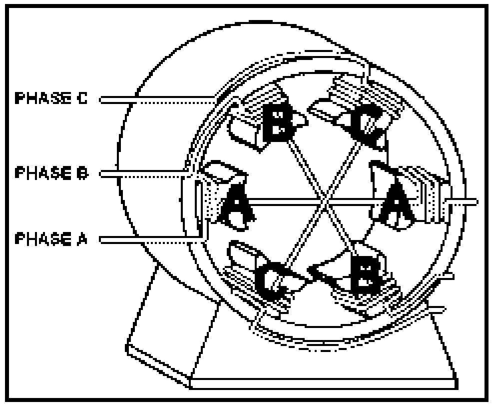



**FIG: Three pairs of field coils on the stator, set 120* apart**

The three currents start at different times. Phase B starts 120° later than phase A and phase C starts 120° later than phase B. This is shown on the sine wave graph in Figure, which indicates the way the magnetic field will point at various times in the cycle.

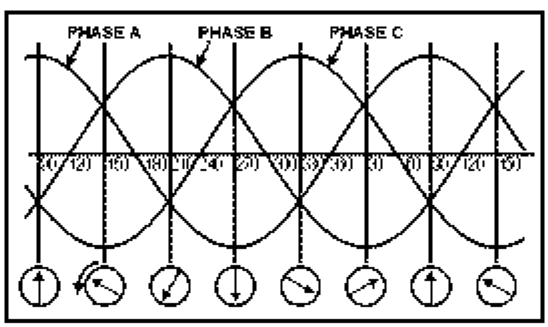



**FIG: Magnetic Field Rotation Providing Torque To Turn The Motor**

Introducing these different phase currents into three field coils 120° apart on the stator produces a rotating magnetic field, and the magnetic poles are in constant rotation.

The magnetic poles chase each other, simultaneously inducing electric currents in the rotor (generally, bars of copper imbedded in a laminated iron core). The induced currents set up their own magnetic fields, in opposition to the magnetic field that caused the currents. The resulting attractions and repulsions provide the torque to turn the motor, and keep it turning.

If each magnetic pole were to “light up” whenever it was energized, the effect would appear as though the lights were “running” around the stator, much as the lights on some electric signs simulate a running border.

Let’s walk through one revolution of the motor to see how it works.
First, the A poles of the stator are magnetized by phase A. Then, the B poles are magnetized by phase B. The rotor turns, due to the induced current. Then, the C poles are magnetized by phase C. The rotor turns, due to the induced current. The rotor has completed one-half turn at this point.

Now, the A poles of the stator are magnetized again, but the current flow is in the opposite direction .

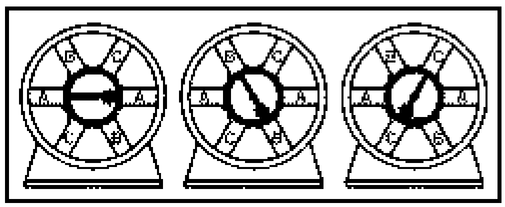
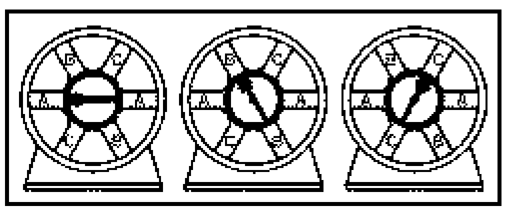


**FIG: Rotating Magnetic Field Turns the Motor**

This causes the magnetic field to continue to rotate, and the rotor follows. Then, the B poles are magnetized by phase B. The rotor turns, due to the induced current. Then, the C poles are magnetized by phase C. The rotor turns, due to the induced current.



The rotor has completed one full revolution at this point, and the process repeats itself.

**Construction Of Three Phase Motors:**
The three-phase motor is probably the simplest and most rugged of all electric motors.

All three-phase motors are constructed with a number of individually wound electrical coils. Regardless of how many individual coils there are in a three-phase motor, the individual coils will always be wired together (series or parallel) to produce three distinct windings, which are called phases. Each phase will always contain one-third of the total number of individual coils. As we mentioned, these phases are referred to as phase A, phase B and phase C.

Three-phase motors vary from fractional KW size to several thousand KW. These motors have a fairly constant speed characteristic but a wide variety of torque characteristics. They are made for practically every standard voltage and frequency and are very often Dual Voltage Motors. (We will look briefly at dual voltage motors later.)

**Dual Voltage**

Many three-phase motors are made so that they can be connected to either of two voltages. The purpose in making motors for two voltages is to enable the same motor to be used with two different power line voltages. Usually, the dual voltage rating of industrial motors is 230/460V. However, the nameplate must always be checked for proper voltage ratings.

When the electrician has the choice of deciding which voltage to use, the higher voltage is preferred. The motor will use the same amount of power, giving the same HP output for either high or low voltage, but as the voltage is doubled (230 to 460), the current will be cut in half. With half the current, wire size can be reduced and savings can be realized on installation.

**Speed Control**

Speed control is essential in many applications. Mining machines, printing presses, cranes and hoists, elevators, and conveyors, among others, all depend on speed control.

In choosing the speed control method for an application, there are three main factors to consider:

- Type of equipment (load) the motor drives
- Application type
- Motor type

We will discuss each of these factors in turn.
Loads and application types are as varied as the types of motors available. However there are two fundamental motor types: AC and DC. Each type has its own ability to control different loads at different speeds.

In order to select the correct motor type for a given application, it is necessary to understand the load requirements first. To understand these requirements, you need to be familiar with the concepts of force, work, torque, power and KW, and how they relate to speed.

Force, Work and Torque

Work is done when a force overcomes a resistance.

Work = Distance x Force

In the case of an electric motor, force is not exerted in a line, but in a circle, about a cylindrical shaft. As you recall, turning force is called torque .
*Torque = Radial Distance x Force*

**Power and KW**

Power takes into consideration how fast work is accomplished. Power is the rate of doing work

Power = Work/Time

The reason for this difference is the amount of work that can be delivered in a given amount of time. Obviously, a larger motor should be able to deliver more work in a given time than one that is considerably smaller. It is this difference that determines the power rating of the motor.
Motors are rated in KW (HP). One KW is equal to 746 watts.

**Putting It All Together**
Torque, KW, and speed are all interrelated when turning a load. KW is proportional to torque and speed. The following formula ties them all together:

T=974*KW/rated speed

This means that if either speed or torque remains constant while the other increases, KW increases. Conversely, if either torque or speed decreases while the other remains constant, KW will decrease.

**Speed Control for an AC Motor**

Because each motor type has its own characteristics of KW, torque and speed, different motor types are more suited for different applications.

The basic characteristics of each AC motor type are determined by the design of the motor and the supply voltage used.

The induction motor is basically a constant speed device. The speed at which an induction stator field rotates is called its <u>Synchronous Speed</u>. This is because it is synchronized to the frequency of the AC power at all times. The speed of the rotating field is always independent of load changes on the motor, provided the line frequency is constant.

The number of poles that the motor has and the frequency being supplied to it determines synchronous speed. The equation for determining the synchronous speed of a motor is:

N = 120f/P Where:

N = the synchronous speed of the motor in revolutions per minute (RPM)

f = the frequency supplied to the motor in Hertz (Hz)

P = the number of poles the motor has

Motors designed for 50 Hertz use (standard in the INDIA) have synchronous speeds as follows:

| **Poles** | **RPM** |
|---|---|
| 2 | 3000 |
| 4 | 1500 |
| 6 | 1000 |
| 8 | 750 |
| 10 | 600 |

Induction motors do not run at synchronous speed; they run at Full Load Speed, which is the rotational speed of the rotor. Full load speed is always slower. The percent reduction in speed is called Percent Slip. The slip is required to develop rotational torque. The higher the torque, the greater the slip.

The motor speed, under normal load conditions, is rarely more than 10% below synchronous speed. If the motor is not driving a load, it will accelerate to nearly synchronous speed. As the load increases, the percent slip increases.

For example, a motor with a 2.8% slip and 1800-rpm synchronous speed would have a slip of 50 rpm, and a full load speed of 1750 rpm (1800 - 50 = 1750 rpm). It is this full load speed that will be found on the motor's nameplate.

From the formula, it is evident that the supply frequency and number of poles are the only variables that determine the speed of the motor.

Varying the voltage is not a good way to change the speed of the motor. In fact, if the voltage is changed by more than 10%, the motor may be damaged. This is because the starting torque varies as the square of the applied voltage.

Because the frequency or number of poles must be changed to change the speed of an AC motor, two methods of speed control are available. These are:

- **Changing the frequency applied to the motor**

Changing the frequency requires a device called an Adjustable Frequency Drive to be inserted upstream from the motor. This device converts the incoming 50 Hz into any desired frequency, allowing the motor to run at virtually any speed.
For example, by adjusting the frequency to 30 Hz, the motor can be made to run only half as fast.

**Winding**

Winding uses round enameled wires, inserted into the slots and self supported on overhang well tied to form a robust ring structure. The insulation materials used in the winding, make up an insulation system which has class F or class H temperature rating and mechanical strength high enough to withstand rapid auto-reclosing. The materials withstand the abuse of the winding work, and the impregnating resin/ varnish adheres strongly to them making a solid mass. The impregnating resin is an epoxy resin having a long-term temperature rating and mechanical characteristics, which remain almost unchanged over the entire operating temperature range.

**MOTOR TERMINOLOGY**

- **AC (Alternating Current)**
  The commonly available electric power supplied an AC generator and is distributed in single or three-phase forms. AC current changes its direction of flow (cycles).

- **AC Motors**
  A motor,(see motor definition) operating on AC current that flows in either direction(AC current).There are two general types viz induction and synchronous.

- **Active Iron**
  The amount of steel (iron) in the stator and rotor of a motor. Usually the amount of active iron is increased or decreased by lengthening or shortening the rotor and stator (they are generally the same length).

- **Adjustable Frequency Drive**
  This device converts the incoming 50 Hz power into any desired frequency, allowing an AC motor to run at virtually any speed.

- **Air Gap**
  The space between the rotating (rotor) and stationary (stator) member in an electric motor.

- **Anti-Friction Bearing**
  An anti-friction bearing is a bearing utilizing rolling elements between the stationary and rotating assemblies.

- **Base Speed**
  The speed, which a motor develops at, rated armature and field voltage with rated load applied.

- **Bearings**
  Are used to reduce friction and wear while supporting rotating elements. For a motor it must provide a relatively rigid support for the output shaft.

The bearing acts as the connection point between the rotating and stationary elements of a motor. There are various types such as roller, ball, sleeve (journal), and needle.

The ball bearing is used in virtually all types and sizes of electric motors. It exhibits low friction loss, is suited for high-speed operation and is compatible in a wide range of temperatures. There are various types of ball bearings such as open, single shielded or sealed.

- **Canopy**
  A protective cover placed on the top of a motor being mounted vertically to protect it from liquids or solids that might drop onto the motor. (It acts similar to an umbrella for the motor.)

- **Conductor**
  A material, such as copper or aluminum, which offers low resistance or opposition to the flow of electric current.

- **Conduit Box**
  The metal container usually on the side of the motor where the stator (winding) leads are attached to leads going to the power supply.

- **Coil**
  The electrical conductors wound into the core slot, electrically insulated from the iron core. These coils are connected into circuits or windings which carry independent current. It is these coils that carry and produce the magnetic field when the current passes through them. There are two major types: "Mush" or "random" wound, round wire found in smaller and medium motors where coils are randomly laid in slot of stator core; and formed coils of square wire individually laid in, one on top of the other, to give an evenly stacked layered appearance.

- **Core**
  The iron portion of the stator and rotor; made up of cylindrical laminated electric steel. The stator and rotor cores are concentric separated by an air gap, with the rotor core being the smaller of the two and inside to the stator core.

- **Coupling**
  The mechanical connector joining the motor shaft to the equipment to be driven.

- **Current**
  The time rate of flow of electrical charge and is measured in amps (amperes).

- **Cycles per second (Hertz)**
  One complete reverse of flow of alternating current per rate of time. (A measure of frequency.)

- **Drip-Proof Motor**
  An open motor in which the ventilating openings are so constructed that drops of liquid or solid particles falling on it, at any angle not greater than 15 degrees from the vertical, cannot enter either directly or by striking and running along a horizontal or inwardly inclined surface.

- **Duty Cycle**
  The relationship between the operating and rest times or repeatable operation at different loads. A motor which can continue to operate within the temperature limits of its insulation system, after it has reached normal operating (equilibrium) temperature is considered to have a continuous duty (CONT.) rating. One, which never reaches equilibrium temperature, but is permitted to cool down between operations is operating under intermittent duty (INT.) conditions such as a crane and hoist motor which are often rated 15 or 30 min. duty.

- **Efficiency**
  The efficiency of a motor is the ratio of mechanical output to electrical input. It represents the effectiveness with which the motor converts electrical energy into mechanical energy.

- **Encapsulated Winding**
  A motor which has its winding structure completely coated with an insulating resin (such as epoxy). This construction type is designed for exposure to more severe atmospheric conditions than the normal varnished winding.

- **Enclosures**
  The housing, frame, of the motor of which there are two broad classifications; open and totally closed.

- **Endshield**
  The part of the motor housing which supports the bearing and acts as a protective guard to the electrical and rotating parts inside the motor.

- **Explosion-Proof Enclosure**
  An enclosure for electrical machinery or apparatus that will withstand, when the covers or other access doors are properly secured, an internal explosion of the flammable gas or vapor which may enter or which may originate inside the enclosure, without suffering damage and without communicating the internal explosion to the external flammable gas in which it is designed to be used, through any joints or other structural openings in the enclosure.

- **Explosion Proof Hazardous Locations**
  Hazardous areas worldwide are classified by zones, according to the risk posed by explosive gas or dust in the atmosphere
  - ✓ Zone 0/20 Continuously – Permanent presence of explosive atmosphere (>1000H per year)
  - ✓ Zone 1/21 Occasionally – Incidental presence of explosive atmosphere during normal duty (10-1000 H per year)
  - ✓ Zone 2/22 Abnormal Condition – Presence of explosive atmosphere only by accident, but not during normal duty (<= 10 H per year)

- **Externally Ventilated**
  A motor using an external cooling system. This is required in applications where the motor's own fan will not provide sufficient cooling; this is true for certain duty cycle applications, slow speed motors, also in environments with extreme dirt. Often a duct with an external blower is used to bring clean air into the motor's air-intake.

- **Frame**
  The supporting structure for the stator parts of an AC motor.

- **Full Load Current**
  The current flowing through the line when the motor is operating at full-load torque and full-load speed with rated frequency and voltage applied to the motor terminals.

- **Induction Motor**
  An induction motor is an alternating current motor in which the primary winding on one member (usually the stator) is connected to the power source and a secondary winding or a squirrel-cage secondary winding on the other member (usually the rotor) carries the induced current. There is no physical electrical connection to the secondary winding, its current is induced.

- **Insulator**
  A material, which tends to resist the flow of electric current (paper, glass, etc.) In a motor the insulation serves two basic functions:
  1. Separates the various electrical components from one another.
  2. It protects itself and the electrical components from attack of contaminants and other destructive forces.

- **Load**
  The burden imposed on a motor by the driven machine. It is often stated as the torque required to overcome the resistance of the machine it drives. Sometimes "load" is synonymous with "required power."

- **Lubrication**
  In order to reduce wear and avoid overheating certain motor components require lubricating (application of an oil or grease). The bearings are the major motor component requiring lubrication (as per manufacturer's instructions). Excess greasing can however damage the windings and internal switches, etc.

- **Nameplate**
  The plate on the outside of the motor describing the motor, HP, voltage, RPM's, efficiency, design, enclosure, etc.

- **Phase**
  Indicates the space relationships of windings and changing values of the recurring cycles of A.C. voltages and currents. Due to the positioning (or the phase relationship) of the windings, the various voltages and currents will not be similar in all aspects at any given instant. Each winding will lead or lag another, in position. Each voltage will lead or lag another voltage, in time. Each current will lead or lag another current, in time. The most common power supplies are either single (10) or three phase (with 120 electrical degrees between the 3 phases).

- **Primary Winding**
  That winding of a motor, transformer or other electrical device, which is connected to the power source.

- **RTD (Resistance Thermal Detectors)**
  - ✓ Winding RTD

  A resistance device used to measure temperature change in the motor windings to detect a possible over heating condition. These detectors would be embedded into the winding slot and their resistance varies with the temperature.
  - ✓ Bearing RTD

  A probe used to measure bearing temperature to detect an overheating condition. The RTD's resistance varies with the temperature of the bearings.

- **Roller Bearing**
  A special bearing system with cylindrical rollers capable of handling belted applications, too large for standard ball bearings.

- **Rotor**
  The rotating member of an induction motor made up of stacked laminations. A shaft running through the center and a squirrel cage made in most cases of aluminum which holds the laminations together and act as a conductor for the induced magnetic field. The squirrel cage is made by casting molten aluminum into the slots, cut into each lamination.

- **Shaft**
  The rotating member of the motor which protrudes past the bearings for attachment to the driven apparatus.

- **Slip**
  The difference between the speed of the rotating magnetic field (which is always synchronous) and the rotor in a non-synchronous induction motor is known as slip and is expressed as a percentage of a synchronous speed. Slip generally increases with an increase in torque.

- **Space Heater**
  Small resistance heater units mounted in a motor, that are energized, during motor shutdown, to prevent condensation of moisture on the motor windings.

- **Speed**
  The speed of the motor refers to the RPM's (revolutions per minute) of the shaft.

- **Starting Current**
  Amount of current drawn at the instant a motor is energized – in most cases much higher than that required for running. Same as locked rotor current.

- **Stator**
  That part of an AC induction motor's magnetic structure which does not rotate. It usually contains the primary winding. The stator is made up of laminations with a large hole in the center in which the rotor can turn; there are slots in the stator in which the windings for the coils are inserted.

- **Totally Enclosed Enclosure**
  A motor enclosure which prevents free exchange of air between the inside and the outside of the enclosure but is not airtight. Different methods of cooling can be used with this enclosure.

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**Speed Variation of Motor**:

In many of the applications the speed of the system is determined primarily by its mechanical design and loading. For an increasing number of these applications, owever, it is necessary to control the speed of the system by controlling the speed of the motor.

**Variable Speed Drives**

The speed of a motor can be controlled by using some type of electronic drive equipment, referred to as variable or adjustable speed drives. Variable speed drives used to control DC motors are called DC drives.

Variable speed drives used to control AC motors are called AC drives. The term inverter is also used to describe an AC variable speed drive. The inverter is only one part of an AC drive, however, it is common practice to refer to an AC drive as an inverter.

AC drives receive AC power and convert it to an adjustable frequency, adjustable voltage output for controlling motor operation. A typical inverter receives 440 VAC, three-phase, 50 Hz input power and in turn provides the proper voltage and frequency for a given speed to the motor. The three common inverter types are the variable voltage inverter (VVI), current source inverter (CSI), and pulse width modulation (PWM)..

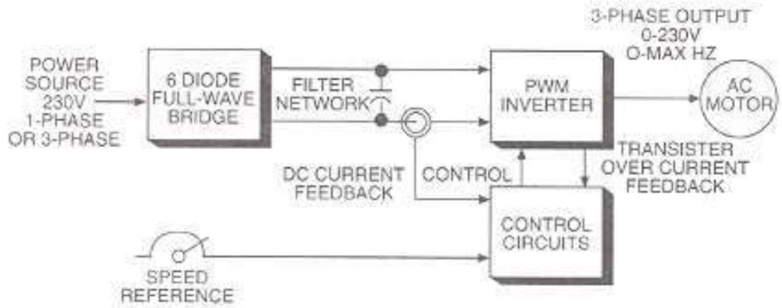
Another type of AC drive is a cycloconverter. These are commonly used for very large motors All AC drives convert AC to DC, and then through various switching techniques invert the DC into a variable voltage, variable frequency output.

**Basic working of AC Drive:**

The block diagram below indicates the basic working module of a variable speed AC drive. The standard 440 V, 50 Hz supply connected to the drive is first converted in to a DC supply through a 6 diode full wave rectifier bridge. This DC supply is now converted in to a AC supply of desired frequency. The Control Circuit module does this critical task. This controls the number of switching and accordingly a desired output frequency is obtained. This AC supply of variable frequency, when supplied to an ac motor, gives corresponding variable speed.

There are various techniques of switching the DC supply and getting a variable frequency AC supply.

For the purpose of this lesson, we need not go in to the finer technicality of these switching methods.




As the applied frequency is changed, the motor will run faster or slower. Standard three-phase AC motors, designed for fixed speed operation at standard line frequency, may be easily adapted for use with the AC controller by considering the following:

a. A slight increase in motor losses occurs with inverter power.
b. The motor thermal capacity must typically be de-rated as a function of the minimum, continuous operating speed, due to the reduced ventilation.

**EXERCISE:**

1. What is an electric motor ? What is the difference between AC & DC motors?
2. Describe the principle of Induction.
3. How the principle of induction is applied to AC motor?
4. Describe the advantages of AC squirrel cage induction motor over DC motor.
5. Describe the working principle of 3-phase induction motor.
6. Describe the construction of 3-phase induction motor.
7. What is Variable Frequency Drive (A.C. Drive)?
8. Explain following terms:

| | |
|---|---|
| a) Alternating Current | b) Adjustable Frequency Drive |
| c) Air Gap | d) Bearing |
| e) Conductor | f) Canopy |
| g) Coil | h) Cycles per Second (Hertz) |
| i) Drip Proof Motor | j) Encapsulated Winding |
| k) Duty Cycle | l) Explosion proof Enclosure |
| m) Insulator | n) Name Plate |
| o) RTD | p) Stator |

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## STATUTORY REQUIREMENT

When any new electrical installation is to be carried out, it is a statutory requirement to get the drawings for electrical installations approved by Chief Electrical Inspectorate (or Commissioner of Electricity) of State Govt. Before starting the erection jobs of electrical equipment, such approval, in writing, becomes statutory. There are various drawings and information/records to be sent to Electrical Inspectorate Office working under Industry, Mining & Power Department (I M & P Dept).

Main records / drawings to be sent are as under:

(a) Layout of electrical equipment like HT/LT switch gear, Power/Distribution transformers, HT/LT motors, Earthing Layout etc.

(b) Name plate details of major equipment like Power transformers, HT motors, switchgear etc.

(c) For transformers, the distances from walls/fencing, earthing pits, neutral CT arrangement etc.

(d) Substation floor layout panels' layout, dimensions and distances from walls

(e) Various design data like rupturing capacity (in KA or MVA) for HT switchgear.

(f) For hazardous area, the type of enclosures of Electrical equipment used in the plant.

Purpose of such approval is obviously electrical safety. From electrical point of view, Electrical Inspectorate Office checks whether the installation meets the requirements or not. If necessary, they can recommend some modification or addition/deletions. Approved drawings are duly stamped, signed and sent to the applicant. These drawings are to be preserved as important records. Any major modification or extension in Electrical installation needs to be approved by the competent authority. The existing (earlier approved) drawing and proposed modification drawings are to be sent to Electrical Inspectorate, for approval.

Following main points are scrutinized, from the safety point of view.

- Distances of switchgear, transformers etc. from the wall. This is for safe movement of the personnel during working and exit during emergency.
- Earthing - Size of earthing depends upon the equipment. Also, in earthing of generator or transformer is checked from safety point of view.
- Size of cable or GI strips or copper strips used for earthing network.
- Volume soak pit in case of higher rating power transformers.
- Type of enclosures in case of hazardous area.

Electrical Inspectorate is to be informed before starting the installation and on the completion of the installation. Electrical Inspectorate visits and checks that the installation is as per approval. Clearance for energizing the installation is given, in writing, by Electrical Inspectorate.

Commissioner of Electricity or Chief Electrical Inspector has his office in the state capital. They appoint electrical Inspectors for each District. Asst Electrical Inspectors assist the Electrical Inspector for the entire job/procedure. CEO or CEI approves initial drawings.

Once the installation is energized, Electrical Inspectorate or CEI inspects it every year, with prior intimation to the owner. They check following documents:

- Maintenance records for major equipment like transformers, HT/LT motors, switchgear etc.
- Test results of transformer oil
- Earthing record & Earthing conditions for the installation

After inspection, if electrical Inspector has any observation, it is intimated in writing to the owners for compliance, within the stipulated time.

For Public Undertakings, statutory approvals/inspections are carried out by the Central Electricity Authority, Panaji, Goa. Therefore, all Public Undertakings do not come under the purview of State Govt., Electrical Inspectorate.

**Lifts:**

All new lift installations need to be approved similar to that for electrical installations. Also, every year, load test is to be carried out and lift is to be certified by chartered engineer or agency authorized by Lift inspector.

Lift Inspector inspects lift once a year.

**Electricity Duty :**

Based on the generation capacity installed (GTG, STG & Emergency DG sets), Electricity duty is to be paid every month, to state govt. Amount is fixed, irrespective of actual generation. All energy meters in generation systems are to be tested by Authorized Test House & to be sealed.

It can be seen from above that for electrical installation and for lifts, Industrial Mining and Power (IM&P) Department has got very important responsibility. Keeping Indian Electricity rules and changing technology in view, they fulfill their role, with updated knowledge. They see that safety is observed and new regulations are enforced for safety of the industry in general and public at large.

**EXERCISE:**

1. List the drawings / records to be sent to Chief Elect Inspector before approval.
2. List the documents which the electrical inspector would check during annual inspection.
3. Why and when a lift is inspected ?

# UNIT- 05

## VALUATION TECHNIQUES & CASE STUDY

In the previous chapters you have learnt the basics of engineering. The intention of the previous chapters is not to make an engineer but to have some understanding of engineering aspects of the general machinery a valuer might come across in his day-to-day professional life. Some idea of basic engineering will help in understanding the variations in the industry.

The detail theory and principal of Valuation do not come under the scope of this subject, you have studied it else where. In day-to-day action, a valuer will surely come across a situation, which is peculiar to some situation. The copybook method of valuation may not give us a right indication. These are the occasions when experience of a valuer comes in handy. An attempt is made to visualize a couple of such situation for guidance.

A valuer during his professional carrier would deal with various types of installations, ranging from a small scale plastic injection molding unit to a large size multi product unit to a software development unit with practically no machinery and only intellectual installations like software. A valuer cannot be an expert in the field of his client unit. However, he need to have a macro view of the entire set up, extract maximum amount of relevant data, generate certain data from the market and then use his own judgment and wisdom to arrive at a value which will be closest to the actual.

When a valuer starts a project, he would get certain data from the client like date of manufacturing, expenditure made on the plant for maintenance or renovation, maintenance history and schedule etc.

All these data have some significance with respect to valuation. Let us have a brief look at these and discuss the significance of each with respect to the valuation process:

**Date of Purchase & Commissioning Date:**
This will give an idea of the age of the equipment. In general this will determine the value of the equipment, but there is certain typical situation where the expertise & judgment ability of the valuer plays an important role.

There can be an instance where equipment might not have been commissioned for a long time after purchase. In such cases the wear & tear is to be considered accordingly. The value of two similar plants procured during same period say 10 years back, one commissioned immediately and running continuously and other not used at all due to some reason or the other can not have same valuation. If the valuer follow the book value route, the result can be misleading.

In such case one has to look for the reason of non operation of the plant. E.g. a chemical unit needing lot of water for process is set up in a area where there is scarcity of water, can not be valued equally even if the machinery is un used. The unit as a whole has no value, but the equipment in isolation can be sold and re installed at other location, so individual equipment can have value.

**Production Rate:**

Valuer can not be an expert to know the intricacy of a equipment. Even if he is an expert engineer, he may not have time and/or an opportunity to open the machine and inspect. Production rate data will indicate the condition of the machine. If all other conditions which can effect the production like market availability, labour un rest, power situation etc are normal then a low production rate data, indicates that the equipment is not very healthy.

**Operating Hours:**

The total operating hours can indicates about the healthy ness of the machine on one hand while as on other hand it also indicates the wear & tear of the machine.

**Maintenance Schedule & it's implementation:**

Any plant and machinery has to be maintained properly. Maintenance does not mean only break down maintenance. It need to have a preventive maintenance also i.e one has to take care of the machine and nurish it so that it does not fail prematurely. A simple example is lubrication or greasing. To ensure that a machine bearing does not run dry, we put oil or grease at a regular interval. This prevents the bearing from failure.

By looking at the maintenance schedule and confirming that this schedule is really adhered to, the valuer can judge the condition of the machine. A poorly maintained machine is likely to fail earlier then the other which is regularly maintained.

**History Of Breakdowns & major maintenance:**

The valuer should critically examine this data, because any repetitive major failure indicates that there may be something wrong with the machine. Such failure also reduces the Residual Life (Remaining Life) of the equipment.

The valuation has an analogy of our purchasing a second hand car. Knowingly or unknowingly all above factors are pressed in service by us When we go for buying a second hand car we will select a one either of the doctor because it might have run less OR of an engineer because it might have been maintained well. We will enquire about any major accident or repair of the engine to judge the residual life.

**Expenditure Made:**
In case you as a valuer do not get the engineering data mentioned above, you can ask for the data of the expenditure incurred on maintenance and modifications. A high amount of maintenance expenditure does not necessarily indicate very good maintenance. It may mean poor health of the machine.

A valuer will be satisfied if he gets above data. By using the data as a tool, he can derive a near actual valuation. But in the professional life, he may not be always so lucky to get all the data. Even if gets some of the above, he can still work out, but what if the unit do not have majority of these data? In such a situation the wisdom and expertise comes in to play an important role.

The valuer has to now arrive at the value based on external factors. These factors though widely remain same but may vary depending on the type of the equipment. In the following paragraphs we will examine certain factors with examples and see how best a value can be judged. Student should remember that these examples should be taken as a guideline only and not as a valuation principal, since the methodology will vary from equipment to equipment and also for similar equipment from case to case.

**Case Study 1: Pump**
If the equipment under valuation is a pump and there is no useful data is available then the valuer should find out the capacity of the pump, the liquid it is handling, the MOC (Material Of Construction), HP of the motor etc. The capacity of the pump & the liquid handled can help in finding out an equivalent pump. If the pump is in a scrape condition the MOC & Motor capacity can indicate the scrape value i.e. if the MOC is SS then the scrape value will be Rs 75 / Kg , if it is Cast Iron it will be Rs 7 / Kg but if it is Brass then it would be Rs 225 / Kg. The cost of scrape copper (Electrical Grade) would be Rs 350 / Kg. All the rates are indicative and on 2006 price base. A valuer is advised to check the current market price since there may be some fluctuation in these rates. The HP of the motor can give an approximate idea of the copper conductor used in side which can be retrieved and sold as scrape. As a thumb rule one can consider 1 Kg of Copper per HP of motor.

The table under gives a estimate of material cost of some of the commonly used MOC:

| Material | Market Rate (2006) |
|---|---|
| Lead | 65 |
| Gun Metal | 225 |
| Brass | 225 |
| Copper | 350 |
| Aluminium | 130 |
| Mild Steel | 25 |
| Cast Iron | 07 |

**Case Study 2: Lancashire Boiler**

In earlier days the Lancashire boiler was the most popular boiler and was almost omni present. These boiler were very sturdy and comperatively easy to maintain. Many of the boilers are in use even today and is performing reasonably satisfactorily. With the passage of time, new technology has taken over. The new boilers are designed and manufactured and have gradually phased out the good old Lancashire boilers from manufacturing floor.The new boilers These are much larger in capacity, better in efficiency, flexible in type of fuel used and reduced in size.

Now, when a valuer come across a Lancashire boiler, what he will do ?

- If he takes the route of book value, then the book value by now will be practically zero. The boiler is still operative, so he can not value it as zero.
- Other method is by weight of the material. This route is chosen for a scrape item but in this case this also is not applicable since boiler is in working condition.
- He can not have the price of a new Lancashire Boiler since it is out of manufacturing range of all the manufacturers.
- He can not straight away take the price of a new version boiler since it is different then the object in question in many aspects and much superior in technological design.

A wise valuer will get the price of a modern boiler of almost the same capacity and using the same type of fuel. Though the new and the old ones are similar in capacity, there are certain major differences, like –

- This new version boiler will be better in efficiency. Find out the efficiency of the old boiler and de-rate the new boilers value to that extent.
- The size of the new boiler will be much less. Compare this with the Lancashire boiler and take the value of the space in to consideration. One has to deduct the land and building price for this additional space. For major cities where land price is very high, this is a very dominant factor.
- The controls of the new boiler would be very sophisticated, presumably a PLC or a micro processor based. The old boiler would have a hard wire relay logic type of control. Find out the price of such control panel and take in to account while deriving the value.

Thus the cost of the new version boiler minus the de rating factors due to above will give us the equivalent price of a new Lancashire boiler if it would have manufactured today. Now, the valuer can use his standard copy book methodology for deriving the value of this old but still operative boiler.

**Case Study 3: Lancashire Boiler**

In the situation of case study 2 above, there is one more method of accessing the value. It is a market based method. There exists a very large market of second hand machinery & equipment. The valuer can explore the market through traders, engineering magazines publishing advertisements and data for used equipment and also on various web sites dealing in such items. Having compared the age and the capacity of the second hand boiler, with the installed one, check the condition of the boiler. The price offered (after negotiations) can be considered as the value for the installed boiler. This can be termed as market derived depreciation.

The value so derived is generally accurate one but one has to be very careful since one should select a similar equipment not only in terms of type, age and capacity but also it should be similar in condition.

**Case Study 4: Minimum Oil Circuit Breaker:**

The electrical system of an old unit will have Minimum Oil type of circuit breaker. These were very popular and were widely accepted technology till eighties. From nineties the use of vacuum and SF6 (gas filled) circuit breakers started and manufacturer gradually phased out the old technology breakers from manufacturing range. The MOCB however are still in use in many electrical sub stations.

If a valuer wants to find out the value of a MOCB, he may not find a manufacturer to get today's price. What is widely used today is a Vacuum Circuit Breaker (VCB). The VCB is sturdy, compact and have no hazardous consumable like oil in the system. The breaking capacity of the VCB is much higher then the MOCB. We may not get the exact similar characteristic breaker because the datum level has gone up. In such case, the valuer can get the rate of a VCB, de-rate by say 20% for space utilization and 15 to 20 % for technology difference. Thus this de rated value will be our replacement value. By using other standard valuation tools, we can derive the true value. Just to give an idea of this method, let us take a real life example. The price of a MOCB in 1985 was Rs. 75000/-. We do not have a replacement price today since it is out of manufacturing range. A new VCB will cost Rs 4,00,000/- , with the de rating of 20% for space utilisation + 20% for technology difference, the replacement cost will work out to be Rs 2,40,000/ -. Now, using the standard tools, the valuer can find out the value as on date.

The other method of finding the value is market-derived value, which is discussed, in earlier case study.

**Case Study 5: Non Standard Make:**
When one is out in the market to buy machinery, one is bound to get various widely varied offers. The highest price offer of a branded / high repute manufacturer, with very high quality standard and the lowest will be from a local unknown manufacturer with not so high quality checks. The variation in price is due to various reasons like difference in input cost, over heads, brand equity etc. Any manufacturing unit while procuring machinery will evaluate the offers keeping a question of "How much for how much" in mind. If the product of a local manufacturer meets the requirement, the user will surely go for it. While doing the valuation of such similar functioning & similar looking items, valuer must give due consideration to the "Make" of the item, with above aspect in mind.

As an example let us consider an electrical panel. (or Motor Control Centre – MCC) There are numerous manufacturers of electrical panels. On one hand there are brands like Siemens, L & T, Crompton etc. All these are giants in the field and manufacture panels using their own branded components like switch, fuse etc. However, there are other small and medium scale units, who fabricate a panel, buy components of various make from the market and wire them in the panel. The components used in the panel can be of varied make from say Siemens Switch to a local hand mould fuses. The quality of fabrication and painting can be different. Their overheads are also less. Many a times they are out of Excise Duty regime. Due to all above reasons the cost of the locally manufactured panel can be cheaper up to 30%. A valuer must open the locally manufactured panel and access the brand of the components, material of construction of bus bars (copper or aluminum) etc before judging the value.

Plant and equipment valuation situations are varied, and circumstances may even require the estimation of more than one type of value in a single assignment. Accordingly, plant and equipment will be valued on a basis that is appropriate for the circumstances, and that basis will be appropriately defined in the valuation Report.

The Time effect in valuation:

When we talk of valuation of an old unit, it includes all equipment & facility installed in the company i.e. one has to take in to account the procurement cost as well as labour cost involved for installation. In the previous paragraphs we have seen how the value of the equipment procured is arrived at especially in case of old equipment. Now, we will try to analyze the effect of labour cost in valuation of such old equipment. With increase in standard of leaving and the inflation, the cost of labour is constantly going up. The statutes have also raised the minimum wages of the labour to protect them from exploitation.

It is interesting to note that the unit rate of the work have not increased proportionate to the increase in wages of labour mainly due to increase in competition. The effect of inflation is some what nullified by reduction in profit margin. There are many contractors today as compared to the earlier days and as a result of stiff competition amongst them, the industry has gained. Just to give an example of rise in labour cost vis-à-vis the competitive market; let us consider an item of cable laying. Cost of laying a 3 core, 2.5 sq mm cable was Rs 5 / Mtr in 1978, Rs 6 / Mtr in 1991 and Rs 9 / Mtr in 2006.

Though the labour cost have defeated the law of inflation to some extent, due to increase in the raw material cost , the cost of equipment have surely gone up with passage of time. Also as we have seen in above paragraphs, the type of material used has widely varied over a period of time. A valuer while valuing an old asset should keep both these factor in mind.

There are numerous types of equipment in the industries. The variation in cost and the type will be different in each case. However, to understand the effect of time in valuation, let us consider an example of a electrical sub station with a HT over head in-comer, HT breaker, a transformer and cable for connecting the transformer. We have not included LT side equipment in this example for simplicity. The following table gives an idea of varying cost and type of equipment in such typical electrical sub station.

| Sr No | Description | Cost Of Equipment (Type of Equipment) in Rs in respective Year of Installation | | |
|---|---|---|---|---|
| | | 1977 | 1991 | 2006 |
| 1 | DP Structure for out door tapping | 8000 | 20000 | 30000 |
| 2 | Transformer 250 KVA 11KV/415V | 30000 | 80000 | 200000 |
| 3 | HT Circuit Breaker Panel (Cost/Type/Size) | 100000/MOCB/3 sq mtrs | 200000/MOCB/2 sq mtrs | 400000/VCB/1 sq mtrs |
| 4 | HT Cable (Cost per Mtr / Type) | 300 (Paper Insulated) | 500 (PVC Insulated) | 900 (XLPE Insulated) |

If one has to find out a valuation of the sub station mentioned above, the table above can help in deciding various factors discussed in the chapter.

**Indirect Costs:**

The Market Value of plant and equipment rests upon the belief that a prudent purchaser would pay no more for an asset or a group of assets than the cost of acquiring (an) equally desirable substitute(s) in the market. In the valuation of plant and equipment, the cost of the substitute(s) often includes costs to make the asset(s) productive. These costs are called make-ready and/or indirect costs. Often included in these costs are necessary, associated expenses such as engineering, interest during construction, transportation, installation, attachment to utilities, and start-up.

Plant and equipment includes installations and support facilities for processes or manufacturing which are designed to perform a specific predetermined function. These include all non-realty devices in fixed or movable form deployed in the processing, manufacturing, or assembling of products from the stage of raw materials to finished goods. Separately reported items such as materials inventories, finished products, patents, and the like are not included. Thus, it is essential to the valuation Process that all items to be valued are neither omitted nor accounted for twice in the valuation and related reporting.

**Assignment 1**

1. Define a boiler.
2. Describe significance of “Boiler Specifications”
3. What is IBR ? Where it is applicable.
4. Describe the classification of boilers by the type of construction.
5. Discuss various systems of a boiler.
6. Describe “Fire Tube”, :Water Tube” & “Package” boilers.
7. Discuss “High Temperature Hot Water Boilers” covering Advantages – Disadvantages & heat transfer liquid used.
8. What is “Waste heat boilers”?
9. Write note & describe the following :
    a. Fire Tube Boilers
    b. Scotch Marine Boilers
    c. Lancashire Boilers.
    d. Utility Boilers.
    e. High temperature Hot Water Boilers with Advantages & Dis advantages.
    f. High temperature heat transfer methods.
    g. Waste Heat Boilers.
    h. Waste fuel Boilers.
    i. Fluidised Bed Boilers.
10. Describe the components of pipe work
11. What is a pump & what is a compressor?
12. What are different parts of pumps?
13. Describe a Centrifugal pump with construction and working details.
14. List types of Pumps.
15. What are the technical factors considered in selection of a pump?
16. Describe basic concept of a centrifugal pump operation OR Describe working mechanism of a Centrifugal pump.
17. Discuss the statement :Pump can pump only liquid and not vapour”

**Assignment 2**

1. Write note on classifications of compressors.
2. Describe in brief the methods to compress gas.
3. Draw a sketch and describe Reciprocating Compressor.
4. Describe a Centrifugal Compressor.
5. What is Geared Compressor ? What are advantages of geared compressor ?
6. Write notes on following :
    a. Fans & Blowers
    b. Centrifugal Compressor
7. What is Prime Mover ? Name important primemovers.
8. Describe different types of prime movers.
9. What is Gas Turbine?

10. What is air conditioning? What one would expect to find in an a/c installation?

11. Where a/c system for raising ambient temperature is used? Name the systems for raising ambient temperature. Describe one of them.

12. What are the basic parts of a/c cooling system? Describe the cooling cycle

13. Draw and describe refrigeration cycle.

14. Describe an absorption cycle.

15. Explain the parts & working of window a/c.

16. Why one need Humidifiers ? Explain the working in brief.

17. Name circulating / distribution equipment.

18. Write note on Fan & Blowers.

19. Define the terms
    Force, Energy, Power, Voltage & Current

20. Describe Voltic cell and it's analogy with water pump.

21. What is Ohm's Law. Explain in brief the relation between Voltage applied, Current passing through and the resistance.

**Assignment 3**

1. Draw and describe the general electrical distribution diagram. What are the elements involved .
2. Explain the power flow concept in electrical engineering. Explain the same giving analogy.
3. How is the transmission voltage determined? Why the transmission voltage is kept high ?
4. Describe the types of primary distribution system.
5. What are the requirement of electrical sub station room ?
6. What are the equipment one will normally find in an electrical sub station ?
7. Write brief note on following :
    a. Switchgear Breaker
    b. Unit s/s
    c. Motor Control Centre (MCC)
    d. Transformer
    e. Types of switch boards
    f. Types of distribution boards.
8. What is Power factor Correction ? Why it is done ?
9. Describe all three types of Distribution boards.
10. Explain the advantages of circuit breaker over fuse.
11. What is MCB?
12. Explain Trickle (or Float) and Boost charging in a battery.
13. What is meant by Primary battery? List the basic application of primary battery.
14. Describe the Function of Protective Relaying

15. What is meant by “Normal operation of a system “ when we are talking about the protection ?

16. What are the Features for prompt disconnection of an faulty element?

17. Detail the General Consideration of protection.

18. What is “cable”?

19. List the key factors governing the selection of a cable.

20. What is XLPE cable ?

21. Describe the basic theory of an induction motor.

22. What is meant by AC motor or DC motor ?

23. Explain construction of Squiral cage induction motor stating advantages.

24. Describe speed variation in AC motors.

25. What is meant by Explosion proof motor ? Where it is used?

26. Explain any three important terminology used in motors.

27. What are the documents required to be sent to Electrical inspector for statutory permissions?

28. What are the points scrutinized by Electrical Inspector?

29. Who is the statute body for PSU and Private sector industries.

30. Do you agree with the statement “A valuer cannot be an expert in the field of his client unit.” – Why ?

31. What data a valuer should collect while doing the project ? What is the significance of each data ? Describe each.

32. Describe & discuss with case study the effect of external factors on valuation.

## VI. Impact of Indian accounting standards, International Valuation Standards and Standards to be published by Ministry of Corporate Affairs, GOI on valuation of plant and machinery

According to Indian Accounting Standard (Ind. AS) 16 -*Property, Plant and Equipment* - An item of property, plant and equipment that qualifies for recognition as an asset shall be measured at its cost.

The cost of an item of property, plant and equipment comprises:

(a) its purchase price, including import duties and non-refundable purchase taxes, after deducting trade discounts and rebates.

(b) any costs directly attributable to bringing the asset to the location and condition necessary for it to be capable of operating in the manner intended by management.

(c) the initial estimate of the costs of dismantling and removing the item and restoring the site on which it is located, the obligation for which an entity incurs either when the item is acquired or as a consequence of having used the item during a particular period for purposes other than to produce inventories during that period.

The examples of directly attributable costs are:

(a) costs of employee benefits (as defined in Ind. AS 19, *Employee Benefits*) arising directly from the construction or acquisition of the item of property, plant and equipment;

(b) costs of site preparation;

(c) initial delivery and handling costs;

(d) installation and assembly costs;

(e) costs of testing whether the asset is functioning properly, after deducting the net proceeds from selling any items produced while bringing the asset to that location and condition (such as samples produced when testing equipment);

and

(f) professional fees.

Please refer to General Standards IVS 101 to 105 and IVS 300 Plant and Machinery of 2017 document of International valuation Standards Committee.

At the time of publication of this material in Dec.2017 the Ministry of Corporate Affairs, Govt. of India have not published the standards.

# LAW- PLANT AND MACHINERY

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Kirit P. Budhbhatti

Chairman, CVSRTA

**1.Preamble – Sales of Goods Act, 1930**

- The law relating to sale and purchase of goods, prior to 1930 were dealt by the Indian Contract Act, 1872.
- In 1930, Sections 76 to 123 of the Contract Act was repealed and a separate Act known as the Sale of Goods Act, 1930 was passed
- This act lays down special provisions governing the contract of sales of goods .The general law of contract is also applicable to the contracts for the sale of goods unless they are inconsistent with the express provisions of the Sale of Goods Act

**2.Definition of Contract of Sale**
According to Section 4 of the Act, a Contract of sale means *"a contract where the **seller transfers** or **agrees to transfer/"ownership" the property** in **goods** to the **buyer** for **price**". Includes both Sale and Agreement to sell. Will be between two parties and will be express (oral) or in written.*


Contract of Sale is of two types : Sale and Agreement to Sell
(As Mentioned Above)

**3.Sale of Goods and Agreement to Sell**
**Sale :** It is a contract where the ownership in the goods is transferred by seller to the buyer **IMMEDIATELY** at the conclusion of Contract.

**Agreement to Sale:** It is a contract of Sale where the transfer of property in goods is to take place at a future date or subject to fulfillment of certain conditions. Here the seller **agrees** to transfer the property in goods to the buyer for a price.

**Key Difference between Sale and Agreement to Sale :** Where under a contract of sale the property in the goods in transferred from the seller to the buyer, the contract is called a sale, but where the transfer of the property in the goods is to take place at a future time or subject to some condition thereafter to be fulfilled, the contract is called an agreement to sell.

An agreement to sell becomes a sale when the time elapses or the conditions are fulfilled subject to which the property in the goods is to be transferred. ***(So, Ultimately the agreement to sale will become sale as time lapses subject to fulfillment of conditions)***

**4.Distinction between Sale and Agreement to Sale**

| Basis | Sale | Agreement to Sale |
|---|---|---|
| Transfer of Property | Ownership if transferred immediately. It is executed Contract | Ownership if transferred at a future date subject to conditions. It is executory Contract. |
| Type of Goods | Existing and Specific Goods | Future and Contingent Goods |
| Risk of Loss | Buyer even if the goods are in possession of the seller. | Seller even if the goods are in possession of seller |
| Consequences of Breach | If buyer fails to pay the seller, seller can sue for the price of goods. | If there is any breach, then buyer can sue seller only for damages and not for price (e.g Liquidated damages) |
| Right to resell (from Seller) | No | Yes |

**5.Defination of Goods**

**Defination of Goods:** Goods is the subject matter—Goods means every kind of movable property other than ACTIONABLE CLAIMS AND MONEY and includes stocks and shares, growing crops, grass and things attached to or forming part of the land which are agreed to be severed before sale or under the contract of sale. Trade marks, copyrights, patent rights, goodwill, electricity, water, gas are all goods.

Category of Goods – Specific Goods, Ascertained Goods (Sale) Future Goods, Contingent Goods (Fishing Example, Agreement to Sale)

**Actionable claim** means a claim to a debt or any beneficial interest in movable property not in possession (which can be enforced by action in a court. A debt from one person to another is an actionable claim and cannot be bought or sold as goods but they can only be assigned. **(An unsecured debt)**

A disputed claim which can be enforced through court of law and is excluded from the definition of good.

Definition of Goods – Existing Goods (Sale) and Future Goods (Agreement to Sell)

**Specific Goods:** Those Goods which are identified and agreed upon at the time of contract of sale.

**Ascertained Goods:** Though similar to specific goods are those goods which become ascertained subsequent to the formation of a contract of sale

**Unascertained Goods:** Goods which are not identified and agreed upon at the time of contract of sale. These good are called generic goods and are defined by description only and may form part of big lots of goods.

**Future Goods:** Goods not in existence at the time of contract of sale, Goods are to be manufactured or produced or acquired by the seller after making the contract of sale.

E.G I Phone for Existing Goods.
(Ownership = Title + Possession)

**6.Unpaid Seller- Section 45 of the Sale of Goods Act, 1930**

Rights of unpaid seller:
An unpaid seller is one

- who has not been paid/tendered the price
- A bill of exchange or other negotiable instrument received but dishonoured or otherwise irregular
- Who has got a court decree but not yet satisfied ( or executed)
- Any person who is in the position of the seller ( agent or a consignee who had paid for the goods and responsible for the price

A unpaid seller has an immediate right of action for the price.

Unpaid seller has two kinds of rights:

- Against the goods
- Against the buyer personally

Right against the goods

- when the property in goods has passed: Lien, Stoppage in Transit and Re-sale
- when the property in goods has not passed: Withholding delivery and Stoppage in Transit

Right against the buyer personally

- Suit for the price
- Suit for damages
- Repudiation of the contract **(Cancellation of Contract)**
- Suit for interest **(If late payment, need to compensate with Interest)**

Examples of Unpaid Seller

- X Sells goods of Rs. 5 lacs to Y on a credit of one month, but after expiry of one month he does not pay the price, here X is said to be unpaid seller
- X Sells goods of Rs 5 lacs to Y on a credit period of 1 month but Y pays only 1 lac after 1 month, x is termed as unpaid seller.

**7. Rights of Unpaid Seller- Section 46 of the Sale of Goods Act, 1930**

Right of Lien: (Ownership Transferred, however possession of Goods with Seller)

A lien is a right to retain the possession of the goods until the price is paid. This right is immediate in case of cash sales. In case of credit sales it is after the expiry of the credit period. The right is also available when the buyer becomes insolvent at any time.

Lien depends on actual possession and not on title whether as seller or as his agent or as bailee for the buyer

Possession of the goods by the seller must not expressly exclude the right of lien Lien can be exercised only for the price and not for other charges ( like taxes, duties)

Seller having made part delivery of the goods may exercise lien on the remainder (unless there is a condition to waive the lien)

*(Eg : Seller had to supply 100 Kgs of wheat of which 40 Kgs were supplied, can Lien be exercised on remaining 60 Kgs) – "Yes", Since 60 Kgs is in Seller's Possession*

A sold certain goods to B for a price 500 and allowed him to pay the price within 1 month. B becomes insolvent during the period of credit.A unpaid seller can exercise his right of lien.

Right of stoppage in transit: (Ownership Transferred)
This right is available: a) when the buyer becomes insolvent and b) when the goods are in transit.
Insolvency means failure to pay them on the due date whether he has committed an act of insolvency or not

This right is an extension of the right of lien

The carrier may hold goods as an agent of the seller

If the carrier is holding goods as an agent of the buyer, seller cannot exercise the right of stoppage in transit

If the carrier is holding goods in an independent capacity, the seller has the right of stoppage. Stoppage can be effected by taking possession or by giving notice of stopping.

Right of lien or stoppage in transit is not affected by any sale or pledge which the buyer would have made unless the seller has assented to the same.

***Right to Stoppage in Transit : Essence is to regain possession and Right of Lien : Essence is to retain possession.***

Right of Resale: (Ownership Transferred)

When the goods are perishable

When the notice of resale is given to the buyer but buyer does not respond by payment /tender of price within a reasonable time

In case of loss in a resale, seller can claim it from the buyer as damages for breach of contract

In case of surplus the seller is not bound to hand it over to the buyer (buyer cannot benefit from his own wrongs)

Notice is a must or there should be clause in the sale contract expressly reserving the seller's right of re-sale

Right of withholding delivery: (Ownership Not Transferred)

Where the property in goods has not passed to the buyer, the unpaid seller has a right of withholding delivery This right is co-existent with the right of lien and stoppage in transit

Rights of the Unpaid seller against the buyer personally: **(Ownership Not Transferred)**

a) Suit for the Price; b) Suit for damages for non-acceptance; c) Repudiation of the contract before due date and d) Suit for interest

**8.Remedies of Buyer Against the Seller (From Buyer Perspective)**

**Damages for Non Delivery:** Where the seller wrongfully neglects or refuses to deliver the goods to the buyer the buyer may sue the seller for damages for non delivery.

**Suit for Specific Performance:** where the seller commits of breach of the contract of sale, the buyer can appeal to the court for specific performance.

**Suit for breach of warranty:** If there is a breach of warranty on the part of seller, or where the buyer elects to treat breach of condition as breach of warranty in such circumstances the buyer is not entitled to reject the goods.

Suit for damages for repudiation of contract by the seller before the due date

Suit for Interest.

**9.Warranty and Condition – Express and Implied**

A Condition is a stipulation – Which is ESSENTIAL to the main purpose of contract and the breach of which gives the aggrieved party a RIGHT TO TERMINATE THE CONTRACT.

A warranty is a stipulation which is COLLATERAL to the main purpose of the contract and the breach of which gives the aggrieved party a RIGHT TO CLAIM DAMAGES and not right to terminate the contract or reject goods.

Condition and warranty may be express or implied.

Express means which are agreed upon between the parties at the time of contract and implied means which are presumed by law to be present in the contract.

**9.Implied Conditions (Presumed by law)**

Condition as to title Section 14(a)

Condition as to description

**Sale by Sample (Covered)**

**Sale by Sample as well as by description (Covered)**
Condition as to merchantable quality

Sale as quality and fitness

Condition as to wholesomeness.

**10.Implied Condition – Sale as to Sample (Section 17)**

Condition as to Sample (Section 17) in a contract of sale of sample there is an implied contract:

- The bulk shall correspond with the sample in quality
- The buyer shall have a reasonable opportunity of comparing the bulk with the sample
- The goods shall be free from any defect rendering them un- merchnatile.

Eg: A Company sold certain shoes made of special sole by sample for French army. The shoes were found to contain paper not discoverable by ordinary inspection. Held, the buyer was entited to the refund of the price plus damages**.**

A agreed with B to sell certain oil described as refined sunflower oil, warranted only equal to sample. The goods tendered were equal to sampls, but contained a mixture of hemp oil. B can reject the goods.

**11.Rule of Caveat Emptor – Let the Buyer be aware (Section 16)**

When sellers display their goods in the open market, it is for the buyers to make a proper selection or choice of the goods. If the goods turn out to be defective, he cannot hold the seller liable.

It is duty of buyer to satisfy himself before buying the goods on his own skill and judgement.

A sold pigs to B. These pigs being infected caused infection to other pigs as well. It was held that the seller was not bound to disclose that the pigs are unhealthy.

Exceptions:

- When purpose of buying is in seller notice (Buyer relies on sellers skills – described Goods)
- When goods are sold under BRAND name
- When good are bought by sample
- When goods are sold under description
- When seller commits fraud.

**12.Passing of Property in "Goods" (Section 18-24)**

Passing or tranfer of property constitutes the most important element and factor to decide the legal rights and liabilities of seller and buyer. Passing of property implies passing of ownership. If the property has passed to the buyer the risk in the goods sold is that of buyer and not of seller, though the goods may still be in seller possession.

Transfer of ownership in different stages of SPECIFIED Goods (Sale)

**13.Passing of Property in “Goods” in case of Specific Goods**

Goods in a deliverable state:

> ***Example:*** *X goes into a shop and buys a television and asks the shopkeeper for its home delivery. The shopkeeper agrees to do it. The Television immediately becomes the property of X.*

Goods to be put into a deliverable State:

> ***Example:*** *A stock of wheat was sold at an agreed price per quintal. The wheat was to be weighed by the seller for ascertainment of the price. A part of the wheat was weighed and carried by the buyer but the remaining was swept away by the flood. Held, the loss of the remainder should be borne by the seller since the property in the remainder has not passed because the required weighing was not done.*

> ***Example:*** *A sold carpets to the Company which were required to be laid. The carpet was delivered to the company's premises but was stolen before it could be laid. It was held that the carpet was not in deliverable state as it was not laid, which was part of the contract and hence, the property had not passed to the buyer company*

**14.Passing of Property in "Goods" (Section 18-24) – Future Goods i.e unascertained Goods**

In case of a contract for the sale of unascertained or future goods, ownership will not pass to the buyer, unless and until the goods are ascertained.

Goods by description:

Example: A agrees to purchase 1000 quintals of cotton from warehouseman, out of which he took delivery of 500 quintals and remaining to take later on. The warehouseman weighed the cotton and kept the remaining separately and informed A to take them and agreed to do so. Before he takes delivery of the remaining goods the warehouse caught fire and destroyed the cotton. A, is liable for the price to the warehouseman since he has appropriated the goods, and the ownership is transferred to him.

**(Appropriation of goods involves selection of goods with the intention of using them in performance of the contract and with the mutual consent of the seller and the buyer)**

Delivery to the carrier:

Example: A bill of lading of railway parcel is made out in the name of the buyer and is sent to him, the ownership in the goods passes from the seller to the buyer. In case the goods are subjected to accidental loss or by theft, the seller will not be liable.

Goods sent on approval or “on sale or return”

**Example :-** *A, sends to B a water motor on approval or return in March 2012. B to return it after trial in August, 2012. The water motor has not been returned within a reasonable time, and therefore, A is not bound to accept it and B must pay the price.*

Risk passes with property: The owner of goods must bear the loss or damage of the goods unless otherwise agreed to. Under Section 26 of the sale of goods act, unless otherwise agreed the goods remain at the sellers risk until property therein has passed to the buyer. After the event they are at the buyer’s risk, whether the delivery has been made or not.

**15.Sale by Non – Owners (Transfer of Title by Non-Owners) Covered under Tranfer of Title i.e Section 27 – 30**

“Nemo Dat Qui Non Habet”—No one can give that which one has not got.(latin)

A thief cannot pass a better title to his buyers than what he himself has. It is only the owner

In general, the seller sells only such goods of which he is an absolute owner.

Sometimes, persons other than owners can pass on good title: a) Title by estoppel (where the owner by his conduct or silence leads the buyer to believe that the seller has authorised); b) Sale by mercantile agent (agency in the ordinary course of business); c) Sale by one of the joint owners; d) Sale by a person in possession under a voidable contract; e) Sale by seller in possession after sale (buyer has to buy in good faith); f) Sale by buyer in possession after having bought or agreed to buy; g) Sale by unpaid seller; and h) Sale by finder of lost goods; Sale by pawnee or pledgee; Sale by Official receiver or Assignee; Sale in Market by enforcement

Please Note Sale / Agreement to sale is different from Hire Purchase.

**16.Exceptions – Non owners can pass bonafide title.**

Sale by Mercantile AGENT : He is in possession of goods with consent of owner, ordinary course of business as agent

E.G Authorized Car Seller agent sells at a price less than market. Owner is not happy. Buyer is not obliged to compensate.

Sale by Co-joint owners – A, B and C are three brothers.

Sale by one who has already sold the goods but continues to be in possession thereof:

Example: During ICL matches, P buys a TV set from R. R agrees to deliver the same to P after some days. In meanwhile R sells the same to S, at a higher price, who buys in good faith and without knowledge about the previous sale. S gets a good title.

Sale by buyer obtaining possession before the property in the goods has vested in him :

Example: A took a car from B on this condition that A would pay a monthly instalment of `500 as hire charges with an option to purchase it by payment of ` 10,000 in 24 instalments .After the payment of few instalments. A sold the car to C. B can recover the car from C since A had neither bought the car, nor had agreed to buy the car. He had only an option to buy the car.

**Salient Features of Factory Act, 1948**

Objectives of Factories Act; Working Hours (Holidays, Extra time), Health, Safety, Welfare & Penalties

Section 2(m) defines factory as whereon ten or more workers or were working on any day of the preceding twelve months and in any part of
which a manufacturing process is being carried on with the aid of power OR

whereon twenty or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on without the aid of power, or is ordinarily so carried on.

Health Section 11 to 20 deals with the health of workers in the work place defining the various parameters in maintaining the cleanliness, disposal of effluent, standard of lightening, noise levels, latrines, etc.,

Safety Section 21 to 41 deals with the safety provisions. Fencing of machineries, restriction of women and children in certain type of process, testing of pressure plants, hoists and lifts, lifting machineries, chains, ropes and lifting tackles by competent persons, appointment of safety officers etc., are explained.

Welfare Section 42 to 50 specifies the necessity for welfare of workers such as washing facilities, first aid appliances, rest room, crèches, canteen,
appointment of welfare officers, etc.,

Provision relating to Hazardous Process Section 41(A) to 41(H) deals various special provisions for factories wherein hazardous process are carried on. Here compulsory disclosure of information by the occupier to the workers as well as to the public, permissible limit of exposure of
chemicals and toxic substance, workers participation in safety management etc, are prescribed.

Working Hours Section 51 to 66 handles the restriction of working hours such as weekly hours, weekly holidays, compensatory holidays, night
shifts, over time, etc.,

Employment of Young Persons Section 67 to 77 explains the working conditions of young persons, regarding the certificate of fitness reduced
working hours etc.
Annual Leave with wages Section 78 to 84 deals with the leave eligibility for a worker

Penalty and Procedure Section 92 to 106A deals with the penalty provisions. For any contravention of the provisions of this act, or of any rules
made there under, the occupier and the manager of the factory shall each be guilty of an offence and punishable with imprisonment for a term
which may extend to 2 Years of with fine which may extend to 1 lakh rupees or with both.

## Salient Features of Electricity Act, 2003

| Sr No. | Category | Key Features of Indian Electricity Act 2003 |
|---|---|---|
| 1 | Objectives | ▸ Encouraging autonomous regulation with the separation of policy regulation and operational aspects<br>▸ Rationalizing tariff and lowering the cross-subsidization levels<br>▸ Creating competition in the industry<br>▸ Ensuring supply of electricity to all areas<br>▸ Protecting consumer interests |
| 2 | Policy | ▸ A National electricity plan shall be prepared in accordance with National Electricity Policy every 5 years National policy on stands alone systems for rural areas and Non-conventional energy systems National policy on electrification and local distribution in rural areas |
| 3 | Restructuring | ▸ Vertical integration instead of horizontal unbundling of State Electricity Boards (SEBs) to make them financially strong<br>▸ State governments will have the freedom to decide the sequence and phases of restructuring, and also retain the integrated structure of the SEB for a limited period<br>▸ Introduction of the concept of power trading as a distinct activity, and the introduction of a spot market for bulk electricity |
| 4 | Generation | ▸ Removal of captive power plants from the ambit of licensing and other permissions<br>▸ Generators can contract directly with DISCOMs<br>▸ DISCOMs can have embedded generation<br>▸ Captive generation allowed freely—can supply to associates<br>▸ Elimination of Licensing requirement and techno-economic clearances for generation projects except hydel projects |
| 5 | T & D | ▸ Provision for Private participation in distribution<br>▸ Surcharge for open access to meet current cross-subsidy burden (except for CPP's)<br>▸ Dedicated transmission lines allowed (not regulated)<br>▸ Central and State transmission Utilities ( CTU and STUs) not permitted to trade<br>▸ Transmission licensees allowed<br>▸ Multi Year Tariff (MYT) recommended<br>▸ Bidding allowed |

# PRINCIPLES OF INSURANCE AND LOSS ASSESSMENT

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# INDEX

# UNIT – 1

## INTRODUCTION TO INSURANCE

### 1.1 What is Insurance?

There is normally expected lifetime for the asset, during which time it is expected to perform. However, if the asset gets lost earlier, being destroyed or made non-functional, through an accident or other unfortunate event, the owner and those deriving benefits there from suffer. Insurance is a mechanism that helps to reduce such adverse consequences.

### 1.2 Purpose and Need of Insurance

Assets are insured, because they are likely to be destroyed or made non-functional, through an accidental occurrence. Such possible occurrences are called perils, like fire, earthquake, flood, break down, accident etc.

The damage that these perils may cause to the asset, is the risk that the asset is exposed to.

The risk only means that there is a possibility of loss or damage, it may, or it may not happen. There has to be an uncertainty about the risk. If there is no uncertainty about the occurrence of an event, it cannot be insured against.

The risk may sometime be referred to as subject matter of insurance.

There are other meanings of the term 'risk'. To the ordinary man in the street 'risk' means exposure to danger. In Insurance practice, 'risk' is also used to refer to the peril or loss producing event. For examples, it is said that fire insurance covers the risks of fire, explosion, cyclone, flood etc. Again, it is used to refer to the property covered by insurance, for example, a timber construction is considered to be a bad 'risk' for fire insurance purpose.

Conceptually, the mechanism of insurance is very simple. People who are exposed to the same risk come together and agree that, if any one of member suffers the loss, the others will share the loss and make good to the person who lost. By this method the risk is spread among the community and the likely big impact on one is reduced to smaller manageable impacts on all Insurance does not protect the asset. It does not prevent its loss due to the peril. The peril cannot be avoided through insurance.

Insurance only tries to reduce the impact of the risk on the owner of the asset and those who depend on that asset. It compensates, may not be fully, the losses. Only economic or financial losses can be compensated

The purpose of insurance is to safe guard against misfortunes by making good the losses of the unfortunate few, through the help of fortunate many, who are exposed to the same, risk but saved from the misfortune. Thus, the essence of insurance is to share losses and substitute certainty with uncertainty.

1.3 **How Insurance Works?**

People facing common risks come together and make their small contributions to a common fund. The contribution to be made by each person is determined on the assumption that while it may not be possible to say beforehand, which person will suffer, it is possible to say, on the basis of past experiences, how many persons, on an average, may suffer losses. The following examples explain the above concept.

- In a village, there are 400 houses, each valued at Rs.20,000/-. Every year, on an average, 4 houses got burnt, resulting into a total loss of Rs.80,000/- If all 400 owners come together and contribute Rs.200/- each, the common fund would be Rs.80,000/-. This is enough to pay Rs.20,000/-, to each of the 4 owners whose houses got burnt thus the risk of 4 no. house owners is spread over 400 no. house owners of the village. Rs.200/- paid by house owner is called premium payable. Rs.20,000/- is the sum insured of the risk.

- Similar risk is houses in a village, claim of few Rs.20,000/- each, total Rs.80,000/-, loss suffered by the 4 house owners and shared by 400 house owners insurer is in the position of trustee as it is managing the common fund.

- It has to ensure that that nobody is allowed to take undue advantage of the arrangements. The decision to allow the entry is the process of underwriting of risk. Both underwriting and claim settlement have to be done with great care.

**The Business of INSURANCE – POOLING OF RISK & RESOURCES**

The business of insurance done by insurance companies, called insurers, is to bring together persons with common insurance interests (sharing the same risks), collecting the share of contribution (called premium) from all of them, and paying out compensations (called claims) to those who suffer. The premium is determined on the same lines as indicated in the example above with some additions made for the expenses of administration.

Thus, insurance may be described as a method or a technique which provides for collection of small amounts of premium form many individuals and firms out of which losses suffered by the few are paid.

**ROLE OF INSURANCE IN ECONOMIC DEVELOPMENT.**

An insurance company's strength lies in the fact that huge amounts are collected and pooled together, these amounts come by way of premiums. Every premium represents a risk that is covered by that premium. In effect, therefore, these vast amounts represent pooling of risk. The funds are collected and held in trust for the benefit of the policyholders. The management of insurance companies is required to keep this aspect in mind and make all its decisions in ways that benefit the community. This applies also to its investments. That is why successful insurance companies would not be found investing in speculative ventures. Their investments benefit the society at large.

The system of insurance provides numerous direct and indirect benefits to the individual and his family as well as to industry and commerce and to the community and the nation as a whole. Those who insure, both individuals and corporates, are directly benefited because they are protected from the consequences of the loss that may be caused by the accident or fortuitous event. Insurance, thus, in a sense protects the capital in industry and releases the capital for further expansion and development of business and industry.

Insurance removes the fear, worry and anxiety associated with this future uncertainty and thus encourages free investment of capital in business enterprises and promotes efficient use of existing resources. Thus, insurance encourages commercial and industrial development and thereby contributes to a vigorous economy and increased national productivity. No bank or financial institution would advance loans on property unless it is insured against loss or damage by insurable perils.

Insurers are closely associated with several agencies and institutions engaged in fire loss prevention, cargo loss prevention, industrial safety and road safety.

Before acceptance of a risk, insurers arrange survey and inspection of the property to be insured, by qualified engineers and other experts. The object of these surveys is not only to assess the risk for rating purposes but also to suggest and recommend to the insured, various improvements in the irks, which will attract lower rates of premium.

Insurance ranks with export trade, shipping and banking services as earner of foreign exchange to the country. Indian insurers operate in more than 30 countries. These operations earn foreign exchange and represent invisible exports.

# UNIT – 2

## FUNDAMENTALS/PRINCIPLES OF GENERAL INSURANCE

**CONTRACT OF INSURANCE**

When the insured pays the premium and the insurer accepts the risk, the contract of insurance is concluded. The policy issued by the insurer is the evidence of the contract.

### 2.1 Conditions Necessary for a Contract

1. There should be consideration, i.e. there should be offer and acceptance of both parties, and one party will give offer the other party will accept.
2. There should be consent of both parties, (agreement). – Both parties should be of the same mind with a common intention. For example, if the proposer desired fire insurance, and the insurers issue a burglary policy, there is no consent arising out of common intention.
3. The parties to contract must be competent, minors and person of unsound mind are not competent to sign contracts.
4. The object of contract must be legal and not against public policy. For example, stolen goods cannot be insured.

### 2.2 Principles of General Insurance

Insurance contracts are subject to certain special principles evolved under common law in the U.K. and are generally followed by Indian courts. The principles are known as fundamental or basic principles of law of insurance.

#### 2.2.1 Utmost good faith

The parties to a commercial contract, according to law, are required to observe good faith. The seller cannot mislead the buyer in respect of the transaction, but he has no obligation to disclose all information about the subject of the contract. It is the buyer's duty to be careful while entering into the contract. 'Let the buyer beware.' Is the legal rule?

In insurance contract there is duty of utmost good faith and giving material facts information. The proposer has duty to disclose all material information/facts about the subject matter of insurance to the insurer. The material fact is that, enables insurer to decide whether to accept the risk and the rate of premium and terms and conditions of acceptance. The duty applies not only to the material facts which the proposer knows, but also extends to the material facts which he ought to know.

**The following are some examples of material facts**
Fire Insurance (a) Construction of the building; (b) Occupancy (e.g. office, residence, shop, godown, manufacturing unit, etc.) (c) The nature of goods, i.e. non-hazardous, hazardous extra-hazardous etc.

Marine Insurance (a) Method of packing i.e. whether in single gunny bags or double gunny bags, whether in new drums or second hand drums' etc. (b) the nature of goods (e.g. whether the machinery is new or second hand);

Motor Insurance (a) Cubic capacity of engine (private car); (b) the year of manufacture; (c) carrying capacity of a truck (tonnage); (d) the purpose for which the vehicle is used; (e) the geographical area in which it is used; etc

Personal accident Insurance (a) the exact nature of occupation; (b) age, height and weight; (c) physical disabilities etc.

General (a) The fact that previous insurers had rejected the proposal, or charged extra premium, or cancelled, or refused to renew the policy (b) Previous losses suffered by the proposer.

**Note:** If the insurance is placed through an agent, the latter has similar duty to disclose all material facts known to him or communicated to him by the proposer.

Facts which are common knowledge or matters of law need not be disclosed by the proposer. For example, if a proposer seeks riot cover, he need not disclose the fact of prevalence of riot conditions. Insurance are expected to know about it in the normal course.

The duty of disclosing material facts ceases when the contract is concluded by the issue of a cover note or a policy. The duty arises again at the time of renewal of the policy. However, a policy condition provides the duty also arises during the period of the policy, if there is any change in the risk.

The breach of duty of utmost good faith may arise unintentionally through an oversight or because the proposer thought that it was not a material fact, if there is non-disclosure or mis-representation with fraudulent intention, the insurance contract will become void; it will not be contract at all. If duty of utmost good faith is breached in any other way, the contract becomes voidable, which will mean, the insurers have the option to avoid the contract and reject the claim.
**Unenforceable contracts are those which cannot be produced as an evidence in court of law, If an insurance policy is not stamped as per the Indian stamp act, the contract becomes unenforceable.**

**Contractual duty**
Proposal forms are designed to obtain all material information about the subject matter of insurance. Each form contains a declaration to the effect that all the questions have been answered truly and correctly, and that the proposal and declaration shall be the basis of the contract.

The legal effect of the above declaration is that insurers can avoid the contract if any answer is inaccurate or incorrect, even if the answer is not material to the risk. This is called the contractual duty of utmost good faith, which is far stricter than the common law duty.

The duty of disclosure of "material information" regarding a proposal or policy also applies to insurers, agents or insurance intermediaries, as provided in IRDA Regulations (Protection of Policyholders' Interests) 2002.

### 2.2.2 Insurable Interest

The owner of property has a right under law to effect insurance on the property, if he is likely to suffer financially, when property is lost or damaged. This legal right to insure is called insurable interest. Without insurable interest, the contract of insurance will be void. Because of this legal requirement of insurable interest, insurance contracts are not gambling transactions.

**Examples of insurable interest**

(a) Ownership of property (and joint ownership) is a clear example of insurable interest.

(b) A bank has insurable interest in the property on the mortgage of which loans have been given. The interest is limited to the amount of the loan. Usually, under such circumstances, the policies are issued in the joint names of the insured and the bank.

(c) A ship owner has insurable interest in the ship owned by him. Cargo owners, both sellers and buyers, have insurable interest in the goods owned by the owner.

(d) The owner of a motor vehicle has insurable interest in the vehicle; he also has insurable interest in potential third party liability. If a third party is injured in the accident, the damages payable to the third party would be financial loss to the insured, Hence, he can insure his third party liability.

(e) A person has insurable interest on his own life.

Insurable interest can arise in a variety of ways but the above examples are sufficient to explain the concept.

**Time When Insurable Interest should be Present**

In fire and miscellaneous insurance, insurable interest must be present both at the time of taking the policy and at the time of loss. For example, if the property insured under a fire insurance policy is sold and there is a loss after the sale, the insured cannot recover the loss as he has no insurable interest at the time of loss.

In marine cargo insurance, insurable interest is required at the time of loss. It may not be present at the time of effecting insurance. An importer of goods may insure the goods under a marine policy, although at the time, he may not be the owner of the goods. Ownership of the goods passes from the exporter to the importer when the payment is made. If goods arrive damaged at destination, and if the importer had paid for the goods, he can recover the loss as he has insurable interest at the time of loss and also has a policy. In marine hull insurance, insurable interest must be present both at the time of taking the policy and at the time of loss.

**Assignment**

Assignment means transfer of rights and liabilities of an insured to another person who has acquired insurable interest in the property insured. Generally fire and miscellaneous insurance policies are assigned only with the consent of the insurers.

Marine cargo policies are, however, freely assignable without the previous knowledge or consent of the insurer. The reason is that the ownership of goods insured under a marine cargo policy frequently changes when the goods are still in transit, and it is necessary that the benefit of the policy should pass to the new owner, A marine hull policy cannot be assigned without the consent of the insurers.

### 1.2.3 Indemnity

The principle of indemnity arises under common law and requires that an insurance contract should be governed by principle of indemnity. The object of the principles is to place the insured in the same financial position as far as possible, as he occupied immediately before the loss. The effect of this principle is to prevent the insured from making any profit out of his loss or gaining any benefit or advantage.

**The measure of indemnity applied to some types of property is explained below:**

**Building**

In these cases, the cost of reinstating the building or repairing the damage portion, is assessed and from that an appropriate allowance is made toward depreciation, depending upon the age and condition of the building.

**Machinery**

In practice, the measure of indemnity is the replacement value at the place and date of loss or damage. Less an appropriate allowance towards depreciation.

If the damaged machinery is repairable, the measure of indemnity is the cost of repairing the damage. If however, during repairs, any part is replaced, an appropriate allowance is to be made towards depreciation on the total cost of repairs including labour cost.

**Stocks**

In respect of the stocks of wholesalers and retailers, the measure of indemnity is not the selling price of the wholesaler or the retailer, but it is the price at which he can replace the goods, the element of expected profit does not pay any part in computing the measure of indemnity.

Fire insurance policies may be issued on Reinstatement Value basis. Under these polices, generally issued for covering building or machinery, the basis of indemnity is the cost of repairs or cost of reinstatement or replacement of damaged or destroyed property by new property of the same type. In as much as the insured gets new property in the place of old, the principle of indemnity is modified, (this is explained in Unit – 6 : Fire and Special Peril Insurance).

**Motor Insurance**

The indemnity shall not exceed.

(a) For total/constructive total loss of the vehicle the insured's Declared Value of the vehicle (including accessories thereon) as per Schedule of the policy less the value of the wreck.

(b) For partial losses, costs of repair / replacement as per depreciation limits specified in the policy.

Claims for third party liability are indemnified as per law, subject to limits, if any, under the policy.

**Marine Insurance**

The values of cargo are subject to constant fluctuations during transit from one country to another, Besides, the market values of ships fluctuate widely, but the market value may not reflect the true value of the ship to its owner, Therefore, almost all the marine ship/hull insurance policies are issued as valued policies or agreed valued policies, where under the sum insured is agreed between the insurers and the insured as the value of the insured property. The agreed amount is payable in the event of total loss, irrespective of considerations of depreciation, etc.

**Personal Accident Insurance**

Personal accident insurances are not contracts of strict indemnity. After an accident in which the insured person is disabled, it is not practicable to place him in the same financial position in which he was before the accident, since no monetary value can be placed on human life. So, these are fixed benefit policies.

**Limitation of Liability of Insurer**

i. The sum insured is the maximum limit of liability under the policy and is always defined in policy.
ii. If sum insured is less than required the condition of average will be applicable. In such case only that proportion of loss is payable, which the sum insured bears to the market value of the insured property at the time of loss.
iii. Some policies are subject to “excess” or “franchises”.
iv. The difference between ‘excess’ and ‘franchise’ should be clearly understood. In either case, if the loss does not reach the limit, it is not payable at all. If it exceeds the limit, the excess only is payable under the ‘excess’ clause and the entire loss is payable under the ‘franchise’ clause
v. For example, if there are two insurance policies ‘A’ and ‘B’ policy ‘A’ subject to an excess of Rs.1,000/- and policy ‘B’ subject to a franchise of Rs.1,000/-, and if a loss of Rs.500/- is reported under each policy, nothing will be payable under both the policies.
vi. If however, the loss under each policy was Rs.1,100/-, policy “A’ will pay Rs.100/- only but policy ‘B’ will pay Rs.1,100/-.
vii. Salvage is property, which is partially damaged, by fire for example, and if the full loss is paid, the insurers may take over the salvage and dispose it off.

**2.2.3.1 Subrogation under Policy Conditions**

The right of subrogation is implied in all contracts of indemnity and is automatic and without any express condition in contract.

Subrogation may be defined as the transfer of rights and remedies of the insured to the insurer who has indemnified the insured in respect of the loss. If the insured has any rights of action to recover the loss from any third party, who is primarily responsible for the loss, the insurer, having paid the loss, is entitled to avail himself of these rights to recover the loss from the third party. The effect is that the insured does not receive more than the actual amount of his loss and any recovery effected from the third party goes to the benefit of the insurer to reduce the amount of his loss.

The principle may be illustrated by the following example:

If cargo is damaged due to the negligence of a carrier (e.g. railways, truck operators, shipping companies etc.) who has an obligation to make good the loss of the insured, the benefit of this obligation passes to the insurer.

The right of subrogation is implied in all contracts of indemnity, In other words its application to contracts of indemnity is automatic without any express condition in the contract. It arises, however, only after payment of a loss.

Fire and miscellaneous policies contain an express condition to the effect that the right of subrogation can be exercised by the insurer even before payment of a claim. In certain circumstances, it becomes necessary to take action immediately against a third party in order to ensure that the rights of recovery are not prejudiced by any delay.

Marine insurance policies are subject to the doctrine of subrogation, but the policies do not contain any conditions, and the insurers are subrogated to the rights of the insured only after payment of claim.

The IRDA Regulations make specific provisions that the policyholders shall assist the insurer in recovery of claims from other parties.

**2.2.3.2 Contribution under Policy Conditions**

If an insured takes out more than one policy, say two policies, he can not recover the claim two times, it would amount to making profit, he can recover only one claim from any one of insurance companies, or each company is liable for ratable proportion of claim.

| | | | |
|---|---|---|---|
| Sum Insured Rs.3,00,000/- | Claim Rs.1,80,000/- | | |
| | | | Claim |
| Sum insured with insurer A | Rs. 50,000/- | A pays | Rs.30,000/- |
| Sum insured with insurer B | Rs.1,00,000/- | B pays | Rs.60,000/- |
| Sum insured with insurer C | Rs.1,50,000/- | C pays | Rs.90,000/- |
| | Total Rs.3,00,000/- | | Total Rs.1,80,000/- |

The application of the principle of contribution is subject to the following pre-requisites.

1. The subject matter must be common to all policies.
2. The peril, which is causing loss, must be common.
3. The interest covered must be the same in all policies, must be in favour of same insured.
4. The policies must be in force at the time of loss.
5. The policies must be legally enforceable.

### 2.2.4 Proximate Cause

In an insurance contract the claim/loss to the property is payable if it is caused by a peril insured in the policy, similarly if it is caused by uninsured peril it is not payable. If the loss is caused by one peril only it is easy to decide if claim is payable or not. In actual situation the loss may be the result of two or more causes acting simultaneously, or one after the other. It becomes then, necessary to choose the most important, the most effective, and the most powerful cause which has brought about the loss. This cause is termed as the Proximate Cause all other causes being considered as remote.

#### 2.4.1.1 Example

A person insured under a personal accident insurance policy went out hunting and met with an accident. Due to shock and weakness, he was not able to walk, while lying on the wet ground he contacted cold, which developed into pneumonia, which caused his death.

The court held that the proximate cause was accident covered in the policy and the remote cause was pneumonia, hence claim was payable.

#### 2.4.1.2 Example

A person was covered under personal accident insurance policy. He suffered accidental injuries and was taken to hospital. While undergoing treatment he contracted an infectious disease, which caused his death. The court held that the proximate cause of death was infectious disease and the remote cause was accident. Hence the claim was not payable under personal accident policy.

The proximate cause or theory of cause proxima enables one to decide which one is remote cause and which one is proximate cause. If there are more than one cause or concurrent causes theory of cause proxima must be used.

# UNIT – 3

## FIRE AND SPECIAL PERILS INSURANCE

**INTRODUCTION**

Fire insurance offers financial protection against property damage due to fire or specified special perils.

### 3.1 Subject Matter Insured – Examples of Insurable Property

- Building.
- Electrical installation.
- Contents of building (plant & machinery, equipment, accessories)
- Goods in open/storage in building, Raw material, in process, semi finished, finished, packing materials,
- Utility, boiler, water treatment plant, sub-station, pump-house
- Furniture, fixtures, fittings,
- Pipelines (including content), inside/outside premises.
- Contents in dwelling, shops, hotels etc.

**The standard fire and special perils policy covers the following perils:**

**The perils specified in the policy are -**

**1. Fire**

Excluding destruction or damage caused to the property insured by -

(a) (i) its own fermentation, natural heating or spontaneous combustion.

(ii) its undergoing any heating or drying process.

(b) Burning of property insured by order of any Public Authority:

**Note:** Spontaneous Combustion can be covered at extra premium

**2. Lightning**

3. **Explosion / Implosion**

Explosion / Implosion cover excludes loss, destruction of or damage.

(a) To boilers (other than domestic boilers) or their contents resulting form their own explosion / implosion.

(b) Caused by centrifugal forces.

**Note:** This risk be covered by Boiler Explosion policy in Engineering Insurance

4. **Aircraft Damage**

Destruction or damage caused by Aircraft, other aerial or space devices and articles dropped there from excluding those caused by pressure waves.

5. **Riot, Strike and Malicious Damage**

Loss of or visible physical damage or destruction by external violent means directly caused to the property insured by riot, strike, and malicious damage.

**Terrorism damage exclusion warranty:**

Notwithstanding any provision to the contrary within this insurance it is agreed that this insurance excludes loss. Damage cost or expense directly or indirectly caused by, any act of terrorism.

For the purpose of this endorsement an act of terrorism means an act, including but not limited to the use of force or violence and / or the threat thereof, of any person or group(s) of persons whether acting along or on behalf of or in connection with any organization(s) or government(s), committed for political, religious, ideological or similar purpose including the intention to influence any government and / or to put the public, or any section of the public in fear.

**Terrorism cover**

When the insured opts for Terrorism Damage cover by paying additional premium as provided, cover will be granted by attaching an endorsement:

Terrorism cover will be a separate cover which can be granted only in conjunction with Riot, Strike and Malicious Damage cover (RSMD), Terrorism cover will not be given in isolation without RSMD cover.

**Deductibles**

Every claim under terrorism cover will be subject to a deductible as under:

| | |
|---|---|
| Industrial Risks: | 0.5% of Total Sum Insured subject to a minimum of Rs.1 Lakh. |
| Non-industrial Risks: | 0.5% of Total Sum Insured subject to a minimum of Rs.25,000/- |

6. **Storm, Cyclone, Typhoon, Tempest, Hurricane, Tornado, Flood and Inundation**

The natural perils cover is defined as :

Loss, destruction or damage directly caused by Storm, Cyclone, Typhoon, Tempest, Hurricane, Tornado, Flood or Inundation excluding those resulting from earthquake, volcanic eruption or other convulsions of nature (wherever earthquake cover is given as an "add cover" the words " excluding those resulting form earthquake, volcanic eruption or other convulsions of nature" shall stand deleted.)

7. **Impact Damage**

Loss or visible physical damage or destruction caused to the property insured due to impact by any Rail / Road vehicle or animal by direct contact not belonging to or owned by –

(a) The insured or any occupier of the premises or

(b) Their employees while acting in the course of their employment.

8. **Subsidence and Landslide including Rockslide**

"Loss, destruction or damage directly caused by subsidence of part of the site on which the property stands or Landslide/Rockslide excluding…."

(a) The normal cracking, settlement or bedding down of new structures

(b) Demolition, construction, structural alterations or repair of property or ground works or excavations.

9. **Bursting and/or Overflowing of Water Tanks, Apparatus and Pipes**

10. **Missile Testing Operations**

11. **Accidental Leakage from Automatic Sprinkler Installations**

**12. Bush Fire**

Excluding destruction or damage caused by forest Fire.

## 3.2 General Exclusions

This policy does not cover –

(a) The first 5% of each and every claim subject to a minimum of Rs.10,000/- in respect of each and every loss arising out of "Act of God" perils such as Lightning, STFI, Subsidence, Land slide and Rockslide.

(b) The first Rs.10,000/- for each and every loss arising out of other perils (the excess is not applicable to dwellings).

(c) Loss, destruction or damage caused by war, and kindred perils.

(d) Loss, destruction or damage directly or indirectly caused to the property insured by nuclear peril.

(e) Loss destruction or damage caused to the insured property by pollution or contamination excluding -

  (i) Pollution or contamination which itself results form a peril hereby insured against.

  (ii) Any peril hereby insured against which itself results from pollution or contamination.

(f) Loss, destruction or damage to bullion or unset precious stones, curios or works of art for an amount exceeding Rs.10,000/- manuscripts, plans, drawings, stamps, coins or paper money, cheques, books of accounts or other business books, computer systems records, explosives etc. Unless otherwise expressly stated in the policy.

(g) Loss, destruction or damage to the stock in cold storage premises caused by change of temperature.

(h) Loss, destruction, or damage to any electrical machine, apparatus, fixture or fitting arising from or occasioned by over-running, excessive pressure, short circuiting, arcing, self-heating or leakage of electricity from whatever cause (lightning included) provided that this exclusion shall apply only to the particular electrical machine, apparatus, fixture or fitting so affected an not to other machines, apparatus, fixture of fitting which may be destroyed or damaged by fire so set up.

This is known as "electrical Risks" exclusion. These risks can be covered under Machinery Insurance policy (Engineering Insurance).

It is to be noted that only damage to the particular electric machine, etc by specified electrical risks is excluded; but resulting fire damage to other machines, etc is covered.

(i) Expenses incurred on

(a) Architects, Surveyors and Consulting Engineer's Fees; and

(b) Debris Removal necessarily incurred by the insured following a loss destruction or damage to the property insured by an insured perils in excess of 3% and 1% of the clam amount respectively.

**Note:** Cover for expenses in excess of 3% and 1% can be arranged by endorsement

The other exclusions under the policy are –

(a) Loss or damage by spoilage from the interruption of any process caused by any of the perils covered.

(b) Loss or damage by earthquake.

(c) Loss or damage to insured property if removed to any building or place other than the insured premises (except machinery temporarily removed for repairs etc for a period not exceeding 60 days)

(d) Theft during or after the occurrence of any insured perils.

**Note:** Add-on cover is available for (a), (b), and (c)

### 3.3 Sum Insured

3.3.1 Market value basis/depreciated value basis which is arrived at by deducting, depreciation from its present day replacement value.

3.3.2 Reinstatement value basis, which is arrived at by reinstating the property with same kind or type by new property.

### 3.4 Period of Insurance

3.4.1 Usually 12 months, expires at mid-night on last day.

3.4.2 The policy can be taken for short period by paying short period rate.

## 3.5 Premium Rate

Premium rate depends on following:

1. Nature of industry
2. Nature of storage in open/inside building etc.
3. Nature of property
4. Nature of operation/construction/processing etc.
5. Nature of segregation of property etc.

## 3.6 Policy Conditions

3.8.1 Refers to misrepresentation, misdescription or non-disclosure of material facts. In such event the policy becomes voidable.

3.8.2 Refers policy ceases after 7days from the date of fall or displacement of any building or part thereof. Insurer can continue on revised terms.

3.8.3 Refers to discontinuing risk, if there is any change in risk insured must inform insurer.

3.8.4 If there is concurrent marine policy claim will be preferred in marine and then under fire.

3.8.5 Cancellation of policy by insured on short period basis of premium rates, cancellation of policy by insurer on pro rata basis of premium rates.

3.8.6 Refers to duty of insured after happening of claim, notice of claim, 15days to file claim details, of other insurances going to court, arbitration, etc.

3.8.7 Refers to rights of insurers after the happening of claim, this does mean that insured cannot abandon damaged property, whether the insurers takes possession or not.

3.8.8 Refers to fraudulent false, claim willful negligence, etc all benefits will be forfeited.

3.8.9 Refers to option available to the Insurance Company to reinstate or replace instead of paying claim, i.e. when insured prefers highly exaggerated claim.

3.8.10 Refers to condition of average, when sum insured selected in policy is lower than its value. This is the condition of average. An insured is expected to insure his property for its full value. In the event of claim if it is found that he has not covered the property for its full value, then he has to bear a portion of the claim on his own account.

**Example**

Value of property = Rs.2,00,000/-

Sum insured = Rs.1,50,000/-

Loss = Rs.80,000/-

The amount payable = $\frac{1,50,000}{2,00,000}$ $x$ $80,000 = Rs.60,000/-$

3.8.11 Refers to condition of contribution, i.e. risk covered in more than one policy.

3.8.12 Refers to condition of subrogation, i.e. if third party is responsible for causing damage.

3.8.13 Refers to provision for arbitration.

3.8.14 Refers to all communication to insurers in writing or printed.

3.8.15 Refers to re-instatement of sum insured i.e. after the claim is Settled the sum insured is required to be reinstated by paying premium.

### 3.7 Extensions (Add on covers)

1. Architects fees in excess of 3.0%
2. Debris removal expenses in excess of 1.0% of claim amount
3. Deterioration of stocks in cold storage premises due to temperature rise
4. Spontaneous combustion
5. Forest fire
6. Impact damage
7. Omission to insure, additions alterations or extensions
8. Earthquake (shock and fire)
9. Spoilage material damage cover under a separate item in the policy
10. Temporary removal
11. Loss of rent
12. Start up expenses
13. Escalation clause

**Escalation clause:**

This clause, applicable to policies on buildings, machinery and accessories only, can be incorporated in policies on payment of additional premium.

The clause allows automatic regular increase, not exceeding 25% in the Sum Insured throughout the period of the policy. The automatic increase operates from the date of inception up to the date of occurrence of any of the insured perils. Pro rata condition of average will apply as usual.

### 3.8 Special Policies

1. **Floater Policy**

   These policies cover stock at various specific locations under one sum insured. The insured may have stocks in two or more godowns, He is able to declare for insurance the total value of goods in all godowns but not separate values for each godown.

   Unspecified locations are not allowed. Similarly, in a manufacturing risk, the stocks in the process blocks, godowns and /or in the open can be covered under one sum insured

2. **Declaration Policies**

   To take care of frequent fluctuations in stocks / stock values, Declaration policy(ies) can be granted subject to the following conditions.

The policy is issued for a sum insured selected by the insured (Insurers stipulate a minimum Sum Insured).

a. Monthly declarations based on the average of the value at risk on each day or highest value on any day of the month shall be submitted by the insured. If declarations are not received within the specified period, the full Sum Insured under the policy shall be deemed to have been declared.

b. Refund of premium on adjustment based on the declaration / cancellation shall not exceed 50% of the total premium.

**Illustration**

| | |
|---|---|
| Sum Insured | Rs.1,00,00,000 (1 crore) |
| Rate | Re.1/- per mille |
| Premium | Rs.10,000/- |

Monthly declaration:

| | |
|---|---|
| January | 52,00,000 |
| February | 56,00,000 |
| March | 46,00,000 |
| April | 46,00,000 |
| May | 30,00,000 |
| June | 30,00,000 |
| July | 30,00,000 |

| | |
|---|---|
| August | 30,00,000 |
| September | 40,00,000 |
| October | 40,00,000 |
| November | 40,00,000 |
| December | 40,00,000 |

| | | |
|---|---|---|
| Total Declaration | ------------- | Rs.4,80,00,000/- |
| Average Sum Insured | Rs.40,00,000/- | |
| Premium | | Rs.10,000/- |
| Premium on average S.I. | | Rs.4,000 |
| | | Rs.6,000 |

According to rules above refund cannot exceed 50% of the total premium. Therefore, refund is Rs.5,000/- and not Rs.6,000/-

**2. Reinstatement Value Policy**

This is the fire policy with the reinstatement value clause attached to it. The clause provides that in the event of loss, the amount payable is the cost of reinstating property of the same kind or type, by new property.

This basis of settlement differs from the basis under the fire policy where the losses are settled on the basis of market value i.e. making deductions for depreciation, etc.

The reinstatement value clause incorporates the following special provisions:

(a) Reinstatement must be carried out by the insured and completed within 12 months after the destruction of damage, failing which the loss will be settled on the normal indemnity basis i.e. according to the fire policy.

(b) The reinstatement basis of settlement will not apply.
- If the insured fails to intimate to the insurer within 6 months or any extended time his intention to replace the damaged property.
- If the insured is unable or unwilling to replace the damaged property. In such cases the loss will be settled on the normal basis of indemnity.

(c) The work of reinstatement may be carried out upon another site and in any manner required by the insured provided the liability under the policy is not thereby increased.

These insurances are granted to insured whose bonafide are satisfactory and, are generally issued only in respect of building, plant and machinery in a comparatively new condition.

These insurances are not granted on stocks.

**3. Industrial All Risks Policy**

This is package cover designed for industrial risks (both manufacturing and storage facilities) with an overall sum assured of Rs.100 crores and above. The policy provides cover for the following:

- Fire and special perils
- Burglary
- Machinery Breakdown / Boiler Explosion / electronic equipment (Material Damage)
- Business Interruption (Fire & allied perils )
- Business Interruption (machinery Breakdown). This is an optional cover.

Discounts in rates are provided. Under insurance of up to 15% is permitted. Apart from the reduced costs of premium, there is administrative convenience both for the insured and the insurer.

**3.9 Consequential Loss (Fire) Insurance**

Fire insurance is designed to provide protection in respect of loss of or damage to buildings, machinery, furniture and fittings, goods and merchandise, etc. by fire and allied perils. The insurance affords cover for “material damage”. However an indemnity for the “material damage” does not provide complete protection to the insured who may also suffer trading losses due to total or partial stoppage of the business.

The purpose of consequential loss or loss of profit insurance (also known as Business Interruption Insurance) is therefore, to make good these losses, namely net profit, standing charges and increased cost of working.

Turnover of a business consists of the following elements:

(a) Variable Charges:

These are expenses incurred in producing the goods (e.g. purchase of raw materials, wages, etc.)

(b) Standing Charges:

These expenses are fixed in amount irrespective of the volume of the business transacted (e.g. taxes, bank interest, salaries to permanent staff, etc.)

(c) Net Profit:

This is turnover minus variable and standing charges.

(d) Gross Profit:

Standing charges, and net profit together constitute the gross profit of the business.

**Indemnity Period**

The profits policy provides indemnity in respect of loss of gross profits during the indemnity period which is selected by the insured. The indemnity period chosen by the insured may vary from 3 months to 3 years.

The indemnity period is to be distinguished from the period of insurance which is usually a year; the insured peril must occur during the period of insurance and the indemnity period commences on the date of loss and terminates when the business returns to normal level or on the completion of selected period whichever is earlier.

**The Sum Insured**

The sum insured is to be fixed by the insured. As the indemnity provided by the consequential loss policy is in respect of loss of gross profits for the indemnity period naturally the sum insured should represent the gross profits of the indemnity period selected. Where the indemnity period is 12 months or lees, the sum insured should be the annual amount of the gross profit i.e. the annual amount of the net profit and the insured standing charges. Where the indemnity period is 24 months, the sum insured should represent twice the annual gross profit and so on.

The sum insured is to be computed form the insured's accounts. The standing charges have to be computed from the insured's accounts. The standing charges have to be specified by the insured. Some examples of the standing charges are :-

- Interest on loans, bank overdrafts and debentures, including brokerage on deposits;
- Rent;
- Directors fees and remuneration;
- Legal, auditing and other professional fees and expenses;
- Insurance premiums;
- Advertising and publicity expenses;
- Conveyance, Stationery, Postage, Telephone, Telex, Telegram, Telephone expenses;
- Office and General Establishment expenses;
- Salaries to permanent staff including Employees State Insurance contributions;
- Wages including Employees State Insurance contributions etc.

**When Loss becomes Payable**

(a) Fire or other insured peril must occur at the insured premises
(b) Property used for the business of the insured at the insured premises must be destroyed or damaged and the loss must be admissible in material damage policy.
(c) The business must be interrupted or interfered with as a consequence.
(d) The resulting loss is paid in accordance with the provisions of the policy.

**Note:** A formula is incorporated in the policy to calculate the loss. (This is known as "specification").

Payment of loss under the L.O. P. policy is subject to payment or admission of liability for the loss under the material damage insurance i.e. fire and special perils policy. (This is the material damage clause)

# UNIT – 4
## CLAIM

**4.1** The processing and settlement of claims is one of the important functions in an insurance organization. Indeed, the payment of claims may be regarded as the primary service of insurers to the public.

For proper settlement of claims, it is necessary to have a sound basic knowledge of General Law of Contract as applicable to insurance and the special principles of law governing in Insurance contracts. In addition it is necessary to have a thorough knowledge of the terms, conditions and warranties incorporated in the policies as also the loss assessment procedures.

The settlement of claims has to be prompt as well as fair. It is also necessary that the personnel handling claims must have the personal qualities of patience, tact, diplomacy and courtesy.

The settlement of claims involves examination of the loss in relation to the coverage under the policy and compliance with policy conditions and warranties;

The first aspect to be dealt with is whether the loss is within the scope of the policy. The legal doctrine of proximate cause provides guidelines to decide whether the loss is caused by an insured peril or an excepted peril.

The burden of proof, or to use the legal expression, the onus of proof that the loss is within the scope of the policy is upon the insured. However, if the loss is caused by an excepted peril the onus of proof is on the insurer. However, this onus of proof under some policies is shifted back to the insured so that he has also to prove that the loss was not caused by an excepted peril.

The second aspect to be decided is whether the insured has complied with policy conditions, especially conditions which are precedent to liability. These conditions relate to immediate notification of loss to the insurers, submission of proof of cause and extent of loss, providing assistance and cooperation to the insurers in recovering losses from third parties, or others responsible for the loss.

If a breach of condition is alleged, the onus of proving it is on the insurers. If the insurers, after having learnt of breach of conditions, have ignored the breach then they are deemed to have waived their rights and cannot rely upon the breach of condition to repudiate liability.

The third aspect is in respect of compliance with warranties. The survey report would indicate whether or not warranties have been complied with. Insurers, however, take a liberal view when the breach of warranty is purely of a technical nature and is not in any way connected with the cause of loss or the extent of loss.

The fourth aspect relates to the examination of the observance of utmost good faith by the proposer before the conclusion of the contract, and if provided by policy conditions, during the currency of the policy. Especially on the occurrence of a loss the insured is expected to act as if he is uninsured. In other words, he has a duty to take measures to minimize the loss.

The fifth aspect concerns the determination of the amount payable. The amount of loss payable is subject to the sum insured. However, the amount payable will also depend upon the following:

(i) The extent of the insured’s insurable interest in the property affected
(ii) The value of salvage
(iii) Application of pro-rata average
(iv) Deduction for any excess or franchise
(v) Application of contribution and subrogation conditions

The sixth aspect relates to resolution of disagreement between the insurers and the insured. The majority of property and liability policies incorporate an Arbitration condition to resolve disputes regarding the amount of loss, the liability being admitted under the policy. If question of liability is involved, the matter has to be settled through a court of law. In marine policies there is no arbitration condition.

The final aspect deals with recovery from the third parties under subrogation proceeding and requisite contributions from co-insurers, facultative and treaty reinsures, etc.

**4.2** The claims which are dealt with under insurance policies fall into the following categories:

(a) Standard claims:
These are claims which are clearly within the terms and conditions of the policy. Settlement of these claims present no difficulty.

(b) Non-Standard claims:
These are claims where the insured has committed a breach of condition or warranty. The settlement of these claims is considered subject to certain rules and regulations framed by the insurers.

(c) Ex-gratia payments:
These are losses which fall outside the scope of cover under the policy and hence are not payable. However, in very special cases, to avoid hardship to the insured, settlement of these losses is considered as a matter of grace. For example, due to genuine oversight a certain item of property is not included in the insurance although it was the intention of the insured to include it.
Ex-gratia settlements are never made on the basis of the full amount of the loss. A certain percentage only is paid.

Also, such claims are paid "without precedent" so that the insurers do not have an obligation to meet similar claims in future. Although, there is no legal liability to pay for such losses yet the courts have approved of such settlements. In the English case Taunton vs. Royal Insurance Co., the court held that the directors were authorized, for the benefit of the business, under the discretionary powers vested in the managers of a trading concern to pay such losses, the payment being akin to an expenditure upon an advertisement. Thus ex-gratia payments can be justified on grounds of good business policy.

Since the payments are made without admission of legal liability, subrogation rights do not arise under these payments. Where co-insurance is involved the leading office has to consult the co-insurers before deciding on ex-gratia settlement. In any case, ex-gratia payments require the approval of the Boards of Directors of the companies.

## 4.3 Claim Settlement – Preliminary Procedure

### 4.3.1 Notice of loss

1. Policy conditions usually provide that the loss be intimated to the insurer immediately. The purpose of an immediate notice is to allow the insurer to investigate a loss at its early stages.
2. Under certain types of policies (e.g. Burglary) notice is also to be given to police authorities. Under Rail transit cargo policies, notice has to be served on the Railway also.

### 4.3.2 On receipt of intimation of loss or damage insurers check that:

- The policy is in force on the date of occurrence of the loss or damage;
- The loss or damage is by a peril insured by the policy;
- The subject matter affected by the loss is the same as is insured under the policy; and
- Notice of loss has been received without undue delay.

#### 4.3.3 Investigation and assessment of loss

Surveyor will carry out investigation for following Property damaged. What is the most probable cause of damage?

If property will be repaired/ replaced or combined, no temporary repairs will be permitted; Photographs will be taken as evidence. Surveyor will assess the cost of repairs/replacements and give final assessment.

#### 4.3.4 Survey report

Surveyor may give preliminary/ interim /final report considering status of claim progress. Surveyor may give adjustment of loss in terms of policy conditions. It will include salvage, under insurance, deductibles, parts not payable etc. He must give clear opinion regarding cause of damage and if that is covered in terms of insurance contract. He must give opinion about sum insured of damaged item and its replacement value as on the date of damage.

Insured will submit claim form, photographs and estimate/bills of repairs to surveyors to facilitate the procedure of claim.

**4.3.5** Insurer will offer claim settlement along with claim discharge voucher.

#### 4.3.6 Arbitration

If the claim is payable and there is difference of opinion regarding quantum of loss, insured can go for arbitration. If there is difference of opinion regarding cause of damage, the insured can go to court of law within 12 months from date of disclaimer.

#### 4.3.7 Salvage

The parts, which require repairs/replacements will become property of insurer, Surveyors must assign / assess salvage value, which must be deducted from claim amount.

#### 4.3.8 Recoveries

After the claim settlement, the insurers under the law of subrogation are entitled to the rights and remedies of the insured and to recover the paid loss from third party who may be responsible for loss under respective law applicable.

#### 4.3.9 Loss minimization

Surveyors are finding out the cause of damage/accident and therefore they have to suggest the measures of loss minimization in their survey report for avoiding the loss in future.

#### 4.3.10 Reinsurance

If a policy is having reinsurance, then the loss can be recovered from reinsurers. Details may be submitted to reinsurers.

# UNIT – 5

## EXAMPLES – PRINCIPLES OF CLAIM SETTLEMENT

### 5.1 Example on Reinstatement Basis

M/s. Adarsh Chemicals had taken a Fire and Special Perils Insurance Policy for their Chemical Plant at Karamsad for the period 01/01/03 to 31/12/03 on Reinstatement value basis as under:

| Item | Sum Insured |
|---|---|
| a. Building | Rs.1,00,00,000/- |
| b. Plant and Machinery | Rs.3,50,00,000/- |
| c. Electrical Installation including sub-station | Rs.75,00,000/- |
| d. Furniture Fixtures and Fittings | Rs.40,00,000/- |
| e. Stocks and Stocks in Process | Rs.3,00,00,000/- |

On 25th February 2003 there was a fire in the plant and they reported the loss to their insurance company. The insurance Company appointed M/s. Arun Dasgupta & Co. as surveyor, who surveyed the loss and submitted their final Survey Report on April 15th, 2003. Following is an extract from the survey report.

1. Fire affected building was partly repaired and replaced and the cost incurred was Rs.12,00,000/- The reinstatement value of the building was found to be Rs.1,20,00,000/- on the date of repair completion/reinstatement.
2. The cost of repairs and replacement of Plant and Machinery affected by the fire was Rs.57,00,000/- net of salvage. The re-instatement value of the plant and machinery was found to be Rs.5,25,00,000/- at the time of reinstatement.
3. Electrical installation was affected by fire to the extent of Rs.8,00,000/- its present re-instatement cost was Rs.1,00,00,000/-
4. Furniture Fixtures and Fittings were affected to the extent of Rs.9,00,000/- by fire and were re-instated by them. The re-instatement value of Furniture Fixtures and Fittings was Rs.60,00,000/- on the date of the loss.

5. Cost of stocks and stocks in process was affected by fire to the extent of Rs.30,00,000/- (market value). The sum insured was adequate.

Insured had incurred a cost of removal of debris of Rs.1,25,000/-

What is amount of claim M/s. Adarsh Chemicals will get from the insurance company?

Compute the loss on reinstatement basis.

**SOLUTION**

(Assessment on Reinstatement value basis)

**A. <u>Building</u>**

| | |
|---|---|
| Repairs to building | Rs.12,00,000/- |
| Insured value | Rs.1,00,00,000/- |
| Reinstatement value | Rs.1,20,00,000/- |

They are found under insured in the proportion of

$$\frac{1,00,00,000}{1,20,00,000}$$

Therefore claim payable on building will be

$$12,00,000 \times \frac{1,00,00,000}{1,20,00,000} = \text{Rs.}10,00,000/- \qquad \text{(A)}$$

**B. Plant & Machinery**

| | |
|---|---|
| Repairs and replacement of Plant & Machinery | Rs. 57,00,000/- |
| Insured value of Plant & Machinery | Rs. 3,50,00,000/- |
| Reinstatement value of Plant & Machinery | Rs. 5,25,00,000/- |

They are found under insured in the proportion of

$$\frac{3,50,00,000}{5,25,00,000}$$

Therefore claim payable on plant & machinery will be

$$57,00,000 \times \frac{3,50,00,000}{5,25,00,000} = \text{Rs.}38,00,000/- \qquad \text{(B)}$$

**C. Electrical Installations**

| | |
|---|---|
| Repairs/replacements | Rs. 8,00,000/- |
| Insured value | Rs. 75,00,000/- |
| Reinstatement value | Rs.1,00,00,000/- |

They are found under insured in the proportion of

$$\frac{75,00,000}{1,00,00,000}$$

Therefore claim payable on electrical installations will be

$$8,00,000 \times \frac{75,00,000}{1,00,00,000} = \text{Rs.}6,00,000/- \qquad \text{(C)}$$

**D. Furniture, Fixtures and Fittings**

| | |
|---|---|
| Cost of Repairs/replacement | Rs.9,00,000/- |
| Insured value | Rs.40,00,000/- |
| Reinstatement value | Rs.60,00,000/- |

They are found under insured in the proportion of

$$\frac{40,00,000}{60,00,000}$$

Therefore claim payable on furniture, fixtures and fittings will be

$$9,00,000 \times \frac{40,00,000}{60,00,000} = \text{Rs.}6,00,000/- \qquad \text{(D)}$$

**E. <u>Stocks and Stocks in Process</u>**

Stocks value affected (market value) Rs. 30,00,000/-
Insured value (market value basis) Rs.3,00,00,000/-
(No under insurance)

Therefore claim payable on stocks will be Rs.30,00,000/- (E)

Therefore total claim will be Rs. A + B + C + D + E

= Rs.10,00,000 + Rs.38,00,000 + Rs.6,00,000 +
Rs.6,00,000 + Rs.30,00,000
= Rs.90,00,000/-
============

## *Removal of debris claim*

As the insured has not covered the ADD ON cover for removal of debris, insured is covered for removal of debris only up to 1.0% of claim amount i.e. Rs.90,000/- and therefore insured will get claim only up to Rs.90,000/- out of their claim for Rs1,25,000/-.

Final claim of insured will be Rs.90,00,000 + Rs.90,000 = Rs.90,90,000/-
An excess of Rs.10,000/- will be further applicable

5.2 Example on Market Value Basis

M/s. Indian Chemicals had taken a Fire and Special Perils Insurance Policy for their Chemical Plant at Vadodara for the period 01/01/05 to 31/12/05 on market value basis as under

| Item | Sum Insured |
|---|---|
| a. Building | Rs.1,00,00,000/- |
| b. Plant and Machinery | Rs.3,50,00,000/- |
| c. Electrical Installation including sub-station | Rs.75,00,000/- |
| d. Furniture Fixtures and Fittings | Rs.40,00,000/- |
| e. Stocks and Stocks in Process | Rs.3,00,00,000/- |

On 25th February 2005 there was a fire in the plant and they reported the loss to their insurance company. The insurance Company appointed M/s. Arun Dasgupta and Co. as surveyor, who surveyed the loss and submitted their final Survey Report on April 15th, 2005.

Following is an extract from the survey report:

1. Fire affected building was partly repaired and replaced and the cost incurred was Rs.12,00,000/-. The reinstatement value of the building was found to be Rs.1,20,00,000/- on the date of repair. Market value was Rs.1,08,00,000/-arrived at by deducting 10% depreciation from RIV on date of damage.
2. The cost of repairs and replacement of Plant and Machinery affected by the fire was Rs.57,00,000/-. The re-instatement value of the plant and machinery was found to be Rs.5,25,00,000/- on the date of damage. Market value was Rs.3,94,00,000/- arrived at by deducting 25% depreciation from RIV on the date of damage.
3. Electrical installation was affected by fire to the extent of Rs.8,00,000/- its present re-instatement cost was Rs.1,00,00,000/- on the date of damage. Market value was Rs.80,00,000/- arrived at by deducting 20% depreciation from RIV on the date of damage.
4. Furniture Fixtures and Fittings were affected to the extent of Rs.9,00,000/- by fire and were re-instated by them. The re-instatement value of Furniture Fixtures and Fittings was Rs.60,00,000/- on the date of the loss, market value was Rs.48,00,000/- arrived at by deducting depreciation of 20% from RIV on the date of damage.

5. Cost of stocks and stocks in process was affected by fire to the extent of Rs.30,00,000/-(market value).

Insured had incurred a cost of removal of debris of Rs.1,25,000/-

What is amount of claim M/s. Indian Chemicals will get from the insurance company? Compute the loss on the market value basis. Assume that fire has taken place after 5 years of operation.

**SOLUTION**

(Assessment on Market value basis)

**A. <u>Building</u>**

| | |
|---|---|
| Repairs to building | Rs.12,00,000/- |
| Insured value | Rs.1,00,00,000/- |
| Reinstatement value | Rs.1,20,00,000/- |

Less depreciation 10% = Rs.12,00,000/- (at 2% per year or part thereof)

**Therefore market value = Rs.1,08,00,000/-**

The insured were found under insured on market value basis and under insurance is applicable as under:

$$10,80,000 \times \frac{1,00,00,000}{1,08,00,000} = \text{Rs.}10,00,000/- \qquad \text{(A)}$$

**B. <u>Plant & Machinery</u>**

| | |
|---|---|
| Cost of Replacements net of salvage | Rs. 57,00,000/- |
| Insured value | Rs.3,50,00,000/- |
| Reinstatement value | Rs.5,25,00,000/- |

Less depreciation 25% = Rs.1,31,25,000/- (at 5% per year or part thereof for 5 years)

**Therefore market value = Rs.3,94,00,000/-**

The insured were found under insured on market value basis and under insurance is applicable as under:

$$42,75,000 \times \frac{3,50,00,000}{3,94,00,000} = \text{Rs.}37,97,589/-$$

Say Rs.38,00,000/- (B)

**C. <u>Electrical Installations</u>**

| | |
|---|---|
| Cost of Reinstatement by repairs/replacements | Rs. 8,00,000/- |
| Insured value | Rs. 75,00,000/- |
| Reinstatement value | Rs.1,00,00,000/- |

Less depreciation 20% = Rs.20,00,000/- (at 4% per year or part thereof for 5 years)

**Therefore market value = Rs.80,00,000/-**

The insured were found under insured on market value basis and under insurance is applicable as under:

$$6,40,000 \times \frac{75,00,000}{80,00,000} = \text{Rs.}6,00,000/- \quad \text{(C)}$$

**D. <u>Furniture, Fixtures and Fittings</u>**

| | |
|---|---|
| Cost of Reinstatement by repairs/replacement | Rs.9,00,000/- |
| Insured value | Rs.40,00,000/- |
| Reinstatement value | Rs.60,00,000/- |

Less depreciation 20% = Rs.20,00,000/-

**Therefore market value = Rs.80,00,000/-**

The insured were found under insured on market value basis and under insurance is applicable as under:

$$7{,}20{,}000 \times \frac{40{,}00{,}000}{48{,}00{,}000} = \text{Rs.}6{,}00{,}000/- \qquad \text{(D)}$$

**E. <u>Stocks and Stocks in Process</u>**

| | |
|---|---|
| Stocks value affected (market value) | Rs. 30,00,000/- |
| Insured value (market value basis) | Rs.3,00,00,000/- |
| Total market value - fully insured | Rs.3,00,00,000/- |

The insured were adequately covered and they get their claim in full for

Rs.30,00,000/- (E)

Therefore total claim will be Rs. A + B + C + D + E

= Rs.10,00,000 + Rs.38,00,000 + Rs.6,00,000 + Rs.6,00,000 + Rs.30,00,000

= Rs.90,00,000/-

============

## *Removal of debris claim*

As the insured has not covered the ADD ON cover for removal of debris, their claim is covered in the policy to the extent of 1% of claim amount = Rs.90,000/- out of Rs.1,25,000/-.

<u>Final claim on Market Value</u>

<u>Insured will get total claim of Rs.90,00,000 + Rs.90,000 = Rs.90,90,000/-</u>

An excess of Rs.10,000/- will be further applicable

CVSRTA

### 5.3 Guiding Principles of Claim Settlement

1. Insured must have insurable interest in property damage at the time of claim.
2. There must be insurance contract and property should be damaged by perils covered in the policy, (claim is admissible) if damage is caused by more than one peril use principle of proximate cause and arrive at efficient, powerful, effective cause.
3. Surveyor must assess the claim after physical inspection of damaged property, observe the principle of indemnity and observe the basis of claim settlement provided in the policy.
4. Surveyor must list out the damaged parts and assess the salvage value of damaged parts, if insured wants to retain damaged parts as emergency spares, surveyor should give proper comment on the same.
5. If the damage is caused, for which third party is responsible the subrogation rights must be reserved for insurer.
6. If the property insured is covered with more then one insurance company the condition of contribution must be observed.
7. If the cause of damage is not clear, surveyor must resort to laboratory testing and try to find the most probable cause of damage.
8. If there is breach of any warranty surveyor must bring it to the notice of insurer and insured.
9. If there is any difference of opinion, surveyor must consult insurer and appoint technical expert.

# UNIT – 6

## OBLIGATIONS AND RIGHTS OF INSURER AND INSURED

### 6.0 OBLIGATIONS AND RIGHTS OF INSURER & INSURED, DUTIES OF THE INSURER AND THE INSURED

All insurance policies impose certain duties on the insured. Some of the duties are supplemented by the common law, state statutes and regulations. Similarly the duties of the insurer are implied by insurance contracts and it is strengthen by Protection of Policyholders' Interest Regulations framed by Insurance Regulatory and Development Authority of India.

### 6.1 The rights, duties and obligations of the Insured are briefed below.

1. Obligation to pay the premium to purchase the insurance policy, to examine the policy and to decide the exercise of free look period as allowed by the policy.
2. Duty to observe utmost good faith while purchasing the policy and throughout the policy period. The misrepresentation can void a policy. This is the application of honesty.
3. To act/behave as if uninsured and take all reasonable steps to protect the subject matter. If it is discovered that the insured is behaving recklessly or in a way that could invite the loss or increase the loss or liability, the claim will be prejudice.
4. Duty to notify the loss or claim to the insurer. The policy condition provides the time limit (normally forthwith) for claim intimation and also for other compliance.
5. To notify all material facts concerning to the incident and the loss or underlying claim.
6. To provide proof of loss and required documents.
7. The duty to cooperate with the insurer and the surveyor.
8. The duty requiring the insurer's consent for incurring the defence cost.
9. In case of property damage claim, the duty to take all reasonable and necessary steps to prevent further damage after the loss.
10. Duty and obligation to protect the rights of subrogation. When the Insured has a right of recovery from the third party who is responsible for the loss, the insured has to take all steps to protect the right of recovery and to subrogate his right to the insurance company as per the policy condition and common law.
11. Right of indemnification i.e. right to receive the claim as per the terms, coverage, limitations and compliance of the policy.

**6.2 The rights, duties and obligations of the Insurer are briefed below.**

1. It is the duty of the insurer to ensure that
   a. Interest of the insurance policy holders (insured) is protected.
   b. Insurer, distribution channels and other regulated entities fulfil their obligations towards policyholders and have in place standard procedures and best practices in sale and services of insurance policies.
   c. Policy holders-centric governance by insurer with emphasis on grievance redressal.
2. Duty to defend the Insured. It is insurer’s obligation to provide an insured with defense to claim made under a liability insurance policy.
3. Duty to gain the insured’s cooperation. It is the duty of the insurer to maintain good relationship with the insured. Each party must be able to rely on one another and abide by the guidelines of their end.
4. The duty of good faith and fair dealing. The insurer owes a duty to deal fairly and in good faith with its insured. The duty at the time of entering contract is to provide all details of coverage. The timely issuance of policy. Fair dealing and supporting at the time of claim.
5. The duty to settle the claims/pay benefits. Insurer should be careful to make settlement offers based on a realistic evaluation of the covered exposure. Once the insured contingency/accident happens and the damages have been reviewed, if it is found that the claim qualifies based on the benefits, time periods and exclusions given in the policy, it is the duty of the insurer to pay for it.
6. In case the claim is not admissible, it is the duty of the insurer to inform the insured giving reasons.
7. Privacy protection. It is the duty of the insured to protect the privacy of the insured.
8. It is the duty of insurer to adopt all required measures for the assessment of the risk and fixing the premium. The premium should be as per the associated risk.
9. Reserve for policy. It is the duty of the insurance company to set a side certain amount of income/premium for policy reserve. This will ensure the obedience of their commitment to pay the claim.

FOR DETAIL STUDY REFERANCE-
INSURANCE POLICY
COMMON LAWS AND PRINCIPLES OF INSURANCE
IRDAI NOTIFICATION. PROTECTION OF POLICYHOLDERS’ INTEREST.

SUPPLEMENTARY READING (from PME guidelines 2015)

**(A)** **Fire Insurance Policy** is a contract of indemnity with a view to place the Insured in same or similar pre-damage position. Thus, at the time of loss or destruction of any used asset, the insured is able to obtain a depreciated value by way of a claim from the Insurers which is value as new at the time of damage less depreciation for the use made over the years of usage. The quantum of depreciation provided in the books of account is not of any consequence; as such depreciation is charged on the original cost (purchase price) and moreover repairs and maintenance carried out by the owner is not reflected in the depreciation calculation. The value as new at the time of damage, due to price rise and inflation is much higher than the original cost.

Further, the amount of depreciation charged in the account books is never kept aside in cash form or separately funded and is used up in the industrial operation or expansion, i.e., either in working funds or in capital assets. As a result, the insured had to find a fresh flow of funds to reinstate the destroyed assets to the extent of the depreciation deducted in the claim. If there is any under-insurance, the proportionate loss is borne by the insured and the amount of depreciation together in aggregate would be the fresh funds requirement. In the absence of such funds availability, the insured would normally be forced to give up the rehabilitation or replacement of the destroyed asset. This is the drawback of market value policy.

Keeping the above factors in mind and to meet the varying needs of different types of industries and trade, special types of policies have been designed with certain changes in the basis of indemnity under fire insurance policy by providing **variations to Principle of Indemnity**. The **Reinstatement Value (RIV)** is one of such variations. RIV policy is discussed in detail later.

**(B)** **Insurance valuation under Indian context**

**(i)** **Contract of insurance**

All insurance contracts are inter alia contracts of indemnity except personal accident, i.e. the Insurer undertakes to place the Insured in the same position before the damage subject to adequate sum insured and subject to policy conditions, clauses, warranties.

**(ii) Fire insurance covers**

The standard fire and special perils policy covers fire and allied perils like:-

- Fire
- Lightning
- Explosion / Implosion
- Aircraft damage
- Riot, strike, malicious damage
- Storm, cyclone, typhoon, tempest, hurricane, tornado, flood and inundation
- Impact damage
- Subsidence and landslide including rock slide
- Bursting and/or overflowing of water tanks, apparatus and pipes
- Missile testing operations
- Leakage from automatic sprinkler installations
- Bush fire

The above policy also covers following costs:-

- Architects' consultants' and surveyors' fee up to 3% of admissible claim amount
- Debris removal up to 1% of admissible claim amount

The cost for Architects' fee (above 3%) and debris removal (above 1%) can be insured at additional premium.

Earthquake and terrorism damage are not included in the standard policy referred above. However, an add-on cover for these can be taken separately as add on covers at extra premium.

**(iii)** In case of sum insured for building, machinery and stock exceeds ` 100 crores **Industrial All Risk Policy (IAR)** can be availed. Now in de-tariffed scenario the limit of ` 100 crores is relaxed and many insurers are giving IAR cover for sum insured of ` 50 crores. This policy covers fire and all special perils including flood, earthquake, burglary, machinery break-down, boiler explosion and electronic equipment insurance. The policy covers business interruption (fire & special perils) i.e. fire loss of profit cover. The policy provides option to cover business interruption due to machinery break-down i.e. machinery break-down loss of profit. The amount of ` 50 crores or any limit for IAR fixed by the insurer is not limited to one location but for any number of locations in India under single ownership.

The advantages of this policy are:-

- It includes covers for earthquake, burglary, machinery break-down, boiler explosion & electronic equipment.
- Lower rate of premium
- Machinery break-down risk is covered on single sum insured i.e. total value of plant and machinery in a plant and it is not required to specify each & every machinery with its value/sum insured.

**(C) Indemnity**

**(i) Principle of indemnity:**

Indemnity is compensation for actual material loss or damage sustained due to an insured peril. The indemnity is to secure against loss or damage and make good the loss as per policy terms and conditions. It is imperative to bear in mind that fire insurance contract is a contract of indemnity.

Insurers undertake to place the insured after the loss due to an insured peril in the same financial position as he was before the loss, neither better nor worse; profit of any kind out of insurance taken is not permissible under a fire policy. If it was possible to derive profit, abuse and malpractices would result.

**Lord Mansfield states in a judgement as under:**

"Fire Insurance was considered as an indemnity only, in case of a loss; and therefore the satisfaction ought not to exceed the loss. The rule of indemnity was calculated to prevent fraud, lest the temptation of gain should occasion unfair and willful losses".

That a contract of fire insurance is one of indemnity cannot be too strongly emphasized. A contract of fire insurance is fundamentally one of indemnity, since its object is to make good, within the limits of the amount of insurance, and subject to terms and conditions of the policy, the actual loss sustained and nothing more.

**(ii) Insurable interest**

It is necessary for the insured to have insurable interest in the insured property at time of loss in order to observe the principle of indemnity. Policy does not only insure property itself, but also the insured's interest in the property and measurement of loss is the extent of such interest in property damaged or destroyed by an insured peril.

The following items constitute insurable interest –

* Existence of a property capable of being damaged or destroyed by fire or an insured peril.
* Such property should be the subject matter of insurance.
* The proposer must stand in some legal relationship with this object, whereby he benefits by its safety or be prejudiced by its loss.
  Mere expectancy of interest is not sufficient.

**(D) Utmost Good Faith**

In addition to the general law of contract, the insurance contract is also subject to certain special principles under common law like utmost good faith.

In insurance contracts, the legal doctrine of “utmost good faith” applies. This casts on the insured, the positive duty to disclose all material facts which have bearing on the insurance. A breach of this duty may make the contract void or voidable depending upon the nature of the breach.

Material facts are those which would influence a prudent insurer in his decision as to acceptance of insurance or in fixing premium, and terms and conditions of acceptance.

Duty of disclosures continues throughout preliminary negotiations leading up to the contract, but ceases when contract is complete. It applies again at renewal which is tantamount to making a fresh contract and the insured should make necessary disclosure of any new material fact.

Over and above utmost good faith Insurable Interest and Indemnity also apply in insurance contracts.

**(E) Various add on covers/clauses are available and for each such cover there are applicable clauses. However, for valuer's and insured's point of view the following add on covers/clauses are important:**

(i) Add on cover for omission to insure additions, alterations or extensions

(ii) Add on cover for start-up expenses

(iii) Designation of property clause

(iv) Reinstatement Value clause

(i) Local authorities' clause

(vi) Escalation clause

(vii) Architects', Surveyors' and Consulting Engineers' fees (up to 3% of the admissible claim amount) clause

(viii) Removal of debris clause (up to 1% of the admissible claim amount)

**Explanation to above add on covers/clauses**

**(i) Add on cover for omission to insure additions, alterations or extensions clause (this is to be incorporated if opted at additional premium)**

"The Insurance by this policy extends to cover buildings and / or machinery, plant and other contents as defined in columns ... hereof which the insured may erect or acquire or for which they may become responsible -

(a) at the within described premises,

(b) for use as factories.

* The liability under this extension shall not exceed in respect of (a) above, 5% of the sum insured by each item, in respect of (b) above, 5% of the sum insured by item No.(---).
* The insured shall notify the insurer of each additional insurance as soon as it shall come to their knowledge and shall pay the appropriate additional premium thereon from the date of inception.
* Following the advice of any additional insurance as aforesaid, cover by this extension shall be fully reinstated.
* No liability shall attach to the insurers in respect of any building, machinery, plant or other contents while such property is otherwise insured."

**N.B.**

* All new additions to building and/or machinery and plant not specifically insured/included during the currency of the policy should be declared at the end of the year and suitable additional premium paid on *pro rata* basis from the date of completion of the construction/erection of additions subject to adjust-ment against the advance premium collected.
* If the insured fails to declare the values of such additions within 30 days after the expiry of the policy, there shall be no refund of the advance premium collected.
* “Other contents” in the above clause shall mean ‘furniture and fittings’ and does not include stocks.

**(ii) Add on cover for Start-up expenses (this is to be incorporated if opted at additional premium)**

“It is hereby agreed and declared that this policy extends to cover start-up costs necessarily and reasonably incurred by the insured consequent upon a loss or damage covered by this policy.”

A separate sum insured may be mentioned for this clause if included.

**(iii) Designation of property clause**

“For the purpose of determining, where necessary, the item under which any property is insured, the insurers agree to accept the designation under which the property has been entered in the insured’s books.”

**(iv) Reinstatement Value Clause/Policy (if reinstatement basis is opted):**

This extension of cover is usually granted on buildings, machinery, furniture, fixtures and fittings only. It is not granted for stocks in trade or merchandise.

To safeguard and uphold the principle of indemnity, it is provided that Reinstatement Value Clause shall have no effect, if the insured fails to replace or reinstate the property damaged or destroyed, or the insured is unwilling to replace or reinstate the property destroyed or damaged on the same or another site.

**Reinstatement Value Clause reads as under:**
" It is hereby declared and agreed that in the event of the property insured under (Item Nos.____) of the within policy being destroyed or damaged, the basis upon which the amount payable under (each of the said items of) the policy is to be calculated, shall be the cost of replacing or reinstating on the same site or any other site with property of the same kind or type but not superior to or more extensive than the insured property when new as on date of the loss, subject to the following Special Provisions and subject also to the terms and conditions of the policy except in so far as the same may be varied hereby."

**Special Provisions**
* The work of the replacement or reinstatement (which may be carried out upon another site and in any manner suitable to the requirements of the insured subject to the liability of the Company not being thereby increased) must be commenced and carried out with reasonable dispatch and in any case must be completed within 12 months after the destruction or damage or within such further time as the company may (during the said 12 months) in writing allow, otherwise no payment beyond the amount which would have been payable under the policy if this memorandum had not been incorporated therein shall be made.

* Until expenditure has been incurred by the insured in replacing or reinstating the property destroyed or damaged, the company shall not be liable for any payment in excess of the amount which would have been payable under the policy if this memorandum had not been incorporated therein.

* If at the time of replacement or reinstatement the sum insured representing the cost which would have been incurred in replacement or reinstatement if the whole of the property covered had been destroyed, exceeds the sum insured thereon at the operation of any of the insured perils or at the commencement of any destruction of or damage to such property by any other peril insured against by this policy, then the insured shall be considered as being his own insurer for the excess and shall bear a rateable proportion of the loss accordingly. Each item of the policy (if more than one) to which this Memorandum applies shall be separately subject to the foregoing provision.

**This Memorandum shall be without force or effect if -**

*"the insured fails to intimate to the company within 6 months from the date of destruction or damage or such further time at the Company may in writing allow, his intention to replace or reinstate the property destroyed or damaged.

*the insured is unable or unwilling to replace or reinstate the property destroyed or damaged on the same or another site".

**(v) Important considerations / variations etc.**

**(a)** Valuation of plant for fire insurance purpose is the estimation of possible financial loss by reference to machinery of comparable output, productivity and quality at a given point of time, seen in the background of policy terms and conditions. Valuation is carried out to decide the "Value at Risk" of plant.

This is the maximum possible loss of value of a physical asset measured against policy terms and conditions. Reinstatement Value is the amount payable under the policy to be calculated and shall be the cost of replacing or reinstating on the same site or any other site with property of the same kind or type but not superior to or more extensive than the insured property when new as on date of loss. It is a standard provision of insurance policies that in the event of the loss the insured will take all reasonable steps to minimize his loss. It is common for the insured to attempt to replace the plant as quickly as may be prudent in order to minimize any loss of turnover to the business and goodwill of his added advantage of minimizing any loss-of-profit claim on insurers if such insurance is there.

Reinstatement Value is inclusive of machinery foundation. So, while instructing insurer it should be made clear in writing that the plant and machinery are insured inclusive of their foundations.

**(b)** The important variations which flow from the Insurer's Reinstatement Value clause compared to the Market Value (Depreciated Value) policy are set out hereafter.

(i) Damaged / destroyed / irreparable property to be replaced by new property of "the same kind or type but not superior to or more extensive than the insured property" and the monetary claim to be **allowed on value as new basis without deducting depreciation.**

For damage to repairable property, the full cost of repairs including replacement of parts would be payable without deduction of any depreciation, subject to the repairs / replacement of parts are of the "same kind or type."

(ii) Such monetary claim is to be paid only after actual repairs / replacement of parts / reinstatement has been completed and then payment shall be made for claims made by the insurer, as per terms and conditions of relevant policy.

(iii) The important aspects to be borne in mind by the insured are set out hereafter.

a. The insured has the option to reinstate or not and the said option has to be exercised within 6 months of the damage or any further time limit which may be allowed by the insurer in writing.
b. The reinstatement may be done at the same site or at any other site.
c. The reinstatement has to be completed within 12 months of the date of damage. Extension of time, may be allowed by the insurer.
d. To obtain full coverage and claims, the sum insured has to be adequate to cover the value of insured property **at the time of reinstatement of the damage.**

(iv) To get full advantage of maintaining an undisturbed cash flow and of getting a new asset against the old asset destroyed, it is abundantly clear that full insurance on RIV basis is absolutely essential.

**Example on reinstatement value and condition of average**:

A machine was purchased in 2004 for ` 50,000/-. If it is to be replaced today, it will cost say ` 5,00,000/- (a). The physical depreciation for 10 years is say ` 2,25,000/- (b). In this example,

Actual cost (historical cost) = ` 50,000/-

Reinstatement value
(replacement cost) on date of loss or damage
= ` 5,00,000/- (a)
Depreciated replacement cost
(a) – (b) = ` 2,75,000/-

Thus, if the machinery is totally damaged due to an insured peril and is insured for reinstatement, the insured will get a sum of ` 5,00,000/- even if the machine is worth only ` 2,75,000/- in the market at the time of total loss, provided the actual reinstatement of the damaged machinery is accomplished, as per Reinstatement Value Clause.

If it is desired to take benefit of the escalation clause, with 25% escalation, the insurable value will work out to:

$$5{,}00{,}000 + \frac{25}{100} \times 5{,}00{,}000 = \text{` } 6{,}25{,}000/-$$

If there is a total loss during the year, the maximum amount payable to the insured for the reinstatement of the machinery will be ` 6,25,000/- provided reinstatement cost incurred is ` 6,25,000/- and provided the loss has taken place on the last day of the period of insurance. (Please see Escalation clause under paragraph (vi) later). In all such cases, salvage, if any, of the damaged property will always belong to the Insurance Company.

**Condition of Average**

If the amount of insurance is less than the value of the machinery damaged or destroyed, on the date of damage, due to an insured peril, the condition of average will operate, and the insured will proportionately receive less than the actual loss suffered.

A loss payable as per condition of average is worked out as under:

$$\frac{\text{Sum insured}}{\text{Value of machinery at the time of loss}} \times \text{Loss} = \text{Claim amount payable}$$

(c) However, the manner in which the **condition of average** is applied with particular reference to the sum insured at the time of damage being required to be equivalent to value as new of the insured property item-wise at the time of reinstatement / reconstruction, to ensure full insurance is a very difficult task. The changing factors of prices, local taxes, excise duty, sales tax, customs duty, and fluctuations in the rate of foreign exchange, makes the task almost impossible. Even if the sum insured is fixed adequately at the time of inception or renewal of the insurance policy, no insured can forecast when the damage will take place during the 12 months period of the policy or the type of loss that will take place or the time or period required for reinstatement. In case of a major catastrophic loss involving special purpose imported machinery, such period of reinstatement could exceed two or three years. Alternatively, in small loss or if required spares are available in stock, the period of repairs / reinstatement may be a week or two or even less. The various factors which build up the cost or value may fluctuate after the loss also leading to more difficulty. Unfortunately there is no provision for adjustment of the Sum Insured after the loss. Escalation takes care of inflation up to policy period. If reinstatement extends beyond expiry of policy there is no remedy available for increase in price from the date of expiry of policy to the completion of reinstatement except to over insure.

How much to over insure will depend on the facts and in the circumstances of each individual case.

In view of the above, it is evident that there is no tailor-made exact solution to the problem of how to determine the Reinstatement Value in advance and this is known and recognized by the insurers world-wide.

**(v) Local authority's clause:**

Reinstatement value policy can be extended to cover additional cost of re-instatement solely by reason of the necessity to comply with the regulations of local authority by incorporating the following clause in the policy.

"The insurance by this policy extends to include such additional cost of reinstatement of the destroyed or damaged property hereby insured as may be incurred solely by reason of the necessity to comply with the Building (or other) Regulations under or framed in pursuance of any Act of Parliament or with bye-laws of any municipal or local authority provided that :
The amount recoverable under this extension shall not include:

● The cost incurred in complying with any of the aforesaid Regulations or bye-laws,

in respect of destruction or damage occurring prior to the granting of this extension,

* in respect of destruction or damage not insured by the policy,
* under which notice has been served upon the insured prior to the happening of the destruction or damage,
* in respect of undamaged property or undamaged portions of property other than foundations (unless foundations are specifically excluded from the insurance by this policy) of that portion of the property destroyed or damaged.
* The additional cost that would have been required to make good the property damaged or destroyed to a condition equal to its condition when new had the necessity to comply with any of the aforesaid Regulations or bye-laws not arisen.
* The amount of any rate, tax, duty, development or other charge or assessment arising out of capital appreciation which may be payable in respect of the property or by the owner thereof by reason of compliance with any of the aforesaid Regulations or bye-laws.
* The work of reinstatement must be commenced and carried out with reasonable dispatch and in any case must be completed within twelve months after the destruction or damage or within such further time as the insurers may (during the said twelve months) in writing allow and may be carried out wholly or partially upon another site (if the aforesaid Regulations or bye-laws so necessitate) subject to the liability of the insurer under this extension not being thereby increased.

* If the liability of the insurer under (any item of) the policy apart from this extension shall be reduced by the application of any of the terms and conditions of the policy then the liability of the insurers under this extension (in respect of any such item) shall be reduced in like proportion.
* The total amount recoverable under any item of the policy shall not exceed the sum insured thereby.
* All the conditions of the policy except in so far as they may be hereby expressly varied shall apply as if they had been incorporated herein."

No additional premium is charged for inclusion of this clause in the policy.

**(vi) Escalation clause (if opted at additional premium)**

"In consideration of the payment of an additional premium amounting to 50% of the premium produced by applying the specified percentage to the first or the annual premium as appropriate on the under noted item(s) the sum(s) insured thereby shall, during the period of insurance, be increased each day by an amount representing 1/365th of the specified percentage increase per annum.

Unless specifically agreed to the contrary the provisions of this clause shall only apply to the sums insured in force at the commencement of each period of insurance.

At each renewal date the insured shall notify the insurers:-

* The sums to be insured under each item above, but in the absence of such instruction the sums insured by the above items shall be those stated on the policy (as amended by any endorsement effective prior to the aforesaid renewal date) to which shall be added the increases which have accrued under this clause during the period of insurance up to that renewal date.

* The specified percentage increase(s) required for the forthcoming period of insurance, but in the absence of instructions to the contrary prior to renewal date the existing percentage increase shall apply for the period of insurance from renewal.

All the conditions of the policy in so far as they may be hereby expressly varied shall apply as if they had been incorporated herein."

It will be in order for insurers to allow automatic regular increase in the Sum Insured throughout the period of the policy in return for an additional premium to be paid in advance. The terms and conditions for this extension are as follows:

- The selected percentage shall not exceed 25% of the sum insured.
- The additional premium, payable in advance, will be at 50% of the final rate, to be charged on the selected percentage increase.
- The sum insured at any point of time would be assessed after application of the Escalation Clause.
- Escalation Clause will apply to policies covering building, machinery and accessories only and will not apply to policies covering stock.
- Escalation Clause will apply to all policies and is not restricted to policies issued on reinstatement value basis.
- Pro rata Condition of Average will continue to apply as usual.
- The automatic increase operates from the date of inception up to the date of operation of any of the insured perils.

**(vii) Architects', Surveyors' and Consulting Engineers' fees (up to 3% of the admissible claim amount) clause**

"It is hereby declared and understood that the expenses incurred towards Architects', Surveyors' and Consulting Engineers' fees for plans, specifications, tenders, quantities and services in connection with the superintendence of the reinstatement for the building, machinery, accessories and equipment insured under this policy is covered up to 3% of the adjusted loss, but it is understood that this does not include any costs in connection with the preparation of the insured's claim or estimate of loss in the event of damage by insured perils."

The insurers may cover Architects' fees up to further 4.5% in addition to 3% which is already covered under the policy as per above clause subject to appropriate additional premium payable.

**(viii) Removal of debris clause (up to 1% of the admissible claim amount)**

"It is hereby declared and agreed that the expenses incurred up to 1% of the admissible claim amount is included in the sum insured on:

(a) removal of debris from the premises of the insured;

(b) dismantling or demolishing;

(c) shoring up or propping."

**Note:** (b) and (c) above should be deleted when neither building nor machinery are covered.

The insurers may cover removal of debris charges for higher amount, over and above 1% up to 10% of sum insured subject to additional premium payable.

## (F) Other types of insurance policies

### 1. Machinery break-down policy:

a) The Insurance Policy covers "Unforeseen and sudden physical damage" subject to certain exclusions. The insured has the choice to select specific machinery for insurance. While a deductible of 1% of the Sum Insured is common, this can be increased at the insured's option with a reduction in premium.

b) The Sum Insured "shall be equal to the cost of reinstatement of the insured property by a new property of the same kind and capacity." If the item-wise Sum Insured "is less than the amount required to be insured as per above provision, the Company will pay only in such proportion as the Sum Insured bears to the amount required to be insured.

c) The provisions for settlement of claims are briefly stated hereafter.

(i) If the damage can be repaired, then full cost of repairs to restore the machine to pre-damage condition is payable. No depreciation will be deducted on the value of parts replaced unless such parts are of limited life. However, if the cost of repairs exceeds the actual pre-damage value of the property, i.e., depreciated value, settlement of claim will be limited to actual pre-damage value after taking account of salvage.

(ii) If the insured property is destroyed, the Insurance Company will settle the claim for actual pre-damage value, i.e., depreciated value, after taking into account value of salvage.

(iii) In both the above situations, the Insurance Company will make payments only after being satisfied that the repairs have been effected or replacements have taken place.

(a) It is evident from the above provisions that the Sum Insured has to be equal to the replacement cost while the maximum settlement of any claim for repairs or replacement would be on the basis of actual value net of depreciation and salvage. Further payment of any claim will be made only after repairs or replacements are carried out.
(b) The problems of determining the reinstatement value and the Sum Insured are identical to what has been narrated earlier.

**(i) Boiler and pressure plant insurance policy:**

This policy covers explosion/implosion (including flue gas explosion) and collapse damage to boiler and pressure plants wherein steam is being generated.

**G. Illustration on computation of Insurable Value (Hypothetical Case)**

Insurable value is based on market value or reinstatement value. Both these values are discussed earlier and out of two, reinstatement value is desirable though premium payable is high but the benefits derived are more in the event of loss.

**Computation of reinstatement value of a machine installed in a plant.**

The plant manufactures seafood products by cooking / blanching or raw. The raw materials used are sea caught shrimps, cephalopods (Squids, Octopuses and Cuttlefish) and fishes. The aquaculture shrimps are also used as raw material. The product is either individually quick frozen in IQF freezer or block frozen in plate freezer. The product is also semi IQF in the air blast freezer. Ammonia gases are used as refrigerant. The product is stored in the frozen store below $-18^0$C temperature. The finished product is transported in refrigerated container for shipment.

The machine to be insured is located in a plant in Kerala where the company produces IQF and other frozen products in the unit. The capacity of the IQF plant is 3500 TPA with 3 shift operation, Block plant is 3500 TPA and Blast is also 3500 TPA. Current capacity utilization is around 60 to 70% for IQF and Block. The total manpower of the plant is 300 which includes managers, officers, staff and workmen. Pre-processing, cold store and packaging material facilities are created for facilitating better consumer safety.

**The product profile of the plant is given below:**

- Raw / blanched / cooked IQF shrimps
- Block / blast frozen shrimps
- Raw / blanched / cooked IQF cephalopods
- Block / blast frozen cephalopods
- IQF raw / blanched / cooked sea food mix
- Blast frozen fishes / fish fillet

**The process employed by the plant:**

- IQF freezing (ammonia refrigeration)
- Plate freezing (ammonia refrigeration)
- Blast freezing (ammonia refrigeration)
- Cooking / blanching through steam generation from non IBR boiler
- Cold storage (ammonia refrigeration)

**Valuation procedure**

First step is to inspect the machine and collect the data so that the current cost of brand new machine can be estimated and supplier of machine can quote current price without any further query.

**The details collected for machine under consideration are as under:**

**Plant, machinery and equipment to be valued: IQF Hardening – Tunnel**

Single belt tunnel for individual quick freezing (hardening) of products.

On a plastic modular belt the product is led past the high velocity airflow called Arctic Flow®, which blows the air across the belt and past the product and then continuously blows through the evaporator.

The rapid horizontal Arctic Flow® and the ultra-low temperature ensure a quick and homogenous freezing within a minimum of time. Thus, ensuring a good quality finished product, with an equalized core temperature of minimum $-18^0$ C within a minimum of time.

**Features**

- Plastic modular belt, suitable for small and large products.
- Belt frame and support, in-feed/outlet and guiding plates are in stainless steel in an open design, to ensure easy cleaning and a long life without corrosion.
- In-and-Out – feed openings are fully covered by 2 x double layer silicon strip curtains to minimize air/moisture entering the cabinet, which prevents frosting built-up on the evaporator and prolongs the time in between defrosting periods.
- Self-adjusting mechanically operated belt tension system to slacken or tighten belt.
- Long durable UHMW polyethylene wears rails on frame and belt support, to ensure long belt life.
- Electrically operated ventilators to ensure optimal air circulation from evaporator to product for quick and uniform freezing.
- Evaporator.
- Fully insulated cabinet made of 125 mm sandwich panels, insulated with polyurethane and plated with 0.6 mm galvanized steel plate, coated with 150 µm white PVC.
- Fully welded stainless steel floor with center mounted gully and hatch for water outlet when defrosting and cleaning.
- The cabinet is equipped with access door mounted with electrical door heaters to prevent ice bounding of panel.
- Additional emergency breakers mounted next to in-feed conveyor and inside cabinet for full personnel security.
- Internal electrical neon lights mounted in ceiling for clear view when freezing, cleaning or maintenance.

**Technical data**

| | | |
|---|---|---|
| Cabinet dimension (L x W x H) (external) | : | 3,900 x 2,300 x 2,700 mm |
| Belt type | : | Plastic modular |
| Belt width effective/overall | : | 850 mm effective, 900 mm |
| Conveyor length | : | 3,600 mm |
| Belt speed - minutes per cycle | : | Adjustable from 2 to 10 |
| No. of belt | : | 1 |
| Maximum product height | : | 750 mm |
| Product in-feed height | : | 1,100 mm |
| Product outlet height | : | 750 mm |
| Refrigeration duty to product | : | 10 kW |
| Coolant supply to evaporator | : | 15 kW |
| Suction temperature | : | Minus $40^0$ C, at evaporator |
| Air temperature | : | Minus $35^0$ C |
| Cooling medium system | : | R-717 or R-22 pump |
| Cooling pump flow rate | : | 4-5 times evaporated liquid |
| Installed fan power | : | 3.3 kW |
| Power supply | : | 6 kW |
| Voltage | : | 3 x 380 V 50 Hz |
| Year of installation | : | January, 2013 |
| Date as on which valuation is made | : | 31st December, 2014 |
| Gross Book Value | = | ` 1,25,00,000/- |
| Depreciation | = | ` 14,25,000/- |
| Net Book Value | = | ` 1,10,75,000/- |

The figures indicated in this case are hypothetical.

**The identical machine is available from the same manufacturer.**

The computation of RIV based on the quotation received is as under:

| Particulars | Amount in ` | |
|---|---|---|
| Ex-works price at manufacturer's site. | 1,05,00,000 | (a) |
| C I F (custom duty, insurance and freight) | 35,00,000 | (b) |
| Landed cost at Indian port | 1,40,00,000 | (a) + (b) = (c) |
| Clearing, forwarding and transit insurance from port to the plant | 3,00,000 | (d) |
| Handling charges at plant | 50,000 | (e) |
| Costs of foundation, erection and installation | 6,50,000 | (f) |
| **Total** | **1,50,00,000** | (c) + (d) + (e) + (f) |

(a) The insurance policy is for the period of one year.

(b) ` 1,50,00,000/- is value on first day of policy.

(c) Suppose something happens on last day of policy – what about increase in the price from day one to last day. Let us assume that increase in the price is likely to be 10%.

Therefore, insurable value after considering escalation will work out to ` 1,65,00,000/-.

**Note:** (i) The question of computation of depreciation does not arise as policy recommended is not market value policy but reinstatement value policy (RIV).

(ii) Even if the policy is taken at ` 1,65,00,000/- based on scientific valuation carried out by the valuer, the insurance company will issue RIV policy and collect premium on the basis of ` 1,65,00,000/- but shall not commit to pay ` 1,65,00,000/- in the event of total loss because the question of adequacy of insurable value shall be considered at the time of reinstatement.

**H** The approach to valuation for computation of insurable value is dependent on the type of the policy, i.e. whether policy is on RIV basis or market value basis. However, in both the cases the first step is to estimate current cost of brand new similar item. These costs include following:

**A. For indigenous machine**

(i) Ex-works price of machine
(ii) Packing and forwarding charges
(iii) Excise duty
(iv) VAT (Value added tax)
(v) Handling charges
(vi) Transportation charges
(vii) Transit insurance cost
(viii) Foundation, erection and installation costs

**B. Imported machine**

As per Illustration for valuation for insurable value given earlier.

**Note:** Taxes and duties mentioned above are non-recoverable tax i.e. effective taxes.

If the policy is with the escalation clause then amount worked out by considering above factors would be increased depending upon the escalation amount.

Let us consider the case of a process plant established 5 years back to manufacture a particular product. It has an installed capacity of X unit. The unit has 100 machines. All the machines are to be insured on RIV basis without escalation.

The RIV of each individual machine as on date of taking new policy is say ` 1.00 Crore giving a total of ` 100.00 Crores.

The latest plant to manufacture same product with an installed capacity of X unit can be established with 75 machines, RIV of such entire plant is ` 80 Crores. The latest plant is economical to operate also.

Let us consider the following two situations due to any insured peril:

(a) One of the machines is damaged in such a way that it cannot be repaired.
In this case insurance company will approve the claim for ` 1.0 Crore because RIV of damaged machine is ` 1.0 Crore.

(b) All the machines of plant are damaged and all the machines are beyond repair.
In this case insurance company will not approve the claim for ` 100 Crores as RIV for all the machines as per current technology is ` 80 Crores.

There are differences between the valuation of PME for reinstatement insurance value and replacement cost new for financial reporting. The lack of provision for interest charges in valuation for insurance is one of these. For computation of replacement cost new the finance charges are to be considered. In the case of some large plants, this may represent a significant percentage of the overall cost. In insurance valuation, provisions for the finance charges is incorrect and will lead to the statement of inflated values.

# INDUSTRIAL PROCESSES


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The study material for the subject of Industrial Processes is divided into two parts: Industrial Processes – I and Industrial Processes – II.

This section covers Industrial Processes- I

# INDUSTRIAL PROCESSES - I

# INDEX

CVSRTA

## BRIEF INTRODUCTION

It is very important for students of plant and machinery valuation to study the various industrial processes.

Industrial Processes is a very wide subject covering large number of industries; they are custom-built as per the specific requirement of a client with in a class of industries; it is well nigh impossible to cover the subject in toto for the present study material.

In order to get how things work in the plants it is essential for the students to visit large number of plants of diverse varieties.

Plant and machinery in any Industrial Process can be broadly classified in following categories:-

(a) Process equipment depending on process involved.
(b) Utility equipment

The study material for this subject is divided in following parts:
- Industrial Processes–I and
- Industrial Processes–II.

**Industrial Processes – I** covers :

1. Factory Planning and Layout:
    - Plant location
    - Plant layout
    - Types of Plant Layout
    - Process Layout
    - Product layout
    - Group Layout

2. Production system and automation
    - Types of production
    - Types of automation

3. Material flow, process, sequences, and automation & control and following Industrial Processes:
   - Textile spinning mill
   - Dairy
     - Ice cream
     - Industrial Milk Processing
   - Solvent Extraction and Vegetable Oil Plants

**Industrial Processes – II** covers :

- Iron, Steel and Nosn-Ferrous Metal Production
- Chemical (Dye)
- Pharmaceutical
- Plastic
- Rubber
- Paper and paper products
- Printing, binding and publishing
- Food (Bread making)
- Soft drink

**Note :** Utility is covered in Industrial Processes – I.

# UNIT-1
## FACTORY PLANNING AND LAYOUT

<u>Plant Location:</u>

*"A plant is a place where men, materials, machines and equipment are brought together for manufacturing a product".*

Three major consideration in the plant location are;

- The need to produce close to the customer
- The need to locate near the appropriate labour force
- Availability of raw material

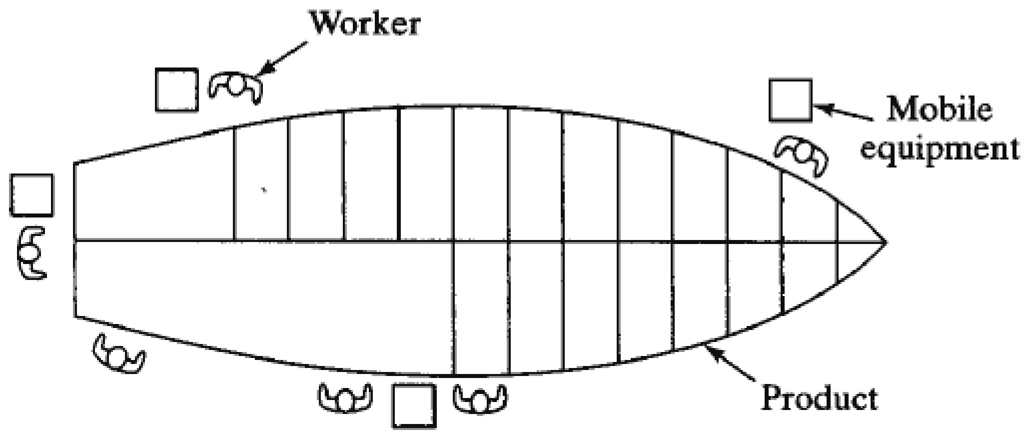
A Valuer has to examine the plant site and its layout while assessing the value of the plant.

<u>Plant Layout:</u>

A plant layout is a systematic arrangement of various departments, machines, equipment and services of men for economical, effective and efficient functioning of an organization for production of any goods. It includes;

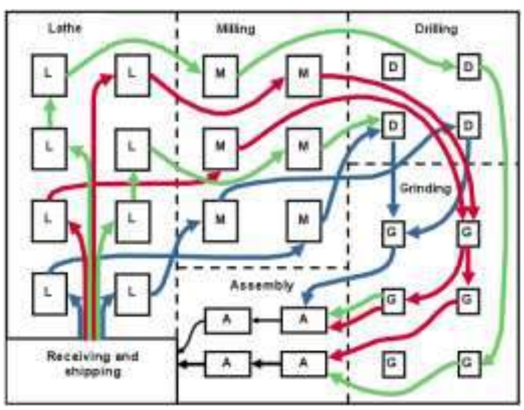
- Space needed for material movement
- Storage
- Hazardous materials storage
- Emergency escape
- Product size

<u>Types of Plant Layout:</u>
Fixed Position Layout: Materials stays at fixed place and Machines are moving. Aircraft and Ship buildings are examples of fixed position layout.



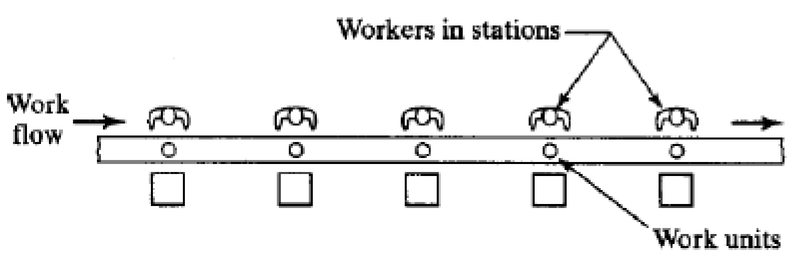

<u>Process Layout :</u>

Machines are fixed and Materials are moving. Small scale production units, repair and maintenance shops are examples of process layout.



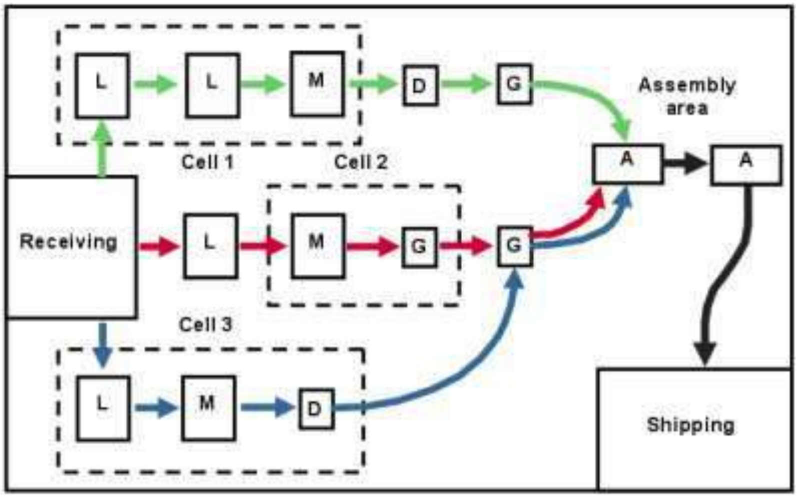

<u>Product Layout:</u>

The volume of production is high where separate production line is justified like Automobile Industries, TV, Refrigerator, Air conditioner, Washing machine.



Group Layout:

Groups of different equipment performs a sequence of operation like Automotive component manufacturing.



# UNIT-2

## PRODUCTION SYSTEM AND AUTOMATION

Production system means manpower, materials, machines and methods in order to accomplish the manufacturing operation of the company and part of the production systems are automated.

**Type of Production:**

Job Shop Production (One-off Production) : Low volume production of customized products such as aircraft, power plants, submarine, ships.

Batch Production: Product is prepared stage by stage over a series of workstations and different batches of products are made. Bakery products, pharmaceuticals ingredients etc. are examples of such production.

Mass Production: Large volume to satisfy high demand and it is a continuous process to manufacture identical parts.

- Quantity production: manufacturing of single parts on standard machines with the use of special dies, moulds. Screws, nuts, nails are examples of such production
- Flow line production (Continuous): To manufacture high volumes of products with high production rates and low costs. Separate dedicated flow line is created for each product. Dedicated machines are used to manufacture the products at high production rates. Assembly lines of cars, bulbs, razors, chemical plants, refineries are examples of such production.

Automation can be defined as the process of following a predetermined sequence of operations with little or no human labour, specialized equipment and devices that perform and control manufacturing process.

Programmable Logic Controller (PLC) system is the most advance version of automation used in the industries which is reducing space, saves energy, easy maintenance, economical, greater life & reliability, flexibility, less project time.

Automation in manufacturing plants can be implemented in manufacturing process, material handling, inspection, assembly and packaging.

**Type of Automation::**

Fixed Automation or Hard Automation: Sequence of processing operations are fixed by the equipment configuration. Many operations are integrated into a single piece of equipment. Production lines are designed to produce a standardized product such as engine blocks, valves, gears and spindle. It has high production rates hence used for mass production of parts. Examples of fixed automation include machining transfer lines foundin the automotive industry, automatic assembly machines.

Programmable Automation: Sequence of operations are controlled by a program so the same equipment is used to produce different products. CNC, industrial robots and PLCs are examples of programmable automation.

Flexible Automation: It is an extension of programmable automation as there is no time lost for changeover from one part type to another while programming the system. It has low production rates.

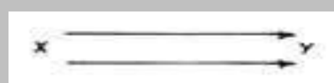
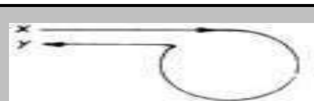
# UNIT-3

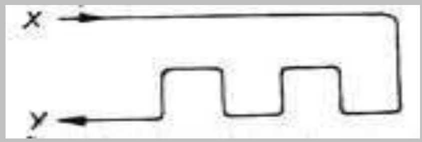
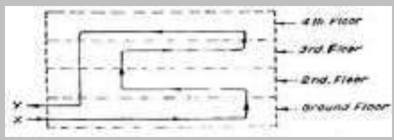
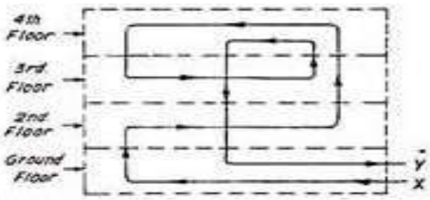
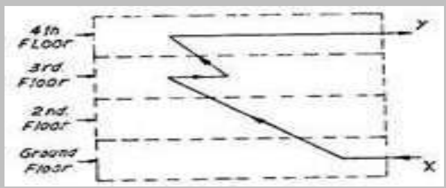
## MATERIAL FLOW, PROCESS SEQUENCES AND AUTOMATION & CONTROL

<u>Material Flow:</u>

One of the most important phase of the plant layout is to achieve an optimum effective flow of material through the plant.

While designing a new plant layout, generally the flow patterns are decided earlier and then system facilities is designed.

| Flow Pattern | Flow Pattern | Characteristics and Place of Use |
|---|---|---|
| **Line Flow** |  | Straight, materials enters at one end and leave at other end. It is preferred in buildings having long length and less widths.<br>Paper Plant |
| **L Type flow** |  | Resembles line flow and used where buildings are more wide but less long.<br>Asphalt Mixing Plant |
| **Circular Flow** |  | Preferred for rotary handling systems.<br>Electric Bulb Industry |
| **U type flow** |  | Supervision is simpler and preferred in square shaped buildings<br>Electric Motor Industry |
| **S or inverted S** |  | Preferred in production lines are longer than U type. The system is compact, space has better utilized and supervision efficient.<br>Automotive Assembly Line |
| **Combination of U and Line Flow** |  | |

| | | |
|---|---|---|
| **Combination of Line Flow and S type flow** |   | |
| **Combination of Line and Circular** |   | This system needs smaller building length as compared to line flow. |
| **Processing Upwards** |   | The material may be processed while moving upwards or downwards in multi-storey buildings. In processing downwards, gravity helps to bring the material down but all the material has to be taken to the top storey. |
| **Retraction type of flow in multi-storey buildings** |   | It involves more material handling cost as compared to (i) but finds better space and equipment utilization. |
| **Inclined Flow** |   | Such system may be adopted depending upon the process characteristics. |

**Process Sequence:**
Process is a sequence of operations and processes designed to create a specific product. It is nothing but the turning materials into product. At every stage it covers one or more resources. These outputs then serve as an inputs for the next stage until a known goal or end result is achieved.

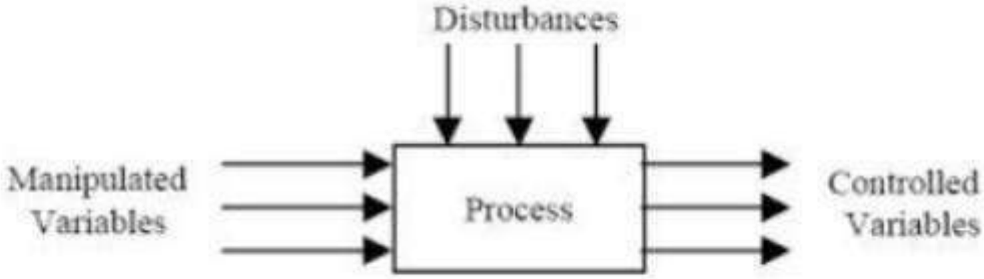
**Activities:**
Production Planning: Required level of production in a specific time horizon. Production Scheduling: Allocation of finite resources to meet the demand requirements such as capacity, precedence, start and due dates.
Production sequence: Resource level ordering of jobs on a shared workstations.

**Priority Rules for sequencing Jobs on shared machines:**
First come, First served (FCFS): Jobs are assigned to a shared resource in the order in which they are placed Shortest Processing Time (SPT): Jobs are ordered based on the length of the processing time means jobs with shortest processing time are ordered first.

Longest Processing Time (LPT): Jobs with the longest processing time are order first.

Earliest Due Date (EDD): Jobs are ordered based on their required delivery dates means jobs with earliest due dates are order first.

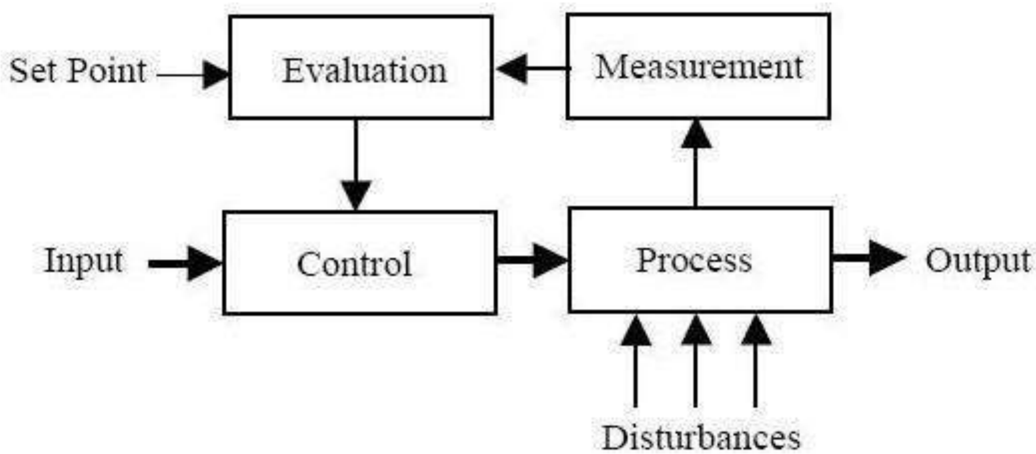
**Automation & Process control:**
Control in process industries refers to the regulation of all aspects of process.
All process systems consists of three main factors or terms:




Manipulated Variables: Valve Position, motor speed, damper position etc.

Controlled Variables: Temperature, Level, Position, Pressure, pH, density, moisture content, weight and speed

The control system must adjust the manipulated variables so the desired value or set point of the controlled variables is maintained despite of any disturbances.
Process control system consists of four elements:

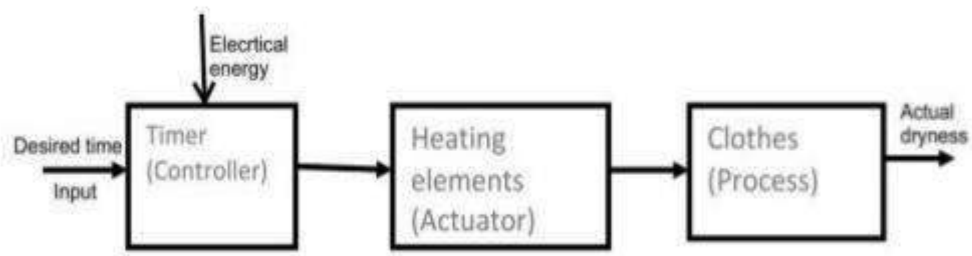



Process: It consists of an assembly of equipment and material related to manufacturing operation. Ex. Liquid level is placed under control includes components as a tank, liquid, flow of liquid into and out of from the tank, inlet and outlet piping.

Measurement: It is conversion of the process variable into an analog or digital signal that can be used by the control system and that device called a sensor or instrument. Typical measurements are pressure, level, temperature, flow, position and speed.

Evaluation: The measurement value is examined, compared with the desired value or set point and the corrective action needed to maintain proper control is determined and device called controller. The controller can be pneumatic, electronic or mechanical.
Control: The control element in a control loops is the device which direct influence on the process or manufacturing sequence. In given example it will be a control valve that adjust the flow of liquid in a process.

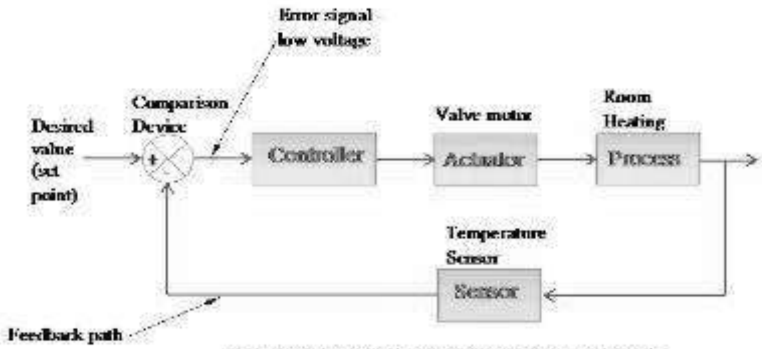
**Type of Process Control System**:
Open Loop Control System: A control action is applied on the output of the system. It does not receive any feedback signal to control or alter the output status.
Set point, Controller, Actuators, Process, Disturbances




❖ An operator would set a timer (controller) to say 30 minutes and at the end of the 30 minutes the drier will automatically stop and turn-off even if the clothes are still wet .

❖In this case, the control action is the manual operator assessing the wetness of the clothes and setting the process accordingly

**Closed Loop Control System**:
The output of the process affects the input control signal. The system measures the actual output of the process and compares it to the desired output.
Comparator, Error Amplifier, Controller, Output Attenuator, Sensor Feedback




HEATING SYSTEM CONTROL LOOP DIAGRAM

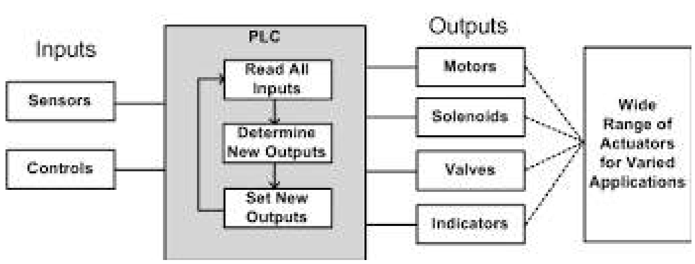
❖The temperature sensor is installed in the room to be controlled and sends a signal back along the feedback path to the comparison device incorporated in the controller.

❖The comparison device compares the value of temperature at the sensor to that of the desired value or set point on the controller.

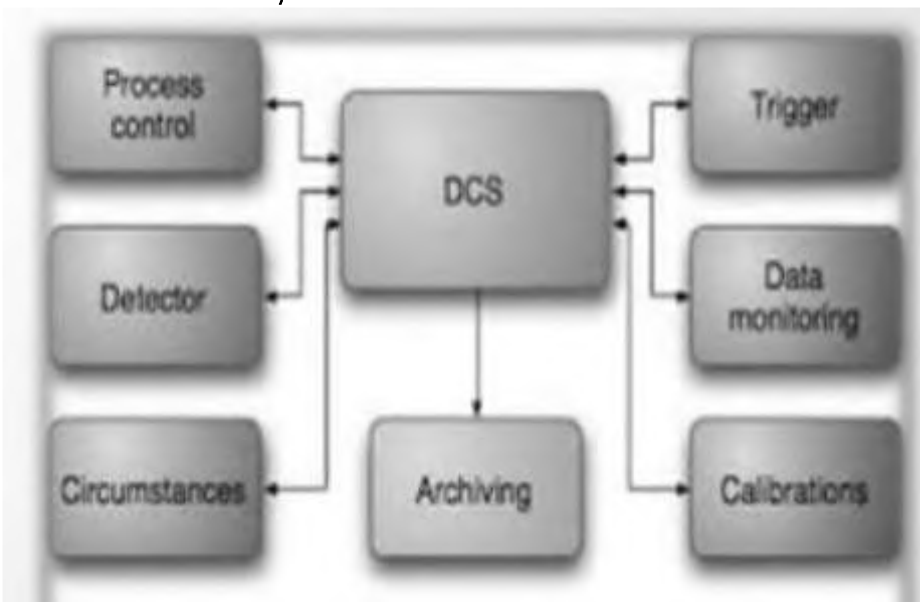
**Primary Devices of Process Control System**:

Programmable Logic Control

Traditional PLC Control



Distributed Control System



# UNIT - 4

## EQUIPMENT EMPLOYED IN INDUSTRIAL PROCESSES

Plant and machinery in any Industrial Process can be broadly classified in following categories:-

(a) Process equipment depending on process involved.

(b) Utility equipment

| Type of utility services | | Broad category of equipment required |
|---|---|---|
| • Electricity | : | Electrical Installations such as transformers, control panels, circuit breakers, DG set, etc. |
| • Steam | : | Boilers, economizers, superheaters, etc. |
| • Water | : | Humidification plant, water reservoir, water supply distribution, ejector system, etc. |
| • Air | : | Air compressors, air dryers, etc. |
| • Cooling: | | Refrigeration compressors, air conditioners, condensers, receivers, etc. |
| • Fire protection | : | Diesel engine pump, jockey pump, water reservoir, fire extinguishers, etc. |
| • Instrumentation | : | Level controllers, flow meters, chemical analyzer, etc. |
| • Effluent Treatment | : | Aerators, tanks, clarifiers, flocculators, pumps, etc. |

It is worth while to mention that though utility services fall broadly under above categories for all the industrial processes; but equipment required within a service differ from plant to plant or say process to process as these are custom built as per client's requirement.

The subject of Industrial Processes is divided into two parts:

- Industrial Processes-I and
- Industrial Processes- II.

Industrial Processes - I covers following :

(a) Topics covered in Unit 1 to 3 (above).

(b) Equipment used for each of above utility services in an industrial plant with technical specifications to give an idea about type of equipment.

(c) The same utility services in different industrial processes employ equipment with quite different technical specifications used in utility services; in order to show this a comparison is made for two industries employing Boilers and ETP and same is covered in Industrial processes - I.

(d) Flow-diagram with brief description of process involved and technical specifications of equipment of following industrial processes :
    - Textile spinning mill
    - Dairy
        - Ice cream
        - Industrial Milk Processing
    - Solvent Extraction and Vegetable Oil Plants

(**Note: <u>Utility equipment are covered only under Industrial Processes – I)</u>**

# UNIT - 5

## UTILITY EQUIPMENT

### INTRODUCTION

Every industrial process have utility services depending upon process involved out of following :-

- Electricity
- Steam
- Water
- Air
- Cooling
- Fire Protection
- Instrumentation
- Effluent Treatment

The study of utility services is essential for student of plant and machinery valuation.

**Note :** The information on technical specifications and other details of utility equipment given herein after pertains to a specific industry. This is to be taken as guidance; because the technical specifications of same equipment vary from industry to industry.

## I. ELECTRICAL INSTALLATIONS

### 1. 2 pole structure

Consisting of

- 11 kV Four Pole structure made out of ISMB pole 250 x 150 mm, M.S. channel 150 x 75 mm, M.S. angles, Red oxide primer and two coats of aluminium painting of the structural members, Concrete foundations (1:2:4) with muffling of 600 x 600 mm and 300 mm h, with clamps 50 x 50 M.S. flat with 11 kV pin insulators – 6 nos. and ACSR conductor (DOG).

- 11 kV GOD with earth switch combination, 200 A suitable for vertical, single break mounting with operating handle and mechanical interlock and 11 kV DO unit with DO fuse.

- 11 kV distribution class lightening arrestors.

- Switchyard gate made out of 40 mm dia. G.I. pipe 1 ½" square 8 SWG GI wire mesh and two leaves gate with clear width of 2500 mm

- 8 SWG GI wire 1 ½" mesh chain link fencing of 2.4 mtr. height with 50 x 50 x 6 M.S. angle at every 2 mtr in interval and 50 x 50 x 6 angle at top. The fencing duly painted 2 coat of red oxide primer with aluminium paint.

- Supply and spreading of gravel 40 mm size, 100 mm thick with due leveling of the switchyard – 8.5 CM

- Stay wire with porcelain, clamps and foundation – 2 nos.

- 3 x 150 sq. mm. XLPE, 11 kV (E) Al conductor armoured cable – 50 mtr

- Outdoor heat shrinkable joint termination for 3 x 150 sq. mm. XLPE, 11 kV Al conductor armoured cable – 1 no.

- Indoor heat shrinkable joint termination for 3 x 150 sq. mm. XLPE, 11 kV Al conductor armoured cable – 5 nos.

**2. Transformer**

| | | |
|---|---|---|
| Rating | : | 1500 kVA |
| Voltage | : | 11 / 0.415 kV |
| Type | : | Oil cooled copper wound |
| Winding connection | : | Delta / Star |
| Vector group | : | Dyn 11 |
| Tap changer | : | On load tap changer<br>+ 10% to – 15% in steps of<br>1.56% |
| Cooling | : | ONAN |

**3. Switchgear**

**a. HT Switchgear**

11 kV, 630 A, Vacuum Circuit Breaker panel

Vacuum circuit breaker

11 kV indoor, 350 m VA, 630 A, Crompton make single panel.

Totally enclosed; single bus-bar; floor-mounting; metal-clad; indoor; extensible type; flush-fronted; horizontal draw-out; horizontal/vertical isolation type. Suitable for voltage (in kV), fault level (in mVA) and rating (in Amps), all three mentioned above, for use on above voltage, 3 phase, 3 wire, 50 Hz, effectively earthed system.

CVSRTA

**b. LT Switchgear**

**LT panels** :

- **Main power distribution board** – 1 no.

- **(Motor Control Centre -1) M.C.C. – 1** - 1 no.

  Comprising of

  - **Incomer of 630 A FSU**
    Control transformer – 1 kVA for 110 V AC control supply

  - **Outgoing feeders:**
    Star/Delta – 45 kW KC-31 1, 2 and 3
    FSUs 63 A – Compressor and Bock compressor 1 and 2
    DOL starter – 5.5 kW CT pump, 2 kW CT condenser fan 1 and 2
    1.5 kW CT pumps 1, 2 and 3, - evaporators 1, 2, 3 and 4 – CT fan 1 and 2 – Fn 1 and 2
    1 kW evaporator 1 and 2
    0.18 kW – CT fan 1 and 2

- **M.C.C. – 2 - 1 no.**

  Comprising of -

  - **Incomer of 630 A FSU**
    Control transformer – 1 kVA for 110 V AC control supply

  - **Outgoing feeders:**
    Star/Delta – 55 kW KC-51 1, 2 and 3
    DOL starter – 5.5 kW condenser pump 1 and 2
    3.7 kW Frick condenser 1 and 2 and condenser pump
    1.5 kW Frick condenser fan
    1.0 kW Frick condenser fan 1 and 2
    0.75 kW condenser fan No.2 /1 and 2
    0.41 kW Condenser fan No.1 / 1, 2, 3 and 4
    1.2 kW – 22 nos. axial / condenser fans and evaporators

- **M.C.C. – 3 - 1 no.**

  Comprising of –

  - **Incomer of 630 A FSU**
    Control transformer – 1 kVA for 110 V AC control supply

  - **Outgoing feeders:**
    Star/Delta – 75 kW – Compressor KC-06/2, KC 51
    Star/Delta – 55 kW KC-06/1
    DOL starter – 5.5 kW CW circular pump 1 and 2
    3.7 kW Brine circular pump, agitator
    3 kW – CW agitator 1 and 2
    2.3 and 2 kW – Chilling pump, CT pump and CW air pump – 1, 2 and 3
    1.5 kW – Frick condenser pump / fan 3 nos., CT mono and fan
    1.2 kW – Frick condenser fan
    0.75 kW – Condenser fan no.2 / 1 and 2
    0.41 kW – Frick condenser fan no. 2, 3 and 4
    1.2 kW – 22 nos. axial / condenser fans and evaporators
    FSUs 200 A / 100 A – CS 2, 3, Pallet cooling

- **Production M.C.C. – 1 no.**

  Comprising of -

  - **Incomer of 630 A FSU**
    Control transformer – 0.5 kVA for 110 V AC control supply

  - **Outgoing feeders:**
    FSUs 125 A – Straight line and power sockets
    FSUs 100 A – HT Fut and 2 spare
    FSUs 63 A – 14 nos. Cre Frez, cata, RT machine etc.
    FSUs 32 A – 8 nos. cut ext, bkm filling and spare

- **Utility M.C.C. – 1 no.**

  Comprising of –

  - **Incomer of 630 A FSU**
    Control transformer – 1 kVA for 110 V AC control supply

  - **Outgoing feeders:**
    FSUs 250 A – ETP
    FSUs 100 A – 2 spare
    FSUs 63 A – 3 nos. boilers
    DOL starter – 21 kW – Air compressor 1, 2 and 3
    15 kW – 2 nos. spare
    5.5 kW – 2 nos. DB blowers
    3.7 kW – 6 nos. RW / Chlo. Water pump and spare
    2.2 kW – 3 nos. water soft pups
    1.5 kW – HSD transfer pump
    0.75 kW – HSD transfer pump

- **Mix Plant M.C.C. – 1 no.**

  Comprising of –

  - **Incomer of 400 A FSU**
    Control transformer – 1 kVA for 110 V AC control supply
  - **Outgoing feeders:**
    Star/Delta – 22.5 kW - homgn
    Star/Delta – 15 kW – 2 nos. spare
    Star/Delta – 12.5 kW - homgn
    DOL starter – up to 5.6 kW – 5 nos. HS mixing and spare
    5.5 kW – 1 no. PHE cooling
    3.7 kW (up to) – 5 nos. Sauce RW, PHE cool and spare
    2.3 kW – 2 nos. hist pumps
    2.2 kW – 10 nos. phe transfer, mix transfer etc.
    1.5 kW – 17 nos. Aging VATS
    1.2 / 1.1 kW – 4 nos. CT blo, mix room and HW pump
    0.8 / 0.75 kW – 5 nos. Kulfi, CaCl etc.

- **M.L.D.B. – 1 no.**

  Comprising of –

  - **Incomer of 250 A FSU**

  - **Outgoing feeders:**
    FSUs 63 A – 12 nos. for different lighting DBs.

- **2500 A L.T. Busduct – 10 mtr complete with**

| | | |
|---|---|---|
| Straight run | : | 9.6 mtr |
| Right angle bend | : | 4 nos. |
| Wall frame assembly | : | 1 no. |
| TPN Al. Flex | : | 1 no. |
| TPN Cu. Flex | : | 1 no. |

Transformer panel with copper bus bars 0.6 m length.

CVSRTA

**4. Cables**

Supply, installation, testing and commissioning of the following :

L.T. Cables
PVC insulated, PVC sheathed, armoured, 1100 V grade power and control cables laid in trays, trenches, buried in ground.

Consisting of -

- 3.5 x 300 sq. mm. AYFY : 250 mtr
- 3.5 x 185 sq. mm. AYFY : 400 mtr
- 3.5 x 150 sq. mm. AYFY : 800 mtr
- 3.5 x 50 sq. mm. AYFY : 250 mtr
- 3 x 35 sq. mm. AYFY : 450 mtr
- 4 x 16 sq. mm. AYFY : 1300 mtr
- 4 x 4 sq. mm. YWY Copper : 450 mtr
- 4 x 6 sq. mm. YWY Copper : 250 mtr
- 3 x 6 sq. mm. YWY Copper : 350 mtr
- 3 x 4 sq. mm. YWY Copper : 650 mtr
- 4 x 2.5 sq. mm. YWY Copper : 350 mtr
- 3 x 2.5 sq. mm. YWY Copper : 3,600 mtr
- 4 x 1.5 sq. mm. YWY Copper : 3,700 mtr

**5. Cable terminations**

LT cable termination

Termination of PVC insulated, PVC sheathed, 650 / 1100 V grade, armoured cable including stripping of cable insulation.

Consisting of -

- 3.5 x 300 sq. mm. AYFY : 9 nos.
- 3.5 x 185 sq. mm. AYFY : 16 nos.
- 3.5 x 150 sq. mm. AYFY : 36 nos.
- 3.5 x 50 sq. mm. AYFY : 5 nos.
- 3 x 35 sq. mm. AYFY : 9 nos.
- 4 x 16 sq. mm. AYFY : 48 nos.
- 4 x 4 sq. mm. YWY Copper : 28 nos.
- 4 x 6 sq. mm. YWY Copper : 7 nos.
- 3 x 6 sq. mm. YWY Copper : 17 nos.
- 3 x 4 sq. mm. YWY Copper : 54 nos.
- 4 x 2.5 sq. mm. YWY Copper : 12 nos.
- 3 x 2.5 sq. mm. YWY Copper : 270 nos.
- 4 x 1.5 sq. mm. YWY Copper : 274 nos.

**6. Lighting**

Industrial dust proof type lighting panels (Degree of protection IP 42)

**Plant – 1**

Consisting of -

- Lighting panel with 63 A TPN.MCB and 3 nos. DP 63 A, 30 mA ELCB shall be incomer and 24 nos. 20A SP MCB's as outgoing. The board is suitable for incoming cable of 4 x 16 sq. mm. AYFY conduit 2 x 2.5 sq. mm. YWY cables on outgoing side – 12 nos.

- Street lighting panel with 63 A TPN-MCB as incomer, 70A contactor, auto manual switch, ON/OFF P.B., indicating lamp, 24 hour timer and 4 nos. 32A 4P30mA – ELMCB as outgoing

- 3/4" dia. M.S. black stove enameled conduit with 3 runs of 2.5 sq. mm. stranded copper conductor PVC wires from MCB DB to Lighting control switch box – 300 mtr

- Light points by using ¾” dia. M.S. black stove enameled conduit and 3 runs of 2.5 sq. mm. Stranded copper conductor PVC wires –260 nos.

- 1” dia. M.S. black stove enameled conduit and 2 runs of 4 sq. mm. + 1 run of 2.5 stranded – 250 mtr

- 5 / 15A socket outlet with surface type switchbox – 30 nos.

- 1 phase – 3 pin – 20-A-metal clad plug socket with 25 Amp, 30mA, DP ELCB in metal enclosure – 50 nos.

- 3 phase, 440 volts, 30 Amp – 5 pin plug sockets with 32 Amp – 30mA, 4P-EL MCB – 6 nos.

**7. Street lights**

Steel tubular pole IS 2713, class B, M.S. pole duly painted with 2 coats of red oxide primer and 2 coats of aluminium paint. 50 mm dia. GI pipes for cable entry, weatherproof type cast iron junction box with 2 nos. earthing terminal receiving 4 x 16 sq. mm. AYFY cable (2 nos.) and 3 nos. 2.5 sq. mm. stranded copper flexible wires (minimum size 200 mm x 115 mm x 115 mm) with necessary MCB protection, Elmex terminals. Type SP 30 height above ground. 7.5 M size 139.7 x 5.4, 114.3 x 4.5, 88.9 x 3.25 mm dia. (Single bracket) – 10 nos.

**8. Earthing**

- Earth pit 40 m dia., 3 m long, class B GI pipe buried in earth pit with charcoal and salt each in alternative layers including excavation re-filling etc. with CI legend identification marker – 25 nos.

- GI earth conductor of following sizes to be laid in cable trays in ground including jointing by welding, connecting to equipment, painting to welded portion by black bitumen paint.

a. 50 x 6 mm GI strip : 850 mtr
b. 25 x 6 mm GI strip : 350 mtr
c. 25 x 3 mm GI strip : 350 mtr
d. 8 SWG GI : 150 mtr
e. 12 SWG GI : 200 mtr
f. 14 SWG GI wire : 250 mtr
g. Test link box : 10 nos.

**9. Cable tray**

2 mm thick perforated / ladder type GI cable tray with coupler plate and hardware of following sizes:

- 50 mm wide x 25 mm height x 2 mm thick perforated – 15 mtr
- 100 mm wide x 25 mm height x 2 mm thick perforated – 15 mtr
- 150 mm wide x 25 mm height x 2 mm thick perforated – 160 mtr
- 300 mm wide ladder type with 75 x 20 mm side channel and 50 x 20 mm rungs tx 2 mm thick – 250 mtr
- 450 mm wide ladder type with 75 x 20 mm side channel and 50 x 20 mm rungs tx 2 mm thick – 150 mtr
- 600 mm wide ladder type with 75 x 20 mm side channel and 50 x 20 mm rungs tx 2.5 mm thick – 250 mtr

**10. Lighting fixtures**

Installation of following lighting fixtures:

- 2 x 36 W mirror opting lighting fixtures – 200 nos.
- 150 W HPSV – street light type lighting fixtures – 12 nos.
- Post stop Lantern – 125 – W – HPMV – 3 nos.
- 11 W – CFL – Fittings – 12 nos.
- 1200 mm sweep ceiling fans - 12 nos.

CVSRTA

## 11. Light fittings

- 46 nos.
  Luminaire : WSS24071
  LP : 2600

  46 nos.
  Luminaire : WLS 701

- 143 nos.
  Luminaire : WIF 42236 SGW
  276 nos.
  Luminaire : L 36/11

- 113 nos.
  Luminaire : WIF 52236 SGW

  209 nos.
  Luminaire : L 36/11

- 78 nos.
  Luminaire : WCF 81236 SGW
  LP : 2475

  172 nos.
  Luminaire : L 36/11

- 3 nos.
  Luminaire : WRF 25118
  LP : 450

  3 nos.
  Luminaire : L 18/11

- 91 nos.
  Luminaire : WCF 26236 SGW
  LP : 1875

  188 nos.
  Luminaire : L 36/11

- 43 nos.
  Luminaire : WHM 91125 NISL

  43 nos.
  Luminaire : WLM 125
  43 nos.
  Luminaire : WGM 16125
  LP : 1650

**II. <u>WATER</u>**

**(a) Purified water plant**

**NaOCI dosing system**

- Raw water storage tank
  No. of units : One
  Capacity : 1000 litres
  M.O.C. : HDPE

- Raw water pump
  No. of unit : One
  Type : Centrifugal monobloc
  Capacity : 1.25 $m^3$/hr
  Head : 30 m WC
  M.O.C. : S.S. 304
  Make : Grundfos, Denmark

- Multigrade filter

  No. of unit : One

  Type of unit : Vertical down flow

  Mode of operation : Manual

  Maximum flow rate : 1.25 $m^3$/hr

  Filter media : Graded sand

  Time required for backwash : 5 – 7 minutes

  Pressure vessel diameter: 257 mm

  Height on straight : 928 mm

  Material of construction : FRP

  Valve type : Manual Diaphragm valve

  M.O.C. of valve : U-PVC

**Ultrafiltration system**

- Ultrafiltration membranes with housing
  No. of units : One
  Mode of operation : Automatic
  Type : Hollow fiber
  Permeate flow rate : 1.12 $m^3$/hr
  M.O.C. : Poly sulphone
  Make : Koch, U.S.A.

- UF fast flush pump
  No. of unit : One
  Type : Horizontal centrifugal
  Capacity : 5.5 $m^3$/hr
  Head : 15 m
  M.O.C. : S.S. 316 – Wettable parts
  Make : Grundfos

- UF backflush pump
  No. of unit : One
  Type : Horizontal centrifugal
  Capacity : 1.8 $m^3$/hr
  Head : 15 m
  M.O.C. : S.S. 304 – Wettable parts
  Make : Grundfos

- UF Premate / DM feed water storage tank
  No. of units : One
  Capacity : 500 litres
  M.O.C. : HDPE

**Demineralisation plant**

- DM water feed pump
  No. of unit : One
  Type : Horizontal centrifugal
  Capacity : 1.12 $m^3$/hr
  Head : 30 m WC
  M.O.C. : S.S. 316
  Make : Grundfos, Denmark

- SMBS dosing system
  No. of dosing pump : One
  Type : Positive displacement pump
  Body : Polypropylene
  Flow range : 1.2 – 6 lph
  Power supply : 1 $\varphi$, 230 V, 50 Hz

  Dosing tank
  No. of unit : One
  Capacity : 50 litres
  M.O.C. : HDPE

- ORP analyzer
  No. of units : One
  Type : On-line
  Make : Fisher Rosemount

- Strong Acidic Cation exchanger
  No. of unit : One
  Type of unit : Up flow packed bed
  Mode of operation : Manual
  Maximum flow rate : 1.12 $m^3$/hr
  Vessel diameter : 305 mm
  Height on straight : 990 mm
  Material of construction : FRP

Valve type : Diaphragm
M.O.C. of valve : U-PVC
Type of resin : Strong Acidic Cation
Make of resin : LANXESS, Germany
Resin quantity : 75 litres
Regenerant (HCl) : 4.12 kgs (100%)

- Regenerant tank for SAC
  Capacity : 50 litres
  M.O.C. : HDPE

- Strong base anion exchanger
  No. of unit : One
  Type of operation : Up flow packed bed
  Mode of operation : Manual
  Maximum flow rate : 1.12 $m^3$/hr
  Vessel dia. : 335 mm
  Height on straight : 1111 mm
  M.O.C. : FRP
  Valve type : U-PVC
  Make of valve : George Fischer
  Make of resin : LANXESS, Germany
  Resin quantity : 100 litres
  Regenerant (NaOH) : 4 kgs (100%)

- Regenerant tank for SBA
  Capacity : 50 litres
  M.O.C. : HDPE

- Conductivity meter
  No. of unit : One
  Type : On-line
  Location : Outlet of SBA unit
  Range : 0 – 100 μs/cm
  Make : Megh

- Mixed bed unit
  No. of unit : One
  Mode of operation : Manual
  Type : Vertical down flow
  Maximum flow rate : 1.12 $m^3$/hr
  Vessel diameter : 200 mm
  Height on straight : 2000 mm
  M.O.C. : MSRL
  Valve type : Diaphragm
  M.O.C. : U-PVC
  Resin quantity
  Cation : 25 litres
  Anion : 25 litres
  Make of resin : LANXESS, Germany
  Internal coating of vessel : Internally rubber lined
  Rubber lining thickness : 3 mm
  External painting : Two coats of red oxide primer
  Regenerant (HCl) : 2.5 kgs (100%)
  Regenerant (NaOH) : 2.5 kgs (100%)

- Regenerant tank for Cation unit of MB
  No. of units : One
  Capacity : 50 litres
  M.O.C. : HDPE

- Regenerant tank for Anion unit of MB
  No. of units : One
  Capacity : 50 litres
  M.O.C. : HDPE

- Aquatech ultra-violet disinfection unit
  No. of unit : One
  Location : Outlet of MB
  Maximum flow rate : 1 $m^3$/hr
  Maximum operating pressure : 3.5 kg/$cm^2$
  Operating temperature : $30^0$C
  Make of UV source elements : Philips, Holland / Light Source, USA
  Inlet /Outlet pipe size : 1”
  Power requirement: 230 V, 39 W, 1 phase
  M.O.C.
    UV chambers : S.S. 316
    Control panel : Made of 16 gauge CRCA Epoxy Powder coated sheet

- Conductivity meter
  No. of units : One
  Range : 0 – 10 $\mu$s / cm
  Location : At outlet of MB units
  Make : Fischer Rosemount

- Flow Indicator-cum-Totalizer
  No. of unit : One
  Type : On-line
  Location : Outlet of mixed unit
  Make : Techtrol

- DM water storage tank
  No. of units : One
  Capacity : 500 litres
  M.O.C. : S.S. 316

- RO feed pump
  Type : Horizontal centrifugal
  Capacity : 1.12 $m^3$/hr
  Head : 20 m
  M.O.C. : S.S. 316 Wettable parts
  Power supply : 3 phase, 440 V, 50 Hz
  Make : Grundfos

- Micron porosity cartridge filter
  No. of unit : One
  Capacity : 1 $m^3$/hr
  Type : Cartridge filter
  Filter elements : 1 lot of spun bonded PP filter elements
  Housing : PP
  Make : Pall

**Reverse Osmosis System**

- R.O. high pressure pump
  Quantity : One
  Type : Vertical multistage
  Capacity : 2.37 $m^3$/hr
  Head : 8.06 bar
  M.O.C. : S.S. 316 wetted parts
  Make : Grundfos, Denmark

- Reverse osmosis membranes
  No. of elements : 1 lot
  Type : Hot water sanitizable membranes
  Membrane diameter : 4"

- Reverse osmosis pressure tube
  No. of units : 1 lot
  M.O.C. : S.S. 316

- Conductivity meter
  No. of units : One
  Make : Fischer Rosemount
  Range : 0 – 10 μs / cm
  Location : Outlet of RO

**Cleaning system for RO membranes (CIP system)**

- CIP pump
  No. of unit : One
  Type : Centrifugal Monobloc
  Capacity : 2.5 $m^3$/hr
  Head : 30 m
  M.O.C. : S.S. 316, Wettable parts
  Make : Grundfos, Denmark

- Cartridge filter
  No. of unit : One
  Capacity : 2.5 $m^3$/hr
  Type : Cartridge
  Filter elements : 1 lot of spun bonded PP elements
  Housing : S.S. 316

- CIP tank (steam jacket heating)
  Capacity : 50 litres
  M.O.C. : S.S. 316

**Purified water distribution system**

- Jacketed and insulated purified water storage tank
  No. of units : One
  Type : Vertical cylindrical with dish ends
  Make : Aquatech
  Capacity : 1 KL
  Diameter of vessel : 1000 mm
  Height of vessel: 1250 mm
  M.O.C. of vessel : S.S. 316 L
  M.O.C. of jacket : S.S. 304
  Cladding : S.S. 304 seal welded

- Hydrophobic vent filter
  Housing : S.S. 316 L electro-polished to 240 grit internally and externally 180 grit
  Cartridge : Jacketed with hydro-phobic cartridge
  Location : Above USP water tank

- Sanitary pressure transmitter for level monitoring
  Type : Sanitary DP transmitter
  Location : Bottom of USP water tank
  Make : Fisher Rosemount
  Tank nozzle M.O.C. : S.S. 316 L
  Measurement range : 0 – 2 bar
  Temperature range : 12 – 85$^0$C

- Product loop pump for recirculation
  Quantity : One
  Type : Sanitary type, centrifugal
  Flow rate : 3 $m^3$/hr
  Head : 40 meters
  Make : Alfa Laval

- Conductivity meter with auto dumping system
  No. of units : One
  Range : 0 – 10 μs / cm

  Make : Fisher Rosemount
  Location : At return line of loop

Manufactured by : Aquatech Industries (India) Private Ltd.

**(b) Ejector system complete with**

**(i) Water jet ejector system**

Capacity : 40 torr

- **Water tank**
  Type : Rectangular
  Capacity : 5000 litres
  M.O.C. : M.S.
  Dimensions :
  Length : 3500 mm
  Width : 1250 mm
  Height : 1260 mm

- **Centrifugal pump**
  Type : MEGA – G – 50 - 125
  Capacity : 60 $m^3$/hr
  Head : 20 m
  Serial no. : 0532915
  Drive : 7.5 hp, 2900 rpm, FLP motor of Crompton Greaves make
  Manufactured by : K.S.B. Pumps Ltd.

- **Centrifugal pump**
  Type : MEGA – G – 50 - 160
  Capacity : 55 $m^3$/hr
  Head : 30 m
  Serial no. : 0532916
  Drive : 10 hp, 2900 rpm, FLP motor of Crompton Greaves make
  Manufactured by : K.S.B. Pumps Ltd.

- **Centrifugal pump**
  Type : MEGA – G – 50 - 160
  Capacity : 55 $m^3$/hr
  Head : 30 m
  Serial no. : 0532911
  Drive : 10 hp, 2900 rpm, FLP motor of Crompton Greaves make
  Manufactured by : K.S.B. Pumps Ltd.

- **Centrifugal pump**
  Type : MEGA – G – 50 - 160
  Capacity : 70 $m^3$/hr
  Head : 32 m
  Serial no. : 0532926
  Drive : 12.5 hp, 2920 rpm, FLP motor of Crompton Greaves make
  Manufactured by : K.S.B. Pumps Ltd.

- **Centrifugal pump**
  Type : MEGA – G – 50 - 160
  Capacity : 55 $m^3$/hr
  Head : 32 m
  Serial no. : 0532917
  Drive : 10 hp, 2900 rpm, FLP motor of Crompton Greaves make
  Manufactured by : K.S.B. Pumps Ltd.

- **Water ring vacuum pump**

  Type : WR 28100 x 100

  Capacity : 250 $m^3$/hr

  Ultimate vacuum : 40 torr

  Eq. No. : 7-05-1700

  Drive : 15 hp, 1475 rpm, FLP motor of Crompton Greaves make

  Manufactured by : H.K. Industries.

- **Vacuum trap tanks – 6 nos.**

  Type : Vertical cylindrical with welded top and bottom torispherical ends.

  Capacity : 500 litres

  M.O.C. : M.S.

  Dimensions

  Dia. : 800 mm

  Height : 1350 mm

**(ii) Steam jet ejector system**

Capacity : 1 torr

- **Water tank**

  Type : Rectangular

  Capacity : 5000 litres

  M.O.C. : PP/FRP

  Dimensions :

  Length : 2850 mm

  Width : 1280 mm

  Height : 1280 mm

- **Centrifugal pump**

  Model : PPCL – 100 - CT

  Capacity : 30 $m^3$/hr

  Head : 35 m

  Serial no. : 0508 PP75 0942

  Drive : 15 hp, 2930 rpm, FLP motor of Crompton Greaves make

  Manufactured by : Antico

- **Centrifugal pump**

  Model : PPCL – 75 - CT

  Capacity : 30 $m^3$/hr

  Head : 35 m

  Serial no. : 0508 PP75 0943

  Drive : 15 hp, 2930 rpm, FLP motor of Crompton Greaves make

  Manufactured by : Antico

- **Centrifugal pump**

  Model : PPCL – 100 - CT

  Capacity : 80 $m^3$/hr

  Head : 25 m

  Serial no. : 0508 PP100 945

  Drive : 15 hp, 1475 rpm, FLP motor of Crompton Greaves make

  Manufactured by : Antico

- **Vacuum trap tanks – 2 nos.**

  Type : Vertical cylindrical with welded top and bottom torispherical ends.

  Capacity : 500 litres

  M.O.C. : F.R.P.

  Dimensions

  Dia. : 800 mm

  Height : 1350 mm

  Supplier : H.K. Industries

## III. BOILERS

### (1) Steam Boiler

| | | |
|---|---|---|
| Type | : | Horizontal smoke tube-cum-water wall multi fuel boiler. |
| Model | : | Agroman-20 |
| Capacity | : | 2500 kg/hr (F & A $100^0$ C) |
| Operating pressure | : | 10.54 kg/$cm^2$g |
| Steam dryness fraction | : | 98% |
| Safety valve set pressure | : | 10.91 kg/$cm^2$g |
| Steam condition | : | 98% dryness fraction minimum |
| Fuel | : | Coal |
| Thermal efficiency | : | 75% $\pm$ 2 with HRU on NCV of fuel as per BS 845 Part-I |
| Flue gas temp. | : | Exit gas from III-pass 210-$240^0$ C<br>Exit gas from HRU 150-$170^0$ C |
| Fuel consumption | : | Coal @ 4500 Kcal/hr : 415 Kg/hr |

<u>Mechanical Data</u>

| | | |
|---|---|---|
| Boiler Tube size | : | |
| Water wall tubes | : | 63.5 mm OD |
| Water wall tube thickness | : | 3.66 mm |
| Smoke tube | : | 63.5 mm OD |
| Smoke tube thickness | : | 3.66 mm |
| Heat transfer area | : | 91 $m^2$ |

<u>M.O.C.</u>

| | | |
|---|---|---|
| Shell/tube plates | : | ASTM 515 / 516 Gr. 70 |
| Water wall tubes / smoke tubes | : | BS 3059 |
| Down corner, riser pipe / header | : | ASTM 106 |
| Stand pipe | : | ASTM 106 |
| Non-pressure part | : | IS 2062 |

Rotating Equipment

F.D. Fan

| | | |
|---|---|---|
| Type | : | Centrifugal direct drive |
| Quantity | : | One |
| Flow | : | 3500 $m^3$ per hour |
| Head | : | 100 mm wg |
| Speed | : | 2900 rpm |
| Motor | : | 3 HP (1.7 kW) |

I.D. Fan

| | | |
|---|---|---|
| Type | : | Centrifugal 'V' belt drive |
| Quantity | : | One |
| Flow | : | 8750 $m^3$ per hour |
| Head | : | 200 mm wg |
| Speed | : | 2900 rpm |
| Motor | : | 10 HP (7.5 kW) |

Feed Pumps

| | | |
|---|---|---|
| Type | : | Centrifugal multistage |
| Quantity | : | Two |
| Capacity | : | 2500 litres per hour |
| Head (pressure for wp of 10.54 $kg/cm^2g$) | : | 120 m |
| Speed | : | 2900 rpm |
| Motor | : | 5 HP (3.73 kW) |

Temperature Profile & Velocity Profile

Boiler

| | | |
|---|---|---|
| Inlet gas temperature of II pass tubes | : | 800 – 950$^{0}$ C |
| Velocity of gases in the II pass tubes | : | 16 to 18 m/s |
| Inlet gas temperature of III pass tubes | : | 300 – 350$^{0}$ C |
| Exit flue gas temperature of III pass tubes | : | 210 – 240$^{0}$ C |
| Velocity of gases in the III pass tubes | : | 16 to 18 m/s |

Heat Recovery Unit

| | | |
|---|---|---|
| Inlet flue gas temperature of HRU | : | 210 – 240$^{0}$ C |
| Velocity of gases in the tubes | : | 16 to 18 m/s |
| Exit flue gas temperature of HRU | : | 150 – 170$^{0}$ C |

Draft Losses

| | | |
|---|---|---|
| Furnace | : | 60 mm WGC |

**2. Water Softening Plant**

Softner

| | | |
|---|---|---|
| M.O.C. | : | M.S.R.L. |
| Diameter / thickness | : | 500 mm |
| Height | : | 800 mm |
| Average treated flow | : | 3 $m^3$ per hour |
| Maximum treated flow | : | 4 $m^3$ per hour |
| Maximum working pressure | : | 4 kg / $cm^2$ |

Minimum working pressure : 2.5 kg / $cm^2$
Average operating pressure : 3.0 kg / $cm^2$

| | | |
|---|---|---|
| Resin quantity | : | 150 litres |
| Inlet hardness | : | 125 ppm |
| Outlet hardness | : | 5 ppm |
| | | |
| Pressure drop across the system | : | 0.7 kg / $cm^2$ |
| Salt quantity for regeneration | : | 23 kg |
| Inlet / Outlet size | : | 25 / 25 |

<u>Salt / Saturator</u>

| | | |
|---|---|---|
| Diameter | : | 450 mm |
| M.O.C. | : | H.D.P.E. |
| Depth | : | 700 mm |

<u>Output between two regeneration</u> : 72 hours

<u>Regeneration cycle Time</u> : 2 hours

<u>Instrumentation</u>

Rotameter

| | | |
|---|---|---|
| No. of unit | : | One |
| Type | : | On line |
| Range | : | 500 – 5000 LPH |
| Location | : | Before inlet of filter unit |

Water meter

| | | |
|---|---|---|
| No. of unit | : | One |
| Type | : | On line |
| Location | : | Before inlet of filter unit |

Resin trap

| | | |
|---|---|---|
| No. of unit | : | One |
| Location | : | Outlet of softner unit |
| M.O.C. | : | S.S. 316 |

**3.** **Feed Tank**

| | | |
|---|---|---|
| Capacity | : | 10,000 litres |
| M.O.C. | : | M.S. |

**4.** **Chimney**

| | | |
|---|---|---|
| Type | : | Cylindrical, vertical with conical flare at bottom |
| Overall size | : | 450 mm ID x 30000 mm long |
| Thickness | : | 8 mm to 14 mm |

<u>Top end</u>

| | | |
|---|---|---|
| Type | : | Cylindrical shell |
| Size | : | 450 mm ID x 10000 mm long |
| M.O.C. | : | M.S. |

<u>Bottom end</u>

| | | |
|---|---|---|
| Type | : | Flare |
| Size | : | 2000 mm ID x 20000 mm ht. |
| M.O.C. | : | M.S. |

IV. HUMIDIFICATION PLANTS

In many industrial process (like textile) it is essential to maintain humidity in the room to a certain pre-requisite level. The humidity in the atmosphere varies with season. During & pre-monsoon season have maximum humidity (It can be even 100% when it is raining). Winter will have minimum humidity. For maintaining the Relative Humidity (RH) and temperature of air in some of the processes, the humidification plants are installed. The humidification plants senses the humidity in the room, and then either adds or removes humidity from the air and then this controlled air is blown in to the room. The humidity can be increased by spraying fine particles of water and can be reduced by either heating the air OR by lowering the temperature of the air. By reducing the temperature, the water vapour gets condensed and can be removed easily. The air with controlled humidy is blown it to the process area and the air from the room is sucked back through return air duct.

Given under is the technical details of the humidification plants deployed in one of the textile unit. The quantity of the plant is also mentioned, so that the students can visualize as to how many units can be used in a single textile mill. It is once again to remind that the details given under is for a typical plant. Size, quantity and specification may differ from plant to plant depending on the nature of use. :

| Sr. No. | Number of Plants | Details of Humidification Plant |
|---|---|---|
| 1. | 5 | Marshall Plant each 27000 CFM capacity with one supply air fan and supply air return Air ducts, Fan Motor 10 HP Crompton Parkinson. Motor for water spray – 7.5 HP Kirloskar make. Location of fan – side. |
| 2. | 1 | Vertical Marshall Plant Fan & Motor same as above. Motor for Water spray – 5 HP. Location of fan Building top. |
| 3. | 2 | C. Doctor make. Capacity : 1,00,000 CFM each comprising two supply air fans (20 HP), two return air fans (40,000 CFM, 12.5 HP), one Kirloskar make water pump (35 liters/sec. 20 HP) and ducting per plant. |
| 4. | 2 | C. Doctor make. Capacity : 75,000 CFM each comprising of two supply air fans (15 HP), one return air fan (60,000 CFM, 20 HP) and one water pump (20 HP) and ducting per plant. |
| 5. | 2 | C. Doctor make. Capacity : 1,05,000 CFM each comprising of two supply air fans (20 HP), two return air fans (84,000 CFM, 15 HP) and one water Pump (35 liters/sec., 20 HP) and ducting per plant. |
| 6. | 78 | Bahnson Humidifiers – C. Docotor make, L type unit 3/4 HP, 2200 CFM, 9 Gal/hr. water evaporation per fan. |
| 7 | 2 | Crompton Water Pumps for all above fans. Kirloskar make. Type PSM-1 63 GPM at 180’, 10 HP Motor. |

Given under is the details of another textile unit . This is given to visualize as to how the machinery can differ from one unit to another.

| | | |
|---|---|---|
| 1 | 2 | HD-4 fan. Capacity – 1200 RFM Motor – 5.75 HP. No separate water pump. |
| 2 | 2 | Bahnson Fan. 2200 CFM Capacity. Motor – ¾ HP |
| 3. | 4 | Marshalling Plant each 2700 CFM capacity with one supply air fan (10 HP) and no return air fan and one water pump (60 GPH, 5HP) per plant with one stand by pump motor (20 HP) common for all four plants. |
| 4 | 4 | SF humidification plant each 5800 M3/hr capacity with two supply air fans (10 HP) and no return air fan and two water pumps (650 liters/min., 7.5 HP) per unit. |
| 5 | 30 | Bahnson fans – 2200 CFM capacity Motor ¾ HP. |
| 6 | 2 | (a) Fan capacity 4200 CFM each with one supply air fan (10 HP) and no return air fan and one water pump (12.5 HP) per unit. |
| 7 | | (b) HD-4 fan. Capacity – 1200 CFM each. Moor HP – 5.75, No water pump and no return air fan. |
| 8 | 1 | (a) Fan Motor HP – 35. Fan Motor HP – 15. Water Pump – 2 Nos. (12.5 HP) |
| 9 | 12 | (b) Bahnson fans. 2200 CFM Capacity. Motor – ¾ HP. |
| 10 | 145 | Bahnson fans same capacity as above with Beacon 2 nos. of water pump (12.5 HP) and one water pump (10 HP). |
| 11 | 6 | (a) Bahnson fans. |
| 12 | 1 | (b) Fan capacity – 4200 CFM. Fan Motor HP – 10. Water Pump – 12.5 HP. |

## V. WATER SUPPLY, DISTRIBUTION AND PURIFICATION PLANTS

Water is essential for life. It can be human life or industry's life. There are many industrial processes, like chemicals or textiles, which need lots of water. The water can be obtained from various sources like Municipal authority, from river or canals or from bore well.

The raw water taken from the source can be used fro some purpose like in humidification plant etc., but for industrial and drinking use, the same is processed first. The processing of water includes filtration to remove solid / suspended impurities. The water after filtration can be used fro drinking purpose. (Some times Chlorine may be added to this water). When water is to be used for generating steam in boilers, the same is treated by softening plant. The water softening plants are used to remove dissolved impurities (like salts) from the water. If we use untreated water in the boiler, the tubes can get choked.

Entire water distribution system consists of raw water pumps, intermediate storage tanks (or sumps), filters, softening plants, pumps at various stages for pumping water from one place to another, final storage tank and of course the piping network for supply of water.

Given under is the details of water supply distribution system of a processing house.

### 1.0 Source of water supply is as under :

(A) From Municipal authority through 6" pipe line.

(B) Canal water from water irrigation department through two pumps located in the factory area, details of which are as under:

Make – Mather & Platt
Motor – 30 HP/27 HP
Size – 10" x 8"/11" x 9".

(C) From Tube well/bore well installed in the mill area.

Water is collected and stored in a tank of 65,100 cu. ft. area. From this tank water is also supplied to caustic recovery plant installed in one of the Unit through two pumps. The details of which are as under:

Make – Everest/Worthington Simpson
HP – 20/12.5
Size – 5" x 4"/4" x 4"
Water is fed from this water tank to the overhead tank for drinking through Mather & Platt make, 30 HP, Size 5" x4" pump.

Water is also supplied from this tank for humidification plants, fire protection and other services where water equipment exists.

Raw water is fed to reaction tank (23'x23'x17'-6") from Factory tank no.1 through pump (HP 12.5 size 4" x 3" capacity – 7000 GPH) Outlet of this reaction tank is connected to two gravity filters (each 7'-6" dia and 10' height). Soft water is collected from these gravity filters in the underground water tank from where it is fed to the boiler feed water tank (10'-6' x 8' – 3000 Gallons) and overhead MS tank (25' x 21' x 9' – 2955 Gallons) through two pumps details of which are as under:-

Make – Kirloskar
Size – 3" x 2½" / 4" x 3"
Motor – 10 HP / 7.5 HP
Capacity – 100 GPM / & 45 GPM

WATER PURIFICATION PLANTS

**(WATER SOFTNERS)**

Water purification plants consists of three water softening plants which are installed in Unit for supply of soft water to all the boilers. This soft water is supplied to feed water tank located in boilers house for further supply to boiler drum. Details of three softening plants are as under:

(a) Water Softener
Make – Candy Filters
Type – Base exchange
Capacity – 69 M3/Hr (15180 GPH)

Raw water is fed from Mill tank No.1 and tube well through pumps to water softener and soft water is collected from the outlet of the softener in the underground softened water well of 50’ dia. and 30’ deep. From this softened water well, soft water is pumped to overhead MS tank of capacity 24000 Gallons. The details of these pumps are as under:

Make – Kirloskar
Type – Centrifugal
Size – 6” – 4”
Capacity – 10000 GPH
Motor – 50 HP

(b) Water Softener
Make – Permutit Co. England
Type – Base exchange
Capacity – 2000 GPH

(c) Water Softener
Make – Candy Filters
Type – Lime Soda – Sodium Aluminate
Capacity – 14000 GPH

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## VI. AIR COMPRESSORS

1. Air dryer

| | | |
|---|---|---|
| Type | : | Heatless |
| Model | : | ECHL 10 |
| Capacity | : | 170 $Nm^3$ per hour |
| Working pressure | : | 150 psig |
| Test pressure | : | 250 psig |

2. Air Compressor

| | | |
|---|---|---|
| Type | : | Reciprocating |
| Model | : | 7 x 5 ESV 1 NL2 Package |
| Size | : | 7” x 5” |
| Speed | : | 750 rpm |
| Discharge pressure | : | 100 psig |
| Displacement | : | 165 cfm |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 22 kw |
| Speed | : | 1440 rpm |
| Make | : | Siemens |

<u>After cooler</u>

| | | |
|---|---|---|
| Type | : | Vertical after cooler with moisture separator |

<u>Air receiver tank</u>

| | | |
|---|---|---|
| Capacity | : | 0.54 $m^3$ |
| Serial no. | : | PE 1942 |

3. Process Air Tank

| | | |
|---|---|---|
| Type | : | Cylindrical, vertical with top and bottom dished ends |
| Capacity | : | 5,200 litres |

<u>Shell</u>

| | | |
|---|---|---|
| Size | : | 1600 mm ID x 2200 mm long |
| M.O.C. | : | M.S. |
| Thickness | : | 10 mm |

<u>Dished ends</u>

| | | |
|---|---|---|
| Type | : | 10% Torispherical |
| M.O.C. | : | M.S. |
| Thickness | : | 12 mm |

4. Instrument Air Tank

| | | |
|---|---|---|
| Type | : | Cylindrical, vertical with top and bottom dished ends |
| Capacity | : | 2,000 litres |

<u>Shell</u>

| | | |
|---|---|---|
| Size | : | 1200 mm ID x 1400 mm long |
| M.O.C. | : | M.S. |
| Thickness | : | 8 mm |

<u>Dished ends</u>

| | | |
|---|---|---|
| Type | : | 10% Torispherical |
| M.O.C. | : | M.S. |
| Thickness | : | 10 mm |

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## VII. REFRIGERATION

1. Brine Chilling Plant

| | | |
|---|---|---|
| Capacity | : | 75 TR |
| Make | : | Kirloskar Pneumatic |

<u>Compressor</u>

| | | |
|---|---|---|
| Model | : | KC-6 |
| Refrigerant | : | R717 |
| RPM | : | 750 |
| TR at selected RPM | : | 76.5 TR |
| Power consumed | : | 88.3 kw |
| Motor | : | 150 hp, 1488 rpm, Crompton Greaves make |

<u>Condenser</u>

| | | |
|---|---|---|
| Type | : | Shell and tube |
| M.O.C. | : | Shell : M.S. |
| | | Tube : BS 3059 ERW Steel |
| Condensing temp. | : | $40^0$ C |
| Cooling water inlet temperature | : | $32^0$ C |
| Cooling water outlet temperature | : | $36^0$ C |
| Cooling water pressure drop | : | 0.8 kg/cm$^2$ |
| Cooling water flow rate | : | 77 m$^3$ / hr (for condenser) |
| Area of heat transfer | : | a. Water side : 58.4 m$^2$ |
| | | b. Refrigerant side : 73 m$^2$ |
| Heat transfer (heat rejection ) rate | : | 244333 kcal per hour |
| Shell | : | 760 mm OD x 3048 mm long |
| No. of tubes | : | 240 |
| Tube | : | 31.75 mm OD x 3048 mm long |
| Tube thickness | : | 3.25 mm (10 gauge) |
| No. of passes | : | 8 |
| Make | : | Aircon |

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<u>Chiller</u>

| | | |
|---|---|---|
| Medium | : | 30% w/w MEG |
| Chilled brine flow rate | : | 48 $m^3$ per hour |
| Chilled brine pressure drop | : | 0.6 $kg/cm^2$ |
| Area of heat transfer | : | 1. Chilled brine side: 49.80 $m^2$ |
| | | 2. Refrigerant side : 63.25 $m^2$ |
| M.O.C. | : | 1. Tube : BS 3059 ERW Steel |
| | | 2. Baffles : M.S. |
| | | 3. Shell : M.S. |
| Evaporating temp. | : | (-) 13$^o$ C |
| L.M.T.D. | : | 7.2$^o$ C |
| Chilled brine inlet temp. | : | (-) 3$^0$ C |
| Chilled brine outlet temperature | : | (-) 8$^0$ C |
| No. of passes | : | 8 |
| Shell | : | 710 mm OD x 3048 mm long |
| Tube | : | 31.75 mm OD x 3048 mm long |
| Shell thickness | : | 10 mm |
| Tube thickness | : | 3.25 mm (10 gauge) |
| No. of tubes | : | 208 |
| Make | : | Aircon |

<u>Receiver</u>

| | | |
|---|---|---|
| M.O.C. | : | M.S. |
| Size | : | 610 mm dia. x 3000 mm long |
| Shell thickness | : | 10 mm |
| Dish thickness | : | 10 mm |
| Mounting | : | Horizontal |
| Make | : | Aircon |

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<u>Surge drum</u>

| | | |
|---|---|---|
| M.O.C. | : | M.S. |
| Size | : | 406 mm dia. x 1800 mm long |
| Shell thickness | : | 8 mm |
| Dish thickness | : | 8 mm |
| Mounting | : | Horizontal |
| Make | : | Aircon |

2. Brine Chilling Plant

| | | |
|---|---|---|
| Capacity | : | 75 TR |
| Make | : | Kirloskar Pneumatic |

<u>Compressor</u>

| | | |
|---|---|---|
| Model | : | KC-6 |
| Refrigerant | : | R717 |
| RPM | : | 750 |
| TR at selected RPM | : | 76.5 TR |
| Power consumed | : | 88.3 kw |
| Motor | : | 150 hp, 1488 rpm, Crompton Greaves make |

<u>Condenser</u>

| | | |
|---|---|---|
| Type | : | Shell and tube |
| M.O.C. | : | Shell : M.S.<br>Tube : BS 3059 ERW Steel |
| Condensing temp. | : | $40^0$ C |
| Cooling water inlet temperature | : | $32^0$ C |
| Cooling water outlet temperature | : | $36^0$ C |
| Cooling water pressure drop | : | 0.8 kg/cm$^2$ |
| Cooling water flow rate | : | 77 m$^3$ / hr (for condenser) |
| Area of heat transfer | : | a. Water side : 58.4 m$^2$<br>b. Refrigerant side : 73 m$^2$ |

| | | |
|---|---|---|
| Heat transfer (heat rejection) rate | : | 244333 kcal per hour |
| | | |
| Shell | : | 760 mm OD x 3048 mm long |
| No. of tubes | : | 240 |
| Tube | : | 31.75 mm OD x 3048 mm long |
| Tube thickness | : | 3.25 mm (10 gauge) |
| No. of passes | : | 8 |
| Make | : | Aircon |

<u>Chiller</u>

| | | |
|---|---|---|
| Medium | : | 30% w/w MEG |
| Chilled brine flow rate | : | 48 $m^3$ per hour |
| Chilled brine pressure drop | : | 0.6 $kg/cm^2$ |
| Area of heat transfer | : | 1. Chilled brine side: 49.80 $m^2$ |
| | | 2. Refrigerant side : 63.25 $m^2$ |
| M.O.C. | : | 1. Tube : BS 3059 ERW Steel |
| | | 2. Baffles : M.S. |
| | | 3. Shell : M.S. |
| Evaporating temp. | : | (-) $13^0$ C |
| L.M.T.D. | : | $7.2^0$ C |
| Chilled brine inlet temp. | : | (-) $3^0$ C |
| Chilled brine outlet temperature | : | (-) $8^0$ C |
| No. of passes | : | 8 |
| | | |
| Shell | : | 710 mm OD x 3048 mm long |
| Tube | : | 31.75 mm OD x 3048 mm long |
| Shell thickness | : | 10 mm |
| Tube thickness | : | 3.25 mm (10 gauge) |
| No. of tubes | : | 208 |
| Make | : | Aircon |

Receiver

| | | |
|---|---|---|
| M.O.C. | : | M.S. |
| Size | : | 610 mm dia. x 3000 mm long |
| Shell thickness | : | 10 mm |
| Dish thickness | : | 10 mm |
| Mounting | : | Horizontal |
| Make | : | Aircon |

Surge drum

| | | |
|---|---|---|
| M.O.C. | : | M.S. |
| Size | : | 406 mm dia. x 1800 mm long |
| Shell thickness | : | 8 mm |
| Dish thickness | : | 8 mm |
| Mounting | : | Horizontal |
| Make | : | Aircon |

3. Brine Circulation Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | CC 125 x 100 – 200 |
| Flow rate | : | 130 $m^3$ per hour |
| Head | : | 40 m |
| Size | : | 125 x 100 |
| Serial no. | : | 105266 – 02 |
| Make | : | Sulzer Pumps India Ltd. |

Motor

| | | |
|---|---|---|
| Capacity | : | 40 hp |
| Speed | : | 2940 rpm |
| Motor make | : | Hindustan |

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4. Brine Circulation Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | CC 125 x 100 – 200 |
| Flow rate | : | 130 $m^3$ per hour |
| Head | : | 40 m |
| Size | : | 125 x 100 |
| Serial no. | : | 105266 – 01 |
| Make | : | Sulzer Pumps India Ltd. |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 40 hp |
| Speed | : | 2940 rpm |
| Motor make | : | Hindustan |

5. Brine Circulation Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | CC 100 x 80 – 160 |
| Flow rate | : | 60 $m^3$ per hour |
| Head | : | 25 m |
| Size | : | 100 x 80 |
| Make | : | Sulzer Pumps India Ltd. |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 10 hp |
| Speed | : | 2910 rpm |
| Motor make | : | Hindustan |

6. Brine Circulation Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | CC 100 x 80 – 160 |
| Flow rate | : | 60 $m^3$ per hour |
| Head | : | 25 m |
| Size | : | 100 x 80 |
| Serial no. | : | 105265 – 02 |
| Make | : | Sulzer Pumps India Ltd. |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 10 hp |
| Speed | : | 2910 rpm |
| Motor make | : | Hindustan |

7. Brine Circulation Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | CC 100 x 80 – 160 |
| Flow rate | : | 60 $m^3$ per hour |
| Head | : | 25 m |
| Size | : | 100 x 80 |
| Serial no. | : | 105265 – 01 |
| Make | : | Sulzer Pumps India Ltd. |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 10 hp |
| Speed | : | 2910 rpm |
| Motor make | : | Hindustan |

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8. Brine Storage Tank

| | | |
|---|---|---|
| Type | : | Cylindrical, vertical with conical top and flat bottom |
| Capacity | : | 40,000 litres |

<u>Top end</u>

| | | |
|---|---|---|
| Type | : | Conical |
| Size | : | 3550 mm OD |
| M.O.C. | : | M.S. |
| Thickness | : | 5 mm |

<u>Bottom end</u>

| | | |
|---|---|---|
| Type | : | Flat |
| Size | : | 3650 mm OD |
| M.O.C. | : | M.S. |
| Thickness | : | 10 mm |

<u>Shell</u>

| | | |
|---|---|---|
| Size | : | 3500 mm ID x 4500 mm HT |
| M.O.C. | : | M.S. |
| Thickness | : | 8 mm |

## VIII. COOLING TOWER

1. Cooling Tower

| | | |
|---|---|---|
| Model | : | D8-8002 |
| Flow rate | : | 425 $m^3$/hr |
| Draft / Flow rate | : | Induced / Cross |
| Hot water temp. | : | $37^0$ C |
| Cold water temp. | : | $32^0$ C |
| Wet bulb temp. | : | $28^0$ C |
| Packing type/depth | : | Splash/1525 mm |
| Average heat load per 24 hours | : | 710 TR |
| Make | : | Techno |

<u>Mechanical equipment data</u>

| | | |
|---|---|---|
| Fan type | : | FRP |
| Quantity | : | 2 nos. |
| Model | : | P6-1900 |
| Capacity | : | 125000 $m^3$ per hour |
| Diameter | : | 1900 mm |
| Blades | : | 6 |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 10 hp |
| Speed | : | 960 rpm |
| Make | : | Techno |

<u>M.O.C.</u>

| | | |
|---|---|---|
| Frame | : | Wooden (treated) |
| Casing and Louvers | : | Asbestos cement sheet |
| Drift eliminators | : | Treated timber |
| Fill | : | Treated timer |
| Make | : | Techniq |

2. Cooling Water Transfer Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | UP 80/30 |
| Flow rate | : | 75 $m^3$ per hour |
| Head | : | 25 m |
| Size | : | 80 x 125 |
| Make | : | Kirloskar Bros. Ltd. |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 15 hp |
| Speed | : | 1455 rpm |
| Motor make | : | ABB |

3. Cooling Water Transfer Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | UP 80/30 |
| Flow rate | : | 75 $m^3$ per hour |
| Head | : | 25 m |
| Size | : | 80 x 125 |
| Serial no. | : | 1745204091 |
| Make | : | Kirloskar Bros. Ltd. |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 15 hp |
| Speed | : | 1455 rpm |
| Motor make | : | ABB |

4. Cooling Water Transfer Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | UP 80/30 |
| Flow rate | : | 75 $m^3$ per hour |
| Head | : | 25 m |
| Size | : | 80 x 125 |
| Serial no. | : | 1745204090 |
| Make | : | Kirloskar Bros. Ltd. |

Motor

| | | |
|---|---|---|
| Capacity | : | 15 hp |
| Speed | : | 1455 rpm |
| Motor make | : | ABB |

5. Cooling Water Circulation Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | UP 150/38 A |
| Flow rate | : | 225 $m^3$ per hour |
| Head | : | 40 m |
| Size | : | 150 x 200 |
| Serial no. | : | 1746004103 |
| Make | : | Kirloskar Bros. Ltd. |

Motor

| | | |
|---|---|---|
| Capacity | : | 75 hp |
| Speed | : | 1475 rpm |
| Motor make | : | Crompton Greaves |

6. Cooling Water Circulation Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | UP 150/38 A |
| Flow rate | : | 225 $m^3$ per hour |
| Head | : | 40 m |
| Size | : | 150 x 200 |
| Make | : | Kirloskar Bros. Ltd. |

Motor

| | | |
|---|---|---|
| Capacity | : | 75 hp |
| Speed | : | 1475 rpm |
| Motor make | : | Crompton Greaves |

7. Sand Filter

| | | |
|---|---|---|
| Supplied by | : | Seion International |

## IX. PIPING INSTALLATIONS

1. Ammonia valves and fittings for ammonia refrigeration system
   Consisting of -

- Expansion valves of required size and quantity
  Type : Expansion, flanged with set
  Temperature
  applications : Low temperature, - $50^0$ C

- Non-return valve of required size and quantity
  Type : Liquid, flanged with set
  Temperature
  applications : Low temperature, - $50^0$ C

- Ammonia line valves of required size and quantity
  Type : Globe
  Temperature
  applications : Low temperature, - $50^0$ C

- Solenoid valve with filter set (Castle) of required size and quantity
  Type : Flanged with set
  Temperature
  applications : High temperature

- Thermostatic expansion valve (Danfoss) of required size and quantity
  Type : Flanged with set
  Temperature
  applications : Range $-5^0$ to $-20^0$ C

- Back pressure regulating valve with CVP (Danfoss) of required size and quantity
  Type : Flanged with set
  Temperature
  applications : Range $-5^0$ to $-20^0$ C
  Make : Danfoss

2. Ammonia valves and fittings for ammonia refrigeration system

Consisting of -

- Electronic float switch of required size and quantity

| | | |
|---|---|---|
| Type | : | Threaded |
| Temperature applications | : | Low temperature, - $50^0$ C |
| Make | : | Sigma |

- Dual safety valve manifold of required size and quantity

| | | |
|---|---|---|
| Type | : | Threaded |
| Temperature applications | : | High temperature |
| Make | : | Superfreez |

Safety relief valve of required size and quantity

| | | |
|---|---|---|
| Type | : | Threaded |
| Temperature applications | : | Low temperature, - $50^0$ C |
| Make | : | Superfreez |

- Expansion valve of required size and quantity

| | | |
|---|---|---|
| Type | : | Expansion, flanged with set |
| Temperature applications | : | Low temperature, - $50^0$ C |
| Make | : | Super |

- Non-return valve of required size and quantity

| | | |
|---|---|---|
| Type | : | Gas, flanged with set and Liquid, flanged with set |
| Temperature applications | : | High temperature |
| Make | : | Super |

- Ammonia filter required size and quantity

| | | |
|---|---|---|
| Type | : | Flanged with set |
| Temperature applications | : | Low temperature, - $50^0$ C |
| | : | High temperature |
| Make | : | Superfreez |

- Ammonia flow indicator of required size and quantity

| | | |
|---|---|---|
| Type | : | Flanged with set |
| Temperature applications | : | High temperature |
| Make | : | Superfreez |

- Oil drain valve of required size and quantity

| | | |
|---|---|---|
| Type | : | Needle |
| Temperature applications | : | Range $–5^0$ to $–20^0$ C |
| | | High temperature |
| Make | : | Super |

- Solenoid valve with filter set (Castle) of required size and quantity

| | | |
|---|---|---|
| Type | : | Flanged with set |
| Temperature applications | : | High temperature |
| Make | : | Manik's |

3. Compressed air piping (S.S. 304 schedule 10 pipe) of required size and quantity
4. Compressed air piping (GI 'B' class pipe) of required size and quantity
5. Raw water piping (GI 'B' class pipe) of required size and quantity
6. Chlorinated water piping (GI 'B' class pipe) of required size and quantity
7. De-chlorinated water piping (GI 'B' class pipe) of required size and quantity
8. Soft water piping (GI 'B' class pipe) of required size and quantity
9. Chilled water piping (GI 'B' class pipe) of required size and quantity
10. Glycol piping (GI 'B' class pipe) of required size and quantity

11. Steam supply and distribution piping (M.S. seamless IBR A-106 pipe) of required size and quantity
12. Ammonia high temperature piping (M.S. seamless,106, Grade 'B' pipe) of required size and quantity
13. Ammonia low temperature piping (M.S. seamless, A-333, Grade 6LT pipe)
14. S.S. conduit pipe
15. S.S. square pipe
16. PUF insulation
17. Hot insulation
18. Insulation
19. M.S., G.I. and Steel (Low and High temperature) pipeline fittings
20. S.S. Dairy pipes – (1.6 mm thick)
21. S.S. Sch 5 pipe
22. S.S. Unions
23. S.S. Bend
24. S.S. – 2 way plug valve with SMS unions
25. S.S. – 3 way plug valve with SMS unions
26. S.S. – NRV with SMS unions
27. S.S. – B/F valve with SMS unions
28. S.S. 304 rectangular pipe –

    Type : High polished
29. S.S. 304 square pipe –

    Type : High polished
30. PUF pipe section – 50 mm thickness

    Temperature : High quantity – 30

    Low quantity – 60

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## X. FIRE FIGHTING EQUIPMENT

The system comprises of 9 ground hydrants, 3 monitors and 3 fire escape hydrants equivalent to 21 hydrants. (One monitor is considered equivalent to three hydrants). The mains have been laid underground and above ground over pedestals and over pipe racks carrying utility piping. The mains are M.S. heavy confirming to IS 1239 and have been provided wrapping and coating for the underground portion.

The system is fed by one no. 171 $m^3$ per hour diesel engine driven fire service pump. A jockey pump of 10.8 $m^3$ per hour has been provided to maintain the pressure in the system. Details of the pumps are as follows :

1. Main Pump with Engine with Control Panel

<u>Pump</u>

| | | |
|---|---|---|
| Type | : | CE 80/32 |
| Size | : | 80 x 125 |
| Capacity | : | 171 $m^3$ per hour |
| Head | : | 70 m |
| Pump no. | : | 18823040010 |
| Make | : | Kirloskar Brothers Ltd. |

<u>Engine</u>

| | | |
|---|---|---|
| Type | : | 4 RI 3467 |
| Rated hp | : | 94 |
| Speed | : | 2150 rpm |
| Make | : | Kirloskar Oil Engines Ltd. |

2. Jockey Pump

| | | |
|---|---|---|
| Type | : | Centrifugal |
| Model | : | CPHM – 25 – 26 A |
| Size | : | 25 x 50 |
| Capacity | : | 10.8 $m^3$ per hour |
| Head | : | 70 m |
| Serial no. | : | 1789304162 |
| Make | : | Kirloskar Brothers Ltd. |
| <u>Motor</u> | | |
| Capacity | : | 2 hp |
| Speed | : | 2900 rpm |

The pressure switch of the Jockey pump has been set in such a way that the pump will come into operation when the system pressure drops to 5.5 $kg/cm^2$ and will cut out when the pressure reaches 7 $kg/cm^2$. The pressure of the main pump has been set to operate the pump at 4.5 $kg/cm^2$. The stopping of the main pump is manual.

Pressure gauges have been provided on the delivery of the pump sets before non-return valves to indicate the pressure developed by the pump. One more pressure gauge has been provided near the pressure switches to indicate the system pressure. An air vessel has been provided to dampen the water hammers.

The pumps draw water from an above ground reservoir of 375 $m^3$ and the pumps work under flooded suction condition.

<u>Operation of the System</u>

The pressure in the system will be generally maintained at 7 $kg/cm^2$. In case of minor leakages if the pressure drops to 5.5 $kg/cm^2$ the Jockey pump will come into the operation. When the pressure in the system reaches 7 $kg/cm^2$ the pump will stop automatically.

In case any hydrant or monitor is opened the pressure will drop rapidly and the Jockey pump will not be able to maintain the pressure. When the pressure drops down to 4.5 kg/cm$^2$ the Diesel Engine driven pump will come into operation. This pump, however will have to be stopped manually after closing the hydrants or monitors opened.

<u>Fire extinguishers</u>

| | | | |
|---|---|---|---|
| 1. | Quantity | : | 36 nos. |
| | Type | : | $CO_2$ |
| | Capacity | : | 4.5 kgs. |
| 2. | Quantity | : | 29 nos. |
| | Type | : | D.C.P. |
| | Capacity | : | 5 kgs. |
| 3. | Quantity | : | 3 nos. |
| | Type | : | Mechanical foam |
| | Capacity | : | 9 litres |
| 4. | Quantity | : | 1 no. |
| | Type | : | Mechanical foam |
| | Capacity | : | 50 litres |

<u>Piping</u>

Underground hydrant system

| | | |
|---|---|---|
| Size | : | 200 NB |
| Under ground | : | 117.49 m |
| Size | : | 150 NB |
| Under ground | : | 489.21 m |
| Above ground | : | 36.53 m |
| Size | : | 125 NB |
| Under ground | : | 728.25 m |
| Above ground | : | 40.00 m |

| | | |
|---|---|---|
| Size | : | 100 NB |
| Under ground | : | 268.73 m |
| Above ground | : | 76.28 m |

| | | |
|---|---|---|
| Size | : | 80 NB |
| Under ground | : | 252.94 m |
| Above ground | : | 57.66 m |

## XI. INSTRUMETNATION

### Fundamentals of Process instrumentation

In a process industry, out of the other engineering fields, Instrumentation is one which contributes very high in the cost. Instrumentation is very costly and are of very divergent in nature. The technology in instrumentation changes very rapidly. An instrument procured today may become obsolete within couple of years.

Due to this reason, it is very important for a valuer to know little in-depth about instrumentation.

At the end of the chapter, an effort is made to track the changing technology in the instrumentation. This will help to decide the replacement cost.

### What is Instrumentation ?

- Instrumentation is art & science of measurement & control.
- It makes available the necessary process information (Indication/ Trending/ Status) at a predetermined destination in a pre determined form.
- It also controls the parameter within a specified limits / at specified value.
- Instrumentation provides a means to the plant operator to operate the plant safely, continuously & consistently with optimum productivity.
- It minimizes the human element in the plant operation.

**Instrumentation provides Handle for Monitoring**

- Health of the Process
- Health & Performance of Equipments
- Draws attention to the exceptional conditions

In fact Instrumentation acts as eyes & ears for engineers of all the disciplines in general and chemical engineers in particular.

**Parameters Measured**

The Parameters encountered in the Process Industry are:

Basic parameters-

- Pressure
- Level
- Flow
- Temperature

Other parameters that are also important in process industry and which are controlled are –

- Quality of Intermediates & Finished Products
  - Physical
  - Chemical

- Speed / Vibration/ Displacements for rotary machines

**Basic Instrument Terminology**

Now before learning something about instrumentation, let us see some of the basic terminology :

**Process:-**

This is the series of Continuous or regularly Recurring steps or actions, intended to achieve a predetermined result, as in refining oil, heat treating metal, or manufacturing paper.

**Primary Element:-**

The element or device which generates conditions in the measured variable that may be detected by a sensing element. e.g. Orifice Plate

(**Note:** A primary element may also be a sensing element)

**Transmitter:-**

A transducer which responds to a measured variable & converts it to the standardized transmission signal which is a function only of the measurement.

**Controller:-**

A device or program which regulates automatically to regulate variable.

**Converter:-**

A transducer which responds to a instrument signal & changes its form e.g. I/P Converter.

**Actuating Element:-**

That part which adjusts the Correcting element in response to a signal e.g. Valve Actuator

**Correcting Element:-**

The part of the correcting unit which directly adjusts the value of the operating conditions e.g. Valve

**Signal :-**

It is the event or phenomena that conveys data from one point to another.

- Pneumatic air Pr. 0.2 to 1.0 Kg/cm2 g through tubes
- Electrical 4 to 20 mA through copper conductor
- Digital signal through twisted / shielded pairs.

**Typical Instrument Characteristic**

As a valuer one has to differentiate between different variants of same function instrument. One must compare following specifications to know this difference -

**Accuracy:-**

In Process Instrumentation, degree of conformity of an indicated value to a recognized accepted Standard value, or Ideal value.

**TERMINOLOGIES**

**Range:-**

The region between the limits within which a Quantity is measured, received or transmitted.

**Upper Range Limit (URL):-**

The highest quantity that a device can be adjust to measure.

**Lower Range Limit (LRL):-**

The Lowest quantity that a device can be adjusted to measure

**Upper Range Value (URV):-**

The highest quantity that a device is adjust to measure.

**Lower Range Value (LRV):-**

The Lowest quantity that a device is adjusted to measure

**Reading the Specification:-**

x %age of Calibrated Span

x %age of URL

x %age of Reading

**Error:-**

Zero Error

Span Error

'Zero & Span Error are sometimes expressed together as a Total Error'

**Other Important Characteristics:**

Precision, Sensitivity, Dead Zone & Rangeability

**Accuracy & Calibration:-**

ISO Standard states that the calibration instrumentation. Must have ≥5 times the accuracy of the instrumentation to be calibrated.

**EXAMPLE OF SPECIFICATION SUPPLIED BY MANUFACTURER:**

**Functional Specification:-**

Environment within which the instrument can operate & still meet its performance specification.

Most Common are: Service, Output, Power Supply, Load Limitation Indication, Hazardous Location

**Performance Specification**:

Temperature effect, Over pressure effect, Static pressure effect & Vibration effect.

**MTBF** (Mean Time Between Failure)

## BASIC MEASUREMENTS IN INSTRUMENTATION

Having understood the basics of instrumentations, let us see the various types of instruments widely found in the industry –

- Pressure
- Temperature
- Flow
- Level

### Pressure Measurement

**Pressure measurement** and control is necessary because in all process many reactions are function of the pressure (positive or vacuum) as well as temperature. In addition to it's control, to obtain desired condition for the process it is also necessary for delivery of material through equipment piping. The other variables  such as level and flow can be inferred from Pressure Measurements.

The principles used for pressure sensors are :

- U tube manometer
- Bourdon tubes
- Bellows
- Diaphragm
- Strain gauges
- Variable Capacitance
- Piezo Resistor
- Piezo electric
- Resonant wire sensor
- Silicon resonant sensor

The principle of working of each is not covered under this scope of study.

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**Temperature Measurement**

Energy in form of heat is most important variable & vital parameter in process control for quality control of product & safe operation of plant.

This parameter is very sluggish in measurement for changes in temperature.

Temperature form high no. of control loop in the most of the process & hence one will find many instruments for this parameter.

**Temperature is the degree of Hotness or Coldness measured on Definite scales**.

1. Fahrenheit Scale : $^{o}F$
2. Celsius Scale : $^{o}C$

**Temperature Measurement Method**

There are two basic methods of instruments to measure temperature i.e Non Electric method and Electric method.

**Non Electrical Method**

- Change in volume of liquid when it's temperature is changing.
- Change in pressure of when it's gas temperature is changing.
- Change in vapour pressure when it's temperature is changing.
- Change in dimension of solid when it's temperature is changing.

These method based Temperature Measuring instruments are generally used for local field indication only.

Some of the examples are - Liquid filled thermometer, Vapor pressure filled thermometer , Gas filled thermometer, Mercury filled thermometer, Bimetallic thermometer

**Electrical Method**

- Electromotive force generated by Thermocouple.
- Change in Resistance of material.
- By asserting the energy received by Radiation.
- By comparing colours of the controlled filament and object whose temperature is sought.

Some of the examples are :-

- Thermocouple : -

  J Type : Iron- Constantan

  T Type : Copper- Constantan

  K Type : Chromel – Alumel

  E Type : Chromel - Constantan

  R Type : Plat 13% Rhod-Plat

  S Type : Plat 10% Rhod-Plat

  B Type : Plat 30% Rhod-Plat

- Resistance Detector Thermometer (RTD)

  When a material changes resistance, with a change in temperature, the change is called the 'temperature coefficient of resistance', for a material. This coefficient is expressed, as ohms per degree of temperature is positive for most metals.

  Metals chosen for resistance thermometer have a high degree of linearity over the resistance temperature range for which the thermometer designed.

- Semiconductor Resistance Thermometer
- Optical Pyromeer
- Radiation Pyrometers

**Level Measurement**

Types of Level Measurement

a. Bubbler type

Usually local indicator on open tanks containing corrosive, slurry or viscous process liquids. Can also be used on pressurized tanks, but only up to the pressure of air supply.

b. Capacitance type

Point and continuous level measurement of solids and liquids (both conductive and non conductive) utilizing the wetted probe.

c. Buoyancy type

d. Differential pressure type

e. Ultrasonic type

f. Radar type

High accuracy, non contact measurement of liquids in larger tanks. Interference can be caused by agitators and other metallic surfaces, thick foam or window coating. Suitable where material is flammable or dirty.

g. Nucleonic type

h. Level gauges

i. Level switches

**Flow Measurement**

Types of Flow Meters

a. Orifices
b. Pitot Tubes, Averaging and Duct Section Units
c. Turbine Flow meters
d. Magnetic Flow meters
e. Ultrasonic Flow meters
f. Variable Area Flow meters
g. Mass Flow meters – Coriolis

**Changing Technology**

Instrument is a field which is changing very rapidly. Given under is the evolution history of a particular type of instrument. It indicates as to what technology was used earlier and how gradually it changed to the today's technology.

**(A) Indication**

Indication Local
Indication Remote

- Pneumatic
- Analog Electronics
- Digital Electronics
- Microprocessor (Configurable)
- DCS & PLC (Programmable)

**(B) Recording**

- Paper – Pen
- Thermal Charts
- Trending

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**(C) Control**

- Local Instruments
- Local Panels
- Plant Wise Control Room
- Centralized Control Room for numbers of Plants

**(D) Transmission Media**

- Pneumatic air pressure 0.2 to 1.0 $Kg/cm^2g$ through tubes
- Electrical 4 to 20 mA through copper conductor
- Digital signals through twisted/ Shielded pairs
- Light signals through Fiber cables
- Air waves – wireless

## XII. EFFLUENT TREATMENT PLANT

1. Centrifuge

| | | |
|---|---|---|
| Type | : | Three point suspension |
| Size | : | 60” |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 15 hp |
| Speed | : | 1440 rpm |
| Motor make | : | Hindustan |

2. Storage Tank

| | | |
|---|---|---|
| Type | : | Vertical, cylindrical |
| Capacity | : | 25,000 litres |
| M.O.C. | : | H.D.P.E. |

3. Transfer Pump

| | | |
|---|---|---|
| Type | : | HRZ |
| Model | : | 1 – 6 |
| Size | : | 40 x 25 |
| Capacity | : | 20 $m^3$ per hour |
| Head | : | 20 m |
| Serial no. | : | 119 |
| Make | : | Global Engineering |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 5 hp |
| Speed | : | 2880 rpm |
| Motor make | : | Hindustan |

4. Transfer Pump

| | | |
|---|---|---|
| Type | : | H R C |
| Model | : | 1 – 6 |
| Size | : | 40 x 25 |
| Capacity | : | 6 $m^3$ per hour |
| Head | : | 17 m |
| Serial no. | : | 117 |
| Make | : | Global Engineering |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 3 hp |
| Speed | : | 2860 rpm |
| Motor make | : | Hindustan |

5. Transfer Pump

| | | |
|---|---|---|
| Type | : | H R Z |
| Model | : | 1 – 6 |
| Size | : | 40 x 25 |
| Capacity | : | 20 $m^3$ per hour |
| Head | : | 22 m |
| Serial no. | : | 118 |
| Make | : | Global Engineering |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 5 hp |
| Speed | : | 2860 rpm |
| Motor make | : | Hindustan |

6. Controlled Volume Pump

| | | |
|---|---|---|
| Model | : | WDML – 1750 / 300 |
| Flow rate | : | 250 litres per hour |
| Strokes per minute | : | 100 |
| Discharge pressure | : | 2 $kg/cm^2$ |
| Make | : | Swelore Engineering Pvt. Ltd. |

Motor

| | | |
|---|---|---|
| Capacity | : | 1 hp |
| Speed | : | 1440 rpm |
| Type | : | F L P |
| Motor make | : | S.P.M. |

7. Rotary Gear Pump

| | | |
|---|---|---|
| Size | : | ½” x ½” |

Motor

| | | |
|---|---|---|
| Capacity | : | 0.5 hp |
| Speed | : | 1380 rpm |
| Motor make | : | Hindustan |

8. Reactor

| | | |
|---|---|---|
| Type | : | Cylindrical, vertical with flat bottom, open top with flat cover |
| Capacity | : | 15,750 litres |

Shell

| | | |
|---|---|---|
| Size | : | 2800 mm ID x 3200 mm height |
| M.O.C. | : | F.R.P. |

Dished ends

| | | |
|---|---|---|
| Type | : | Flat |
| M.O.C. | : | F.R.P. |

Agitator

| | | |
|---|---|---|
| Type | : | $45^0$ pitched blade turbine type – 2 sets |
| Size | : | 900 mm (sweep dia.) x 125 mm width ‘T’ sect. – 4 blades per set |

| | | |
|---|---|---|
| M.O.C. | : | F.R.P. |
| Thickness | : | 16 mm |

Shaft

| | | |
|---|---|---|
| Size | : | 130 mm dia. X 3750 mm long |
| M.O.C. | : | EN-8 with FRP lining |

Reduction Gear Box

| | | |
|---|---|---|
| Type | : | V – 400 |
| Ratio | : | 20:1 |

Motor

| | | |
|---|---|---|
| Type | : | F L P |
| Capacity | : | 10 hp |
| Speed | : | 1440 rpm |
| Motor make | : | Hindustan |

9. Reactor

| | | |
|---|---|---|
| Type | : | Cylindrical, vertical with flat bottom, open top with flat cover |
| Capacity | : | 15,750 litres |

Shell

| | | |
|---|---|---|
| Size | : | 2800 mm ID x 3200 mm height |
| M.O.C. | : | F.R.P. |

Dished ends

| | | |
|---|---|---|
| Type | : | Flat |
| M.O.C. | : | F.R.P. |

Agitator

| | | |
|---|---|---|
| Type | : | $45^0$ pitched blade turbine type – 2 sets |

| | | |
|---|---|---|
| Size | : | 900 mm (sweep dia.) x 125 mm width 'T' sect. – 4 blades per set |
| M.O.C. | : | F.R.P. |
| Thickness | : | 16 mm |

<u>Shaft</u>

| | | |
|---|---|---|
| Size | : | 130 mm dia. X 3750 mm long |
| M.O.C. | : | EN-8 with FRP lining |

<u>Reduction Gear Box</u>

| | | |
|---|---|---|
| Type | : | V – 400 |
| Ratio | : | 20:1 |

<u>Motor</u>

| | | |
|---|---|---|
| Capacity | : | 10 hp |
| Speed | : | 1440 rpm |
| Motor make | : | Hindustan |

10. $H_2O_2$ Day Tank

| | | |
|---|---|---|
| Type | : | Cylindrical, vertical with conical top and flat bottom |
| Capacity | : | 2 $m^3$ |

<u>Top end</u>

| | | |
|---|---|---|
| Type | : | Conical |
| M.O.C. | : | F.R.P. with 3 mm thick PP lining |

<u>Bottom end</u>

| | | |
|---|---|---|
| Type | : | Flat |
| Size | : | 1550 mm dia. |
| M.O.C. | : | F.R.P. with 3 mm thick PP lining |

Shell

| | | |
|---|---|---|
| Size | : | 1400 mm ID x 1600 mm HT |
| M.O.C. | : | F.R.P. with 3 mm thick PP lining |

**<u>It will be interesting to study how the equipment in the same category of utility has altogether a different sets of equipment which is evident from equipment in Boiler and ETP depts. mentioned below for another industry</u>**

**<u>Name of the department : Boilers</u>**

**(1)** Coal/oil fired boiler - no.1

| | | |
|---|---|---|
| Type | : | Two drum integral type natural circulation water tube boiler equipped with spreader stroker and oil burners for multi fuel firing. |
| Capacity | : | 25 t/hr |
| Steam pressure (pr.) at super heater outlet | : | 63 bar g. |
| Steam temperature | : | $400^{o}C \pm 10^{o}C$ |

Accessories :-

| | | |
|---|---|---|
| - Oil burners | : | 4 nos. |
| Type | : | steam assisted pressure jet fuel burners. |
| Capacity | : | 450 kg/hr of oil |
| Make | : | Wesman Hamworthy (LU-300) |
| - Stroker | : | 5.5m long x 3.25m wide chain grate |
| - Coal spreaders | : | 3 nos. |
| - ID fans | : | 2 nos. |
| Capacity | : | 20,000 $m^3$ |
| Motor | : | 100 HP |

- FD fan

  Capacity : 39,200 $m^3$/hr

  Motor : 40 HP

- CA fan

  Capacity : 2,900 $m^3$/hr

  Motor : 40 HP

- SA fan

  Capacity : 7,840 $m^3$/hr

  Motor : 20 hp

- Mechanical dust collector

  Make : Andrew Yale

- R.F. multi cyclone type collector

- Grit Interceptor

- Boiler Feed water pumps :

  1. Pump

     Model : HDA 65/13

     Capacity : 32 $m^3$/hr

     Motor

     KW : 125

     R.P.M. : 2970

     Make : K.S.B.

  2. Pump – 2 nos.

     Type : 450 DOH

     Model : HDAF 65/13

     Make : K.S.B.

- Soot blowers – 5 nos.

| | | |
|---|---|---|
| Type | : | Electrically operated retractable multinozzle manually operated rotary. |

- Instrumentation and controls
- Water level control having indications and alarm system
- Economizer

| | | |
|---|---|---|
| Make | : | ISGEC John Thompson |

**(2)** Steam turbine generator

| | | |
|---|---|---|
| Model | : | Simple cylinder axial flow impulse reaction |
| Capacity | : | 1440 kW |
| Speed | : | 10,000 r.p.m. |
| Inlet steam pressure | : | 64.24 kg/cm$^2$ |
| Exhaust pressure | : | 16.32 kg/cm$^2$ |
| Initial steam temp. | : | 400$^o$C |
| Max. steam flow rate | : | 22.5 t/hr. |
| No. of nozzle control Valves | : | 2 + 1 |
| Rate of oil circulation | : | 17.5 m$^3$/hr |
| Oil cooler | : | shell and tube type |
| Generator | : | SGK 210201/4 air cooled three phase synchronous generator. |
| Rating | : | 1800 kVA, 1440 kW, 3 ph, 1500 rpm, 2504 A, 0.8 pf lag, 50 c/s, 415 v $\pm$ 5% with 4 terminals. |
| Make | : | BHEL |
| Excitation unit | : | 50 volt, 220 amp, static (tyristor type) 11 kW unit. |
| Air cooler | : | Quantity of air - 11520 m$^3$/hr<br>Quantity of water - 20m$^3$/hr |
| Make | : | BHEL |

**(3)** D.M. Plant

| | | |
|---|---|---|
| Type | : | 2 stream continuous operation |
| Capacity | : | (a) 50t/hr |
| | | (b) 300 $m^3$/regeneration |
| Normal output | : | 25$m^3$/hr |

Raw water specifications :

ph - 8.0 silica - 20 ppm

Total dissolved solids – 145 ppm as $caco_3$

The plant consists of following major equipment :-

- Alum. dosing system - 2 nos.
  Capacity : 40 litres
- Upflow filters - 2 nos.
  Maximum flow outlet : 50 $m^3$/hr
  Water turbidity : < 2 ppm

- Activated carbon - 2 nos.
  Flow : 50 $m^3$/hr
  Filter : M.S. vessel

- Strong acid cation - 2 nos.
  Flow : 50 $m^3$/hr
  Each filled with 1130 litres INDON 225 RESIN

- Degasser Tower - 1 no.
  Flow : 50 $m^3$/hr
  M.O.C. : M.S. lined with rubber and polypropynopylene rings.

- Strong base anion units - 2 nos.
  Flow : 50 $m^3$/hr
  Capacity : 1700 litres
  M.O.C. : M.S. lined with 3 mm rubber

- Regeneration equipment
  Bulk acid and alkaline tanks, dilution tanks, acid and alkali transfer pumps.

- DM water transfer pumps (with s.s. parts) - 2 nos.

| | | |
|---|---|---|
| Capacity | : | 60 $m^3$/hr |
| Model | : | CHPM |
| Head | : | 115 m |
| Make | : | Akay |

- DM storage tanks - 2 nos

| | | |
|---|---|---|
| Capacity | : | 90 T and 120 T |
| M.O.C. | : | M.S. lined with epoxy each |

- Chemical dosing metering pumps – 2 nos.

| | | |
|---|---|---|
| Type | : | Duplex plunger |
| Model | : | DP/30/DVP |
| Capacity | : | 3 litres/hr and 2 litres/hr |

2 nos. mixing tanks, 1 ton cap. each with M.S. circular tank for sulphite and phosphate solutions.

Make : ION exchange

**(4)** Coal handling plant

Capacity : 40 t/hr. single stream operation

(One crusher and one bucket elevator standby)

| | | |
|---|---|---|
| Coal size at feed hopper | : | 250mm max. |
| Product of crushed coal | : | +20mm - 2% |
| | | 20 to 20mm - 32% |
| Lifting capacity | : | 20 kg |

- Coal crushers - 2 nos

| | | |
|---|---|---|
| Type | : | hammer |
| Capacity | : | 40 tph |
| Make | : | Motkal |

- Bucket elevators - 2 nos.

  Positive discharge spaced buckets with double strand ROL-LON make chain and 40 tph capacity.

- Conveyor no.2

  | | | |
  |---|---|---|
  | Type | : | reversible |

- Belt conveyor no.: 3

  (for conveying coal from bucket elevator to coal bunker)

  | | | |
  |---|---|---|
  | Capacity | : | 40 t/hr |
  | Size | : | 400 mm width x 41.5 m length |

- Conveyor No.4A

  (for feeding coal to bunker no.1)

  | | | |
  |---|---|---|
  | Capacity | : | 40t/hr |
  | Size | : | 400 mm width x 41.5 m length |

- Conveyor 4B

  (for feeding coal to bunker no.2)

  | | | |
  |---|---|---|
  | Capacity | : | 40t/hr |
  | Size | : | 400 mm width x 8 m length |

- Vibrating feeder

  | | | |
  |---|---|---|
  | Type | : | Spring mounted electrically operated |
  | Capacity | : | 0 to 40t/hr |

- Magnetic separator

  Cross bolt self cleaning magnetic separator with lifting capacity of 20 kg.

- Electronic belt weigher

  PA make 40 t/hr capacity continuous weigher with totalizing counter.

- LNG coal bunkers

160 t coal capacity fully welded M.S. bunkers feeding to anti separation chutes of boiler

Supplied by : Inter Roll Pvt. Ltd., New Delhi.

**(5)** Ash handling plant

| | | |
|---|---|---|
| Type | : | Submerged belt, conveyor belt, screw conveyors etc. |
| Capacity | : | 2 t/hr of ash per boiler |

**The plant consists of following major equipment :-**

- Conveyor no.1A

| | | |
|---|---|---|
| Capacity | : | 2 t/hr |
| Length of conveyor | : | 10.10 m |
| Width of belt | : | 600 mm |
| Speed | : | 1.2 m/minute |
| Material of belt | : | nylon 4 ply |
| M.O.C. | : | 4 ply nylon |

- Conveyor no.1B

| | | |
|---|---|---|
| Capacity | : | 2 t/hr |
| Length of conveyor | : | 13.77 m |
| Width of belt | : | 600 mm |
| Speed | : | 1.2 m/minute |
| Material of belt | : | Nylon duck 4 ply |
| M.O.C. | : | 4 ply nylon |

- Conveyor no.2

| | | |
|---|---|---|
| Capacity | : | 14 t/hr |
| Length of conveyor | : | 50.80 m |
| Width of belt | : | 500 mm |
| Speed | : | 20 m/minute |
| Material of belt | : | Nylon 5 ply 3002 |

- Screw conveyors - 4 nos.

M.S. screw conveyors complete with drive units to remove ash from economizer and dust collector hoppers of both boilers of capacity 26 t/hr and 4 t/hr respectively.

- Riddling hopper ash removal
  6” dia CI pipe system below riddling
  hopper with water jet

- Ash silo
  Concrete ash silo of 120 t capacity (1.3 t/$m^3$ wet ash capacity) 3.35 m above ground level having two outlets for loading with truck.

Supplied by : Simplicity Projects Pvt. Ltd.

(6) Deaerator

| | | |
|---|---|---|
| Type | : | Tray type |
| Capacity | : | 60 t/hr |
| M.O.C. | : | A 285 Gr. ‘C’ for shell and dished ends. |
| M.O.C. (tray) | : | SS 304 |
| Spray nozzles | : | 4 nos. |
| M.O.C. (spray nozzles) | : | S.S. |
| Deaerator water capacity: | | 60 t/hr. |
| Water pump | : | 140$^{o}$C saturated |
| Storage tank capacity | : | 30$m^3$ |
| Design pressure | : | 4.0 kg/$cm^2$ |
| Temperature | : | 225$^{o}$C |
| Make | : | WATCO |

**(7)** Pressure reducing desuperheat station from installed in parallel to turbine generating set

| | | |
|---|---|---|
| Capacity | : | 63 kg/$cm^2$ |
| Temperature | : | 250$^{0}$C |
| M.O.C. | : | Hardened S.S./Vulcanised ASTM A216 - WCB |
| Make | : | Copes Vulcan Ltd., U.K. |

**(8)** Air compressors – 2 nos.

| | | |
|---|---|---|
| Type | : | Horizontal balanced opposed, double acting two stage reciprocating electrical driven, oil less. |
| Model | : | 2HY, 2TERT |
| Capacity | : | 225 c.f.m. |
| Working pressure | : | 8 $kg/cm^2$ |
| Air temperature after last stage | : | $148^oC$ to $150^oC$ |
| Air Temperature after cooler | : | - $40^oC$ to $41^oC$, |
| Speed | : | 825 r.p.m. |
| Motor | : | 75 hp, 1440 rpm |
| Air dryer | : | 200 c.f.m. |
| Make | : | Lamda |
| Make | : | K.G. Khosla |

**(9)** L.S.H.S. storage tanks - 2 nos

| | | |
|---|---|---|
| Type | : | Vertical cylindrical insulated |
| Capacity | : | 180 $m^3$ |
| Thickness | : | 10 mm |
| M.O.C. | : | M.S. |

**(10)** Boiler chimney - 1 no.

| | | |
|---|---|---|
| Type | : | Self supported |
| Size | : | 1372 mm ID x 45.7 m height |
| M.O.C. | : | M.S. |

**(11)** D.G. set complete with accessories

Details of engine :-

| | | |
|---|---|---|
| Capacity | : | 840 hp at 428 r.p.m. |

Details of generator :-

| | | |
|---|---|---|
| Capacity | : | 730 kVA, 415 V, 428 rpm |

Diesel storage tank with unloading and transfer pumps

| | | |
|---|---|---|
| Capacity | : | 75 $m^3$ |
| M.O.C. | : | M.S. |
| | | |
| Make | : | SKL |

**(12)** Cooling tower

| | | |
|---|---|---|
| Type | : | Series 10 |
| Model | : | A365-101 |
| Capacity | : | 540 US GPM (100$m^3$/hr) |
| Hot water | : | 380$^o$C |
| Cold water | : | 31$^o$C |
| Fan | : | One 72” dia. 6 blades driven by 15 hp motor |
| Gear box | : | 20 T series spiral bevel gear |

**(13)** Boiler with super heater and other accessories

| | | |
|---|---|---|
| Type | : | Oil fired |
| Capacity | : | 16 t/hr at 16 kg/$cm^2$ |
| Super heater temperature | : | 300$^o$C |

Feed water pumps – 2 nos.

| | | |
|---|---|---|
| Capacity | : | 25 t/hr. |

Steam driven feed

| | | |
|---|---|---|
| Water pumps | : | 25 t/hr |

Induced draft fan

Accessories :

- Water softening plant

| | | |
|---|---|---|
| Capacity | : | 400 m3/regeneration |
| Flow rate | : | 25 m3/hr |

Pumps - 2 nos.

| | | |
|---|---|---|
| HP | : | 20 |

- Insulated raw water tank

| | | |
|---|---|---|
| Capacity | : | 50 $m^3$ |
| M.O.C. | : | M.S. |

- Insulated soft water tank

| | | |
|---|---|---|
| Capacity | : | 70 $m^3$ |
| M.O.C. | : | M.S. |

- Insulated feed water tank

| | | |
|---|---|---|
| Capacity | : | 60 $m^3$ |
| M.O.C. | : | M.S. |

- Furnace oil tank with transfer pumps – 2 nos.

| | | |
|---|---|---|
| Capacity | : | 45 $m^3$ |

- M.S. chimney

| | | |
|---|---|---|
| Height | : | 30 m |

Make : Sieinmuler, Germany

**(14)** Boiler with super heater, deaerator and accessories.

| | | |
|---|---|---|
| Type | : | Package |
| Model | : | Stemax - ST/35/F/75/P/1 |
| Capacity | : | 3500 kg/hr |
| Working pressure | : | 73.6 $kg/cm^2$ |
| Fuel | : | Furnace oil |
| Make | : | Thermax |

**(15)** Boiler with super heater, deaerator and accessories

| | | |
|---|---|---|
| Type | : | Package |
| Model | : | Stemax - ST/35/F/75/P/1 |
| Capacity | : | 3000 kg/hr |
| Fuel | : | Furnace oil |
| Accessories | : | Furnace oil service tank and D.M. water feed tank |
| Make | : | Thermax |

**(16)** Boiler with accessories

| | | |
|---|---|---|
| Type | : | Package |
| Capacity | : | 10 t/hr saturated steam |
| Make | : | Wester Works |

**(17)** Common equipments for boilers near MOR

- M.S. furnace oil storage tank with transfer pumps.

- D.M. plant
  S.S. D.M. water storage tanks - 2 nos.
  Capacity : 3.0 $m^3$ each

- M.S. chimney
  Bottom dia. : 1450 mm
  Top dia. : 750 mm
  Height : 51 m

**Name of the department : Effluent Treatment Plant (E.T.P.)**

E.T.P.

| | | |
|---|---|---|
| Capacity | : | 1200 T/day |

The plant consists of :-

- Raw effluent tank

| | | |
|---|---|---|
| Type | : | R.C.C. with acid proof tiling |
| Capacity | : | 50 T |

It consists

(a) Agitator driven by 15 hp/1440 r.p.m. motor.

(b) Raw effluent pumps driven by 15 hp/1440 r.p.m. motor.

| | | |
|---|---|---|
| Make | : | Chem flow |

- Initial sumps – 2 nos.

| | | |
|---|---|---|
| Type | : | Fat trap R.C.C. with acid proof tiling |
| Capacity | : | 20 T each |

- Equalising tank with agitator

| | | |
|---|---|---|
| Type | : | R.C.C. with acid proof tiling |
| Capacity | : | 50 T |
| Drive | : | Reduction gear box driven by 15 hp motor. |

Pumps – 2 nos.

| | | |
|---|---|---|
| HP | : | 2.5 |

- Neutralizers – 2 nos.

| | | |
|---|---|---|
| Type | : | R.C.C. with acid proof tiling |
| Capacity | : | 150 T |
| Drive | : | Reduction gear box driven by 5 hp motor. |

Pumps – 2 nos.

| | | |
|---|---|---|
| Type | : | 3 NK10 |
| HP | : | 15 |
| R.P.M. | : | 1440 |

- Primary clarrifier

| | | |
|---|---|---|
| Capacity | : | 150 T |

Primary sludge pumps

| | | |
|---|---|---|
| Type | : | 3 NK10 |

- Acidification tank – 2 nos.

| | | |
|---|---|---|
| Capacity | : | 7 tons each |

High speed pumps – 2 nos.

| | | |
|---|---|---|
| Drive | : | 20 hp/2900 r.p.m. motor |
| Make | : | Chem Flow |

- Line slurry tank with agitators

| | | |
|---|---|---|
| Capacity | : | 40 t |

Agitator driven by 7.5 hp motor – 4 nos.

- Dissolved oxygen tank with agitator

| | | |
|---|---|---|
| Type | : | R.C.C. |
| Capacity | : | 7 / 10 T |

- Filter press

| | | |
|---|---|---|
| Capacity | : | 45 plates x 25 frames |

Screw type conveyor driven by 37.5 hp/1440 r.p.m. motor.

- Aeration tanks – 2 nos.

| | | |
|---|---|---|
| Type | : | R.C.C. |
| Capacity | : | 750 T |

It consists

(a) Surface aerators driven by 25 hp motor with reduction gear box – 2 nos.
(b) Sludge pumps for circulation.

- Secondary clarrifier

| | | |
|---|---|---|
| Type | : | Cylindrical |
| Capacity | : | 80 T |

It consists R.C.C. tank with an arm driven by 5 hp double geared motor.

- Thickner

| | | |
|---|---|---|
| Capacity | : | 90 T |

- Acid storage tanks – 2 nos.

| | | |
|---|---|---|
| Capacity | : | 15 T each |

The above comparison makes it amply clear that each industry has its specific type of utility equipment

**EXERCISE**

1. Enumerate types of utility services.
2. Write short note on equipment required in utility services.

# UNIT - 6

## INDUSTRIAL PROCESSES

### A. MANUFACTURING PROCESS IN A TEXTILE SPINNING MILL

In a textile mill a series of manufacturing process is undertaken for converting cotton and other fibres into yarn and for converting the yarn into fabrics. The raw material for a textile mill continues to be cotton. However, other fibres are also being used as raw material either with or without cotton.

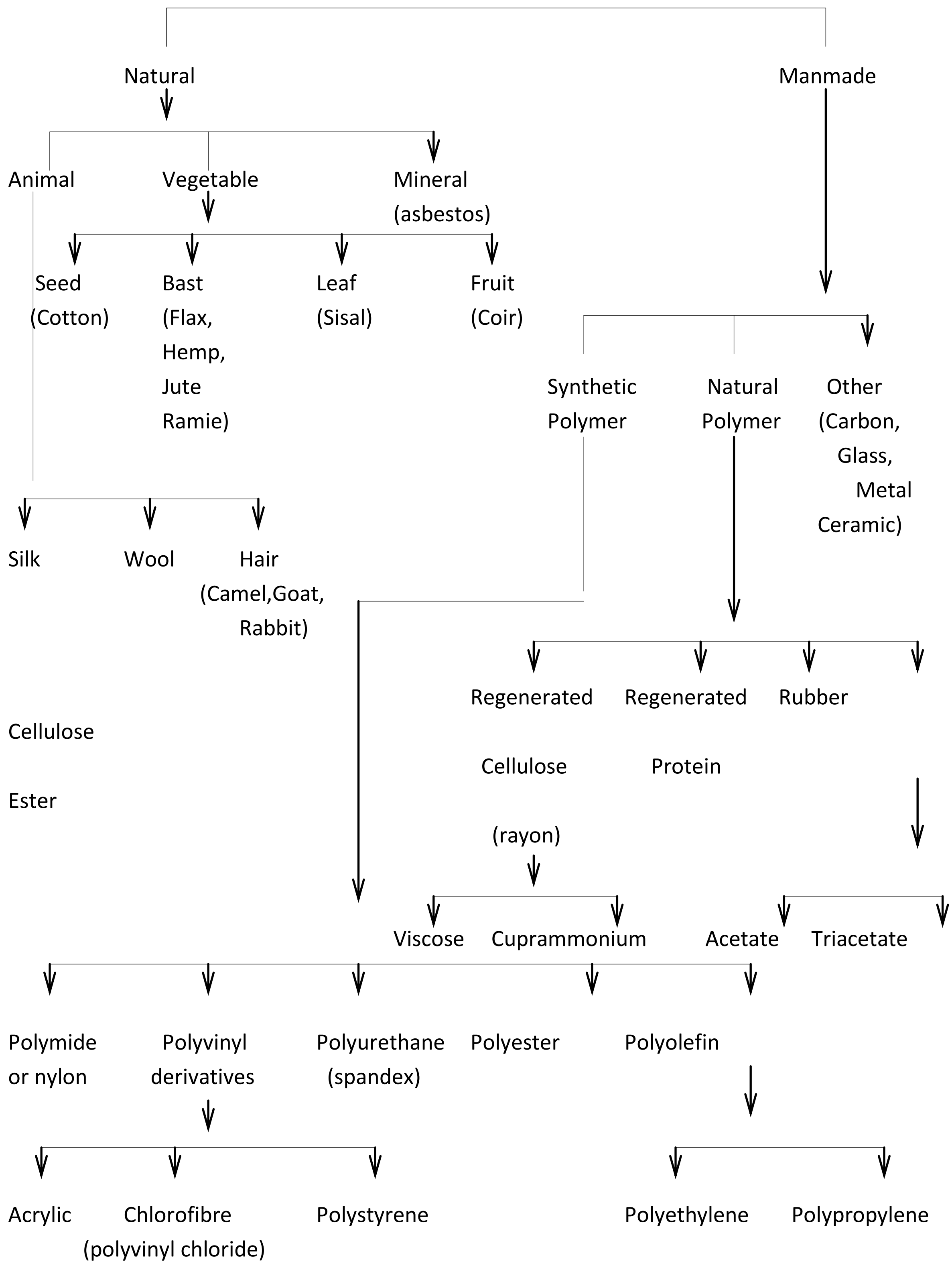
**<u>Classification of textile fibres:</u>**

The textile fibres may be divided into major groups, namely, (a) natural fibres and man-made fibres. **Table on next page describes the different fibre** types classified under each major group.

Any textile spinning mill has following departments:

- Mixing and blow room
- Carding
- Combing
- Draw frame
- Speed frame
- Ring frame
- Open-end spinning
- Air-jet spinning

**Textile Fibres**



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**TEXTILE MILL**

**PROCESS FLOW DIAGRAM**

**(SPINNING)**

COTTON FIBRE IN BALES

↓

MIXING AND BLOW ROOM
(LAP)

↓

CARDING
(SLIVER)

↓

COMBING
(SLIVER)

↓

DRAW FRAME
(SLIVER)

↓

SPEED FRAME
(ROVING)

↓

RING SPINNING

↓

YARN

- **Mixing and blow room :**

The functions of a blow room line are –

* To open the cotton from matted condition to the loose open state in which it was before bailing.
* To remove all the impurities and make the cotton look as clean as possible.
* To mix thoroughly the different component fibres of a mixing so as to give a homogeneous blending.
* To prepare the cotton into a convenient package from being transported to subsequent machines.

Each machine in the blow room line is known as an opening or as a beating point. The points are in reality doing the function of teasing and opening the lumps and, thus, reducing them in size, so as to prepare the materials ready for the beater that follows.

The types and number of machines required in a blow room line are governed by the class-condition of the cotton. American and Egyptian varieties of cotton are cleaner and, for opening and cleaning such cottons milder treatment with very less number of cleaning points are required. Whereas, most Indian cottons being very dirty can only be cleaned with a harsher treatment with more number of cleaning points.

- **Carding :**

The object of carding is to open out thoroughly the tine lumps, locks or tufts to a state where fibre becomes individualized and the cotton is no more in an entangled state. Equally important function is the removal of all impurities, neps, short fibres etc, which have escaped the blow room action and finally it has to prepare the well cleaned material into a compact silver form and lay into containers for subsequent processes.

Next to blow room, carding is the only major stage for cleaning cotton. The two major regions of a card where this cleaning takes place are taker-in and flats. The variations in the cleaning efficiencies of the card may arise from the nature of trash present in the lap cotton and the condition of carding.

The sheet of cotton in the form of a roll or lap is fed to the carding engine at a very slow rate. The first to start the action is a saw tooth covered licker-in roller, next in action comes the cylinder which has its surface covered with tiny wire points. The surface speed of this is almost twice that of the licker-in. Due to the difference of surface speeds the fibre bunches are stripped off the licker-in by the cylinder wire. The bunches now receive the real seathing, teasing or carding action, when they come between the two sets of wire points, namely flat wire and cylinder wire. Next to the cylinder(a) is small cylinder which moves at a very slow speed than cylinder (a) and it is known as doffer. The centrifugal force of the cylinder throw off the fibres to the doffer.

- **Combing :**

Combing is a process which is introduced in spinning of finer yarns and high quality yarns from cotton. Carded material is short of several important properties which a combed quality normally possesses. The carded material still contains short fibres, neps, fine kitty and leaf particles; short fibres are a hindrance to spinning of finer counts where the number of fibres in the cross section of the yarn is very less. In case of quality yarns, the short fibres cause thick and uneven places in the yarn length and the yarn looks hairy. Besides, very short fibres do not contribute any thing to yarn strength. Comber is a machine where short fibres below a certain pre-determined length can be easily separated out.

After combing the fibres are more or less uniform, well straightened or parallelised and free from neps and particles of trash that escaped carding.

There are different grades of combing based on amount of waste extracted. The percentage of waste extracted depends entirely on the end use of the product.

| | | |
|---|---|---|
| Up to 9% waste | : | Half combed yarn quality |
| 10 to 18% waste | : | Ordinary combing quality |
| Over 18% waste | : | Fully combing quality |

- **Draw frame :**

By carding, the tangled mass of fibres is well opened so that every fibre becomes quite free. These individual free fibres lie haphazardly criss cross in the web. These haphazard fibres require to be straightened and parallelised to the possible extent. The function of draw frame :

* To straighten the fibres in the silvers
* To make them lie in a manner parallel to their neighbours and to the sliver axis
* To improve the uniformity or evenness of the slivers

Straightening of the fibres is accomplished by drafting them with pairs of rollers which are made to revolve at different surface speed. Doubling, that is feeding more slivers together into drafting zone improves the uniformity, but if not properly manipulated tends to produce unevenness.

- **Speed frame :**

Speed frame forms the final stage in spinning preparatory sequence of operations. The main object of a speed frame process is to reduce the sliver bulkiness to a diameter suitable enough for the ring spinning frame to spin yarn. The diameter reduction is done by drafting system without disturbing the regularity. The desired degree of fineness or hank of material is known as roving.

As the drafting takes place, the fibres per cross section of roving reduces, and the roving is too loose and weak with insufficient cohesive power to keep up the continuous strand form. For this purpose minimum twist is imparted to the roving as it comes out of the front roller nip after drafting. After twist the roving is would on to a bobbin, that is doffed when full. This package or bobbin can be conveniently transported to the next machine, i.e. ring frame.

- **Ring frame :**

Ring spinning is the most conventional way of producing spun yarns. In this system yarn is twisted by using a revolving traveler. As the rotational speed of the package is greater than that of the traveler, winding of yarn takes place. Helically twisted structure of free yarn gives a smoother feel of the fabric.

This is the final stage where actual yarn is manufactured. All the earlier processes are considered under “spinning preparatory”.

The object of spinning preparatory is three fold, namely :

* to draw out the roving being fed to the ring frame to the desired degree of fineness;
* to impart sufficient twist to the emerging strand of fibres and form continuous yarn; and
* to wind up the spun yarn into same convenient package form.

Twist is the only physical means known to keep the fibres together in a continuous strand form. The fibres take a helical form and entwine with the neighbouring fibres as twist is imparted. For a given type of cotton, there is an optimum twist per inch for the optimum strength. Beyond this the downward trends in strength is noticed owing to the fibres suffering a crushing effect rather than closer clinging.

- **Open-end spinning :**

A spinning system in which, sliver feed stock is highly drafted, ideally to individual fibre state and thus creates an open end or break in the fibre flow. The fibres are subsequently assembled on the end of a rotating yarn twisted in rotor spinning. A method of open-end spinning uses a rotor (a high speed centrifuge) to collect and twist individual fibres in to yarn. The fibres on entering a rapidly rotating rotor are distributed around its circumference and temporarily held there by centrifugal force. The yarn is withdrawn from the rotor wall and because of the rotation of the rotor, twist is generated.

Rotor spun yarns are more regular, bulkier and weaker as compared to ring spun yarn.

- **Air-jet spinning :**

It is a system of stable fibre spinning, which utilizes air to apply the twisting to the yarn during its formation. The air is blown through small holes arranged tangentially to the yarn surface and this causes the yarn to rotate. By using two air jets operating in opposite twist direction, yarns with controlled properties but of complex structure are produced. The yarns are comparatively weaker than ring spun yarn and there is also a tendency for fabric handle to be harsh.

**TECHNICAL SPECIFICATIONS OF PLANT AND MACHINERY IN A TEXTILE SPINNING MILL**

## 1. Bale Opener

| | | |
|---|---|---|
| Model | : | 1000 mm |
| Upright lattice | | |
| Working surface | : | 1.5 sq. m. |
| Speed | : | 0.8/1.2/2.4 m/sec |
| Opening cylinder | | |
| Diameter | : | 400 mm |
| Speed | : | 800 to 850 rpm |
| Output per machine | | |
| Normal | : | 60 to 120 kg/h |
| Special cases | : | Up to 150 kg/h |
| Percentage of waste extraction in relation to weight of raw cotton | : | Up to 1.8% |
| Percentage of trash in total waste | : | 60% to 80% |
| Cleaning effect, i.e. quantity of trash removed in relation to trash content of the raw cotton | : | Up to 25% |
| Nominal rating of the three motors | | |
| Opening cylinder motor | : | 4 hp at 960 rpm |
| Upright lattice motor with gear unit | : | 1.1 hp/105 rpm |
| Feed lattice motor | : | 0.5 hp at 17 rpm |

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| | | |
|---|---|---|
| **Space requirements** | | |
| Length of machine without feed belt | : | 3275 mm |
| Width of machine across doors | : | 1286 mm |
| Height of machine | : | 2325 mm |
| **Weight** | | |
| Net | : | 2450 kg |
| Gross | : | 3300 kg |

**2. <u>Double Scutcher</u>**

| | | |
|---|---|---|
| Working width | : | 1020 mm |
| Lap width | : | 900 to 1016 mm |
| Lap length | : | Up to 65 m |
| Lap weight | : | Up to 26 kg |
| Roller pressure per side | : | Up to 2000 kg |
| Delivery speed | : | 5 to 8 m/min |
| Output | : | Up to 180 kg/hr |
| **Nominal rating motors** | | |
| Exhaust and delivery apparatus | : | 6 hp at 1440 rpm |
| Hopper feeder | : | 1 hp at 1440 rpm |
| $1^{st}$ beater (two-bladed) | : | 4 hp at 1440 rpm |
| $2^{nd}$ beater (Kirschner) | : | 4 hp at 1440 rpm |
| Material feeding | : | 4 hp at 960 rpm |
| Lap doffing | : | 0.125 hp at 960 rpm |
| **Space requirements** | | |
| Overall length of machine | : | 8708 mm |
| Overall width of machine | : | 1920 mm |
| Height of scutcher | : | 1560 mm |
| Height of hopper feeder | : | 2325 mm |
| Height of filling trunk | : | 2000 mm |

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| | | |
|---|---|---|
| Overall height (with 2 m filling trunk height) with pipe connecting piece | : | 3825 mm |

**3. <u>ERM Cleaner</u>**

| | | |
|---|---|---|
| Working width | : | 1000 mm |
| Beater diameter | : | 400 mm |
| Speed | : | 1000 rpm, 850 rpm, 650 rpm |
| Output | : | Maximum 500 kg/hr |
| **Nominal rating of motors** | | |
| Beater | : | 5.5 hp at 1450 rpm |
| Feed rollers via gearing | : | 0.75 hp at 5-18 rpm |
| Blow fan | : | 5.0 hp at 2850 rpm |
| **Miscellaneous** | | |
| Pressure head | : | 120 mm WC |
| Net weight | : | 2300 kg |
| **Space requirements** | | |
| Width | : | 1500 mm |
| Length | : | 1000 mm |
| Height | : | 3960 mm |

**4. <u>Mono Cylinder Cleaner</u>**

| | | |
|---|---|---|
| **Pin cylinder** | | |
| Diameter over pins | : | 700 mm |
| Length | : | 1200 mm |
| Speed | : | 700 rpm |
| **Under-pressure in machine** | | |
| Water column | : | 10 mm |
| Air requirements | : | 0.7 to 1.0 cu.m./sec. |

Motor

| | | |
|---|---|---|
| Nominal rating | : | 3 hp |
| Speed | : | 1450 rpm |
| Production | : | Up to 500 kg/h |

Space requirements

| | | |
|---|---|---|
| Width without motor | : | 1500 mm |
| Depth | : | 1095 mm |
| Height | : | 1900 mm |

Net weight : 850 kg

## 5. **Aeromix**

| | | |
|---|---|---|
| Range of utilization | : | Cotton and man-made fibres up to 60 mm |
| Holding capacity | : | Effective volume of mixing 350 kg |
| Production | : | Normally 500 kg/hr |

Power consumption

| | | |
|---|---|---|
| Opening rollers | : | 1 motor 7.5 kw at 1440 rpm |
| Conveying elements | : | 1 gear motor 0.55 kw at 9 to 45 rpm |
| Conveyor belt | : | 1 gear motor 0.55 kw at 9 to 45 rpm |
| Ventilator A5/7 | : | 1 motor 3 kw/2890 rpm |

Air requirements

| | | |
|---|---|---|
| Air at inlet for conveyance of material (maximum permissible volume) | : | 1.6 cu.m./sec |
| Air at outlet for conveyance of material | : | 0.5 cu.m./sec |
| Air for conveyance of dust to filter installation | : | 1.6 cu.m./sec (maximum) |

Space requirements

| | | |
|---|---|---|
| Width | : | 1600 mm |
| Length | : | 5000 mm |
| Height | : | 3430 mm |

**6. <u>Aerofeed</u>**

Duty range

| | | |
|---|---|---|
| Cotton | : | Up to 50 mm cut length |
| Man-made fibres | : | Ascertain suitability by trial in each case |
| Operating conditions | : | Continuous three shift operation if possible, without frequent style changes. |

Performance

| | | |
|---|---|---|
| Output per flock feeder | : | Up to 300 kg/hr |
| Number of cards per flock feeder | : | 5 to 10 high production cards C1/2 |
| Feed weight per card | : | 600-750 g/m |

Feed chute

| | | |
|---|---|---|
| Above C1/2 card height | : | 2815 mm |
| Total weight | : | 2000 k |

Condenser

| | | |
|---|---|---|
| Motor rating | : | 6.0 hp |
| Motor speed | : | 1440 rpm |

Beater

| | | |
|---|---|---|
| Motor rating | : | 3.0 hp |
| Motor speed | : | 960 rpm |
| Beater speed | : | 500, 600, 811 rpm |

Feed rollers

| | | |
|---|---|---|
| Motor rating | : | 0.4 hp |
| Motor speed | : | 0 – 2800 rpm |
| Feed rollers reduction speed ratio | : | 41:1 |

Return feed roller

| | | |
|---|---|---|
| Motor rating | : | 0.25 hp |
| Motor speed | : | 1440 rpm |
| Roller speed | : | 16-23 rpm |

Ventilation fan

| | | |
|---|---|---|
| Motor rating | : | 5.5 hp |
| Motor speed | : | 1440 rpm |
| Fan speed | : | 1200 – 1800 rpm |

**7. <u>High Production Card</u>**

| | | |
|---|---|---|
| Can coiler | : | PA 600 |
| Can diameter | : | 600 mm |
| Can changer | : | For can diameter 600 mm height 1220 mm including castors |
| Levelling | : | Footplates with screw leveling |
| Working width | : | 1000 mm |

Diameters over clothing

| | | |
|---|---|---|
| Licker-in | : | 253 mm |
| Cylinder | : | 1290 mm |
| Doffer | : | 680 mm |
| Feed roll | : | 80 mm |
| Detaching roll | : | 120 mm |

Speeds depending on material

| | | |
|---|---|---|
| Licker-in | : | 590-1150 rpm |
| Cylinder | : | 250, 360, 450 rpm |
| Fats | : | 110 per set, 43 of them in the working position, running forward |
| Flat speed | : | Adjustable to 95, 137, 171 mm/min. |
| Drive | : | By squirrel-cage motor via flat belts |

Main motor

| | | |
|---|---|---|
| Rating | : | 5.5 kw |
| Speed | : | 1440 rpm at 50 Hz |
| Regulating motor | : | 0.37 kw |
| Brush motor | : | 0.2 kw |
| Fan motor | : | 1.85 kw |
| Speed | : | 2800 rpm at 50 Hz |

**8. <u>Draw Frame</u>**

| | | |
|---|---|---|
| Number of deliveries per machine | : | 2 |
| Ends up per delivery | : | 4-6-8 cans up to 600 mm x 1200 mm |

Delivery speeds

| | | |
|---|---|---|
| For combed material | : | Up to 220 m/min |
| For carded material | : | Up to 300 m/min |

Production per machine at 100% efficiency

| | | |
|---|---|---|
| Combed | : | Up to 150 kg/hr |
| Carded | : | Up to 200 kg/hr |
| Draft in drafting arrangement | : | 3.5 to 13 |
| Silver count at delivery (normal) range | : | 0.17 to 0.42 metric |
| Range of staple lengths | : | 22 to 75 mm |

| | | |
|---|---|---|
| Can dimensions at delivery | | |
| Diameter | : | 350 to 500 mm |
| Height | : | 1050 o 1200 mm |
| Compressed air requirements per machine | : | 0.2 cu. m./hr at 2 to 7 at gauge pressure |
| Nominal rating of motor | | |
| Main motor | : | 5 hp at 1440 rpm |
| Blower motor | : | 2.5 hp at 2880 rpm |
| Space requirements | | |
| Width of machine (constant) | : | 1700 mm |
| Depth of machine with 8 feed cans per delivery and with cans up to 450 mm delivery | | |
| Long creel | : | 4860 mm |
| Short creel | : | 3135 mm |
| Super long creel | : | 6360 mm |
| Depth of machine with 8 feed cans per delivery and with cans for 500 mm delivery | | |
| Long creel | : | 4990 mm |
| Short creel | : | 3265 mm |
| Super long creel | : | 6490 mm |
| Diameter of can at feed | : | 350 mm, 400 mm, 450 mm 500 mm, 600 mm |
| Maximum height of machine | : | 1698 mm, 1773 mm, 1848 mm |
| Height of can at delivery | : | 1050 mm, 1125 mm, 1200 mm |
| Height of can at feed | : | 1050 mm, 1125 mm, 1200 mm |

Height from floor to under edge of feed table

When using –

| | | |
|---|---|---|
| Super long creel | : | 1600 mm 1675 mm 1750 mm |
| Long and short creel | : | 1410 mm 1485 mm 1560 mm |
| Operating height = height of delivery roller above floor | : | 1436 mm 1511 mm 1586 mm |
| Distance from front edge of frame to front roller | : | 415 mm operating depth |
| Depth of headstock | : | 960 mm up to 450 mm can delivery 960 mm + 130 mm = 1090 mm for 500 mm can delivery |
| Net weight | : | 2000 kg |

**9.** **<u>Sliver Lap Machine with Auto Lap</u>**

| | | |
|---|---|---|
| Ends up | : | Normally up to 24 ends up possible |
| Count of sliver fed | : | Ne 0.12-0.18 (for 36 ends up sliver count up to Ne 0.22) |
| Can dimensions | : | 400 – 600 mm up to 1250 mm high |
| Weight of feed | : | 75 to 120 grams/m |
| Draft | : | 1.5 – 2.0 |
| Lap weight | : | 50 to 75 grams/m |
| Lap width | : | 250 mm in case of feeding ribbon lap 300 mm in case of feeding comber direct |

Total weight

| | | |
|---|---|---|
| Total weight of laps 250 mm | : | Up to 13 kg |
| Total weight of laps 300 mm | : | Up to 15 kg |
| Working speed | : | Up to 65 m/min |
| Compressor air | : | 1.2 N. cu. m./hr at 7-9 at gauge |
| Nominal motor rating | : | 4 hp, 1440 rpm at 50 Hz |

**10. Ribbon Lap Machine with Auto Lap**

| | | |
|---|---|---|
| Number of heads | : | 6 |
| Staff | : | 500 mm |
| Doubling | : | 6 |
| Width of lap feed | : | 250 mm |
| Weight of feed | : | 50 – 75 g/m |
| Draft | : | 5 – 8 |
| Working speed | : | Up to 65 m/min |
| Width of lap delivered | : | 300 mm |
| Weight of lap delivered | : | 50 – 75 g/m |
| Maximum dia. of lap | : | 450 mm |
| Total weight of lap | : | Up to 15 kg |
| Compressed air required | : | 12 N.cu.m./hr at 7-9 at gauge |
| Nominal motor rating | : | 4 hp, 1440 rpm at 50 Hz |

**11. High Speed Comber**

| | | |
|---|---|---|
| Number of heads per machine/ gauge | : | 8/430 mm |
| Feed lap | | |
| Weight | : | 55-70 g/m, normally 60 g/m |
| Maximum diameter | : | 500 mm |
| Maximum or normal width | : | 300 mm |
| Waste percentage | : | 5 – 25 |
| Nips per minute | : | 140 – 240 |
| Production per machine | : | 16-40 kg/hr at 90% efficiency |
| Slivers per machine/doublings per sliver | : | 2/4 |
| Draft range of drafting arrangement | : | 5 – 10 |
| Count of sliver delivered | : | 0.20 – 0.34 metric |
| Range of fibre lengths | : | 24.6 to 50 mm |

Cad dimensions

Diameters : 400, 450 and 500 mm

Heights : 1050, 1125, 1250 mm

Compressed air required

per machine : 0.2 N. cu. m./hr at 7-10 at gauge

Nominal motor rating : Normal/slow gear

Main drive : 2.2 hp at 1350 rpm/0.16 hp at 81 rpm

Fan : 4.0 hp at 2860 rpm

Weight

Net : 4800 kg

Gross : 5100 kg

Space requirements

Length : 5,619 m

Width : 1,506 m

## 12. **Speed Frame**

Box length : 487.32 mm

Distance between spindles : 121.83 mm

Number of spindles per system : 4

Bobbin size : 300 mm x 160 mm

Number of spindles per machine : 24 to 96, 108, 120

Roving count range Ne : 0.5 – 3.5

Break draft : 1 – 3

Total draft : 3.5 – 13 for 3 roller drafting

9 – 25 for 4 roller drafting

Maximum flyer speed mechanically

possible : 1400 rpm

Maximum delivery rate : 30 m/min for cotton

40 m/min for synthetic

| | | |
|---|---|---|
| Total power requirement depending on the number of spindles (including suction device 2.0 hp) | : | 9.5 – 14.5 hp |
| Machine length for 120 spindles | : | 17000 mm |
| Machine width with cans of 500 mm dia. | : | 3910 mm |
| Compressed air requirements | : | 1.0 N. cu. m./hr |
| Air exhaust from suction system | : | 26 cu. m./min |

## 13. <u>Ring Spinning Frame</u>

| | | |
|---|---|---|
| Spindle gauge | : | 70 mm |
| Ring diameter | : | 42 mm |
| Tube length | : | 200 mm |
| Yarn counts | : | 100 – 4.2 tex<br>10 – 235 Nm<br>6 – 140 Ne |
| Range of twist | : | 140 – 2550 turns/m (3.6 – 64.7 t.p.i) |
| Spindle speed | : | Up to 20000 rpm mechanically possible |
| No. of spindles | : | Up to 864 |

Dimensions

| | | |
|---|---|---|
| Width over spindle centers | : | 620 mm |
| Width of machine without doffer | : | 780 mm |
| Width of machine with doffer | : | 1020 mm |

| | | |
|---|---|---|
| Length of machine for 864 spindles | : | 32500 mm |

**14. Automatic Pirn Winding Machine**

| | | |
|---|---|---|
| Total number of spindles | : | 24 (two sided machine) |
| Length of machine | : | 4.2 mete |
| Width of machine | : | 1.8 metre |
| Spindle speed | : | 5000 – 10000 rpm |
| Power requirement of machine | : | 4 kw |
| Weight of machine | : | 2000 kg |

**15. Open-end Spinning Machine**

| | | |
|---|---|---|
| Gauge | : | 200 mm |
| No. of rotors per machine | : | 168 |
| Rotor speed | : | 31000 – 60000 rpm |
| Rotor dia. | : | 54/66 mm |
| Delivery speed | : | Up to 150 m/min |
| Speed of opening roller | : | 5000 – 9000 rpm |
| Size of feed can | : | 350 mm dia. x 900 mm |
| Take up tube | : | 54/60 mm dia. x 145 mm |
| Size of take up package | : | 300 mm dia. maximum |
| Weight of package | : | Up to 4 kg |
| Installed power | : | 35 kw |
| Motor for rotor drive | : | 2 x 11 kw |
| Motors for opening roller drive | : | 2 x 3 kw |
| Motor for trash suction | : | 2.2 kw |
| Motor for third hand | : | 2 x 2.2 kw |
| Motor for headstock cooling fan | : | 0.1 kw |
| Conveyor motor | : | 0.3 kw |
| Total air discharged from the machine | : | 0.85 cu.m./sec |

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## B. DAIRY

### ICE – CREAM

Ice Cream is a frozen dairy food made by suitable blending and processing of milk cream and other milk product, together with sugar, dextrose, corn syrup in dry or liquid form, with or without stabilizer, emulsifier and colour, and with incorporation of air during the freezing process.

Among milk products, ice cream is an excellent source of food energy, vitamins, calcium, phosphorus and other important minerals. The digestibility and palatability of ice cream is also high. The ice cream can satisfy the satiety level of all people from children to aged people.

Ice Cream can be divided into four main categories according to the ingredient used :

1. Ice cream made exclusively from milk product.
2. Ice cream containing vegetable fat.
3. Sherbet Ice cream made of fruit juice with added milk fat and milk solids not fat.
4. Water ice made of water, sugar and fruit concentrate.

Ice Cream composition varies a lot in different localities and market with the consideration of legal requirement, quality of product desired, raw material available, plant procedure, trade demands, competition, cost etc. A satisfactory composition produces an ice cream which has the desired combination of cost, food value, flavour, body and texture, cooling effect, colour scheme, viscosity, whipping ability and freezing point.

Composition and properties of Ice-Cream Mix

- Composition of Ice-cream is expressed as % of its constituent, i.e. as % of milk fat, SNF, sugar, stabilizer/emulsifier, total solid, etc.
- Generally a good Ice-cream contains 12% fat, 11% milk solid not fat, 15% sugar, 0.3-0.5% of stabilizer and emulsifier, and 38.3% of total solids
- In Ice-cream, the percentage of milk fat varies more than any other constituent
- After considering legal requirement, quality of product, raw material available, plant procedure, trade demands, competition and cost, there is a choice of a product minimum, average or high fat/solids composition.

➢ **Role of Ice Cream Mix Constituents**

**1. Milk fat**

- Milk fat provides flavour, richness, smoothness, and aids in decreasing the size of ice crystals.
- Produces a characteristic smooth texture by lubricating the palate.
- Helps to give body to the ice cream.
- Aids in good melting properties.
- Aids in lubricating the freezer barrel during manufacturing (non-fat mixes are extremely hard on the freezing equipment).
- Milk fat is usually the most expensive ingredient.

Legal requirements for milk fat in ice cream are at least 10% and not more than 20%. If milk fat is increased above 15%, milk solids-non-fat (MSNF) may be decreased to the same extent to as low as 6%. Too much milk fat decreases whipping ability and consumption due to high price, excessive richness, and high calorific value.

## 2. Milk Solids Non-Fat (MSNF)

The serum solids or MSNF contain lactose, caseins, whey proteins, minerals and ash. Protein helps make ice cream more compact, smooth, and resistant to melting. If over used, a salty taste, or sandy defect may result because of the excess lactose. MSNF should be no more than 15.6-18.5% of total solids.

MSNF plays the following role :

1. It is a cheap source of total solids.
2. Improves texture.
3. Gives body and melt resistance.
4. Allows higher overrun without snowy or flaky textures.
5. Protein provides emulsification and whipping properties.
6. Protein increases water holding capacity, enhances viscosity and reduces iciness.

## 3. Sweeteners

Sweeteners provide sweetness and increase viscosity and total solids of the mix. They also improve body, texture, and palatability of ice cream. Sucrose is the main sweetener. Approximately, 45% of the sucrose can be replaced with corn syrup. Corn syrup costs less but isn't as sweet as sucrose. Legally, sweeteners are used at level of 13 to 20% of total solids.

## 4. Stabilizers

Stabilizers are usually polysaccharides such as gelatin, gums, seaweed, carrageenan, and may come from vegetable sources. Stabilizers are responsible for increasing the viscosity of milk and ice cream. Increasing the viscosity decreases water migration, producing a firmer ice cream and reducing ice crystal size. Ice crystals can cause ice cream to be coarse, thus stabilizers increase smoothness and resistance to melting. Too much stabilizer can make the mix too viscous, making the ice cream heavy and soggy.

- Specific functions of stabilizers :
    1. Provides smoothness in body and texture
    2. Retards ice crystal growth
    3. Provide uniformity and resistance to melting
    4. Aids in suspension of flavouring particles
    5. Stabilizes foam
    6. Prevent shrinkage in frozen product
    7. Slow water migration

**5. <u>Emulsifiers</u>**

Emulsifiers contain a hydrophilic portion, and a lipophilic portion letting them act as an interface between fat and water. This allows them to reduce interfacial tension between the two phases creating an emulsion. Emulsifiers aid in developing the appropriate fat structure and air distribution in ice cream. They provide smoothness and a stiffer body, enabling production of smaller and more evenly distributed air cells.

Emulsifiers can be mono- or di-glycerides. Glycerides are derived from partially hydrolysed fats or oils from vegetables or animals. Polysorbate 80 is also an emulsifier. The legal requirements for emulsifiers and stabilizers together is maximum 0.5%

**6. <u>Flavours and Colours</u>**

- Flavour increases the acceptability of Ice-cream. Flavour is considered as the most important characteristics of Ice cream. Natural and synthetic flavour substances are available for flavouring of ice cream.

- Ice cream should have a delicate, attractive colour which can be readily associated with the flavour. Most colours are of chemical origin. Colours are available in liquid or powdered form. Most ice cream manufacture prefer dry colour since these are more economical and can be dissolved in boiling water as and when needed

## Properties of Ice Cream Mix

1. ***Viscosity:*** This is defined simply as the resistance offered by liquid to flow. It is the important property of ice cream mix. Whipping quality and air retention quality of mix is very much dependent on mix viscosity. There are two types of viscosity (a) Apparent viscosity, which is thickening condition that disappear on agitation; (b) Basic viscosity, which remain after apparent viscosity disappear.

   The viscosity of ice cream depends on
   1. Composition of mix
   2. Kind and Quality of Ingredients
   3. Processing and Handling of mix.
   4. Temperature of assessment

2. ***Mix Stability:*** This refers to stability or resistance to separation by the milk protein in an ice cream mix. This defect is caused by various factors which affect the colloidal stability of the milk protein, such as high mix acidity, low citrates and phosphate, high calcium and magnesium content, high homogenizing pressure, high heat treatment, low ageing time etc.

3. ***Specific Gravity:*** Specific gravity or density of an ice cream mix varies with its composition and may range from 1.05 -1.12.

4. ***Surface Tension:*** This pertains to the attraction between the molecules of a liquid at its surface. The normal surface tension values of ice cream mix may range from 48 – 53 dyne/ sq.cm.

5. ***Freezing point:*** It depends on the soluble constituents and varies with the composition. Mix constituents which affect the freezing point directly are sugar, milk sugar, milk salt and any other substance in true solution. An average mix has a freezing point of about 27.5 $^{0}$ F.

6. ***Whipping rate:*** High whipping rate means the ability to whip rapidly to a high over run. Whipping ability is improved by high processing temperature, proper homogenization and ageing of mix.

- **Ice-Cream Ingredients and its Source**

  - ***Sources of Fat:*** Sweet Cream, Frozen Cream, Plastic Cream, Unsalted Butter, Butter oil.

  - ***Sources of Milk Solid Not Fat:*** Skim Milk, Skim Milk Powder, Condensed Skim Milk (plain/sweetened), and Sweet Cream Butter Milk, Whey Solids.

  - ***Sources of Fat and MSNF:*** Whole Milk and its Powder, Condensed Whole Milk (Plain/Sweetened), Evaporated Milk.

  - ***Sweetening Agents:*** Cane or Beet Sugar (Sucrose), Dextrose, Corn Syrup (Dextrose + Maltose), Invert Sugar (Glucose + Fructose), Saccharin.

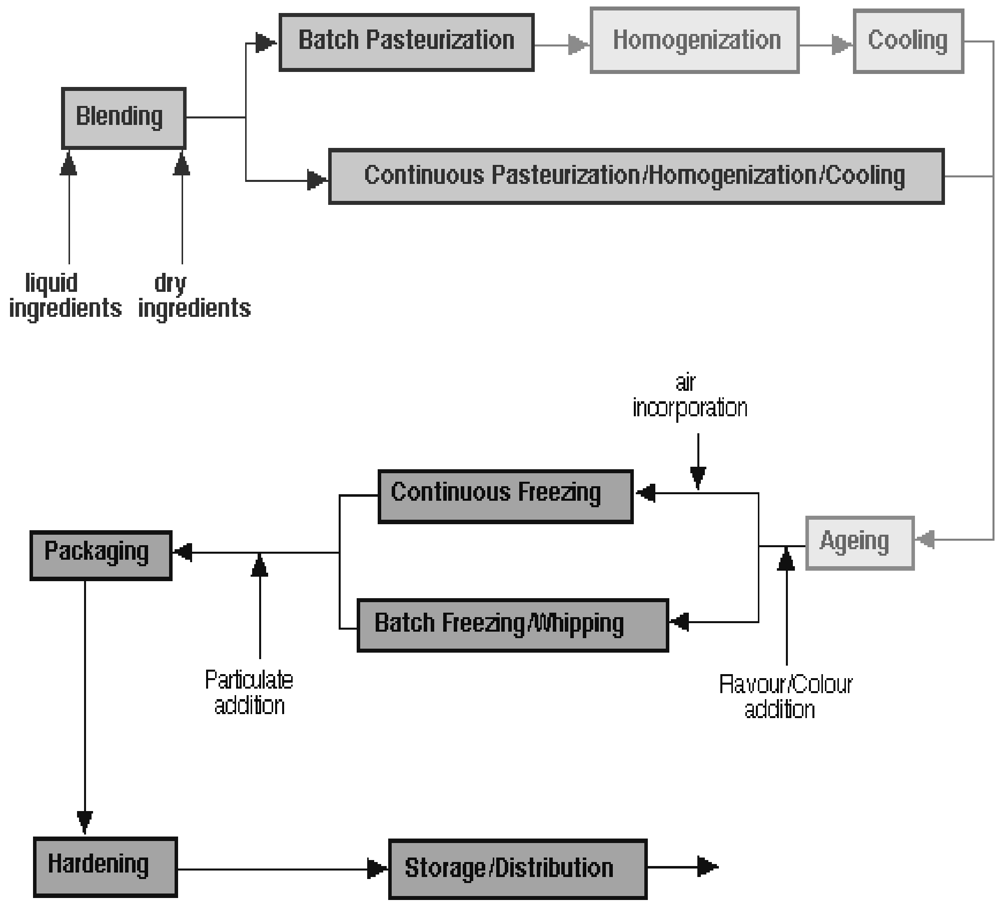
  - ***Stabilizers:*** Sodium Alginate, Guar Gum, Carrageenan, Carboxy Methyl Cellulose, Pectin and other Gums.

  - ***Emulsifiers:*** Mono- or di-glycerides of fat forming fatty acids.

- **Preparation of Ice-Cream**

The basic steps in the manufacturing of ice cream are generally as follows:

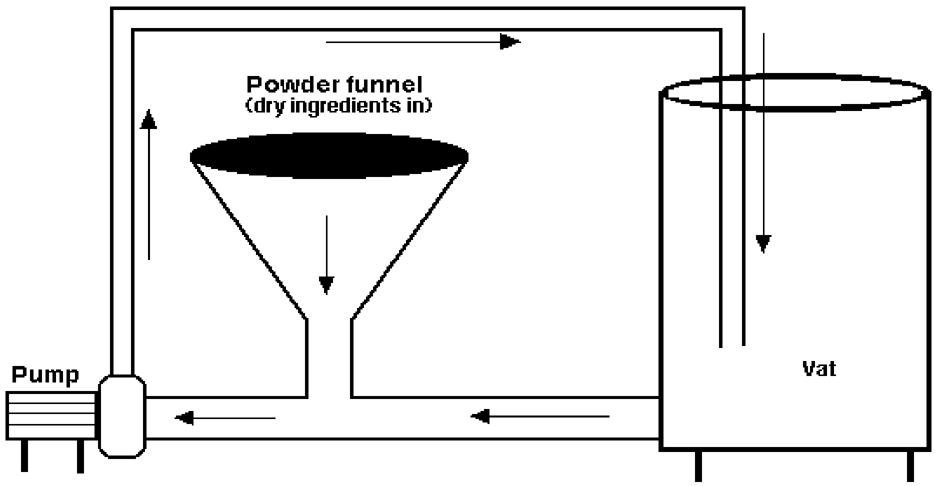
- blending of the mix ingredients
- pasteurization
- homogenization
- ageing the mix
- freezing
- packaging
- hardening




**<u>Process flow diagram for ice cream manufacture:</u>** the red section represents the operations involving raw, unpasteurized mix, the pale blue section represents the operations involving pasteurized mix, and the dark blue section represents the operations involving frozen ice cream.

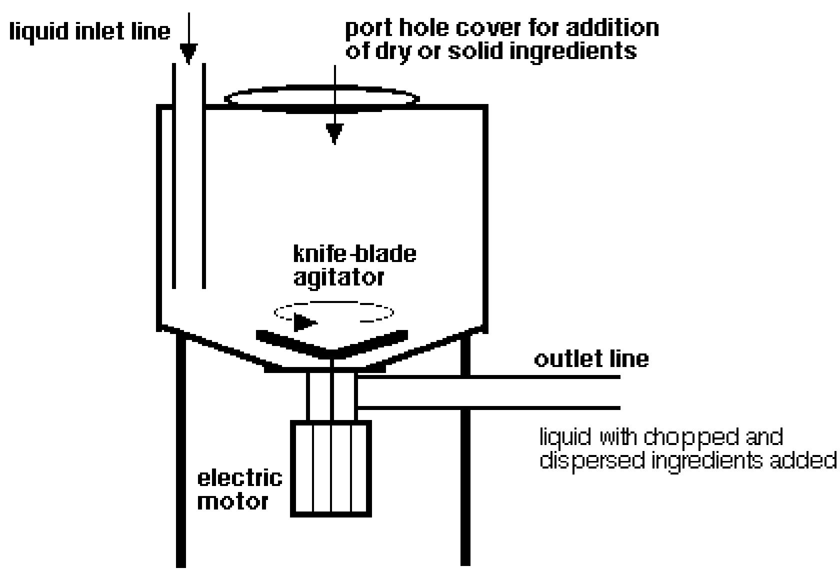
## ❖ <u>Blending</u>

- First the ingredients are selected based on the desired formulation and the calculation of the recipes from the formulation and the ingredients chosen, and then the ingredients are weighed and blended together to produce what is known as the "ice cream mix". Blending requires rapid agitation to incorporate powders, and often high speed blenders are used.




**Simple hopper device for incorporating dry ingredients into recirculating liquids**

**High shear blender for incorporating dry ingredients into ice cream mix.**



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## ❖ Pasteurization

- The mix is then pasteurized. Pasteurization is designed for the destruction of pathogenic bacteria. Pasteurization also reduces the number of spoilage organisms such as psychrotrophs, and helps to hydrate some of the components (proteins, stabilizers).

- Both batch pasteurizers and continuous (HTST) methods are used, which depends on quantity of ice cream mix to be prepared. Generally for preparing small quantity of ice cream mix i.e. less than 2000 liters batch pasteurizers is used and for the mix quantity more than that continuous high temperature short time pasteurization method is used.

**Batch pasteurizers** : Batch pasteurizer lead to more whey protein denaturation which some people feel gives a better body to the ice cream. In a batch pasteurization system, blending of the proper ingredient amounts is done in large jacketed vats equipped with some means of heating, usually steam or hot water. The product is then heated in the vat to at least 69 C (155 F) and held for 30 minutes.
The heat treatment must be severe enough to ensure destruction of pathogens and to reduce the bacterial count to a maximum of 100,000 per gram.

**Continuous pasteurization**: Continuous pasteurization is usually performed in a high temperature short time (HTST) heat exchanger following blending of ingredients in a large, insulated feed tank. Some preheating, to 30 to 40 $^{0}$ C, is necessary for solubilization of the components. The HTST system is equipped with a heating section, a cooling section, and a regeneration section.

Following pasteurization, the mix is homogenized by means of high pressures and then is passed across some type of heat exchanger (plate or double or triple tube) for the purpose of cooling the mix to refrigerated temperatures 4 $^{0}$C.

## ❖ Homogenization

- Homogenization of the mix should take place at the pasteurizing temperature. The high temperature produces more efficient breaking up of the fat globules at any given pressure and also reduces fat clumping and the tendency to thick, heavy bodied mixes. The higher the fat and total solids in the mix, the lower the pressure should be. If a two stage homogenizer is used, a pressure of 2000 - 2500 psi on the first stage and 500 - 1000 psi on the second stage is quite satisfactory. Two stage homogenization is usually preferred for ice cream mix. Clumping or clustering of the fat is reduced thereby producing a thinner, more rapidly whipped mix. Melt-down is also improved.

- Homogenization helps to forms the fat emulsion by breaking down or reducing the size of the fat globules found in milk or cream to less than 1 µ m. Homogenization provides the following functions in ice cream manufacture:
    - Reduces size of fat globules
    - Increases surface area
    - Forms membrane
    - Makes possible the use of butter, frozen cream, etc.

**Two Stage Homogenizer**

- **Ageing**

The mix is then aged for at least four hours or usually overnight. This allows time for the fat to cool down and crystallize, and for the proteins and polysaccharides to fully hydrate.

Ageing provides the following functions:

- Aging is performed in insulated or refrigerated storage tanks, silos, etc. It has a cooling jacket, agitator, spray balls for cleaning, inlet and out let valve and temperature indicator. Mix temperature should be maintained as low as possible without freezing, at or below 5 C. An aging time of overnight is likely to give best results under average plant conditions.
- Improves whipping qualities of mix and body and texture of ice cream
- Provides time for fat crystallization, so the fat can partially coalesce;
- Allows time for full protein and stabilizer hydration and a resulting slight viscosity increase;
- Allows time for membrane rearrangement and protein/emulsifier interaction, as emulsifiers displace proteins from the fat globule surface. This favours partial coalescence of fat during freezing.

**Aging Tank**

- **Freezing**

  - Following mix processing, the mix is drawn into a flavour tank where any liquid flavors, fruit purees, and/or colour is added. The mix then enters the dynamic freezing process which both freezes a portion of the water and whips air into the frozen mix. The "barrel" freezer is a scraped-surface, tubular heat exchanger, which is jacketed with a boiling refrigerant such as ammonia or Freon. Mix is pumped through this freezer and is drawn off at the other end in a matter of 30 seconds, (10 to 15 minutes in the case of batch freezers) with about 50% of its water frozen. There are rotating blades inside the barrel that keep the ice scraped off the surface of the freezer and the dashers inside the machine help to whip the mix and incorporate air.

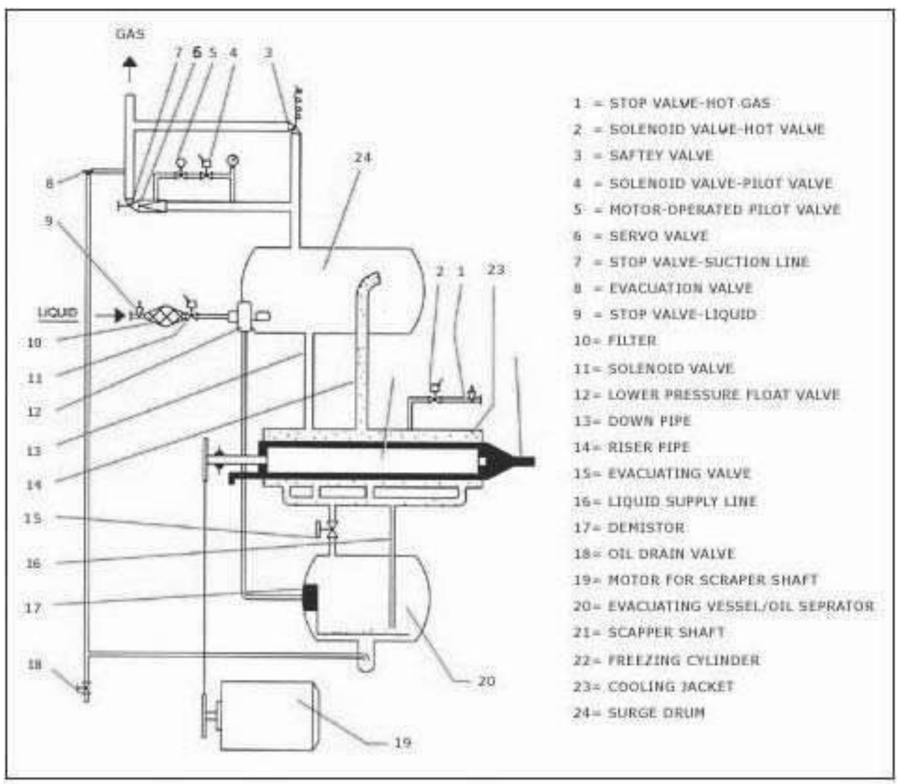
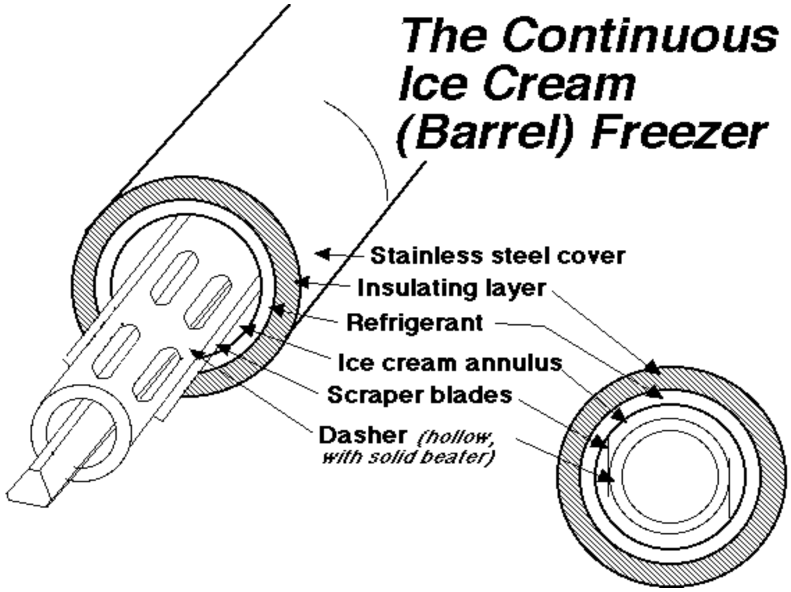



**Fig. 2- Flooded arrangement for ice cream freezer**
**Courtesy of Gram Equipments, Denmark**




- As the ice cream is drawn with about half of its water frozen, particulate matter such as fruits, nuts, candy, cookies etc, is added to the semi-frozen slurry which has a consistency similar to soft-serve ice cream. In fact, almost the only thing which differentiates hard frozen ice cream from soft-serve, is the fact that soft serve is drawn into cones at this point in the process rather than into packages for subsequent hardening.

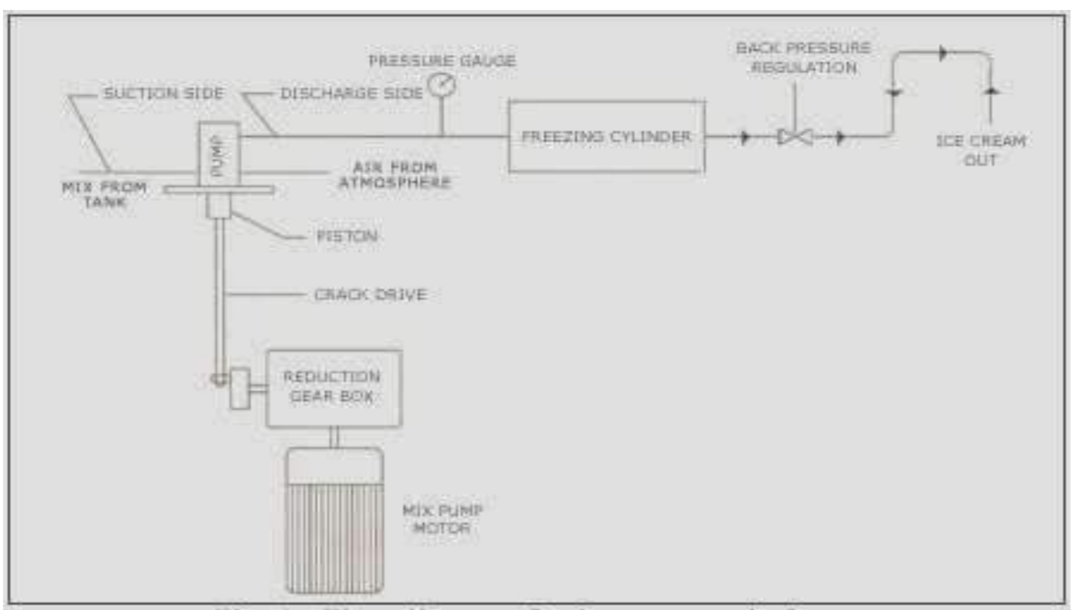



**Fig. 4 - Flow diagram for ice cream mix freezer**

## Packaging of Ice Cream

- When ice cream is drawn from the freezer, it is usually collected in containers which give it the desired shape or size for convenient handling during the hardening and marketing processes.
- The major and basic requirements for packages of ice cream is to give protection against contamination, attractive appearance, ease of opening and reclosure, ease of disposal, protection against moisture loss and temperature fluctuations.
- Most bulk ice cream is packaged in fiber board cartons coated with wax or polythene-wax blends for protection against moisture and oxygen. The most recent trend is plastic cylindrical container with a recloseable lid.
- Retail ice cream is packaged in cups, stick or bars. Cups may be of paper or cardboard specially made to avoid moisture loss.

## Hardening

After the particulates have been added, the ice cream is packaged and is placed into a blast freezer at -30° to -40° C where most of the remainder water is frozen. Below about -25° C, ice cream is stable for indefinite periods without danger of ice crystal growth; however, above this temperature, ice crystal growth is possible. This limits the shelf life of ice cream.

## Over Run in Ice Cream

- Ice cream contains a considerable quantity of air, up to half of its volume. This gives the product its characteristic lightness. Without air, ice cream would be similar to a frozen ice cube. The air content is termed its overrun, which can be calculated mathematically.
- Over run is usually defined as the volume of ice cream obtained in excess of the volume of the mix. I t is usually expressed in percentage.
- This increased volume is composed mainly of the air incorporated during the freezing process.

- The amount of air which is incorporated depends upon the composition of the mix and the way it is processed and is regulated so as to give that percentage of overrun or yield which will give the proper body, texture and palatability necessary to a good quality product.
- Too much air will produced a snowy, fluffy, unpalatable ice cream while too little over run results in to a soggy, heavy product.
- The control of overrun is very important and should be as nearly constant as possible from batch to batch and from day to day.

There are two basic or fundamental methods for calculating percentage overrun i.e. by volume land by weight:

$$\text{(i) \% Overrun} = \frac{\text{(Volume of ice cream)} - \text{(Volume of mix)}}{\text{Volume of mix}} \times 100$$

$$\text{(ii) \%Overrun} = \frac{\text{(Weight of unit volume of mix)} - \text{(Weight of unit volume of ice cream)}}{\text{Weight of unit volume of ice Cream}} \times 100$$

- **Cold Room Storage and Dispatch**

**Cold Room Storage:** After hardening ice cream goes to cold room where it gets stored at -18 $^{0}$C till it is dispatched.

**Dispatch:** It involves great sense of responsibility, efficiency, commitment and accuracy.

**It involves various activities like :**

- To load the refrigerated vans for transport of ice cream.
- To send the order at committed time and place.
- To check and avoid any sort of damage during loading, transportation and unloading.
- To take care about sending bills to distributors as well as collecting DD, checks and cash regarding payment of bills from distributors.

- To take care about the start route i.e. clearing demands of all distributors, which are coming in that route, so that additional transportation cost, is avoided.

**FORMS OF DISPATCH**

- **REFRIGERATED TRUCKS / VANS:** The truck is refrigerated first to attain the required temperature, for a particular period of time. Then it is loaded with hardened ice cream from cold storage.

- **FROZEN PADS OF BRINE:** A Eutectic pad which is jacketed flat metal container containing calcium chloride solution. Temperature around –21°C is attained by putting this pad in the same brine solution at the temperature around -32°C and having specific gravity of 1.26. This pad is kept around the packed ice cream in a big metal box. This type of arrangement is generally used for small routes and for small quantities of ice cream.

- **PLASTIC AND METAL CONTAINERS HAVING DRY ICE :** It is extensively used for transportation of ice cream for short as well as for long distance. It is very old procedure of retailing and transportation of ice cream. Dry ice is broken down in small pieces and wrapped in paper to avoid rapid evaporation, and placed around packages of ice cream in metal or plastic containers by keeping air tight arrangement.

A FLOW CHART FOR COMMERCIAL PREPARATION OF ICE CREAM

**Skimmed Milk powder // Cream // Milk // Sugar // Emulsifiers & Stabilizers**

**Making the Mix**

↓

**Pasteurizing the mix**

↓

**Batch Process**
**(68°C for 30 min)**

**Continuous Process**
**(83-85°C for 25 second)**

↓

**Homogenizing the mix**
**(1st Stage – 2500psi, 2nd Stage- 500psi)**

↓

**Cooling to (0 to 6°C)**

↓

**Ageing the mix in ageing tank (<10°C)**

↓

**Freezing the mix [-4 to –5°C]**
**[Batch or Continuous Freezer]**

↓

**Packaging of ice cream (-4 to -5°C)**

↓

**Hardening Tunnel (-35°C)**

↓

**Cold Storage of ice cream (-23 to -29°C)**

↓

**Dispatch of ice cream (-18 to -25°C)**

## PROCESS FLOWCHART FOR ICE CREAM CUP VARIETIES

Continuous freezer

↓

Ice cream at –4 to –6°C

↓

Toppings (opt.) of sauces, choco mix → Automatic cup filling machine ← Nut or fruit feeder (opt.)

Pneumatically operated by adjusting strokes of piston

Suckers are there to lift cups and lids from cup and lid loader → Automatic cup filling machine

↓

Product is lifted from bottom

↓

Fall-out on horizontal surface

↓

Packing manually in corrugated fiber boxes

↓

Hardening tunnel

↓

Cold storage

**PROCESS FLOW CHART FOR CONE VARIETIES**:

*Continuous freezer*

↓

Ice cream at –4 to -6°C

↓

Granule distribution

Topping (pneumatically operated)

Ice cream from freezer doser

Suction of lid from lid loader

Automatic filling machine

Wafer chocolate spray

Lifting of cone from its edge

Manual loading of cone wafer

↓

Ejecting out horizontally

↓

Hardening tunnel (-35°C)

↓

Packaging in CFB

↓

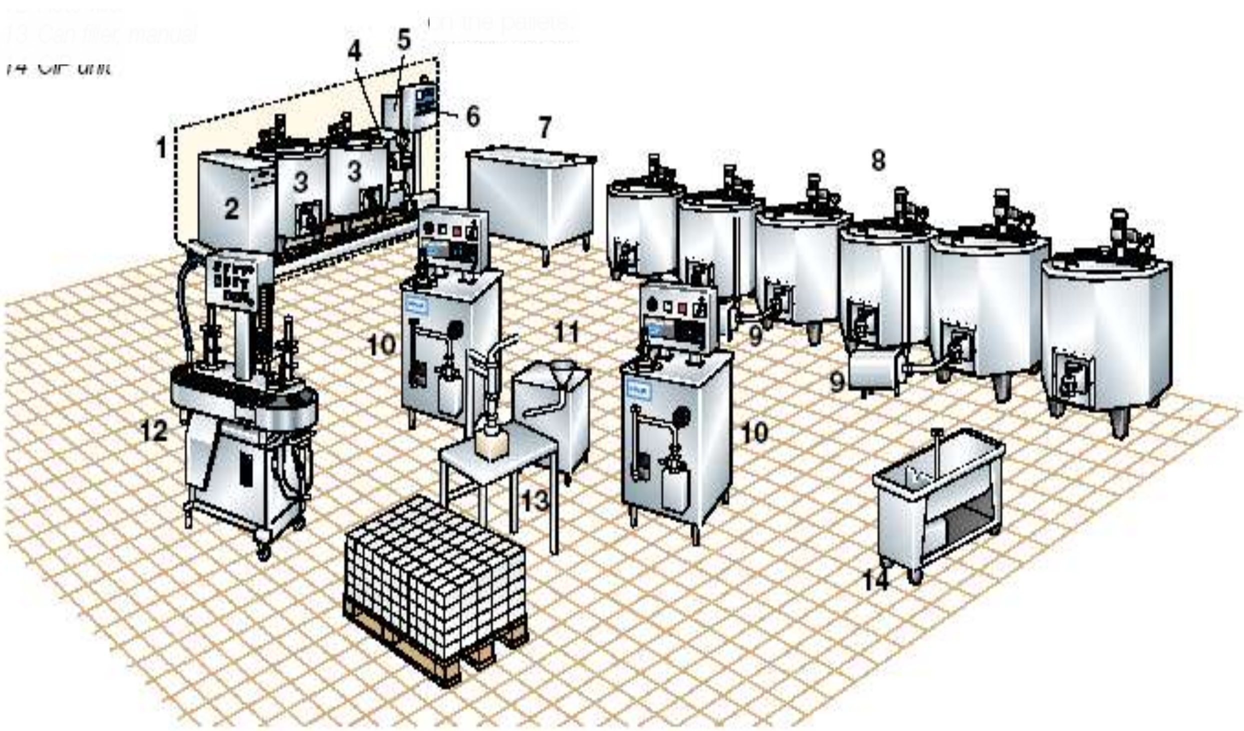
Cold-storage

## ➢ <u>**Ice Cream Defects**</u>

The type of defects that can manifest in ice cream includes

- Flavor Defects
- Body and Texture Defects
- Melting Quality Defects
- Colour and Appearance Defects
- Shrinkage Defect

➢ The below figure shows the production plant for 500 liters per hour of ice cream products.



## MAJOR ASPECT CONCERNING ICE CREAM MANUFACTURING

### ➢ NEED AND IMPORTANCE OF QUALITY CONTROL IN ICE CREAM

It is very much important to control and maintain quality of ice cream in all aspect i.e. right from quality of raw material to final product. As ice cream is consumed by children to aged people, from healthy to sick person, so it is much more essential to maintain quality in case of ice cream.

**Various kinds of defects can occur in commercial ice cream because of use of low quality ingredients, improper handling, misleading the set process and methods of production, improper storage, unhygienic environment, and improper transport.**

**Any Good ice cream can remain edible for almost 1 year if it is made with proper ingredient, standard procedure, proper storing, good handling, accurate storage temperature, proper transport and by keeping under hygienic condition.**

The quality of ice cream can be judged and analyzed with the help of different chemical, physical and biological tests. For this purpose quality control laboratories and section is established and the purpose of achieving set quality standards gets fulfilled.

Various tests and observations which are done for controlling the quality of ice cream are as follows:

- Checking the temperature of butter cold storage and raw material cold storage.
- Checking Adulteration in milk and cream.
- Performing all kind of various bench tests for milk and cream, i.e. checking fat, SNF, acidity, temperature, organoleptic test, etc.
- Analysis of ice cream mix temperature regularly and periodically.
- Checking the same for final finished ice cream.
- For nut Variety: checking its nut weight, organoleptic test, overrun, temperature, acidity, weight of ice cream, fat%, protein%.

- For pain variety: checking its weight, overrun, temperature, acidity, fat%, protein%, organoleptic test.
- For Cone variety: checking its cone toppings, sogginess, volume of chocolate at bottom, organoleptic test, nut contents and its weight, top breakage, ice dream acidity, final weight, volume of total ice cream in it.
- For Stick variety: Checking its overrun.
- Checking the CIP practices followed in plant.
- Checking and maintaining required specific gravity of brine solution of each and every candy tank.
- Taking care of hygienic aspect during handling and processing of ice cream.
- Checking the COD (Chemical Oxygen Demand) and BOD (Biological Oxygen Demand) of incoming effluent water and treated effluent water

❖ **<u>Testing for Raw-Material</u>**

- Dry fruits length, colour, shape and quality.
- Check for adulteration.
- Check for bacterial contamination.
- Quality of fruits.
- Weight of cone wafers, pastry and other commodities.
- Organoleptic test of various commodities.
- Manufacturing and expiry date in case of essence and colour.
- Finding $^0$ Brix and total solids and also organoleptic test in case of squashes.

❖ **<u>Testing for Packaging Material</u>**

- Breaking Strength
- Gram per Square Meter
- Printing Quality
- Locking of Folders and Packs
- Cup and Lid Diameter
- Volume
- Number of Corrugated fiber layers, etc.

## QUALITY ASSURANCE FOR ICE CREAM

In addition to Quality Control another tool known as Quality Assurance Department is established to achieve Total Quality Management (TQM) approach is to implement quality factor in the entire company. TQM covers business plan and strategies, manufacturing, production technology, marketing and sales, customer satisfaction, personnel administration and finance. It is organizational approach towards quality.

- Line inspection of entire company
- Laboratory control.
- Product development (Research & Development).
- Factory sanitation and microbiological aspect.
- Customer Relation and Satisfaction by undertaking consumer complaints.
- Inspection, checking and passing of in coming raw-material and packaging material.

Other major functions of Quality Assurance and Quality Control are as follows:

- In process testing
- Microbiological Testing to check Total Viable Count, Coliform Count, Yeast and Mould count and pathogen testing
- Taking care of consumer complaints
- Random Testing of finished product
- Record Keeping and updating of standards of quality

## CLEANING IN PLACE (CIP)

For safety and quality of final product proper cleaning and sanitization of equipment is must. Cleaning implies the removal of dust and foreign matter from the surface of each machine and connecting and supply pipe lines. While sanitization implies the destruction of all pathogenic and almost all non-pathogenic micro-organism from equipment surface and inside the pipe lines. It is also called Sterilization. Cleaning in Place refers to that system of cleaning and sanitization, which does not require any dismantling of equipments and lines.

In any ice cream manufacturing unit high level of CIP system in followed. It includes cleaning and sanitization of all vats, kettles, storing and ageing tanks, circulating pipe lines, continuous freezers, all handling and processing equipments.

➢ **STEPS FOLLOWED FOR CLEANING IN PLACE(CIP)**

- **For Ageing Tank:**

  First it is rinsed with clean water to drain of all sticking mix inside it and it is also washed from outside to clean dust or any foreign matter sticking to it. Then wash with washing solution. Then with the help of spray balls caustic solution at $80^0$C is sprayed. Then again rinsing it with water at $80^0$C. Finally steaming is done inside the tank for 15 minutes.

- **Mix Circulating Pipe Lines:**

  After the end of production, firstly hot water at $80^0$C is passed through these lines. Then caustic solution is passed through these pipe lines at $80^0$C. Then finally circulation of hot water is done.

- **Vats and Kettles:**

  Water is heated in the vat and kettle with the help of steam around 80 to $90^0$C. Then caustic solution is added in that heated water. After sometime it is drained out and again it is thoroughly rinsed with hot water properly. Final treatment is done with steam.

- **Continuous Freezers:**

  After completion of ice cream production, the flavour tank is rinsed properly by clean water. Then water is passed inside continuous freezer so that ice-cream remaining inside is taken out. Then the specified solution as per freezer manufacturer specification is passed inside it for proper cleaning. Then again water is passed through it.

- **Crates:**

Lots of plastic crates are used for handling, transport and carrying ice-cream. As it in direct contact with ice-cream it is essential to clean and sanitize it. Automatic Crates Washer machine is available or manually it can be cleaned by hot water and steam, which cleans and sanitize all kinds of plastic crates.

**PROCESS OF CIP**

**Circulation of Well Water**

↓

**Circulation of ( 1 % ) lye solution at 80$^0$C for 30min.**

↓

**Circulation of hot water at 80$^0$C for 10min.**

↓

**Circulation of nitric acid solution 0.5% at 80$^0$ C for 20min**

↓

**Circulation of hot water at 80$^0$C for 10min.**

↓

**Circulation of well water**

## RAW- MATERIAL STORING & PURCHASING

### Introduction

Proper buying of materials and merchandise and control of stock are of great importance in any industry. The material must be bought of proper quality and size, at appropriate quantities and at appropriate time.

### PURCHASING DEPARTMENT

The purchase department takes care of each and every requirement needed in the company. The company has its own two stores namely Packaging material store and Raw material store.

### IMPORTANCE OF PURCHASE DEPARTMENT

Purchase department has to make available the needed stock at the required time so that the manufacturing operation is not interrupted. There has to be co-ordination between finance and purchasing department and has to function in close association with other departments.

The quantities in which purchases are to be made should be so decided as to be of greatest economic advantage to the company. The quantity to be ordered for each item will be decided after considering its rate of sales or consumption, the time required from order to delivery, the savings resulting from transportation rates or quantity discounts, safety margin to ensure against unexpected delays, and the prediction of the future business cycle.

There are many ways followed by the purchase department for buying materials like -

- Requirement purchasing
- Hand to mouth purchasing
- Group purchasing
- Forward purchasing
- Schedule purchasing
- Market purchasing
- Speculative purchasing

The packaging material store should be well designed so that no damage due to moisture, water, rain, sun or wind occurs. Particular amount of each and every packaging material is stocked so that no stock out situation occurs.

**RAW MATERIAL SECTION**

This section is the life line of any company. It is the section from where requirements of each and every department are fulfilled. Raw material department of any industry or a food processing industry has a vital role to play in it. The final product quality is mainly dependent on the quality of raw material used.

Raw material section of any food industry requires suitable hygienic conditions, proper floor and storage place, proper cold storage section for perishable items, proper temperature and humidity that depends on kind of goods to be stored.

'**FIRST IN FIRST OUT**' principle should be adopted.

- PLANT MAINTENANCE

It is one of the important sections of any company. It takes care about all utility, which are used to perform all the activities in company. It takes care about the maintenance and proper working of each and every machine used for Ice cream manufacturing like continuous freezers, homogenizers, pumps, motors, compressors etc.

- It provides maintenance facility to all other departments.
- Operating and taking care of whole Refrigeration system, by which proper temperature in hardening, cold storage, candy tank, candy tunnel and raw materials cold store is achieved.
- It provides compressed air for the pneumatically operated automatic packaging machine.
- It takes cares of all pumps, control panel, instruments, electric supply of whole company.
- Boiler plant which supplies steam wherever required in the entire plant is taken care by this section.
- It provides chilled water for ice cream mix ageing and storing tank.
- It makes necessary arrangement for any civil, mechanical and electrical work.
- Takes care of each and every electrical and electronics devices.

Maintenance section is equipped with

- Refrigeration plant
- Boiler plant
- Water softening plant
- Air compression system
- Electrical supply
- Workshop
- Effluent Treatment Plant

Maintenance staff should be highly skilled and experience one. Stocks of various required equipment and spare parts should be also kept. Classification of the people working in maintenance should have combination of all different engineering and technical field e.g. electrician, fitter, welder, refrigerant plant operator, helper, and there respective section engineer.

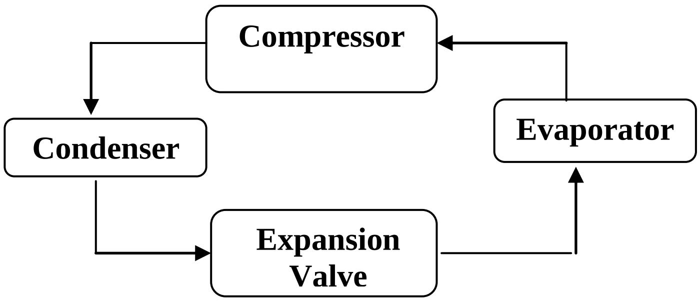
➢ REFRIGERATION PLANT

Mostly refrigeration system used in any commercial ice cream company is Vapor Compression System utilizing ammonia as a refrigerant. The refrigeration plant installed should meet the entire refrigeration requirement of the ice cream plant. It includes :

- Raw Material Cold Store
- Cold Room
- Butter Cold Store Room
- Hardening Room and Tunnel
- Ice cream Storage Room

## REFRIGERATION

### Refrigeration Cycle




| High Side | Low Side |
|---|---|
| High Pressure | Low Pressure |
| High Temperature | Low Temperature |

**Flow Chart for Refrigeration Cycle**

Liquid Ammonia Receiver

↓

Gas Liquid Cooler

↓

Liquid Accumulator (-40°C)

↓

Pressure Reducing Valve

Ammonia Liquid Header

liquid goes to the evaporating coil

↓

Candy Tank & Candy Tunnel | Hardening Tunnels | Cold Rooms | Raw Material & Butter Cold Store

↓

Liquid Accumulator (-40°C)

↓

Ammonia vapor goes to low stage Booster Compressor

↓

High Pressure

↓

Gas Liquid Cooler

↓

High stage suction of compressor

↓

Compressed ammonia vapor goes to oil separator

↓

Shell & Tube Condenser

↓

Liquid Ammonia Receiver

DIFFERENT EQUIPMENT AND THEIR FUNCTION

- Receiver: **This is the tubular shell which stores the refrigerant.**
- **Liquid Accumulator:** Refrigerant through expansion valve accumulates here and from here, it goes to the evaporator coil
- **Water Chiller:** Chilling of water , used to cool mix in ageing and storing tank
- **Compressor:** Low temperature and low pressure compressed to high temperature and high pressure gas.
- **Oil Separator:** To separate oil from high pressure ammonia gas.
- **Economizer:** It is used in liquid line solenoid valve, suction line check valve, thermo-static expansion valve.
- **Condenser:** Shell and Tube Condenser is used to condense the high-pressure gas to high pressure liquid.
- **Cooling Tower:** To supply cool water to condenser.
- **Booster Compressor:** Make the low temperature vapor to high temperature.

Nearly all commercial ice cream plants and particularly the larger plants, use ammonia as a refrigerant. However, refrigerant R-22 is used in smaller plants. Freezing equipment such as batch freezer, small size continuous ice cream freezer, refrigeration aging vat, surface cooler for cooling ice cream mix, ice cream storage cabinets etc. Use R-22, R-12 and R-134a refrigerants.

For economy and safe operation it is recommended to use a multistage ammonia compression system. It is an acceptable practice to select a evaporator temperature of - $40^0$C, - $30^0$C and - $10^0$ C for hardening room, continuous freezer and cold store and ice bank systems respectively. Hence one or more booster compressors are used for different suction pressures and discharge into a second stage.

**Multi Stage Compressor System**

Many plants use an in - built two-stage compressor and select the number of cylinders for low stage and high stage on the basis of application. A separate compressor is used for high temperature refrigeration (for cooling of mix and ingredients cold store).

**SOME IMPORTANT POINT ABOUT REFRIGERATION PLANT:**

- Sulfur Candle Test detects ammonia leakage. In which a dense white fume shall indicate the leakage of ammonia.
- While entering a room with ammonia leakage, put the mask approved for ammonia use or spray water to the plant, which absorbs ammonia
- Oil level should be determined at mid way in the top sight glass provided on the oil separator.

**SAFETY MEASURES TO AVOID AMMONIA LEAKAGE:**

- The ammonia bottle should be stored separately where no other gas bottle is stored.
- Full or empty bottle should be stored horizontally; if vertically then tight fastened so that no falling over takes place.
- It should not be exposed to direct sun light and temperature exceeding 59°C or lower than -10°C.
- It should not in contact with water or alcohol.
- Servicing of each and every valve tapings should be periodically done.

If some leakage is found proper action should be taken immediately. Nearby water valve is kept in case any big ammonia leakage as water absorbs ammonia. First aid kit should also be kept in case of any accident.

**DAILY CHECKLIST:** ( every one hour interval )

- Ammonia level in the receiver.
- Cold water forward temperature.
- Cold storage temperature.
- Hardening room temperature.
- Candy tank and candy tunnel temperature.
- Butter cold storage temperature.
- Raw material cold storage temperature.
- Cooling tower water level.
- Water level in condenser and cooling tower pump is also check.
- Temperature of ageing tank and storing tank of mix section.
- Total operational hours of compressor.
- Defrosting start and stop time.
- Ice thickness.
- Cooling tower pump start and stop time.
- Total bore water consumption.
- Electric current supply available in refrigeration control panel.
- Volt consumed.

**BOILER SECTION**

Boiler is one of the essential equipment in any food industry, which generates steam. Boiler is a pressure vessel in which heat is produce by combustion of fuel to transform water into steam at desired temperature and pressure. It is a high-pressure device so appropriate safety measures are exercised.

**WORKSHOP:**

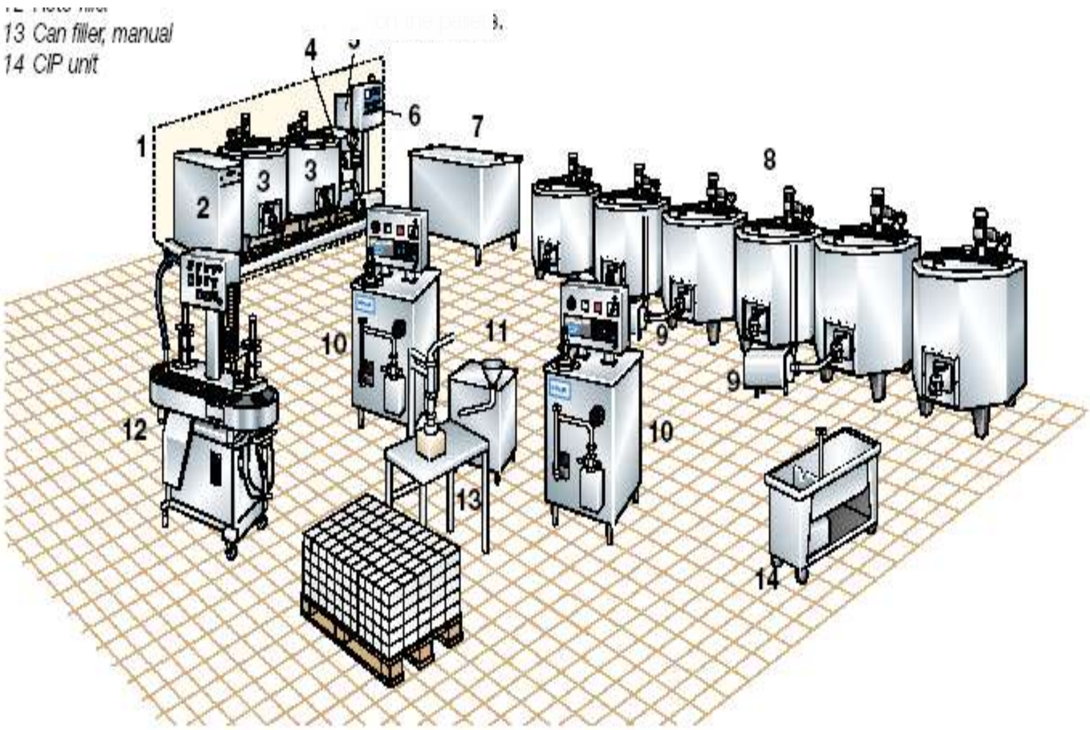
Maintenance and repairing of each and every machine and equipment are taken care of here. Various operations like wielding, replacing of spare parts, servicing, painting and lubricating etc. is done here. A professional approach should be followed to solve each and every problem. In rare cases external assistance is also taken

EFFLUENT TREATMENT PLANT

- All kind of effluent water from the dairy plant enters into this plant for treatment purpose. Different drain lines collect effluent water in a common drain line.
- The first unit after common drain line is collection tank. From this collection tank plastic pieces, different floating matters, candy sticks and various other solid matters is taken out manually with the help of coarse screens.
- The effluent water is allowed to sediment in this tank for certain period of time and regularly the flocculated solid is taken out from it.
- Next the effluent is sent to equalization tank with the help of pump. At equalization tank, effluent is homogenized flow wise through circulation. Here mixing and homogenization is achieved by coarse bubble aeration by provision of air blower. Here flocculants so formed is separated
- In aeration tank aerobic biodegradation of organic content take place due to development of microorganisms. Necessary oxygen required to maintain aerobic condition is supplied by suitable aeration system. Recycling of effluent water is done at aeration tank
- The sludge so obtained is sent to sludge drying beds. After checking BOD & COD of the final treated water it is collected into a treated waste water sump. If the value of BOD & COD of treated effluent is within the permissible limit then from here it is pumped and passed through pressure sand filters and disposed into disposal pipeline.

CVSRTA

➢ Figure shows the production plant for 500 liters per hour of ice cream products.




1. Ice Cream mix preparation module containing
2. Water heater
3. Mixing and processing tank
4. Homogenizer
5. Plate heat exchanger
6. Control Panel
7. Cooling water Unit
8. Ageing Tank
9. Discharge Pump
10. Continuous freezer
11. Ripple pump
12. Roto-filler
13. Can filler, manual
14. CIP Unit

## TECHNICAL SPECIFICATIONS OF PLANT AND MACHINERY IN AN ICE CREAM PLANT :

### A. PRODUCTION

1. Mixing/Ageing Tanks

| | | |
|---|---|---|
| Capacity | : | 1,000 litres |
| Type | : | S.S. conical bottom cylindrical vessel |

Dimensions:

| | | |
|---|---|---|
| Diameter | : | 1,140 mm |
| Straight height | : | 1,085 mm |
| Leg height | : | 600 mm up to outlet V/V |

Agitator:

| | | |
|---|---|---|
| Type | : | Hygienic paddle type fitted with geared motor |
| Speed | : | 30 rpm |
| Power | : | 1 hp |
| M.O.C. | : | S.S. 316 |

Construction:

| | | |
|---|---|---|
| Inner shell and all product contact surfaces | : | S.S. 316, 4 mm thick |
| Intermediate | : | S.S. 304, 2.5 mm thick |
| Insulation (thermocol, high density) | : | 100 mm thick |
| Outer cladding | : | S.S. 304, 1.6 mm thick |

Pressure:

| | | |
|---|---|---|
| Vessel | : | 1 bar |
| Jacket | : | 2 bar |

Others:

- Complete with top conical disc and manhole

Fitted with

- sight glass in manhole cover
- adjustable ball feet
- proper spray ball for effective cleaning
- thermowell for gauge and probe
- pressure release vent / valve (for releasing jacket pressure)
- adequate supports and stiffeners
- S.S. geared motor cover

Connection:

- Mix outlet (at bottom center) (50 mm dia.) with S.S. 304 Butterfly valve
- Chilled water inlet (at side bottom) (25 mm) fitted with S.S. ball valve
- Chilled water outlet (at side top) (40 mm) fitted with NRV
- Drain (at bottom) (50 mm) fitted with brass gate valve
- Mix inlet (at top) (50 mm dia.) with S.S. 304 Butterfly valve

2. Homogenizer

| | | |
|---|---|---|
| Model | : | MC7 – 3TIBS |
| Capacity | : | 2,000 litre per hour |
| Design Pressure | : | 210 bar |
| Driving Power | : | 16 kw |

Maximum Product Temp. $90^{0}$ C

Homogenizing valve assembly

| | | |
|---|---|---|
| Type | : | 2 stage |
| Valve Material | : | Special wear resistant alloy |

Valve Type:

| | | |
|---|---|---|
| First stage | : | Gaulin “Dyna Jet” |
| Second stage | : | Piloted Type |
| Adjustment | : | Hand wheel operated |

Cylinder assembly including flat diaphragm type pressure gauge

| | | |
|---|---|---|
| Pump valves | : | Ball type |
| Pump valve seats | : | Tapered replaceable |
| Lungers | : | Special stainless steel |
| Cylinder block | : | Special stainless steel |
| Packing adjustment | : | Automatically, spring loaded |

Cast iron drive frame, designed to accommodate motor on adjustable motor rail underneath driving mechanism which includes integrated gear reduction, force feed oil lub system with independent electrically driven oil pump with 0.37 kw motor, oil cooler low oil pressure (LOP) safety switch and pulley drive.

| | | |
|---|---|---|
| Exterior finish | : | Stainless steel clad |
| Base type | : | Adjustable feet with rubber dampening pads |
| LOP switch type | : | Standard |
| Drive motor | : | 18.5 kw, 400V, 3 ph, 50 c/s,1500 rpm, type IP-54 |
| Make | : | APV Gaulins |

3. Pump

| | | |
|---|---|---|
| Capacity | : | 2,500 litres per hour |
| M.O.C. | : | S.S. 304 |

4. Pasteuriser

| | | |
|---|---|---|
| Capacity | : | 5,000 litres per hour |
| M.O.C | : | S.S. 304 |
| Type | : | HX |
| Make | : | APV |

5. Ice –cream Freezer

| | | |
|---|---|---|
| Type | : | Hoyer Frigus |
| Capacity | : | 600 litres per hour |
| Model | : | SF 600 N1 |
| Continuous ice-ream freezer capacity | : | 300 litres per hour |
| Mix inflow temperature | : | + $4^0$ C |
| I/C out feed temperature | : | - $6^0$ C |
| Solid content | : | 8 – 12% |
| Power of dasher | : | 5.5 kw |

| | | |
|---|---|---|
| Power of compressor: | | 10.5 kw |
| Pump motor | : | 0.75 kw |
| Auxiliary | : | 0.85 kw |
| Total installed power: | | 34.2 kw |

| | | |
|---|---|---|
| Water consumption: | | |
| $5^0$ C | : | 600 litres per hour |
| $15^0$ C | : | 1300 litres per hour |
| $28^0$ C | : | 3600 litres per hour |
| at minimum pressure: | | 2 kg per sq. cm. |

| | | |
|---|---|---|
| Refrigerant | : | R404 |
| Total quantity | : | 2.8 kg |

| | | |
|---|---|---|
| Air operating pressure | : | 4 to 8 bar |

6. Cone Filler

| | | |
|---|---|---|
| Model | : | ICE PACK 5000 |
| Capacity | : | Minimum 2500 pieces per hour<br>Maximum 5000 pieces per hour |
| Power supply | : | 220-380 V/3phase/50c/s. |
| Electrical Power | : | 1 kw |
| Heating System | | |
| Power | : | 0.5 kw |
| Drive motor | : | 0.48 kw |
| Vibrating system power: | | 0.02 kw |
| Working pressure | : | 6-7 bar |
| Make | : | Cattabrigga, Italy |

7. Cup Filler

| | | |
|---|---|---|
| Capacity | : | 3000 cups per hour |
| Cup size | : | 100 to 125 ml |

8. Lolly machine along with

Rollo machine

| | | |
|---|---|---|
| Model | : | Rollo – 32 |
| Maximum speed | : | 32 strokes per minute |
| No. of lanes | : | 14 |
| | | |
| Main motor power | : | 3 kw |
| Warm brine pump | : | 1.1 kw |
| Cold brine pump | : | 11 kw |
| Chocolate pump | : | 0.37 kw |
| Booster pump | : | 7.5 kw |
| | | |
| Brine quantity | : | 5,000 litres |
| Weight of brine | : | 6,500 kgs |
| Total weight including brine | : | 22,000 kgs |
| Overall dimension: | | |
| Total height | : | 2,750 mm |
| Table height | : | 1,450 mm |
| Width | : | 3,550 mm |
| Length | : | 5,260 mm |

Rollo wrapper

| | | |
|---|---|---|
| Model | : | Hoywrap ML 32-7 |
| Serial no. | : | Z415, 3768 |
| Main motor | : | 3 kw |
| No. of lanes | : | 7 |
| Air pressure | : | 4 to 8 bar |

R.T. machine

| | | |
|---|---|---|
| Speed | : | 25 strokes per minute |
| No. of lanes | : | 4 |
| Motor | : | 2 hp |
| Air pressure | : | 4 to 8 bar |
| Make | : | Rollatainer |

9. Fruit/nut feeder

| | | |
|---|---|---|
| Capacity | : | 3000 litres per hour |
| Drive | : | 1hp |

10. Ice-cream Hardening Tunnel

| | | |
|---|---|---|
| Model | : | 10TR |
| Capacity | : | 1200 litres per hour |

Suitable for 90 trays of 5’ x 2’ 15 gauge ss 316

11. Chilled store room/cold storage with refrigeration unit

| | | |
|---|---|---|
| Room size | : | 6 x 5 x 6 m |
| Skin materials | : | Pre-painted G.I. sheet |
| Temperature to be maintained | : | $2^0$ C to $4^0$ C |
| Product to stored | : | Raw material for ice cream |
| Refrigeration load | : | 7 kw |
| Pull down time | : | 18 hours |

Design parameters:
The refrigeration units are designed $4^0$ to $45^0$ C condensing and $-28^0$C evaporation temperature and suit to ambient temperature 40 to $50^0$C.

Compressor with suitable air-cooled condensing unit to withstand Indian tropical condition and evaporator coil with stainless steel hauling with inner grooved coils.

The evaporator and condenser fans are designed to suit for the both winter and summer session to maintain the required condition in all parameters.

Technical specification for refrigeration unit

| | | |
|---|---|---|
| Type of refrigeration unit | : | Split type |

Condensing unit:

The condensing unit is made up self-supporting steel frame with sealed compressor and Air-cooled condenser coil, fan motor, electrical control and it can be mounted on the floor within 7 mts. radius from the evaporator unit.

Evaporator:

The housing of the evaporator unit is made up of high quality 304a stainless steel, specially designed copper coil, self lubricated axial fans and consisting with all safety controls with defrost circuit with heaters and power saving flow controls. The indoor and outdoor unit is interconnected with copper refrigerant pipeline.

| | | |
|---|---|---|
| Model | : | ERCS 3000 x 2 |
| Condensing unit | : | Danfoss make |
| No. of unit | : | 2 nos. room size (6 x 5 x 6 m) |
| Compressor | : | Danfoss / Kirloskar |
| Cooling capacity | : | 7 kw |
| Power required | : | 4.3 kw x 2 |
| Power supply | : | 440 volts (+ 5 volts) 50 cycles |
| Condenser and evaporator fans | : | 0.75 kw |
| Thermostat-cum-Temperature display | : | Digital electronic control |
| Refrigerant | : | R404a |
| Condenser fans | : | G.E.C. |
| Evaporator unit | : | Eakcon make |

| | | |
|---|---|---|
| No. of unit | : | 2 nos. |
| Evaporator fans | : | EBM Nadi (imported) |
| No. of fans | : | 2 nos. |
| Condenser fans | : | GEC |
| Expansion valve | : | Danfoss / Alco (imported) |
| Solenoid valve | : | Danfoss (imported) |
| Drier | : | Danfoss / Sporian (imported) |

Electric control box
with all arrangement: 2 nos.

**12** CIP unit consists of S.S.jacketted tanks, pumps and filter

**13 Piping installations**

1. Ammonia valves and fittings for ammonia refrigeration system.

   Consisting of -

   - Expansion valves of required size and quantity
     Type : Expansion, flanged with set
     Temperature
     applications : Low temperature, - $50^0$ C

   - Non-return valve of required size and quantity
     Type : Liquid, flanged with set
     Temperature
     applications : Low temperature, - $50^0$ C

   - Ammonia line valves of required size and quantity
     Type : Globe
     Temperature
     applications : Low temperature, - $50^0$ C

   - Solenoid valve with filter set (Castle) of required size and quantity
     Type : Flanged with set

Temperature
applications : High temperature

- Thermostatic expansion valve (Danfoss) of required size and quantity
  Type : Flanged with set
  Temperature
  applications : Range $-5^0$ to $-20^0$ C

- Back pressure regulating valve with CVP (Danfoss) of required size and quantity
  Type : Flanged with set
  Temperature
  applications : Range $-5^0$ to $-20^0$ C
  Make : Danfoss

2. Ammonia valves and fittings for ammonia refrigeration system Consisting of -

- Electronic float switch of required size and quantity
  Type : Threaded
  Temperature
  applications : Low temperature, - $50^0$ C
  Make : Sigma

- Dual safety valve manifold of required size and quantity
  Type : Threaded
  Temperature
  applications : High temperature
  Make : Superfreez

- Safety relief valve of required size and quantity
  Type : Threaded
  Temperature
  applications : Low temperature, - $50^o$ C
  Make : Superfreez

- Expansion valve of required size and quantity

  Type : Expansion, flanged with set

  Temperature applications : Low temperature, - $50^{o}$ C

  Make : Super

- Non-return valve of required size and quantity

  Type : Gas, flanged with set and Liquid, flanged with set

  Temperature applications : High temperature

  Make : Super

- Ammonia filter required size and quantity

  Type : Flanged with set

  Temperature applications : Low temperature, - $50^{o}$C

  : High temperature

  Make : Superfreez

- Ammonia flow indicator of required size and quantity

  Type : Flanged with set

  Temperature applications : High temperature

  Make : Superfreez

- Oil drain valve of required size and quantity

  Type : Needle

  Temperature applications : Range $-5^{0}$ to $-20^{0}$ C

  High temperature

  Make : Super

- Solenoid valve with filter set (Castle) of required size and quantity

  Type : Flanged with set

  Temperature applications : High temperature

  Make : Manik's

3. Compressed air piping (S.S. 304 schedule 10 pipe) of required size and quantity

4. Compressed air piping (GI ‘B’ class pipe) of required size and quantity

5. Raw water piping (GI ‘B’ class pipe) of required size and quantity

6. Chlorinated water piping (GI ‘B’ class pipe) of required size and quantity

7. De-chlorinated water piping (GI ‘B’ class pipe) of required size and quantity

8. Soft water piping (GI ‘B’ class pipe) of required size and quantity

9. Chilled water piping (GI ‘B’ class pipe) of required size and quantity

10. Glycol piping (GI ‘B’ class pipe) of required size and quantity

11. Steam supply and distribution piping (M.S. seamless IBR A-106 pipe) of required size and quantity
12. Ammonia high temperature piping (M.S. seamless,106, Grade ‘B’ pipe) of required size and quantity

13. Ammonia low temperature piping (M.S. seamless, A-333, Grade 6LT pipe)

14. S.S. conduit pipe

15. S.S. square pipe

16. PUF insulation

17. Hot insulation

18. Insulation

19. M.S., G.I. and Steel (Low and High temperature) pipeline fittings

20. S.S. Dairy pipes – (1.6 mm thick)

21. S.S. Sch 5 pipe

22. S.S. Unions
23. S.S. Bend

24. S.S. – 2 way plug valve with SMS unions

25. S.S. – 3 way plug valve with SMS unions

26. S.S. – NRV with SMS unions

27. S.S. – B/F valve with SMS unions

28. S.S. 304 rectangular pipe –
    Type : High polished

29. S.S. 304 square pipe –
    Type : High polished

30. PUF pipe section – 50 mm thickness
    Temperature : High quantity – 30
    Low quantity – 60

INDUSTRIAL MILK PROCESSING :

<u>Flow chart for Industrial milk processing</u>

Raw milk

↓

Chilling using surface cooler or Plate chiller

↓

Refrigerated storage in bulk cooler

↓

Preheat to $40^0$C

↓

Filtration of milk

↓

Clarification of milk
(removal of dust, dirt, leucocytes, etc.)

↓

Standardization of milk
(for specific fat and SNF contents)

↓

Pasteurization
Batch/Holder method, Minimum $63^0$C/30 minutes
HTST method, Minimum $72^0$C/15 seconds
UHT method, Minimum $138^0$C/1-2 seconds

↓

Immediate cooling to < $6^0$C

↓

Packaging
HTST method : Form-fill-seal machine in low density polyethylene sachets
UHT method: Aseptic packing in Tetrapaks

↓

Storage
LTLT/HTST – Refrigeration temperature (< $7^0$C)
UHT sterilised – at ambient temperature

Flow chart for pathway of milk in HTST pasteurizer

Sediment ↑

Raw chilled milk → Regeneration-I (40$^0$C) → Filtration/clarification → Regeneration-II (50$^0$C)

Balance tank ← (if less heated)

Cream → Cream pasteurizer → Cream storage (5$^0$C)

Cream separator Skim milk → Regeneration-III (65$^0$C) → Heating section (73$^0$C) → FDV →

Holding section (15 sec) → Regeneration-III(60$^0$C) → Regeneration-II (35$^0$C)

Regeneration-I (20$^0$C) → Chilling section (5$^0$C) → Pasteurized chilled milk storage tank

**Processing**

The processing operations for fluid or manufactured milk products include cooling, centrifugal sediment removal and cream separation, standardization, homogenization, pasteurization or sterilization, and packaging, handling, and storing.

**Cooling**

After removal from the cow by a mechanical milking machine, (at – 34$^0$C), the milk is rapidly cooled to $\leq$ 4.4$^0$C to maintain quality. At this low temperature, enzyme activity and microorganism growth are minimized. Commercial dairy production operations usually consist of a mi8lking machine, a pipeline to convey the milk directly to the tank, and a refrigerated bulk milk tank in which the milk is cooled and stored for later pickup. The pipelines, made of stainless steel, are usually cleaned by a cleaning-in-place (CIP) process. Bulk milk is pumped from the refrigerated bulk milk tank to a tanker and transported to a processing plant.

**Centrifugation**

Centrifugal devices include clarifiers for removal of sediment and extraneous particulates, and separators for removal of fat (cream) from milk.

*Clarification*

A standardizing clarifier removes fat to provide a certain fat content while removing sediment. Clarifiers have replaced filters in the dairy plant for removing sediment, although the milk may have been previously strained or filtered while on the farm. A clarifier has a rotating bowl with conical disks between which the product is forced. The sediment is forced to the outside of the rotating bowl where the sludge or sediment remains. Some clarifiers have dislodging devices to flush out the accumulated material. The clarified milk leaves through a spout or outlet.

Clarification is usually performed at $4.4^0$C, although a wide range of temperatures is used. The clarifier may be between the bulk milk tanker and raw milk storage tank, the raw milk receiving tanks and raw milks storage tank, the storage tank and standardizing tank, the standardizing tank and high temperature – short time (HTST) pasteurizer, the preheater or regenerative heater for raw milk and the heating sections of the HTST pasteurizer.

*Bactofugation*

The process is not used for ordinary fluid milk, but for sterile milk or cheese. Bactofugation is a specialized process of clarification in which two high velocity centrifugal bactofuges operate at 20,000 rpm in series. The first device removes 90% of the bacteria, and the second removes 90% of the remaining bacterial, providing a 99% bacteria-free product. The milk is heated to $77^0$C to reduce viscosity. From the centrifugal bowl there is a continuous discharge of bacteria and a high density nonfat portion of the milk (1-1.5%).

*Separation*

The original gravity-fed units incorporated air to produce foam and separators developed 5,000 – 10,000 times the force of gravity to separate the fat (cream) from the milk. Skimmed milk is used for standardization and the cream was used for butter and other fat-based dairy products. Separators in the 1990s are pressure or forced-fed sealed airtight units. The separator removes all or a portion of the fat, and the skimmed milk or reduced fat milk is sold as a beverage or ingredient in other formulated foods.

Separation is done between 32 and 38$^0$C, although temperature as high as 71$^0$C are acceptable. Cold milk separators, which have less capacity at lower temperatures, may be used in processing systems in which the milk is not heated.

Separating fat globules from milk serum is proportional to difference in densities, the square of the radius of the fat globule, and centrifugal force; and inversely proportional to flow resistance of the fat globule in serum, viscosity of the product through which the fat globule must pass, and speed of flow through the separator.

The ease with which the separated products leave the bowl determines the richness of the fat. Fluid whole milk enters the separator under pressure from a positive displacement pump or centrifugal pump with flow control (**Figure 1**). The fat (cream) is separated and moves toward the center of the bowl, while the skimmed milk passes to the outer space. There are two spouts or outlets, one for cream and one for skimmed milk. Cream leaves the center of the bowl with the percentage of fat (~ 30-40%) controlled by the adjustment of a value, called a cream or skim milk screw, that controls the flow of the product leaving the field of centrifugal force and thus affects the separation.

**STANDARDIZATION**

Standardization is the process of adjusting the ratio of butterfat and solids-not-fat (SNF) to meet legal or industry standards. Adding cream of high butterfat milk into serum of low butterfat milk might result in a product with low SNF.

A standardizing clarifier and separator are equipped with two discharge spouts. The higher fat product is removed at the center and the lower fat product at the outside of the centrifugal bowl. Accurate standardization is performed by sampling a storage tank of milk and adding appropriate fat or solids, or by putting the product through a standardizing clarifier and them into a tank for adjustment of fat and SNF.

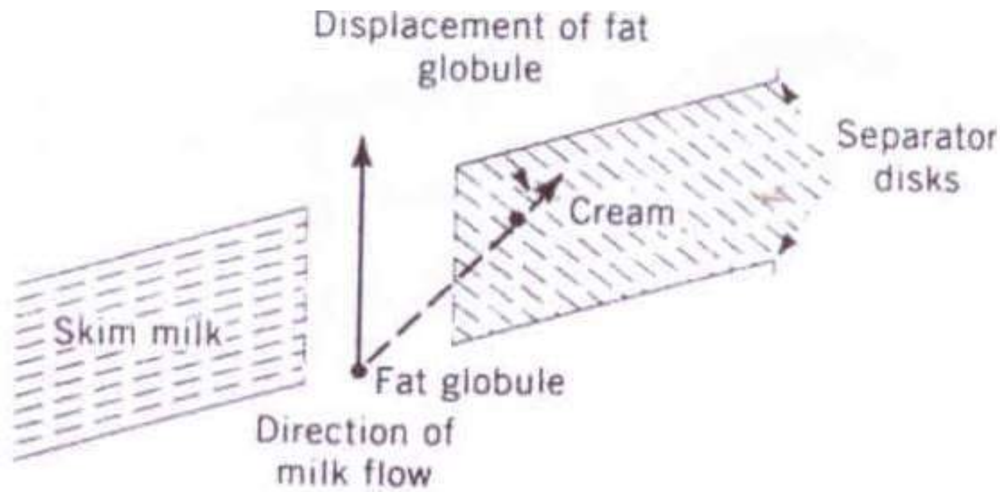



**Figure – 1 : Diagrammatic representation of fat globule separation in a centrifugal separator**

**Homogenization**

Homogenization is an integral part of a continuous HTST pasteurization. It is the process by which a mixture of components is treated mechanically to give a uniform product that does not separate. In milk, the fat globules are broken up into small particles that form a more stable emulsion in the milk. In homogenized milk, the fat globules do not rise by gravity to form a cream line as with untreated whole milk. The fat globules in raw milk are 1-15 µ m in diameter, they are reduced to 1-2 µ m by homogenization.

Milk is homogenized in a homogenizer. It is forced at high pressure through the small openings of a homogenizing valve by a simple valve or a seat, or a disposable compressed stainless steel conical valve in the flow stream (**Figure – 2**). The globules are broken up as a result of shearing, impingement on the wall adjacent to the valve, and to some extent by the effects of cavitation and explosion after the product passes through the valve. In a two-stage homogenizer, the first valve is at a pressure of 10.3-17.2 Mpa (1500-2500 psi) and the second valve at ~ 3.5 Mpa (500 psi). The latter functions primarily to break up clumps of homogenized fat particles, and is particularly applicable for cream and products with more than 6-8% fat.

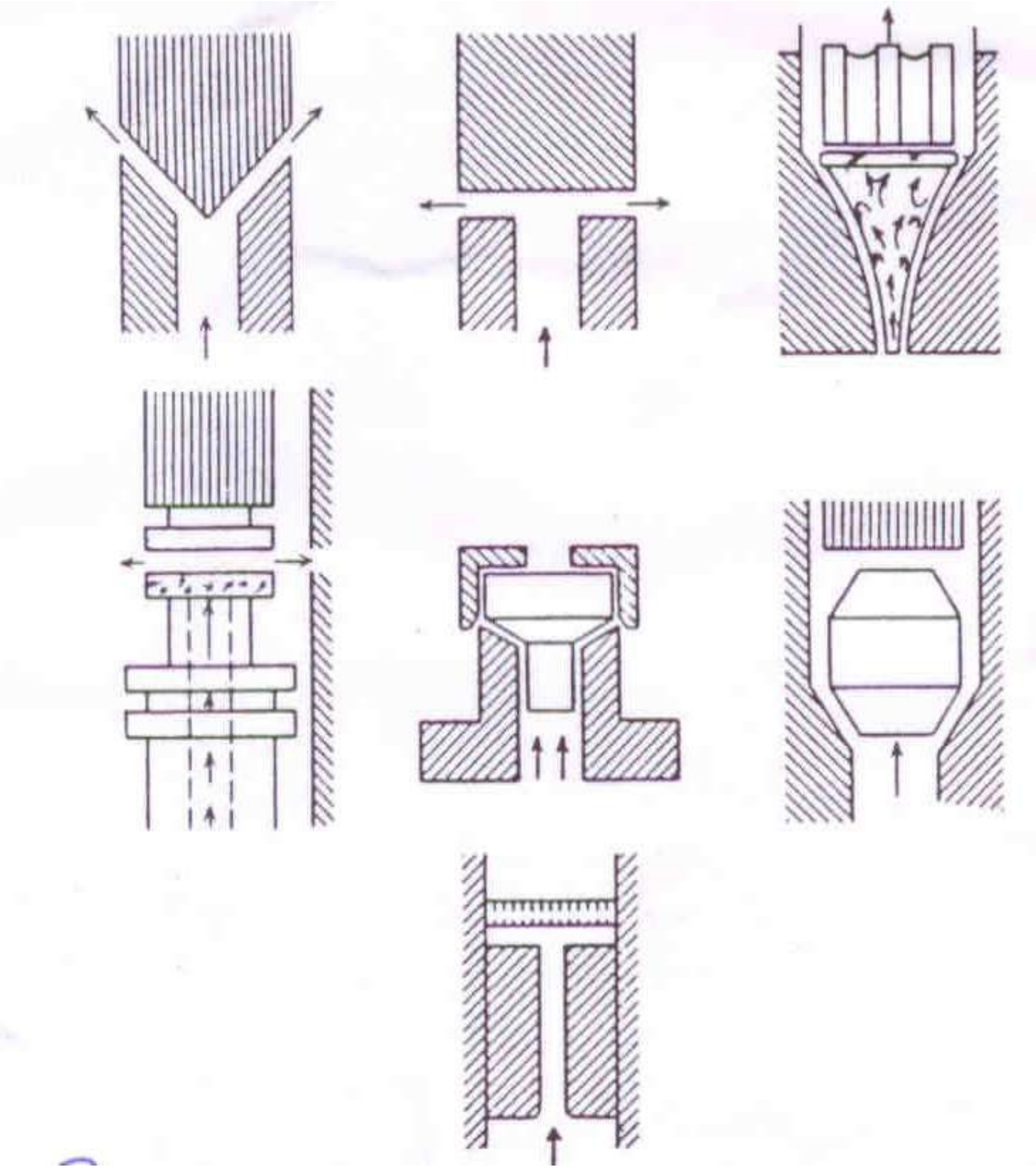


**Figure – 2 : Types of homogenizer valves based on velocity and impact**

A homogenizer is a high pressure positive pump with three, five, or seven pistons, that is driven by a motor and equipped with an adjustable homogenization valve. At 17.2 Mpa (2500 psi) and a volume of 0.91 t/h a 56 kW (75 hp) motor is required.
Several operating factors should be considered:

(1) before homogenization milk is heated to break up fat globules and prevent undesirable lipase activity;
(2) as the temperature of the milk is increased, the size of the globules decreases;
(3) viscosity of fluid milk is not greatly influenced by homogenization, whereas viscosity of cream is increased;
(4) clarification before or after homogenization prevents the formation of sediment which otherwise adheres to the fat.

**Pasteurization**

Pasteurization is the process of heating milk to kill pathogenic bacteria, and most other bacteria, without greatly altering the flavour. It also inactivates certain enzymes, e.g., phosphates.

Pasteurization may be carried out by batch or continuous-flow processes. In the batch process, each particle of milk must be heated to at least $63^0$C and held continuously at this temperature for at least 30 min. In the continuous process, milk is heated to at least $72^0$C for at least 15 s in what is known as high temperature-short time (HTST) pasteurization. For milk products having a fat content above that of milk or that contain added sweeteners, $66^0$C is required for the batch process and $75^0$C for the HTST process. For either method, following pasteurization the product should be cooled quickly to $\leq 7.2^0$C. Time-temperature relationships have been established for other products including ice cram mix, which is heated to $78^0$C for 15 s.

Another continuous pasteurization process, known as ultrahigh temperature (UHT), employs a shorter time (2 s) and a higher temperature (minimum $138^0$C). The UHT process approaches aseptic processing.

*Batch Holding*

The milk in the batch holding tanks is heated in a flooded tank around which hot water or steam is circulated, or by coils surrounding the liner through which the heating medium is pumped at a high velocity. Two other methods include spraying hot water on the tank liner holding the milk, and pumping hot water through a large-diameter coil that circulates in the milk. A self-acting regulator closely controls the temperature of the water, usually heated with steam.

An airspace heater ejects steam into the airspace above the product and into the foam, maintaining a temperature at least $5^0$C above the minimum holding temperature of $63^0$C. The time-temperature exposure is recorded on a chart which must be kept for proof of treatment.

Valves are mounted so that the plug of the valve is flush with the tank to avoid a pocket of unpasteurized milk, and a leak detector valve permits drainage of the milk trapped in the plug of the valve.

Agitators provide adequate mixing without churning, assist in heat transfer by sweeping the milk over the heated surface, and assure that all particles are properly pasteurized.

*High Temperature – Short Time Pasteurizers*

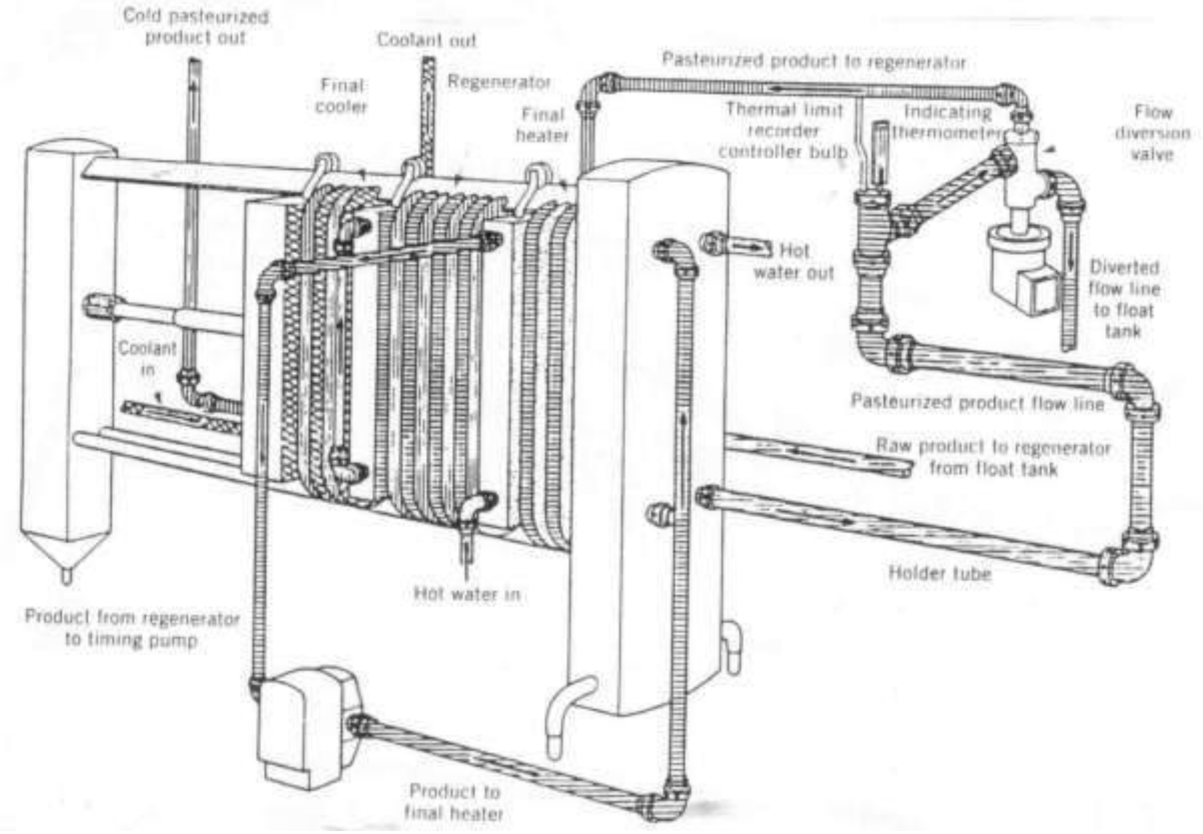
The principal continuous-flow process is the high temperature-short time (HTST) method. The product is heated to at least $72^0$C and held at that temperature for not less than 15 s.

The equipment needed includes a balance tank, regenerative heating unit, positive pump, plates for heating to pasteurization temperature, tube or plates for holding the product for the specified time, a flow-diversion valve (FDV), and a cooling unit (**Figure – 3**). Often the homogenizer and booster pump also are incorporated into the HTST circuit.

The balance or float tank collects raw milk entering the unit, receives milk returned from the flow-diversion valve that has not been adequately heated, and maintains a uniform product elevation on the pasteurizer intake.

The heat-regeneration system partially heats the incoming cold product and partially cools the outgoing pasteurized product. The regenerator is a stainless steel plate heat exchanger, usually of the product-to-product type. The configuration is so arranged that the outgoing pasteurized product is at a higher pressure to avoid contamination. A pump in the circuit moves the milk from the raw milk side and the discharge to the final heater. Heat regenerators are usually 80-90% efficient. The regeneration efficiency may be improved by increasing the number of regenerator plates, and although this increases the energy for pumping, it also increases the cost for additional heat-exchanger plates.

The final heater increases the regeneration temperature (~ $60^0$C) to pasteurization temperature (at least $72^0$C) with hot water. The hot water is ~ 1-$2^0$C above the highest product temperature ($73^0$C). Four to six times as much hot water is circulated compared to the amount of product circulated on the opposite side of the plates.




where ⊟ is raw milk, ▥ pasteurized, ⊡ hot water, and ⊠ coolant.

**Figure – 3 : Flow through a typical HTST plate pasteurizer,**

The holder or holding tube is at the discharge of the heater. Its length and diameter assure that fluid milk is exposed to the minimum time-temperature ($72^{0}$C for 15 s). Glass or stainless steel tubing, or plate heat exchangers, may be used for holders. Holding tubes must be designed for continuous uphill flow 0.64 cm/m) from the start of the tube to the FDV.

On the outlet of the holder tube, the FDV directs the pasteurized product to the regenerator and then to the final cooling section (forward flow) Alternatively, if the product is below the temperature of pasteurization, it is diverted back to the balance tank (diverted flow). The FDV is controlled by the safety thermal-limit recorder.

The final cooling section is usually a plate heat exchanger cooled by water chilled through refrigeration. Milk leaves the regenerator and enters the cooling section at ~ 18-$24^{0}$C and is cooled to $4.4^{0}$C by glycol, or water circulating at $1^{0}$C. The relationships of regenerator, heater, and cooler for flow, number of plates, and pressure drop are given in **Table – 1**.

| Capacity, L/h | 3,800 | 7,600 | 11,360 | 15,140 | 18,930 |
|---|---|---|---|---|---|
| regenerator, 84%[b] | | | | | |
| plates, number | 31 | 51 | 71 | 91 | 111 |
| pressure drop milk, kPa[c] | 62 | 90 | 103 | 103 | 117 |
| heater[d] | | | | | |
| plates, number | | | | | |
| water, L/min | 9 | 15 | 21 | 29 | 33 |
| pressure drop milk, kPa[c] | 261 | 522 | 587 | 787 | 492 |
| pressure drop water, kPa[c] | 55 | 76 | 76 | 69 | 96 |
| | 83 | 117 | 76 | 69 | 165 |
| cooler[e] | | | | | |
| plates, number | | | | | |
| water, L/min | | | | | |
| pressure drop milk, kPa[c] | 9 | 17 | 31 | 41 | 49 |

| | | | | | |
|---|---|---|---|---|---|
| pressure drop water, kPa$^{c}$ | 326<br>55 | 662<br>55 | 462<br>117 | 643<br>117 | 772<br>145 |
| total, 84% regeneration | 131 | 131 | 165 | 165 | 179 |
| plates, number | | | | | |
| pressure drop, milk, kPa$^{c}$ | | | | | |
| size of frame, m | 49<br>122 | 83<br>221 | 123<br>296 | 161<br>289 | 193<br>358 |
| total, 90% regeneration | | | | | |
| plates, number | 1.22 | 1.2 | 1.83 | 2.13 | 2.13 |
| pressure drop, milk, kPa$^{c}$ | | | | | |
| size of frame, m | 73<br>131 | 109<br>200 | 147<br>214 | 189<br>221 | 239<br>207 |
| | 1.52 | 1.83 | 1.83 | 2.13 | 2.44 |

**Table – 1 : Representative Capacities of HTST Plate Pasteurizers**

The heat transfer sections of the HTST pasteurizer, i.e., regenerator, heater, and cooler, are usually stainless steel plates ~ 0.635 – 0.91 mm thick. Plates for different sections are separated by a terminal that includes piping connections to direct product into and out of the spaces between plates. The plates are mounted and connected in such a manner that the product can flow through ports connecting alternate plates. The heat-transfer medium flows between every other set of plates.

The stainless steel plates are separated (ca 3 µ m between) by nonabsorbent vulcanized gaskets. Various profiles and configurations, including raised knobs, crescents, channels, or diamonds, provide a rapid, uniform heat-transfer plate surface. During operation the plates must be pressed together to provide a seal, and mounted and connected in such a manner that air is eliminated.

For regeneration, the milk-to-milk regenerator is most common. A heat transfer medium, usually water, provides a milk-water-milk system. Both sides may be closed (**Figure – 4**) or the raw milk supply may be open.

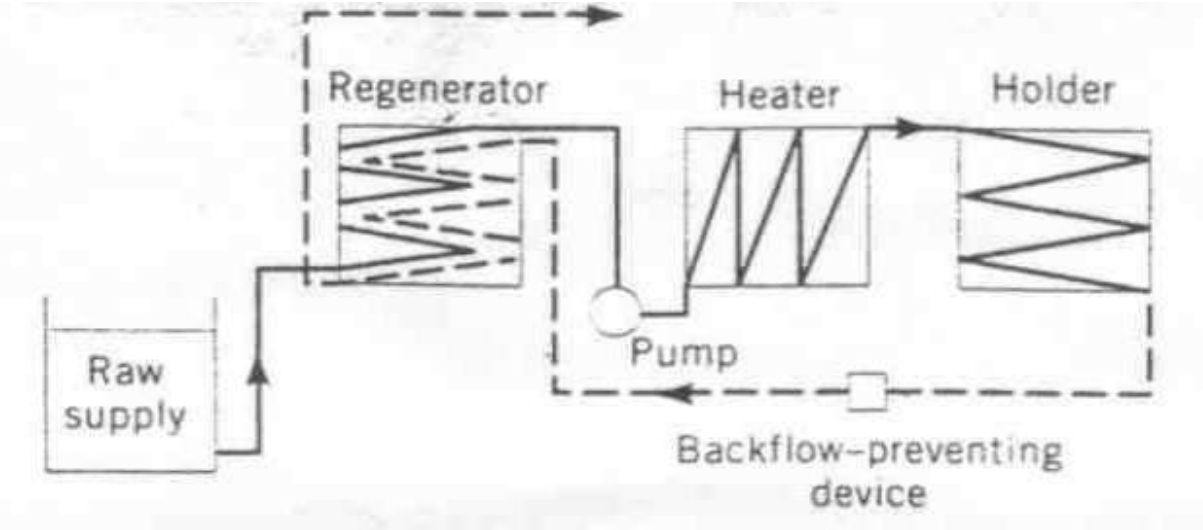



**Figure – 4 : Milk-to-milk regenerator with both sides closed to atmosphere**

A homogenizer or rotary positive pump my be used as a timing or metering pump to provide a positive, fixed flow through the pasteurization system (**Figure – 5**). The pump is placed ahead of the heater and the holding section. Various control drives assure that the pasteurized side of the heat exchanger is at a higher (7 kPa (1 psi)) pressure than the opposite side.

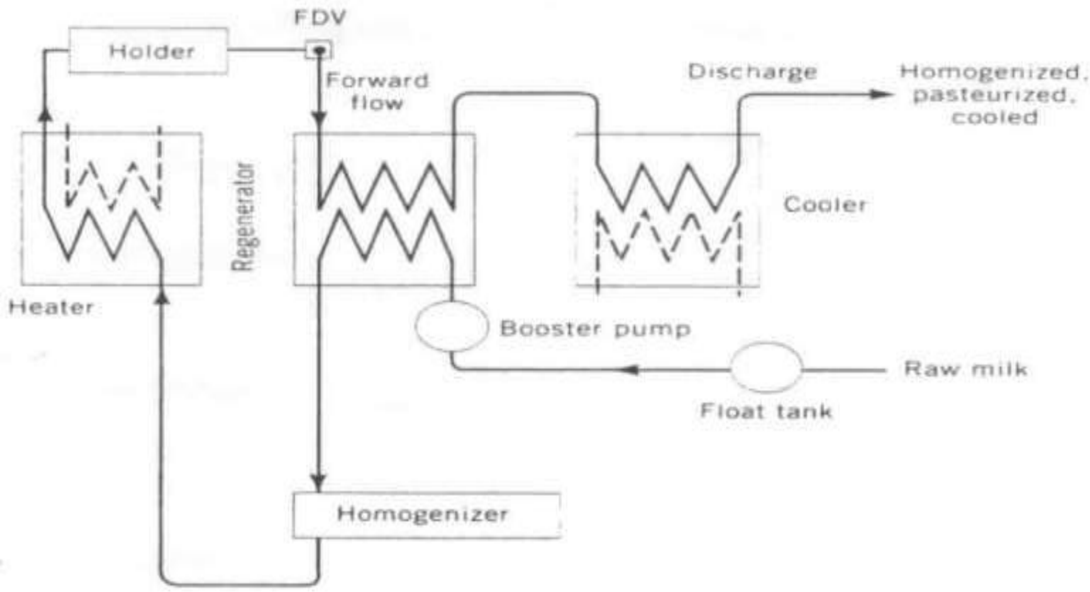



**Figure – 5 : Homogenizer used as a timing pump for HTST pasteurization. Details of bypass, relief lines, equalizer, and check valves are not included**

The homogenizer can be used as a timing pump as it is homogenizing the product (**Figure – 6**) or both the timing pump and homogenizer can be used in the same system.

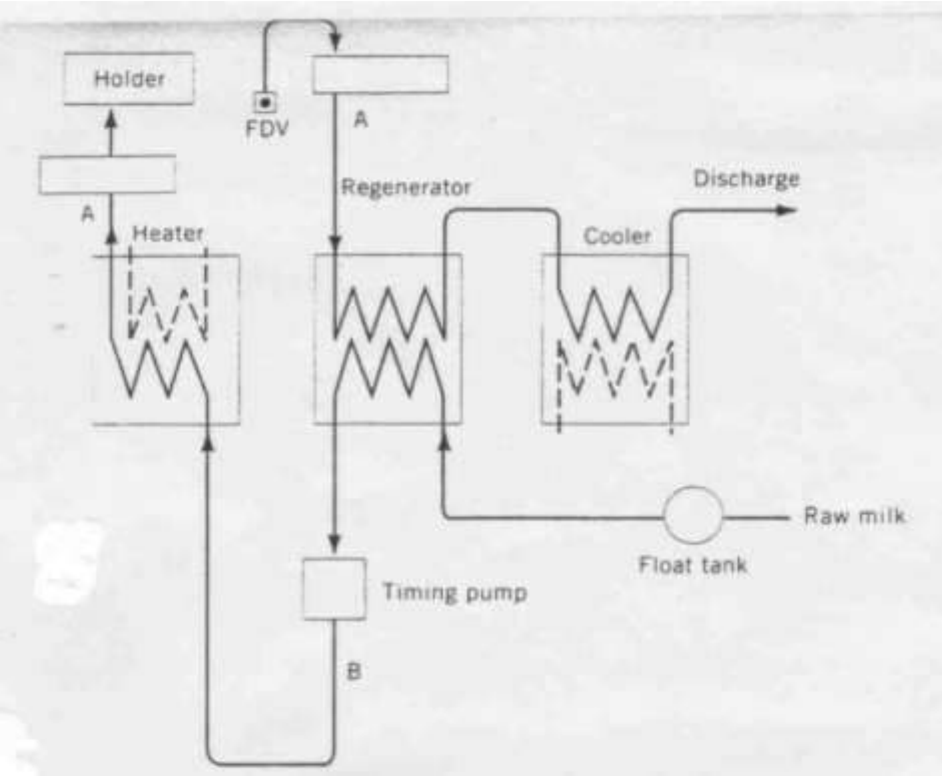



**Figure – 6 : Homogenization of regenerated milk, A, after HTST heat treatment, and B, before HTST pasteurization. Details of bypass, relief lines, equalizer, and check valves are not included**

*Booster Pump*

Use of a centrifugal booster pump avoids a low intake pressure, particularly for large, high volume units. A low pressure (> 26.6 kPa (200 mm Hg)) on the intake of a timing pump can cause vaporization of the product. The booster pump is in the circuit ahead of the timing pump and operates only when the FDV is in forward flow, the metering pump is in operation, and the pasteurized product is at least 7 kPa (1 psi) above the maximum pressure developed by the booster pump (**Figure – 7**).

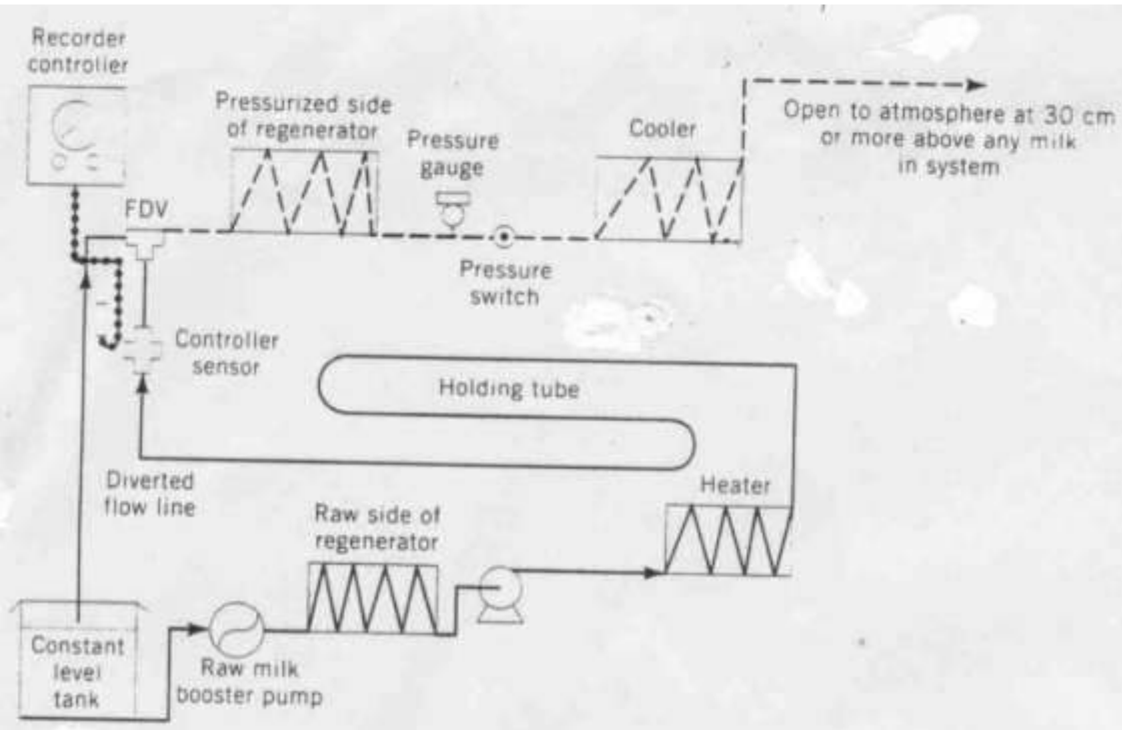



**Figure – 7 : Booster pump for milk-to-milk regeneration, where (---) is pasteurized milk, (--) is raw milk, and (-•-) is capillary tubing**

*Separator*

Fat is normally separated from the milk before the HTST; however, in one system the airtight separator is placed after the FDV, following pasteurization. A restricting device and several control combinations are placed in the line after the FDV to ensure that constant flow is maintained, that vacuum does not develop in the line, that the timing pump stops if the separator stops, and that the legal holding time is met.

*Control System*

For quality control, a complete record of the control and operation of the HTST is kept with a safety thermal-limit recorder-controller (**Figure – 8**). The temperature of product leaving the holder tube, ahead of the FDV, is recorded and the forward or diverted flow of the FDV is determined. Various visual indicators, operator temperature calibration records, and thermometers also are provided.

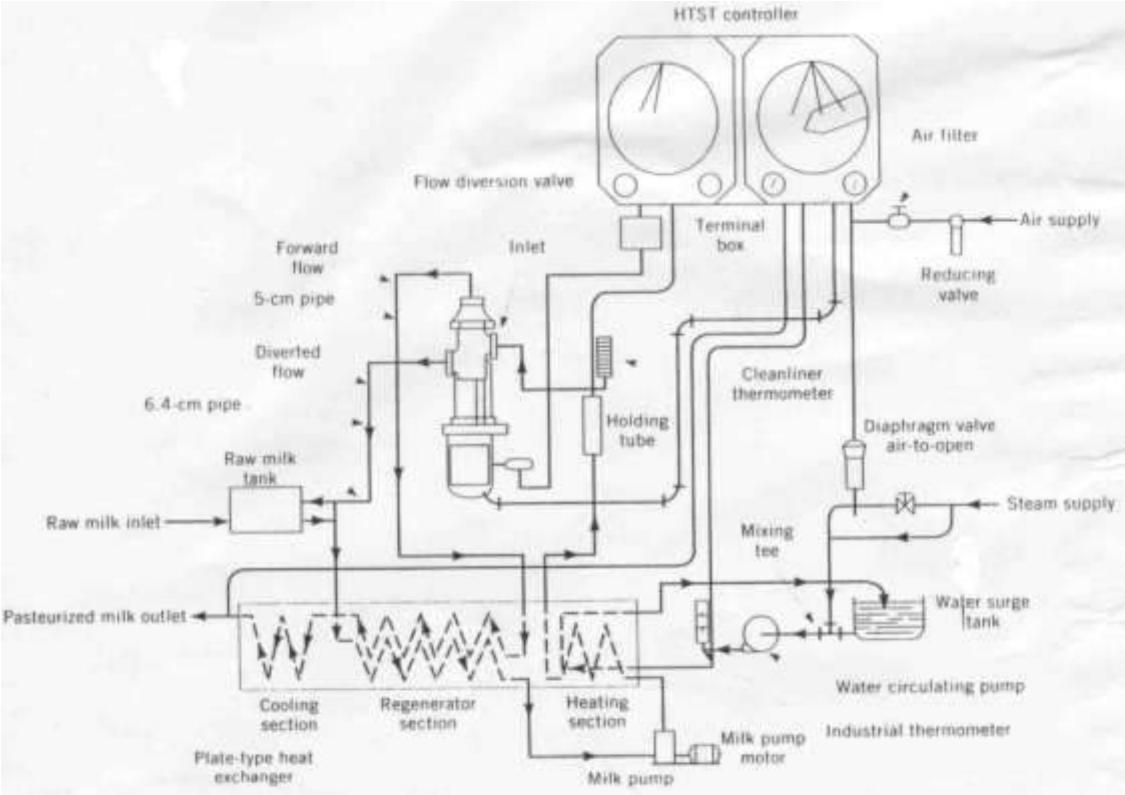



**Figure – 8 : HTST control system**

*Utilities*

Electricity, water, steam refrigeration, and compressed air must be provided to the pasteurizer for heating, cooling, and cleaning of water. The water is heated by steam injection or an enclosed heating and circulating unit. The controller, sensing the hot water temperature, permits heating until the preset temperature is reached, usually 1-2$^0$C above the pasteurization temperature. A diaphragm valve, directed by the controller, maintains the maximum temperature of the hot water by control of the steam. Water is cooled with a direct expansion refrigeration system and may be cooled directly or over an ice bank formed by direct expansion refrigeration. The compressed air should be clean, relatively dry, and supplied at ~ 138 kPa (20 psi) to operate valves and controls.

*Other Continuous Processes*

Various pasteurization heat treatments are identified by names such as quick time, vacuum treatment (vacreator), modified tubular (Roswell), small-diameter tube (Mallorizer), and steam injection. The last three methods are ultrahigh temperature (UHT) processes. Higher treatment temperatures with shorter times, approaching two seconds, are preferred because the product has to be cooled quickly to prevent deleterious heat effects.

*Vacuum Treatment*

Milk can be exposed to a vacuum to remove low boiling substances, e.g., onions, garlic, and some silage, which may impart off-flavours to the milk, particularly the fat portion. A three-stage vacuum unit, known as a vacreator, produces pressures of 17, 51-68, and 88-95 kPa (127, 381-508, and 660-711 mm Hg). A continuous vacuum unit in the HTST system may consist of one or two chambers and be heated by live steam, with an equivalent release of water by evaporation, or flash steam to carry off the volatiles. If live steam is used, it must be culinary steam which is produced by heating potable water with an indirect heat exchanger. Dry saturated steam is desired for food processing operations.

*Product Heat Treatment*

Equivalent heat treatment for destruction of microorganisms or inactivation of enzymes can be represented by plotting the logarithm of time versus temperature. These relationships were originally developed for sterilization of food at 121.1$^0$C, therefore the time to destroy the microorganism is the $F_0$ value at 121.1$^0$C (250$^0$F). The slope of the curve is z, and the temperature span is one log cycle. The heat treatment at 131$^0$C for one minute is equivalent to 121.1$^0$C for 10 minutes (**Figure – 9**).

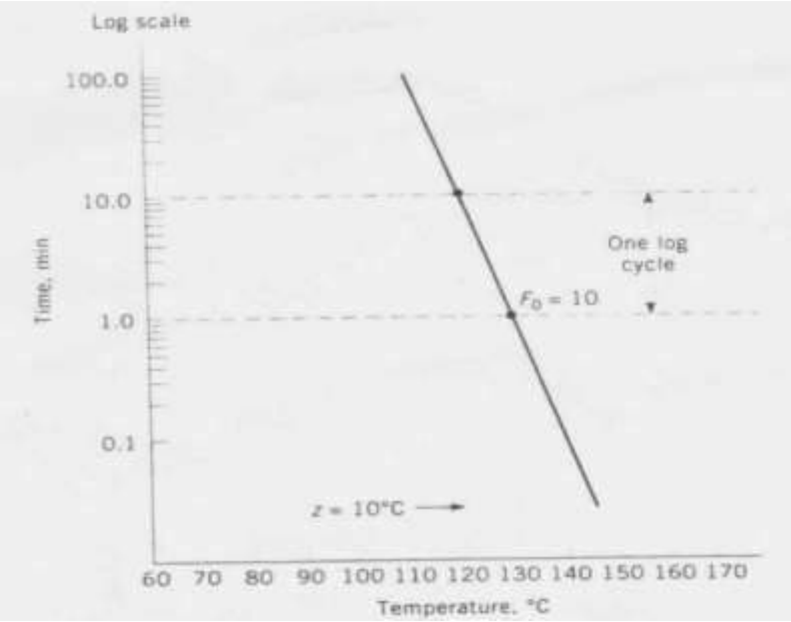



**Figure – 9 : Representation of z and *F* values. $F_0$ is the zero point for identifying the sterilization value at 121.1$^0$C (250$^0$F) : $F_0 / t = e^{2.3/z(T - 121.1)} = 10^{(T - 121.1)/z}$**

**Equipment**

Equipment is designed according to 3A Sanitary Standards established by a committee of users, manufacturers, and sanitarians in the food industry. The objective of the committee is to provide interchangeable parts and equipment, establish standards for inspection, and provide knowledge of acceptable design and materials, primarily, to fulfill sanitary requirements. Sanitary equipment design requires that the material of construction is 18-8 stainless steel, with a carbon content of not more than 0.12%, although equally corrosion-resistant material is acceptable; the metal gauge for various applications is specified; surfaces fabricated from sheets have a No.4 finish or equivalent; weld areas are substantially as corrosion resistant at the parent material; minimum radii are often specified, e.g. for a storage tank, 0.62 cm for inside corners of permanent attachments; no threads are in contact with food; and threads are Acme threads (flat-headed instead of V-shaped).

*Materials of Construction. Stainless Steel*

The use of stainless steel (qv) for flat surfaces, tubing coils, and castings in milk and dairy equipment has advanced since the 1950s. The contact surfaces of milk and dairy equipment are primarily stainless steel, which permits cleaning-in-place (CIP), automation, continuous operations, and aseptic processing and packaging.

Many types of stainless steels are available. The type most widely used in the dairy industry is 18-8 (18% chromium, 8% nickel plus iron). Small amounts of silicon, molybdenum, manganese, carbon, sulfur, and phosphorus may be included to obtain characteristics desired for specific applications.

The most important stainless steel series are 200-, 300-, and 400-series. The 300-series, primarily 302, 304, and 316, is used in the dairy industry, whereas the 400-series is used for special applications, such as pump impellers, plungers, cutting blades, scrapers, and bearings. Surface finishes are specified from No.1 to No.8 (highly polished); the No.4 finish is most commonly used.

Stainless steel develops a passive protective layer ($\leq$ 5-nm thick) of chromium oxide (1118-57-3) which must be maintained or permitted to rebuild after it is removed by product flow or cleaning.

*Cleaning*

Equipment is cleaned to prevent contamination of subsequent dairy processing operations and damage to the surface. In cleaning stainless steel, surface contaminants are removed that would otherwise destroy the protective passive layer. The surface is dried and exposed to air to rebuild the protective passive chromium oxide layer. Metal adhering to the stainless steel surface should be removed with the least abrasive material, and after cleaning, the surface should be washed with hot water and left to dry. Equipment should be sanitized with 200-ppm chlorine solution within 30 minutes before use, not necessarily after cleaning, to avoid corrosion resulting from chlorine on the surface for an extended period of time. For cleaning-in-place (CIP), the velocity of the cleaning solution over the surfaces should be $\leq$ 1.5 m/s.

Excessive velocities can cause erosion of the surface and reduction of the protective layer. Excessive time of contact of the cleaning solution may cause corrosion, depending on the strength of the cleaning solution.

*<u>Piping and Tubing</u>*

Piping size is designated by a nominal rather than an exact inside diameter i.e. a pipe of 2.5-cm diameter can have an inside diameter slightly more or less than 2.5 cm, depending on the wall thickness. Tubing size is designated by the outside diameter, i.e., a tube of 2.5-cm diameter has an outside diameter of 2.5 cm, and as the thickness of the tubing increases the inside diameter decreases and is always less than 2.5 cm. Both piping and tubing have fixed but different outside diameters for a particular size, and standard fittings can be used with different wall thicknesses.

The food industry uses stainless steel tubing or piping extensively for moving food products, conventional steel, cast iron, copper, plastic, glass (qv), aluminum, and other alloys are used for utilities.

Most piping and tubing systems are designed for in-place cleaning. Classification is based on the type of connections for assembly: welded joints for permanent connections; ground joints with Acme threads and hexagonal units having gaskets for connections that are opened daily or periodically, and clamp-type joints.

Corrosion between the support device and the pipeline must be avoided. Drainage is provided by the pipeline slope, normally 0.48-0.96 cm/m of length, and gaskets must be nonabsorbent and of a type that does not affect the food product.

*<u>Fittings</u>*

Fittings connect pipes and provide for the attachment of equipment to change flow direction. They must be easily cleaned inside and out, have no exposed pipe threads, and, if of the detachable type, have an appropriate gasket. The fittings are constructed of the same or similar materials as the pipeline and are installed on tubing.

An air valve, sometimes called the air-activated valve, is widely used for automated food handling operations. Although electronic or electric control boxes may be a part of the system, the valve itself generally is air-activated, and is more reliable than other types. Air-operated valves are used for in-place cleaning systems, and for the transfer and flow control of various products.

*Pumps*

The flow of fluids through a dairy processing plant is maintained by a centrifugal (non-positive) or a displacement (positive) pump. Positive displacement pumps are either of the piston or plunger type, which are usually equipped with multiple pistons, or of the rotary positive type. The pump is selected on the basis of the quantity of product to be moved against a specified head. Generally, a hardenable 400-series stainless steel is used for the moving parts which chip easily and must be handled carefully during disassembly, cleaning, and assembly.

*Centrifugal Pump*

The centrifugal pump consists of a directly connected impeller which operates in a casing at high speed. Fluid enters the center and is discharged at the outer edge of the casing. The centrifugal pump is used with for moving products against low discharge heads or where it is necessary to regulate the flow of product through a throttling valve or restriction. Pumps for a CIP system include a self-cleaning diaphragm.

*Positive Pumps*

Positive pumps employed by the food industry have a rotating cavity between two lobes, two gears that rotate in opposite directions, or a crescent or stationary cavity and a rotor. Rotary positive pumps operate at relatively low speed. Fluid enters the cavity by gravity flow or from a centrifugal pump. The positive pump also may use a reciprocating cavity, and may be a plunger or piston pump. These pumps are not truly positive with respect to displacement, but are used for metering product flow.

**Cleaning Systems**

Both manual and automatic methods are used for cleaning food processing (qv) equipment.

*Cleaning-In-Place*

In diary plants, the equipment surfaces and pipelines are cleaned in place at least once every 24 hours. Cleaning-in-place (CIP) systems evolved from recirculating cleaning solutions in pipelines and equipment to a highly automatic system with valves, controls, and timers. The results of cleaning in place are influenced by equipment surfaces, time of exposure, and the temperature and concentration of the solution being circulated.

In the CIP procedure, a cold or tempered aqueous prerinse is followed by circulation of a cleaning solution for 10 minutes to one hour at 54-82$^0$C. The temperature of the cleaning solution should be as low as possible, because hot water rinses may harden the food product on the surface being cleaned, but high enough to avoid excess cleaning chemicals. A wide variety of cleaning solutions may be used, depending on the food product, hardness of water, and equipment.

A CIP system includes pipelines interconnected with valves to direct fluid to appropriate locations, and the control circuit, which consists of interlines to control the valves that direct the cleaning solutions and water through the lines, and air lines which control and move the valves. A programmer controls the timing and the air flow to the valves on a set schedule. A simple CIP system circuit is shown in **Figure – 10**.

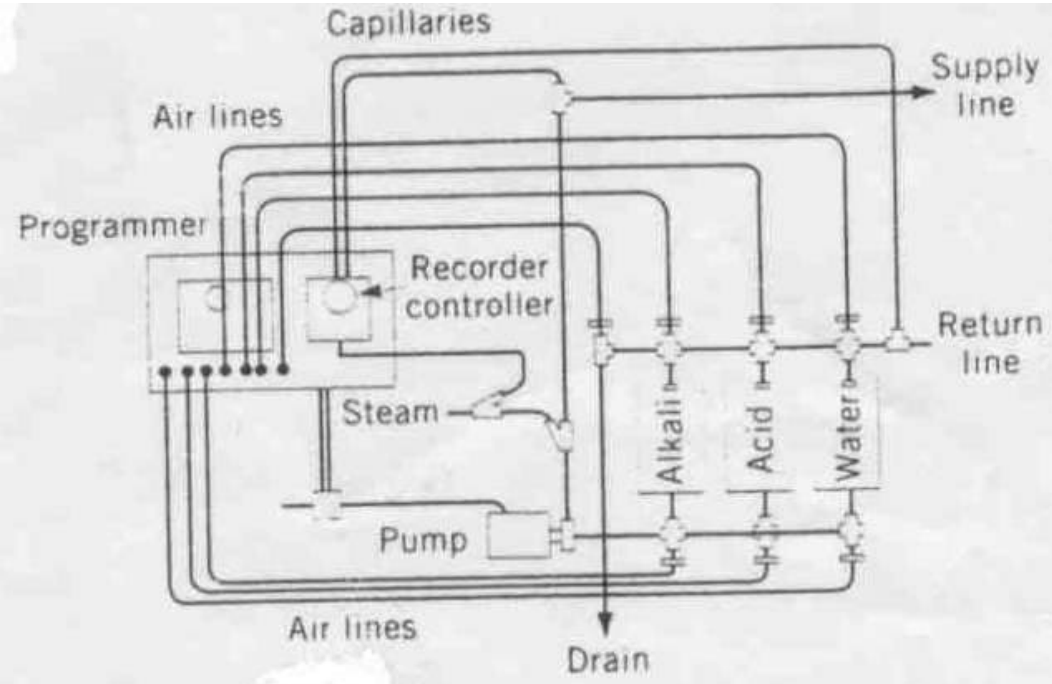



**Figure – 10 : Simple circuit for CIP system**

Storage, Cooling, Shipping and Packaging

**Bulk Milk Tanks**

Commercial dairy production enterprises generally employ tanks in which the milk is cooled and stored. In some operations, the warm milk is first cooled and then stored in a tank; 3A Standards have been established for their design and operation. Among other requirements, the milk must be cooled to $4.4^0$C within two hours after milking. The temperature must not be permitted to increase above $10^0$C when warm milk from the following milking is placed in the tank. Bulk milk tanks are classified according to method of refrigeration, i.e., direct expansion (DX) or ice bank (IB); pressure in tank, i.e., atmospheric or vacuum; regularity of pickup, i.e., every day or every other day; capacity, in liters, when full or at amount which can be received per milking; shape, i.e., cylindrical, half-cylindrical, or rectangular; position, i.e., vertical or horizontal; and method of cooling refrigeration condenser, i.e., by water, air, or both.

**Cooling**

A compression refrigeration system, driven by an electric motor, supplies cooling for either direct expansion or ice bank systems (**Figure – 11**). In the former, the milk is cooled by the evaporator (cooling coils) on the bulk tank liner opposite the milk side of the liner. The compressor must have the capacity to cool the milk as rapidly as it enters the tank.

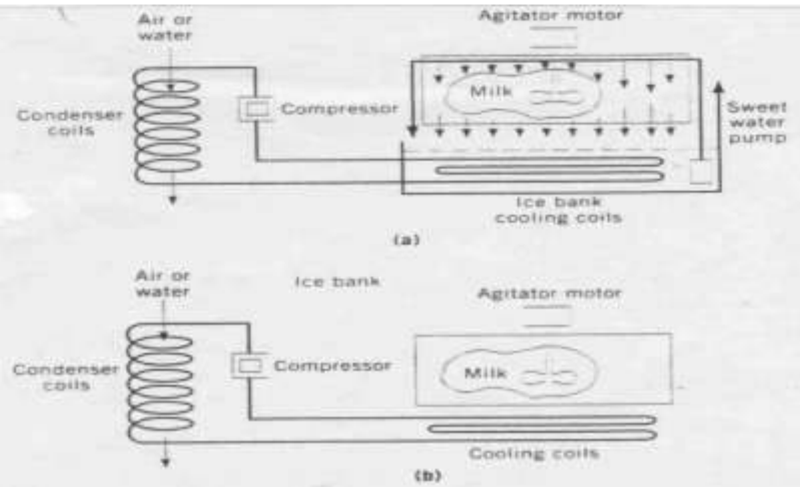



**Figure – 11 : Compression refrigeration supplying cooling for (a) the ice bank, where (↓) represents the flow of sweet water and (---), the water level, or (b) the direct expansion systems**

In the ice bank system, ice is formed over the evaporator coils. Water is pumped over the ice bank and circulated over the inner liner of the tank to cool the milk. The water is returned to the ice bank compartment. This system provides a means of building refrigeration capacity for later cooling; therefore a smaller compressor and motor can be used, although the unit operates two to three times as long as a direct expansion system for the same cooling capacity. Off-peak electricity might be used for the ice bank system, thus reducing operating costs.

Important features of bulk milk tanks include a measuring device, generally a calibrated rod or meter; cleaning and sanitizing facilities; and stirring with an appropriate agitator to cool and maintain cool milk temperatures.

*Surface Coolers*

Milk coming from cows may be rapidly cooled over a stainless steel surface cooler before entering a bulk tank. The cooler may either use compression refrigeration or have two sections, one using cold water followed by a section using compression refrigeration.

**Shipping**

Bulk milk is hauled to the processing plant in insulated tanks using truck tanks or trailer tankers. The milk is transferred from the bulk tank to the tanker with a positive or centrifugal-type pump. For routes of some distance, pick-up every other day reduces handling costs.

*Receiving Operations*

Bulk milk-receiving operations consist primarily of transferring milk from the tanker to a storage tank in the plant. Practically all Grade A milk is handled in bulk.

**Packaging**

Aseptic packaging was developed in conjunction with high temperature processing and has contributed to make sterilized milk and milk products a commercial reality.

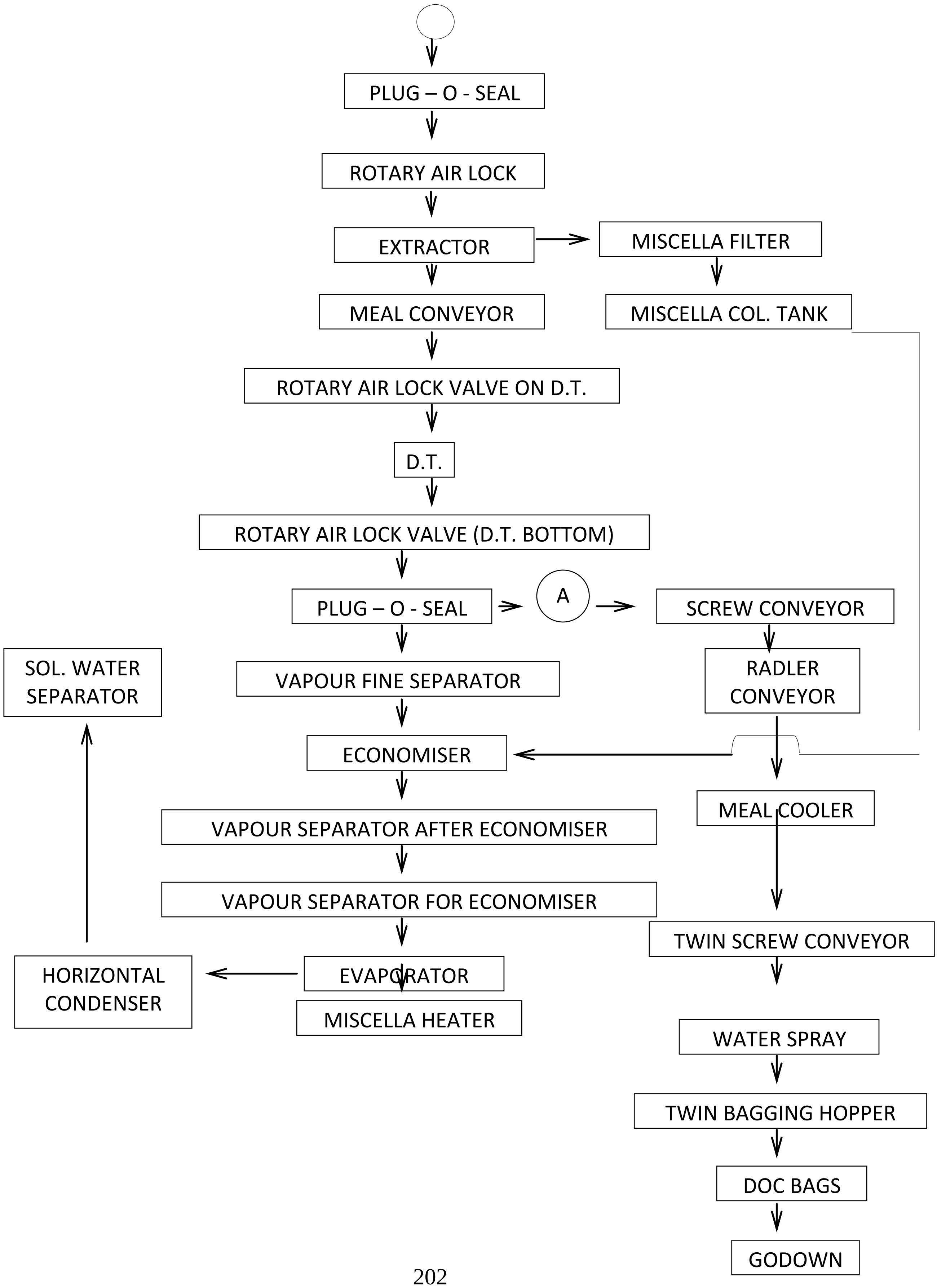
The objects in packaging cool sterilized products is to maintain the product under aseptic conditions, to sterilize the container and its lid, and to place the product into the container and seal it without contamination. Contamination of the head space between the product and closure is avoided by the use of superheated steam, maintaining a high internal pressure, spraying the container surface with a bactericide such as chlorine, irradiation with a bactericidal lamp or filling the space with an inert sterile gas such as nitrogen.

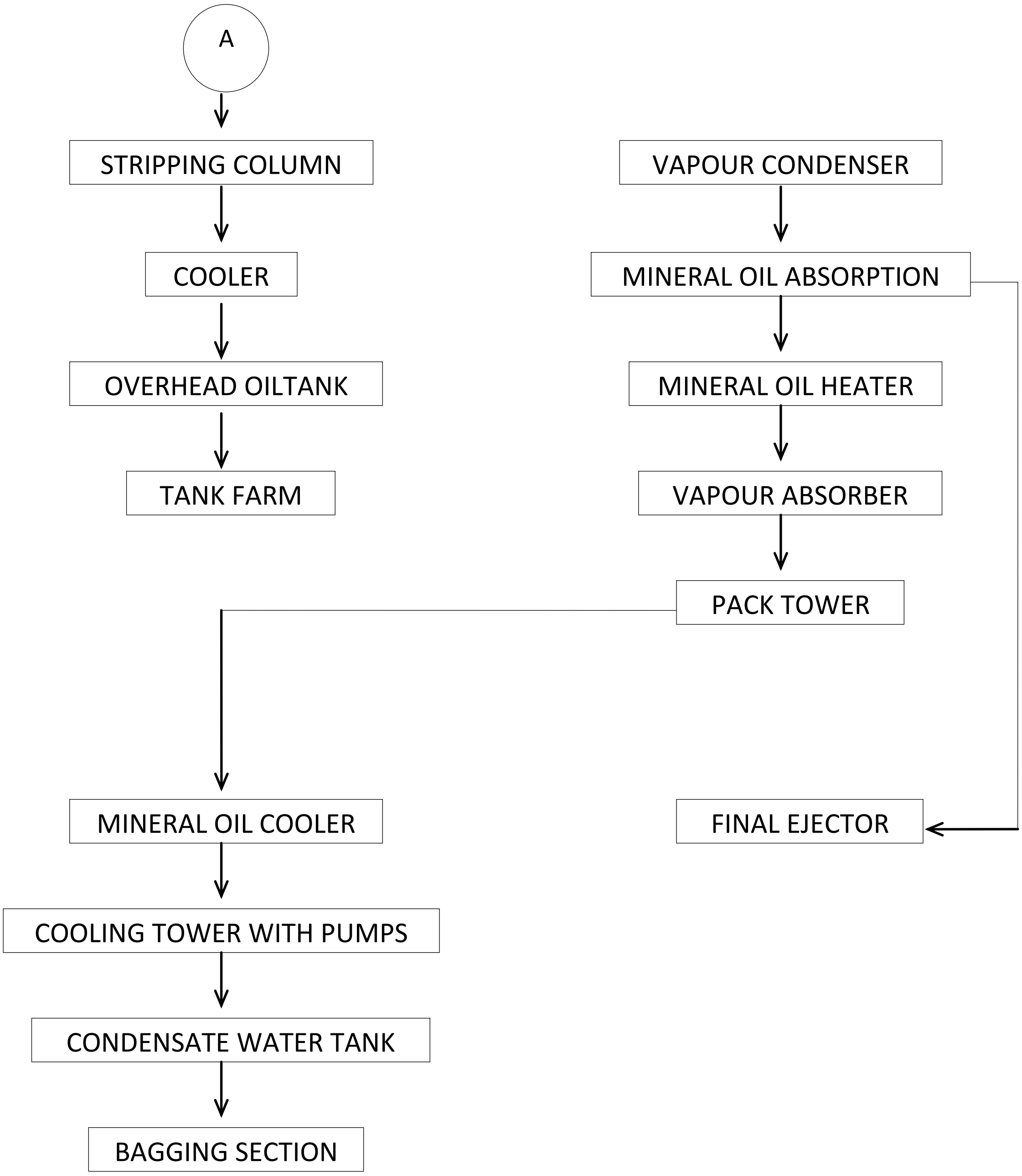
## C. SOLVENT EXTRACTION AND VANASPATI PLANTS

### 1. Solvent Extraction

**PROCESS FLOW DIAGRAM**
**(SOLVENT EXTRACTION PLANT)**

SOYA (RAW MATERIAL)
↓
SILO FEEDING ELEVATOR
↓
BELT CONVEYOR
↓
SILO
↓
DISCHARGE BELT CONVEYOR
↓
ELEVATOR
↓
SEED CLEANER
↓
4 ROLL SEED CRACKER
↓
RADLER CONVEYOR
↓
ELEVATOR
↓
COOKER
↓
SCREW CONVEYOR
↓
FLAKER 5 NOS.
↓
RADLER CONVEYOR
↓
T1 - CONVEYOR
↓


PLUG – O - SEAL
ROTARY AIR LOCK
EXTRACTOR
MISCELLA FILTER
MEAL CONVEYOR
MISCELLA COL. TANK
ROTARY AIR LOCK VALVE ON D.T.
D.T.
ROTARY AIR LOCK VALVE (D.T. BOTTOM)
PLUG – O - SEAL
A
SCREW CONVEYOR
SOL. WATER SEPARATOR
VAPOUR FINE SEPARATOR
RADLER CONVEYOR
ECONOMISER
MEAL COOLER
VAPOUR SEPARATOR AFTER ECONOMISER
VAPOUR SEPARATOR FOR ECONOMISER
TWIN SCREW CONVEYOR
HORIZONTAL CONDENSER
EVAPORATOR
MISCELLA HEATER
WATER SPRAY
TWIN BAGGING HOPPER
DOC BAGS
GODOWN


A
STRIPPING COLUMN
COOLER
OVERHEAD OILTANK
TANK FARM
VAPOUR CONDENSER
MINERAL OIL ABSORPTION
MINERAL OIL HEATER
VAPOUR ABSORBER
PACK TOWER
MINERAL OIL COOLER
FINAL EJECTOR
COOLING TOWER WITH PUMPS
CONDENSATE WATER TANK
BAGGING SECTION

**(1) Solvent extraction plant :**

Solvent extraction is a process to extract oil from oil-bearing materials by treatment with a low boiling point solvent in contrast to methods of extraction by mechanical pressing (such as expellers, hydraulic presses, ghanis etc.). By solvent extraction almost all the oil is recovered leaving only 0.8 to 1.2% residual oil in raw material. In the case of mechanical pressing the residual oil left in the oilcake may be anywhere from 6% to 14%. The solvent extraction method can be applied directly to any low oil content raw materials. It can also be used to extract pre-pressed oil cakes obtained from high oil content materials. Because of high percentage of recovery of oil, solvent extraction has become the most popular method of extraction of oils and fats.

**The process :**

Solvent extraction is basically a process of diffusion of a solvent into oil-bearing cells of the raw material, resulting in a solution of the oil in solvent. Various solvents can be used for extraction. However, after extensive research and consideration of various factors such as commercial, economics, edibility of the various products obtained from extraction, physical properties of the solvent especially its low boiling point etc., hexane is considered to be the best and it is exclusively used for the purpose.

In a nutshell, the extraction process consists of treating the raw material with hexane and recovering the oil by distillation of the resulting solution of oil in hexane called miscella. The hexane absorbed in the material is recovered by evaporation and condensation as also from the distillation of miscella. The hexane thus recovered is reused for extraction. The low boiling point of hexane ($67^0$ C) and the high solubility of oils and fasts in it are the properties exploited in the solvent extraction process. The entire extraction process can be divided into the following stages :-

- Preparation of raw material
- Process of extraction
- Desolventisation of extracted material
- Distillation of miscella
- Solvent recovery by absorption
- Mean finishing and bagging

Because of the highly inflammable character of the normal hexane, those stages of process which involve high speed machinery, such as, material preparation, finishing and begging are carried out at least 50 feet away from the main extraction plant wherein the remaining processing stages involving handling of the solvent are carried out. The typical flow chart illustrates the various processing steps.

**Preparation of raw material :**

For thorough and efficient extraction, it is necessary that each and every oil bearing cell of the material is brought in contact with the solvent. Therefore, proper preparation of materials prior to extraction is very important to ensure this contact. The smaller the material size, the better is the penetration of the solvent into the oil-bearing cells; but too fine a size will prevent the solvent from percolating through the mass. Therefore, an optimum size is to be maintained for best extraction. Hence material preparation methods vary from material to material depending on its oil content, size and physical properties.

For high oil content materials (oil content 15% or more), the following steps of preparation are recommended to make the material suitable for penetration of the solvent into the oil cells as well as for best percolation.

* Passage of the seed through corrugated roller mills with 3 mm flutes to reduce the size to about 3 mm.
* Heating the broken material to about $80^0$ C with open steam in a temperor and humidifying the material to raise the moisture content to about 11 to 12%.
* Flaking of the humidified material between a pair of plain rolls to 0.25 mm thickness or below.
* Conveying the flakes to the extraction system after crisping them firm.

Rice bran is a fine floury material and therefore bound to obstruct the percolation. The best preparation of rice bran for extraction is to pelletise the same after tempering with open steam. The pelletised bran is then crisped in a current of air while conveying to the extractor.

Some oil-seeds can be directly extracted e.g. cotton-seed, soyabean, etc. But they are to be decorticated by special equipment to separate the oil-bearing meats from the hulls. The decorticating equipment vary from seed to seed. The decorticated meats are tempered, flaked and the flakes are sent to extractor after crisping.

The prepared material enters the extractor through the rotary air seal. The extractor consists mainly of a very slow moving articulated band conveyor inside a totally enclosed chamber. The band is lined with perforated sheets and porous stainless steel cloth. The mass of the material moving on this band forms a slow moving bed. During the movement of the bed through the extractor it is washed continuously at various points with miscella of decreasing concentrations and finally with a fresh solvent in a counter current manner by means of sprayers kept in a line over the meal bed. The miscella percolates through the perforated bottom and collects in various hoppers kept below the bed. The miscella from the lat hopper which is concentrated is taken off for distillation.

**Desolventisation of extracted material :**

After the fresh solvent wash the material is discharged from the band conveyor into an air-tight chain conveyor which conveys it to the desolventiser. In the desolventiser the material is heated to about $100^0$ C by jacketed steam, and thus the absorbed solvent is evaporated into vapours (Boiling point of hexane is $67^0$ – $70^0$ C). Finally, the material which is now completely desolventised is continuously discharged through air-tight seal into a pneumatic conveyor, which carries it into the bagging section. The vapours evolved in the desolvemtisers are led through a dust catcher wherein they are washed with hot water, to a condenser.

Some materials, such as cotton-seed and soyabean extractions, are toasted after desolventisation. In these cases both the steps of desolventisation and toasting can be combined into one operation by the use of Desolventiser – Toaster (D.T.) instead of the tubular jacketed desolventiser.

The D.T. consists of a vertical cylindrical vessel with horizontal jacketed compartments and a central rotating vertical shaft on which are mounted sweeps in each compartment. The material to be desolventised and toasted is fed into the top compartment of D.T. and heated with open steam. Open steam condenses a lot of moisture in the material at the same time evaporating the solvent. The moisture up to 14 to 15% is condensed. The material then flows to lower compartment. In lower compartments the material is gradually heated to 115 to $120^0$ C thus evaporating all the solvent, cooking the material and driving away extra moisture. The cooking in presence of moisture destroys undesirable enzymes. High temperature attained toasts the material. The solvent and water vapours from various compartments are led first to a dust catcher wherein they are scrubbed with hot water spray to remove fine dust and then led to a condenser to condense the vapours. The desolventised and toasted meal from bottom most compartment discharges into a radler conveyor.

**Distillation of miscella :**

The final miscella (solution of oil in hexane) obtained from the extractor is collected in a tank from where it is pumped to the distillation column kept under vacuum by means of a series to steam ejectors. The miscella is heated by jacket steam in the distillation column and thus the hexane is turned into vapour immediately. The vapors are led to another condenser through an entrainment separator.

The concentrated miscella from the evaporator is pumped into a similar secondary distillation unit to raise the temperature to about 100 – $110^0$ C and then taken into the final stripper kept under high vacuum. Open steam is injected in the latter to strip the last traces of hexane from the oil. The vapour both from the secondary still and the stripper are condensed in a third condenser. The oil freed from solvent is pumped from the stripper to the storage.

**Solvent recovery by condensation :**

All the condensers are of floating head type with tube-bundles to carry the cooling water. The cooled water at $30^0$ C or below is circulated inside the tubes in all the condensers and the vapours are passed outside the tubes. Thus the vapours are cooled and condensed into liquid.

The uncondensed vapours from each condenser are sucked by the services of ejectors and pushed through the last condenser to a contact cooler where they are washed with cold water spray. All the condensate liquid hexane water from these condensers and contact cooler is led to a solvent water separator wherein the pure solvent is separated from water by settling the difference in densities of water and the solvent and their immiscibility accomplishes complete separation. The fresh pure solvent from this tank is pumped to the extractor continuously for the final washing of the meal bed.

**TECHNICAL SPECIFICATIONS OF PLANT AND MACHINERY FOR SOLVENT EXTRACTION PLANT**

Solvent Extraction Plant is a custom built plant. Solvent extraction capacity is expressed in terms of tones per day of oil extracted.

Plant and machinery is installed in following sections:

A. Raw Material Storage
B. Preparatory
C. Solvent Extraction
D. Meal Finishing

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**<u>RAW MATERIAL STORAGE</u>**

1. **<u>M.S. Seed Storage Silo made out of M.S. Plate of 6 mm, 8 mm and 10 mm thickness</u>**

| | | |
|---|---|---|
| Size | : | Dia. 11.8 m<br>Height : 14.0 m |

2. **<u>Seed Feeding M.S. Hopper</u>**

| | | |
|---|---|---|
| Capacity | : | 10 tonnes |
| Size | : | Length – 2 m<br>Width – 5 m<br>Depth – 2 m |

3. **<u>M.S. Silo Feeding bucket Elevator</u>**

| | | |
|---|---|---|
| Number of buckets | : | 118 |
| Size of bucket | : | 220 mm x 200 mm x 400 mm |
| Type of belt | : | Nylon |
| Width of belt | : | 500 mm |
| Thickness of belt | : | 12 mm |
| Length of belt | : | 54 m |
| Details of drive | | |
| HP | : | 30 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | V – 800 |
| Ratio | : | 20:1 |

## 4. M.S. Silo Feeding Belt Conveyer

| | | |
|---|---|---|
| Capacity | : | 60 tonnes per hour |
| Type of belt | : | Nylon |
| Width of belt | : | 750 mm |
| Thickness of belt | : | 8 mm |
| Length of belt | : | 13.9 m |

Details of drive

| | | |
|---|---|---|
| HP | : | 10 |
| Speed | : | 1500 rpm |

Gearbox

| | | |
|---|---|---|
| Type | : | V – 600 |
| Ratio | : | 20:1 |

## PREPARATORY

## 1. M.S. Bucket Elevator Feeding to Seed Cleaner

| | | |
|---|---|---|
| Capacity | : | 30 tonnes per hour |
| Size of bucket | : | 150 x 150 x 300 mm |
| Number of buckets | : | 40 |
| Type of belt | : | Canvas |
| Width of belt | : | 300 mm |
| Thickness of belt | : | 8 mm |
| Total length of belt | : | 14 m |

Details of drive

| | | |
|---|---|---|
| HP | : | 10 |
| Speed | : | 1500 rpm |

Gearbox

| | | |
|---|---|---|
| Type | : | V – 600 |
| Ratio | : | 20:1 |

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**2. M.S. Vibrating Seed Cleaner**

| | | |
|---|---|---|
| Capacity | : | 30 tonnes per hour |
| Details of drive | | |
| HP | : | 3 |
| Speed | : | 1500 rpm |

**3. M.S. Screw Conveyor Carrying Cleaned Beans to Seed Cracker**

| | | |
|---|---|---|
| Capacity | : | 25 tonnes per hour |
| Pitch of screw | : | 250 mm |
| Casing dia. | : | 320 mm |
| Length of conveyor | : | 5.0 m |
| Details of drive | | |
| HP | : | 3 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | U – 400 |
| Ratio | : | 25:1 |

**4. Seed Cracker**

| | | |
|---|---|---|
| Capacity | : | 50 tonnes per hour |
| Number of rolls | : | 4 |
| Type of rolls | : | Chilled cast iron |
| Details of motor | | |
| HP | : | 60 |
| Speed | : | 1000 rpm |

## 5. M.S. Radler Conveyor for Cracked Bean Discharge

| | | |
|---|---|---|
| Capacity | : | 30 tonnes per hour |
| Length of conveyor | : | 10.9 m |
| Width of chain | : | 484 mm |
| Total length of chain | : | 20 m |
| Pitch of chain | : | 125 mm |
| Details of drive | | |
| HP | : | 5 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | U – 400 |
| Ratio | : | 25:1 |

## 6. M.S. Bucket Elevator Feeding to Seed Cooker

| | | |
|---|---|---|
| Capacity | : | 30 tonnes per hour |
| Size of bucket | : | 150 x 150 x 300 mm |
| No. of buckets | : | 40 |
| Type of belt | : | Canvas |
| Width of belt | : | 300 mm |
| Thickness of belt | : | 8 mm |
| Length of belt | : | 14 m |
| Details of drive | | |
| HP | : | 10 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | U – 600 |
| Ratio | : | 20:1 |

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## 7. M.S. Seed Cooker having 5 Stages with Steam Heating Jacket at each stage

| | | |
|---|---|---|
| Storage capacity | : | 2.5 tonnes |
| Overall size | : | 2.5 m dia. x 5.25 m height |

Seed cooker is provided with IBR 8 mm thick, 65 mm dia., 27 nos. star pipes in each jacket.

Details of drive

| | | |
|---|---|---|
| HP | : | 20 |
| Speed | : | 1500 rpm |

Gearbox

| | | |
|---|---|---|
| Type | : | Helical VB3 – 200 |
| Ratio | : | 52:1 |

## 8. M.S. Bucket Elevator Feeding to Screw Conveyor

| | | |
|---|---|---|
| Capacity | : | 30 tonnes per hour |
| Size of bucket | : | 150 x 150 x 300 mm |
| Number of buckets | : | 40 |
| Chain pitch | : | 75 mm |
| Chain width | : | 100 mm |
| Chain length | : | 14 m |

Details of drive

| | | |
|---|---|---|
| HP | : | 10 |
| Speed | : | 1500 rpm |

Gearbox

| | | |
|---|---|---|
| Type | : | U – 600 |
| Ratio | : | 20:1 |

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**9.** **M.S. Screw Conveyor for Distributing Cracked Beans to all the Flakers**

| | | |
|---|---|---|
| Capacity | : | 30 tonnes per hour |
| Pitch screw | : | 300 mm |
| Length of screw | : | 18 m |
| Size of casing | : | 320 mm |
| Details of drive | | |
| HP | : | 10 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | U – 400 |
| Ratio | : | 25:1 |

**10.** **M.S. Hydraulic Flaker with Chilled Cast Iron Rolls**

| | | |
|---|---|---|
| Capacity | : | 125 tonnes per day |
| Size of roll | : | 500 mm dia. x 1300 mm long |
| Details of drive | | |
| HP of motor | : | 30 |
| Speed of motor | : | 1000 rpm |
| HP of geared motor | : | 2 |
| Speed of geared motor | : | 30 rpm |

**11.** **M.S. Radler Conveyor for Flake Discharge**

| | | |
|---|---|---|
| Capacity | : | 25 tonnes per hour |
| Length of conveyor | : | 59 m |
| Width of chain | : | 485 mm |
| Length of chain | : | 120 mm |
| Pitch | : | 125 mm |

## SOLVENT EXTRACTION

### 1. Extractor Feeding Radler Conveyor

Body of conveyor

| | | |
|---|---|---|
| Capacity | : | 20 tonnes per hour |
| Overall dimensions | : | 500 mm width x 300 mm height x 65 m long made out of 5 mm and 3 mm thick M.S. plate. |

Radler chain

| | | |
|---|---|---|
| Type | : | Pin roller |
| Overall width | : | 485 mm |
| Pitch | : | 125 mm |

Details of drive

| | | |
|---|---|---|
| HP | : | 10 |
| Speed | : | 1440 rpm |

Gearbox

| | | |
|---|---|---|
| Type | : | U – 600 |
| Ratio | : | 20:1 |

Chain drive

| | | |
|---|---|---|
| Type | : | Duplex |
| Pitch | : | 1” |
| Length of chain | : | 5 m |

Sprocket teeth

| | | |
|---|---|---|
| Pinion | : | 19 teeth duplex |
| Wheel | : | 57 teeth duplex |

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**2.** **Plug-O-Seal Screw Conveyor with Mechanical Seal**

| | | |
|---|---|---|
| Capacity | : | 25 tonnes per hour |
| Type | : | Double sealing (Outer body made out of 6 mm) |
| Size | : | 300 mm dia. x 2 m long. |
| Details of screw conveyor | | |
| Pitch | : | 250 mm |
| Length | : | 2 m |
| Details of shaft | | |
| Material of construction | : | M.S. |
| Dia. | : | 50 mm |
| Length | : | 2850 mm |

**3.** **Rotary Airlock Valve for Extractor Sealing**

| | | |
|---|---|---|
| Dia. | : | 300 mm |
| Length | : | 500 mm |
| Details of drive | | |
| HP | : | 3 |
| Speed | : | 1440 rpm |
| Gearbox | | |
| Type | : | U – 400 |
| Ratio | : | 20:1 |

**4.** **Extractor**

Complete with

- Main body
- Belt conveyor assembly
- Inside sprocket and shaft
- Drum shaft
- Brush shaft
- Pumps

Details of each of the above items:

**Main body**

Extractor body is fabricated out of M.S. plate of 10 mm and 5 mm thick.

Overall dimensions:

| | | |
|---|---|---|
| Width | : | 2300 mm |
| Length | : | 23000 mm |
| Height | : | 4500 mm |

The body is fabricated to house the chain conveyor with woven wire carrier. The welded joints are subjected to hydraulic tests for any leakage as the same are subject to the use of inflammable quality of material.

The extractor is in the fire section with one inlet and one outlet. Each section is provided with two 600 mm dia. glass windows.

Details of drive:

| | | |
|---|---|---|
| Type of motor | : | Flame-proof |
| HP | : | 3 |
| Speed | : | 960 rpm |

Gearbox

| | | |
|---|---|---|
| Type | : | U – 1200 |
| Radio | : | 1000:1 |

| | | |
|---|---|---|
| Pinion | : | 14 teeth – 35 mm pitch – 2 nos. |
| Wheel | : | 98 teeth – 35 mm pitch |

**Belt conveyor assembly**

Craddle frame

Number of cradle frame: 120

| | | |
|---|---|---|
| Size of cradle frame | : | 400 mm x 1800 mm |

| | | |
|---|---|---|
| Perforated sheet | : | 400 mm x 1800 mm – 120 nos. with S.S. net 25 g x 28 mesh |

**Inside sprocket and shaft**

| | |
|---|---|
| Inside sprocket | : 4 nos. |
| Dia. | : 1100 mm |
| Number of teeth | : 8 |
| Pitch | : 400 mm |
| Shaft | : 2 nos. |
| Dia. | : 200 mm |
| Length | : 3200 mm |
| Material of construction | : EN8 |

**Drum shaft**

Drum shaft with 136 nos. of M.S. strips and mechanical seal

| | |
|---|---|
| Dia : | 400 mm |
| Length | : 2200 mm |
| Material of construction | : M.S. |
| Size of strips | : 350 x 50 x 8 mm thick |

**Brush shaft**

| | |
|---|---|
| Type of brush | : Nylon wire |
| No. of brushes | : 6 |
| Size of pipe | : 150 mm dia. x 2200 mm long |
| Material of construction | : M.S. |
| Size of shaft | : 80 mm dia. x 2650 mm long with mechanical seal |

**Pumps**

Pumps with flame proof motors

| | | |
|---|---|---|
| Type | : KPD 65/20 | - 12 nos. |
| Type | : 15 PCH 75 | - 3 nos. |
| Type | : 1 PCH 63 | - 2 nos. |

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## 5. De-oiled Meal Sealed Conveyor

| | | |
|---|---|---|
| Size of box : | | 500 mm x 350 mm x 14 m |
| Material of construction | : | M.S. |
| Chain | | |
| Size of chain | : | 485 mm |
| Pitch | : | 125 mm |
| Length of chain | : | 32 m |
| Inside sprocket | : | 9 teeth |
| Drive and driven shaft made out of EN8 | | |
| Size | : | 80 mm dia. x 1000 mm – 1 no. |
| | | 80 mm dia. x 600 mm – 1 no. |
| Details of drive | | |
| Type of motor | : | Flameproof |
| HP | : | 10 |
| Speed | : | 1440 rpm |
| Gearbox | | |
| Type | : | U – 400 |
| Ratio | : | 20:1 |
| Sprocket | : | 19 teeth, 1” pitch |
| | | 57 teeth, 1” pitch |
| Length of duplex chain | : | 4 m |

6. **Rotary Airlock Valve on D.T.**

| | | |
|---|---|---|
| Size | : | 400 mm dia. x 500 mm long |
| Sprocket | : | 38 teeth, 1” pitch |
| Length of simplex chain | : | 6 m |

7. **Dissolventiser Toaster (D.T.)**

| | | |
|---|---|---|
| No. of compartments | : | 7 |
| Material of construction | : | M.S. plate 10 mm thick |
| Overall size | : | 3250 mm dia. x 8250 mm long |
| Type and thickness of insulation | : | 100 mm glasswool |
| Details of inner jacket | : | 3000 mm dia. x 100 mm height with 37 nos. of stay pipe of 75 mm dia. (IBR) |

Details of drive

| | | |
|---|---|---|
| Type of motor | : | Flameproof |
| HP | : | 75 |
| Speed | : | 1440 rpm |

Gearbox

| | | |
|---|---|---|
| Type | : | VB2 – 350 |
| Ratio | : | 57:1 |

8. **Rotary Airlock Valve for D.T. Bottom**

| | | |
|---|---|---|
| Material of construction | : | M.S. |
| Size | : | 250 mm dia. x 400 mm long |
| Sprocket | : | 19 teeth, 1” pitch Simplex |
| Chain length | : | 1000 mm |

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**9. Plug-O-Seal Screw Conveyor**

| | | |
|---|---|---|
| Details of body | : | 300 mm M.S. pipe x 2500 mm long |
| Pitch of screw | : | 250 mm |
| Length | : | 2500 mm |
| Screw plate thickness | : | 5 mm |
| | | |
| Details of drive | | |
| Type of motor | : | Flameproof |
| HP | : | 3 |
| Speed | : | 1440 rpm |
| | | |
| Gearbox | | |
| Type | : | U – 400 |
| Ratio | : | 20:1 |
| | | |
| Chain | | |
| Length | : | 1 m |
| Pitch | : | 1” |
| Sprocket | : | Simplex type |

(a) 25 teeth, 1” pitch
(b) 38 teeth, 1” pitch

**10. Vapour Separator with Water Spray arrangement**

| | | |
|---|---|---|
| Materials of construction | : | M.S. plate 6 mm thick with 75 mm glasswool insulation. |
| Size | : | 1500 mm dia. x 1500 mm long |
| Conical height | : | 950 mm |
| Outlet dia. : | 65 mm | |
| Number of spray | : | 10 |
| Ducting inlet/outlet | : | 700 mm |

**11. Economiser**

| | | |
|---|---|---|
| Material of construction | : | M.S. plate 8 mm thick |
| Overall size | : | 1080 mm dia. x 8000 mm long |

There are **three** sections as under:

**Section – 1**
Cone having length of 1000 mm

**Section – 2**
Central part of 4500 mm long
650 nos. of S.S. 304 tubes of 22 mm dia. x 4500 mm long are housed inside.

**Section – 3**
2500 mm long with 6 nos. of 3 mm thick M.S. baffle at top.

**12. Vapour Separator after Economiser**

| | | |
|---|---|---|
| Material of construction | : | M.S. plate 8 mm with 75 mm thick glasswool insulation. |
| Size | : | 1200 x 1200 x 750 mm Cone |
| Outlet dia. | : | 50 mm |
| Central pipe | : | 500 mm dia. |

**13. Separator for Economiser with Internal Cone**

| | | |
|---|---|---|
| Material of construction | : | M.S. 6 mm plate with 75 mm glasswool insulation. |
| Size | : | 1350 x 1350 x 750 mm Cone |
| Outlet dia. | : | 1080 mm |
| Size of baffle plate | : | 1340 mm dia. x 3 mm thick |
| Internal cone | : | 1080 x 550 x 75 mm |

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**14. <u>Miscella Filter</u>**

| | | |
|---|---|---|
| Material of construction | : | M.S. 5 mm thick plate |
| Overall size | : | 1350 mm dia. x 1500 mm long |
| Size of cone | : | 950 mm long x 65 mm dia. at outlet |

Inner buckets

| | | |
|---|---|---|
| Material of construction | : | S.S. 304 Net of 150 mesh 1 m x 1 m |
| Size | : | 300 mm dia. x 1000 mm long |

**15. <u>Flasher Heater</u>**

| | | |
|---|---|---|
| Material of construction | : | M.S. 8 mm thick plate with 75 mm glasswool insulation. |
| Overall size | : | 950 mm dia. x 3000 mm long. |

Details of tubes

| | | |
|---|---|---|
| Material of construction | : | S.S. 304 |
| Size | : | 22 mm dia. x 3000 mm long |
| Number of tubes | : | 450 |

**16. <u>Flasher Separator</u>**

| | | |
|---|---|---|
| Materials of construction | : | M.S. 6 mm plate with 75 mm glasswool insulation. |
| Overall size | : | 1200 mm dia. x 1200 mm long |
| Size of cone | : | Dia. at bottom 150 mm x 750 mm long. |
| Size of baffle plate | : | 1150 mm dia. x 1150 mm long x 3 mm thick |

**17. Final Heater**

| | | |
|---|---|---|
| Materials of construction | : | M.S. plate 8 mm thick with 75 mm glasswool insulation. |
| Overall size | : | 860 mm dia. x 3000 mm long |
| Details of tubes | : | S.S. 304, 22 mm dia. x 3000 mm long |

**18. Final Heater Separator**

| | | |
|---|---|---|
| Materials of construction | : | M.S. plate 6 mm thick with 75 mm glasswool insulation. |
| Overall size | : | 1200 mm dia. x 1200 mm long |
| Size of cone | : | Dia. at bottom 150 mm x 750 mm long. |
| Size of baffle plate | : | 1150 mm dia. x 1150 mm long x 3 mm thick |

**19. Stripping Column**

| | | |
|---|---|---|
| Materials of construction | : | M.S. plate 8 mm thick with 75 mm glasswool insulation |
| Overall size | : | 1200 mm dia. x 5000 mm long |

15 NB, ‘C’ class M.S. tube is spiraled on outer side of stripper. 400 mm dia. tube fabricated from 22 SWG, S.S. 304 sheets with 65 numbers of 22 SWG, S.S. 304 strips in 300 mm width are provided inside the body along the length. End plates are provided with drilled holes for fixing strippers at both ends.

**20. Miscella Tank and Waste Water Heater**

| | | |
|---|---|---|
| Material of construction | : | M.S. plate 8 mm thick |
| Insulation | : | 100 mm glasswool |
| Overall size including waste water heater. | : | 2000 mm dia. x 7700 mm long |
| Size of waste water heater including waste water heater. | : | 2000 mm dia. x 7700 mm long |
| Size of waste water heater | : | 2000 mm dia. x 1000 mm long |
| Total number of chambers | : | 5 |
| Total number of partitions | : | 4 |
| Material of construction of partitions | : | M.S. plate 6 mm thick |
| Details of each chamber | : | **Chamber – 1**<br>It consists of coil made out of 15 NB 'C' class pipe of 32 m long.<br><br>**Chamber – 2 and 3**<br>Divider of the tank<br><br>**Chamber – 4**<br>Housing inlet pipe of S.S. 304 construction (65 NB, 3 mm thick) in total length of 12 mm with 6 bends.<br><br>**Chamber – 5**<br>Includes float made of 22 SWG, S.S. 304 sheet. |
| Size of float | : | 300 mm x 300 mm |

**21.** **Separator for Vacuum Pump**

| | | |
|---|---|---|
| Material of construction | : | M.S. plate 6 mm thick |
| Overall dimensions | : | 750 mm dia. x 750 mm long |
| Length of cone | : | 500 mm |
| Dia. of outlet | : | 50 mm |

**22.** **Vacuum Breaker**

| | | |
|---|---|---|
| Material of construction | : | M.S. 6 mm thick plate |
| Overall size | : | 500 mm dia. x 750 mm long |
| Size of M.S. pipe | : | 75 mm dia. x 1000 mm long |

**23.** **Condenser**

| | | |
|---|---|---|
| Capacity | : | 350 sq. metre |
| Type | : | Shell and tube |
| Materials of construction | | |
| Shell | : | Made out of 10 mm and 8 mm thick M.S. plate |
| Tubes | : | 19 mm dia. x 1 mm thick S.S. 304 tube 1250 mm dia. x 6000 mm long |
| Overall dimensions | : | 1250 mm dia. x 6000 mm long. |

**24.** **Pressure Breaker**

| | | |
|---|---|---|
| Material of construction | : | M.S. plate 6 mm thick |
| Overall size | : | 500 mm dia. x 750 mm long |
| Size of M.S. pipe | : | 75 mm dia. x 1000 mm long. |

**25.** **Pack Tower**

| | | |
|---|---|---|
| Material of construction | : | M.S. plate 5 mm thick |
| Overall dimensions | : | 450 mm dia. x 4500 mm long |
| Number of raising ring provided | : | 5000 |
| Dia. of atomizer | : | 25 mm |

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**26.** **Mineral Oil Cooler**

| | | |
|---|---|---|
| Material of construction | : | M.S. plate 8 mm thick |
| Overall size | : | 1000 mm dia. x 2500 mm long |

The oil cooler is made out of 1000 mm dia. x 2500 mm long fabricated out of 8 mm thick M.S. plate with 32 mm thick flange plate. The spiral coil made out of 25 NB, ‘C’ class, tube is housed inside the cooler. There are three spiral wound coils as:

400 mm dia., 600 mm dia. and 800 mm dia. totaling to 350 metres long.

**27.** **Cooling Tower with Pumps**

| | | |
|---|---|---|
| Type | : | Double flow, induced draft cross flow cooling tower. Fibre glass with aluminium blade. |
| Capacity | : | 300 cu. m./hr |
| Hot water | : | $42^0$ C |
| Cold water | : | $32^0$ C |
| Design wet bulb | : | $28^0$ C |
| Overall dimensions | : | 7500 x 6300 x 3750 mm |
| Inside basin | : | 7000 x 4500 mm |
| Static pumping head above basin curb | : | 3000 mm |
| Fan diameter/number of blades | : | 2400 mm/6 |

Fans and cells

| | | |
|---|---|---|
| Input BHP | : | 10 |
| Gear reducer series | : | 20 T |
| Type of gears | : | Spiral bevel |
| Motor HP | : | 12.5 |

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**28. Preheater Exchanger**

| | | |
|---|---|---|
| Capacity | : | 30 sq. m. |
| Materials of construction | : | Shell – M.S. |
| | | Tube – S.S. 304 |

**MEAL FINISHING**

**1. M.S. Radler Conveyor for Carrying DOC from SEP to DOC Section**

| | | |
|---|---|---|
| Capacity | : | 25 tonnes per hour |
| Total length | : | 37 m |
| Width of chain | : | 485 mm |
| Length of chain | : | 75 m |
| Pitch of chain | : | 105 mm |
| Details of drive | | |
| HP | : | 10 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | U – 600 |
| Ratio | : | 25:1 |

**2. M.S. DOC Cooler Two Stage**

| | | |
|---|---|---|
| Capacity | : | 25 tonnes per hour |
| Details of drive | | |
| HP | : | 20 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | U – 1000 |
| Ratio | : | 50:1 |

**3. M.S. Radler Conveyor for Carrying Cooled DOC to Bagging Chute**

| | | |
|---|---|---|
| Capacity | : | 25 tonner per hour |
| Total length | : | 13.65 m |
| Width of chain | : | 485 |
| Length of chain | : | 28 m |
| Pitch | : | 105 mm |
| Details of drive | | |
| HP | : | 5 |
| Speed | : | 1500 rpm |
| Gearbox | | |
| Type | : | U – 400 |
| Ratio | : | 25:1 |

**4. Pulverizer**

| | | |
|---|---|---|
| Size | : | 750 mm dia. x 200 mm width |
| Details of drive | | |
| HP | : | 30 |
| Speed | : | 2900 rpm |

**Final solvent recovery by absorption :**

The vapour and gases from the contact cooler are led to absorber where they come into intimate contact with an absorbing oil (vegetable oil or mineral oil). The solvent vapours, if any, are absorbed in this oil and non-condensable gases are let out into the atmosphere. While theoretically these gases leaving the plant are expected to be free from hexane, in practice, a small amount of the solvent is lost with these gases.

The oil containing the absorbed solvent is led into an evaporator kept under vacuum and heated to $100^0$ C. The solvent is vapourized and these vapours are led into one of condensers and recovered. The hot oil from the evaporator is passed through a cooler to cool to room temperature, and having been freed from hexane it is sprayed back into the absorber.

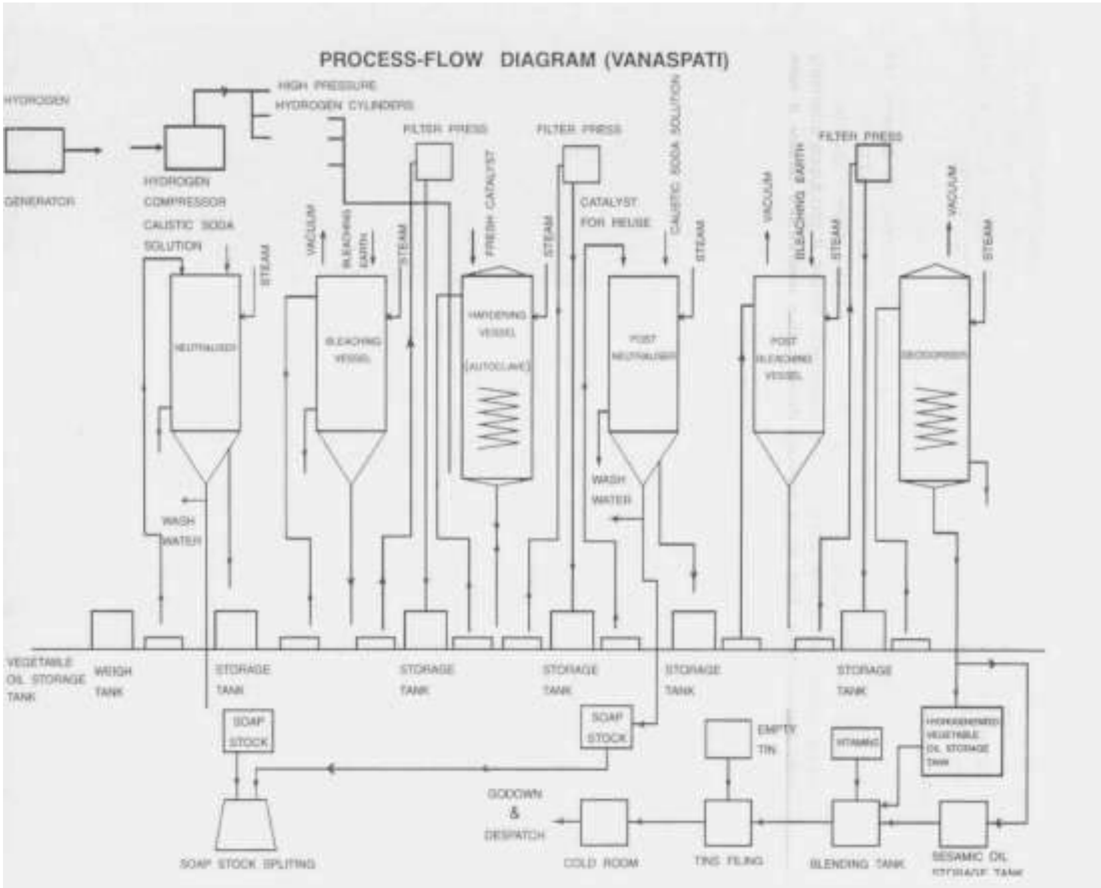
**Meal finishing and bagging :**

The radler conveyor carries the desolventised meal form the DT to bagging section.

The meal is not only conveyed but also cooled to about 45-50$^0$ C by means of cold air draft induced in the conveyor by a blower. The meal drops to a humidifier from the radler. In the humidifier the meal is mixed with enough moisture to bring up the moisture content, thus replacing the amount of water lost during the extraction and desolventisation steps. The humidified meal is then bagged at the discharge of the humidifier.

**(2) Vanaspati plant :**

**Process flow diagram**



**Chemistry of vanaspati**

Everyone know oils and fats as an ingredient of daily food or perhaps as a raw material for soap making. But only a few people know them as a group of organic compounds called ‘fatty acids’. Fatty acids, in their turn, are formed by union of several carbon atoms in a straight chain with hydrogen and oxygen atoms. A single chain may contain anywhere from 6 to 24 carbon atoms, but the common one are 12, 14, 16, 18 and 20 carbon chains. A fatty acid is said to be saturated when all the carbon atoms are combined with hydrogen to their full capacity. They are said to be unsaturated when combination with hydrogen is incomplete and there is a possibility of further addition of hydrogen. Higher the unsaturation, lower is the melting point of fatty acid. As such, many oils containing unsaturationremain as liquids at normal temperature. Those which contain lesser amount of unsaturated acids exist as solid or semi-solid fats at normal temperature. A liquid oil can be converted to a required degree of hardness by reducing its unsaturation by controlled reaction with hydrogen.

Vanaspati is a product obtained by such controlled hydrogenation of edible liquid oils (called ‘soft oils’ in the industry), so that its hardness, consistency and grainy appearance resemble natural Ghee. The addition of hydrogen to an oil occurs when the hydrogen gas is brought into contact with the oil at higher temperatures in the presence of metallic nickel catalyst prepared under controlled conditions. In practice, however, the process is not so simple. Several steps are involved in the process as described in succeeding paragraphs.

**Processing of vanaspati**

**Pre-neutralising :**

Crude vegetable oils, as they are obtained from oil mills or ghanis or solvent extraction plants, contain a small amount of free fatty acids (without combination with glycerin) and traces of mucilage. These, if not eliminated, impede the hydrogenation reaction. Also the presence of these effects the stability of final product in respect of its wholesomeness and life. These are removed by treatment of the oil with a calculated quantity of solution of caustic soda. When so treated, the caustic soda reacts with fatty acids which results into soap forming. When allowed to settle, the soap stock constitutes a valuable by-product. A small portion of oil is thus lost in this operation, the loss depend on the free fatty acid content of oil.

The neutralized oil is then given a series of hot water washes to free it completely from soap and caustic soda, each washing being settled and separated.

**Pre-bleaching :**

The neutralized and washed oil is then heated under vacuum when the moisture from the oil is evaporated and oil becomes dry. The dried oil is mixed with bleaching earth and carbon, stirred and filtered free from earth and carbon. The earth and carbon absorb the colouring matter from the oil thus producing a light coloured oil. Bleaching is essential to produce a snow-white coloured Vanaspati. Improper bleaching may result in darkish colour to the final product.

**Hydrogenation :**

The pre-bleached oil is treated with hydrogen gas in the presence of nickel catalyst for hardening. The extent of hydrogenation is checked by periodic determination of melting point of the oil. When the required melting point has been reached the reaction is stopped, and oil is filtered free from nickel.

**Post-neutralising and bleaching :**

The high temperature of hydrogenation and sometimes the presence of trace of moisture in the hydrogen gas, results in the slight splitting of neutral oil into free fatty acids. Therefore, neutralizing operation is repeated after hydrogenation. Also the drying and bleaching operations are repeated as a necessary sequel to neutralizing. Post-bleaching also helps to remove any traces of nickel left out in the oil after hydrogenation operation.

**Deodorisation :**

The oil is now hardened but still has the original taste and odour. These are removed by the process of steam distillation of oil at high temperature under vacuum. Under these conditions the steam passed through the oil carries with it all the odoriferous matter from the oil as well as any traces of fatty acids still left. When the oil is free from taste and odour it is cooled and filtered to sparkling appearance.

**Blending and packing :**

The oil is then blended with vitamins A and D and filled in clean tins which are then weighed and sealed.

**Chilling :**

This is the operation when the hardened oil takes its final form to Vanaspati with grainy appearance similar to Ghee. The sealed tins are kept in cold room (cooled by refrigeration plants, with regulated temperature and cold air draft, so that chilling is slow and gradual).

This way the oil solidifies with large crystal formation. This form of Vanaspati is very popular in India where people are used to Ghee. Western countries where Ghee is unknown and butter is commonly used, the artificial butter called ‘Margarine’ is made by chilling the hardened oil quickly with continuous agitation. This way, the oil solidifies to soft and uniform buffer consistency. Also perhaps, the hardening of oil is carried out to a lesser degree in the case of Margarine. Margarine is packed in small packets after being chilled.

**Refrigeration :**

The cold air for circulation in the chilling rooms is obtained by blowing air through a refrigeration unit operating with ammonia gas as the refrigerant. The ammonia gas is compressed and cooled in a condenser where it liquefies. The liquid ammonia is evaporated in an evaporator where it produces intensely cold temperature. The air is passed through this evaporator where it gets chilled.

**Hydrogen gas production :**

Hydrogen gas required for the hydrogenation reaction is obtained by the electrolysis of water. When high electric current is passed through water it splits into hydrogen and oxygen. Special cells are used for electrolysis, so that hydrogen and oxygen produced do not mix. The hydrogen gas is washed free from impurities and collected in a low pressure gas holder. It is compressed into high pressure storage cylinders from where it is drawn for use in the processing plant.

The major process equipment consists of :

1. Neutralizers
2. Bleachers
3. Hyrdogenation
4. Deodorization
5. Blending and packing
6. Hydrogen gas production

The bulk of the equipment consists of tanks made out of plates of varying thickness as high as 25 mm in case of autoclaves. Depending upon the requirement the tanks are with heating coils of required sizes. Some of the tanks are insulated, fitted with paddle type stirrers, anchor type stirrer, etc.

The specifications of remaining equipment :

1. Electrolysers

| | | |
|---|---|---|
| Capacity | : | 70 $m^3$/hr of hydrogen gas and 35 $m^3$/hr of oxygen gas |
| Model | : | 150 E 60 |
| Sr. No. | : | 1 |
| Make | : | Bamag |

2. Low Pressure Holder for Hydrogen Gas

| | | |
|---|---|---|
| Capacity | : | 80 $m^3$ |
| Dimensions | : | 5.18 m dia. x 4.57 m ht. |
| Plate Thickness | : | |
| Cell Plate | : | 6 mm |
| Bell Plate | : | 4 mm |
| Bottom Plate | : | 8 mm |
| Material of Construction | : | Mild Steel |

3. Oxygen Gas Low Pressure Holder

| | | |
|---|---|---|
| Capacity | : | 50 $m^3$ |

4. Hydrogen Gas Compressor

Horizontal type, 2 Stage Air Compressor

| | | |
|---|---|---|
| Type | : | ESH-2 Lub |
| Size | : | 9” – 4 ¾” x 7” |
| Drive | : | 47 KW, 1475 rpm flame proof motor |

5. Neutralizers

Insulated with paddle type stirrer, heating coil inside, dilute, caustic soda sprinkling ring on top.

Capacity : 29 T total, 27 T working

Make : Sancer, U.S.A.

6. Autoclave

Capacity : 15.5 T

Dimension : 2.7 m dia. x 5.40 m ht.

Plate Thickness :

Shell : 22 mm

Top and Bottom : 25 mm

Material of Construction : Mild Steel

Working Pressure : 125 lb/sq.inch

7. De odoriser with condenser, catch all, insulated with panel board, steam coil, vacuum system comprising of steam flow chart, vacuum gauge, temperature gauge but without stirrer.

Working Capacity : 12 T

Make : Luster & Samcer Inc., Chemical Engineers, U.S.A.

8. Form Filling and Sealing Machine with Conveyor Belt and Heat Sealing Control

Capacity : 1 kg

Material of Construction : Stainless Steel

9. Volumetric Filling Machine for 2 kg Poly Jar

Type : 2 Head

10. Poly Jar Sealing Machine for 1 Kg

Type : 2 Head

11. Filter Press

Material to be filtered (ltrs.)
Operating temperature ($^0$C)
Operating pressure (kg / cm$^2$)
Flammable / Non flammable / others

Type of plate : Chamber / plate & frame

Plate size (mm) :

Cake Thickness (mm) :
No. of chambers :

Material of filter press
plate : C.I. / P.P. / Wood

Filter press body : C.I. commercial/ C.I. graded / M.S.

Material of flanges : M.S.R.L. / C.S. / S.S. / P.P.

Type of closing devices: Ratchet closing.
Manually operated hydraulic closing mechanism with hand pump.
Electrically operated hydraulic closing mechanism.

Filtrate discharge : Closed / open

Washing : Simple / thorough

Drip collection tray : M.S. / S.S. / P.P. / F.R.P. / other

Auto shifter : Plate shifting device

# INDUSTRIAL PROCESSES - II

# INDEX

# UNIT - 1

## IRON, STEEL & NON-FERROUS METAL PRODUCTION

### INTRODUCTION

The role of materials has been sufficiently important in progress of civilization and advancement of societies. Advanced technologies involve sophisticated materials, as they utilize products, devices and system, which consist of materials. Metals have played a key role in transforming life of human beings. Tremendous developments have taken place in production and ferrous and non-ferrous metals and their respective innumerable alloys, which have made important significant and contributions to the up gradation of technology. In fact early civilization has been also designated by the level of material developments such as Stone Age, Bronze Age and the Iron Age. In present scenario metals are still most versatile material and have largest share in engineering and other applications.

Pure metals, because of their poor physical and mechanical properties, they are rarely used for engineering applications. This has led to the development of alloys like binary, ternary alloys etc. The material, which is a mixture of two or more metallic elements and possesses metallic properties, is called Alloy.

Metals and their alloys used in engineering industry and construction, by virtue of their composition are broadly classified into two groups as (1) Ferrous metals and (2) Non-ferrous metals.

1. Ferrous metals

   These include those materials having iron as their main constituent or base metal. These include wrought iron, cast iron and steels of all kinds. It may be noted that Carbon in Iron is considered as metal.

2. Non-ferrous metals

   Those metals or their alloys, which do not possess iron as their main constituent popularly, known as non-ferrous metals. Examples are aluminium, copper, tin, lead, zinc and their alloys like Brass, Gun Metal, Bronze.

It may be noted that whenever any metal is produced it always contains impurities and their content is generally lower than 1%. They are not intentionally added but are present due to limitation of manufacturing process, viz. Pig Iron contains 3-6% carbon, 1-3% Silicon by virtue of use of coke as a fuel and reducing agent and silica in the Iron Ore.

**Objective :**

By the end of this chapter students will learn about:-

- Ferrous metals
- Non – Ferrous metals
- Non-Ferrous Alloys
- Pig iron
- Wrought iron
- Cast iron
- Steel making

**<u>Ferrous Metals and Alloys</u>**

Ferrous alloys are produced in very large quantities as compared to any other type of metals. They are very important as fabricating and construction materials. The reason for their widespread use are –

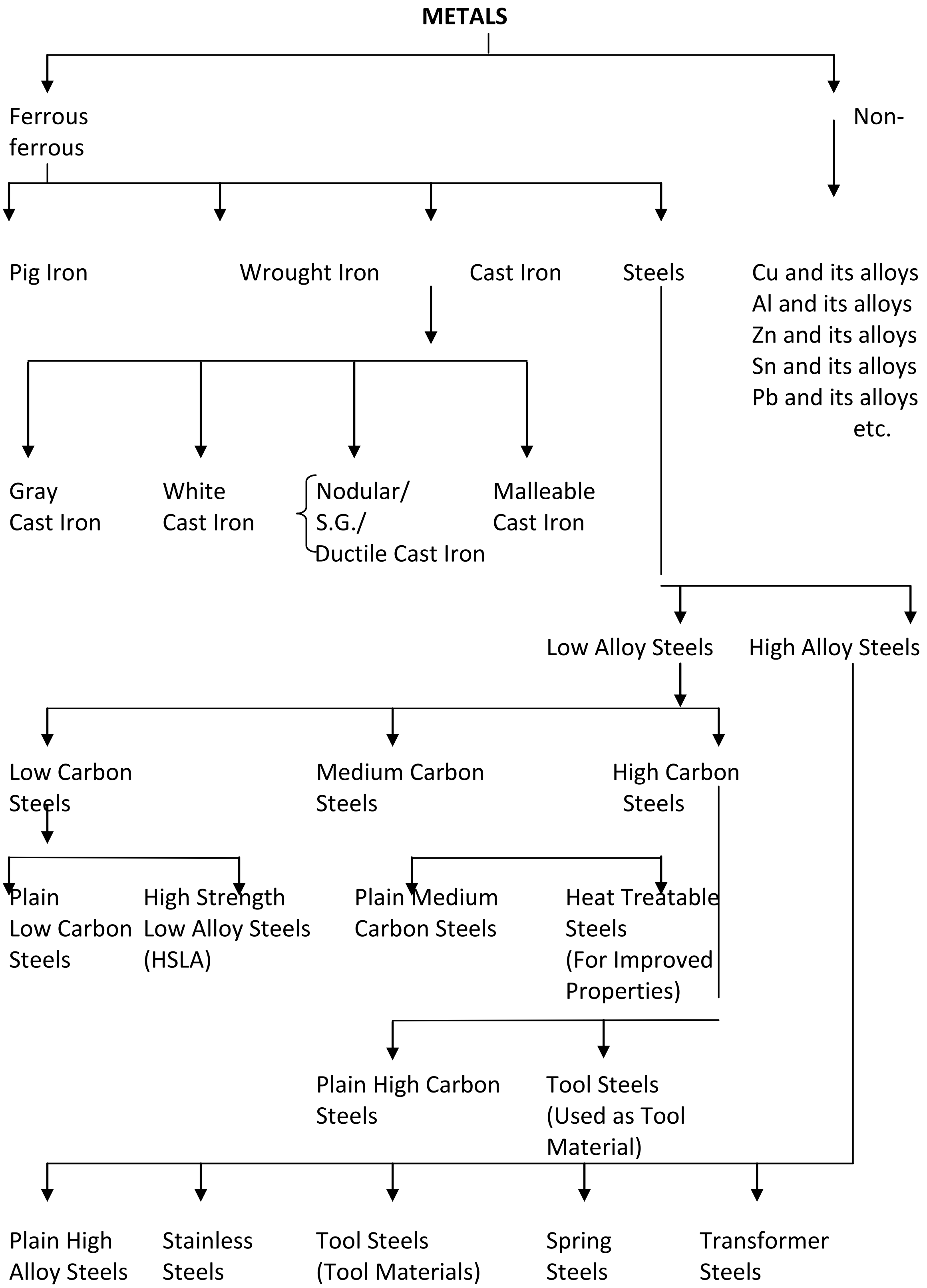
(a) Their ore (raw materials) are abundantly available in several states of India.

(b) Iron and steels production can be economical on basis of cost per unit length.

(c) They are extremely versatile and by giving proper treatment wide range of physical and mechanical properties can be developed.

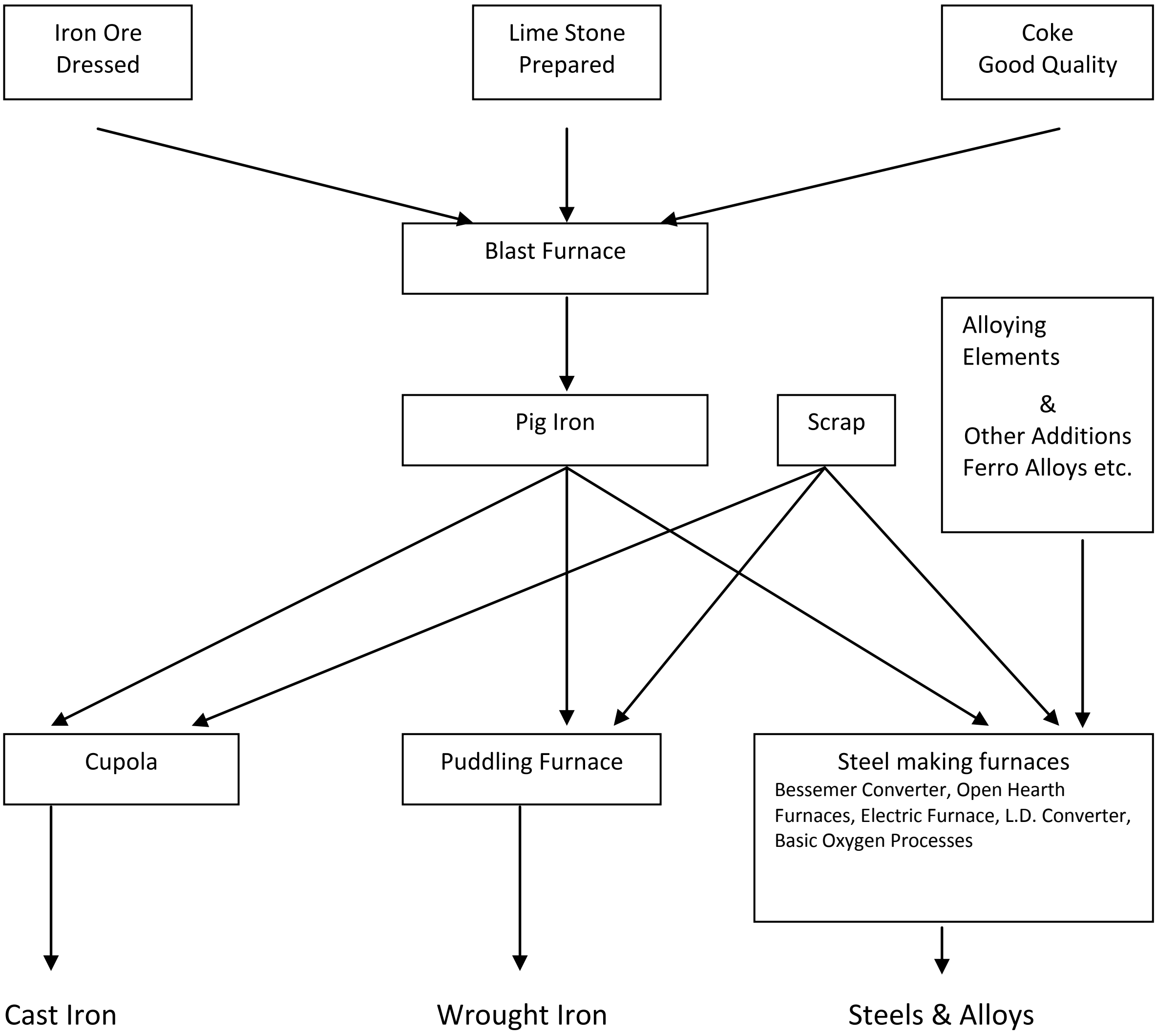
The only principal disadvantage of many ferrous alloys is they are susceptible to corrosion.

The following flow diagram shows the classification of various ferrous alloys.



The flow chart for production of ferrous metals is shown below:

The schematic flow diagram showing the process steps in brief for conversion of raw materials into major groups of ferrous products.



**Manufacture of Pig Iron**

Pig Iron is the basic raw material for all ferrous products like iron and steel. It is manufactured by smelting iron ore in blast furnace using –

(1) A hard porous fuel such as coke which supply intense amount of heat to melt iron ore and also serves as reducing agent.

(2) Lime stone as a fluxing agent to lower down the melting point of iron-ore and to promote removal of gangue material (silica, alumina in the ore, sulphur, ash and other residues of fuel) by forming a fusible slag.

(3) A blast of air which supplies required oxygen for combustion of the fuel.

**The Process**

The process is one in which iron ore, coke and flux are charged in alternate layers from the top of the furnace. The charge is taken to the top of furnace by a specially designed bucket called 'SKIP', running along an incline. The charge is then introduced into the throat by a special arrangement known as "double bell and hopper arrangement." This arrangement prevents hot blast from being released from top of furnace. A hot blast of air under pressure is introduced in near the bottom through a number of nozzles called "Tuyers" spread along the periphery of blast furnace at about 1 m from bottom. These tuyers are water cooled to prevent from getting melted due to immense heat in the zone they are located. The air blast is pre-heated to economize fuel consumption by passing cold air and hot air discharged from furnace, alternately through heated checker work of "hot blast stoves". This heat recovery system is an essential part of blast furnace plant.

The carbon in the coke is burned into carbon dioxide at the tuyers level and the resulting gases rich in carbon dioxide, rise through descending stock. The carbon dioxide disintegrates in to carbon monoxide and free elemental Carbon which reduces iron oxide in to Iron. The temperature in the melting zone is of the order of 1,400 to 1,700$^0$ C. The residue from ore, ash from fuel react with lime stone to form ‘slag’. The molten iron collects in the bottom of hearth covered by a layer of molten slag which acts as a cover preventing molten iron from getting oxidized. Two tap holes are provided in the wall of the hearth, one at the bottom for tapping out molten iron and other near the top of the hearth for discharging ‘Slag’. The iron is tapped at intervals from six to twelve hours. The furnace is kept in operation till its refractory get worn-out.

The modern blast furnace plant for smelting iron is shown in the following figures (1 to 3) and consists of –

1. Blast furnace.
2. The appliance for sending charge (ore, fuel and flux) to top of furnace and charging them into furnace.
3. The blowing engines for sending blast of air.
4. The stoves for heating the air blast.
5. The pumping plant for supplying water for cooling furnace walls and tuyers and for steam raising etc.
6. ‘Dust – catchers’ for cleaning blast furnace gas.
7. Plant for generating power from blast furnace gas.
8. The appliances for disposal of slag and pig iron.

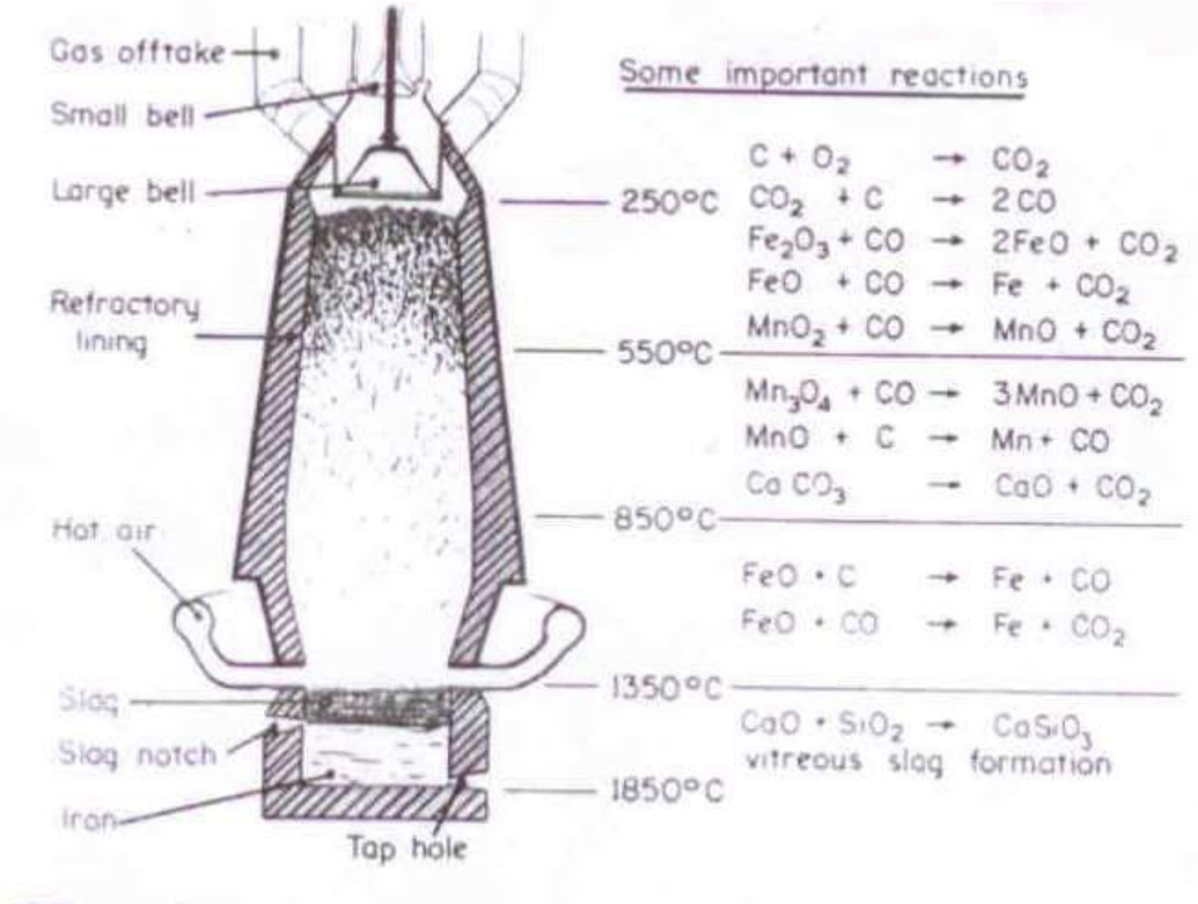



**Figure – 1 : A schematic section through a blast furnace. The important reactions occurring in the various heating zones of the furnace are shown**

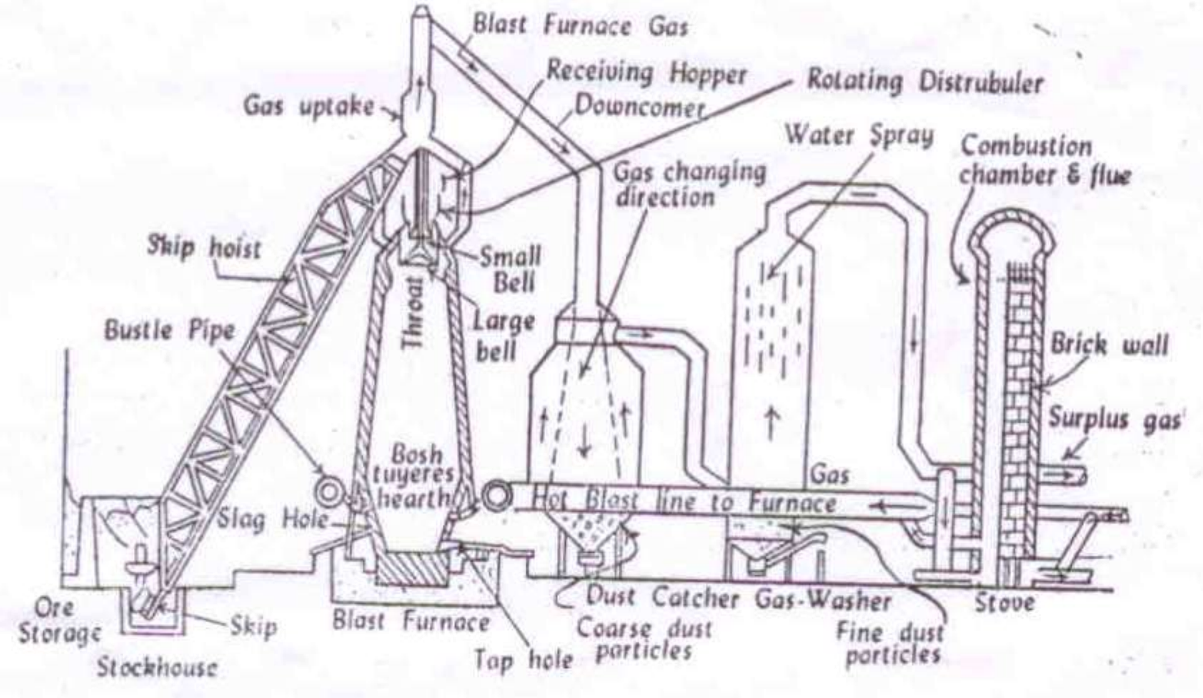



**Figure -2 : Layout of a modern blast furnace plant**

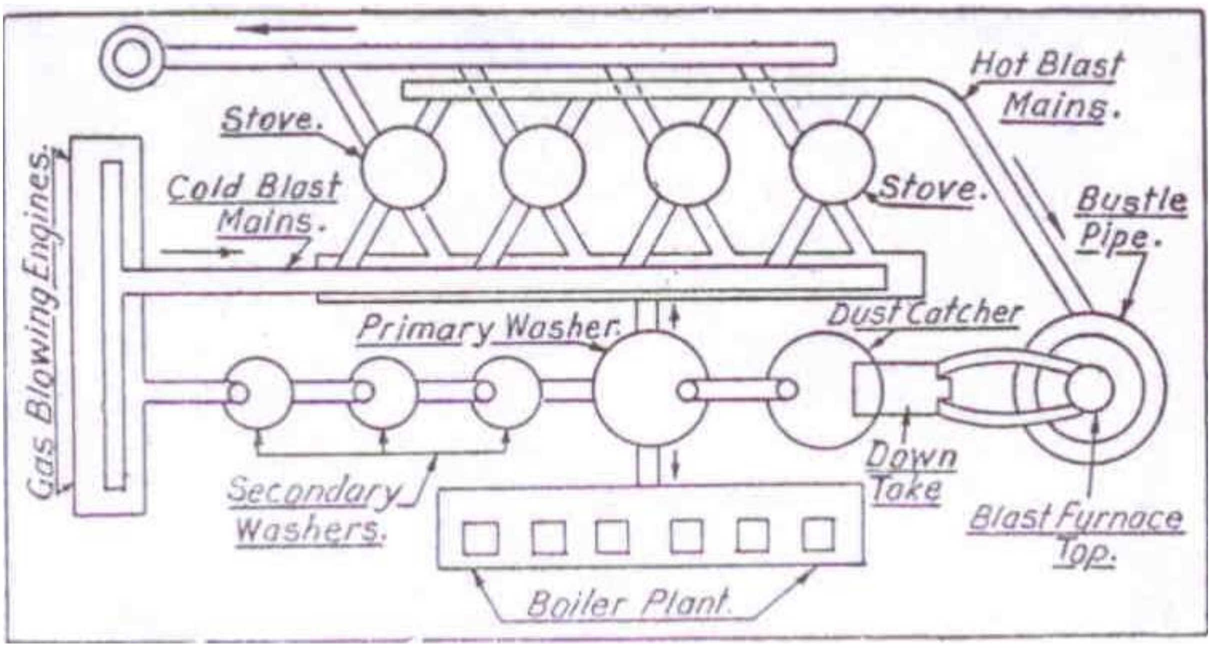



**Figure - 3 : Blast furnace layout plan**

## Disposal of Pig Iron and Slag

The pig iron tapped from the blast furnace is disposed off in one of the three ways:

1. Cast in stand-beds (pig bed)
2. Cast in cast iron moulds in pig – casting machine
3. Directly transferred to steel making process (steel works) in hot metal ladles in molten condition.

1. Casting in sand is the older method and still in use. In this method, sand-beds are prepared in front of furnace and moulds are made into them to receive the liquid pig iron. When the iron is cooled, the pigs are broken away and loaded into wagons for transportation.

2. Casting in cast iron moulds carried out in "Pig Casting Machine", consisting of a long series of moulds carried on an endless chain. When the metal is poured in each mould from a ladle through a spout, the mould moves forward and its place is taken by the next one. The pig iron chills quickly into metal mould and by the time it reaches the other end it is solid and drops automatically into wagon. These empty moulds are given a coating of lime or clay to avoid sticking of pig iron.

3. If blast furnace plant is working in conjunction with a steel works, the pig iron is tapped into a ladle mounted on a carriage and directly transported to steel works where it can be directly charged to steel making furnace or stored in a 'Mixer' which is a vessel of 600 – 1200 tons capacity.

For tapping out of furnace from tap hole is cleaned with chisel rod and clay plug is removed till hot skull in front is visible, then it is opened out by an oxygen jet. After tapping of furnace the tap hole is closed by special mud by 'MUDGUN'. The clay becomes hard and tap is closed effectively.

## Disposal of Slag

The slag made in an iron blast furnace amounts form ½ - 1 ton per ton of pig iron. Being light weight occupies a large volume and therefore to be removed more frequently than iron. In some plants slag is directly granulated by stream of crater jet and obtained in granule form which can be used as ballast for railways or as raw material for slag cement or for making slag bricks, or floor tiles. In plants where slag is not granulated it is poured in tilting slag ladles and dumped away in molten condition in slag yard. The general composition of blast furnace slag consists of $SiO_2$, CaO and $Al_2O_3$ with smaller amount of MgO, MnO, FeO and CaS.

## Types of Pig Iron

The product of blast furnace is classified by chemical composition into three grades:

1. Basic pig iron

   It is mainly used for steel making and is low in silicon. Composition is as follows:

| | | | |
|---|---|---|---|
| Carbon- | 3.5 to 4.4% | Silicon - | 1.5% maximum |
| Manganese- | 1.0 to 2.0 % | Sulphur - | 0.04% |
| Phosphorous- | Up to 1% | Iron - | Balance |

2. Foundry pig iron

   It is mainly used for the production of cast iron castings. Depending on amount of carbon, it is classified in to various grades. The general composition is as follows:

| | | | |
|---|---|---|---|
| Carbon- | 3.0 to 4.5% | Silicon - | 0.5 to 3.5% |
| Manganese- | 0.4 to 1.25 % | Sulphur - | 0.05% maximum |
| Phosphorous- | 0.04 to 1.0% | Iron - | Balance |

3. Ferro alloys

These are alloys of pig iron and use various metals such as manganese, chromium, silicon, tungsten. They are used as as additives in iron and steel industries to control the properties of iron and steel. viz.

(a) Ferro – Manganese - Pig iron contains 75 to 82% Manganese

(b) Ferro – Silicon - Pig iron contains 5 to 17% Silicon

(c) Ferro-Chrome - Pig Iron contains 5- 60% chromius

**<u>Other methods of pig iron production</u>**

The manufacturing process described above is most standard one. But in modern age, attempts are being made to modify it or adopt new methods because of two reasons:

I. Height of modern blast furnace has increased and it requires more capital and labour for its working.

II. The coke which is used as fuel is becoming short in supply and inaccessible.

The following are the alternative methods for pig iron manufacture:

1. Electric reduction furnace
2. Low shaft blast furnace
3. Sponge iron process

Modern trends in blast furnace practice:

In view of acute shortage of good quality metallurgical coal, it will be worthwhile to enumerate some of the present trends to reduce coke consumption in blast furnace:

1. Use of pre-heated blast

2. Fuel injection in blast – With blast, fuel oil or pulverized coke can be used. Where natural gas is available, it reduces consumption of coke. Naphtha can also replace natural gas.

3. Oxygen enrichment of blast to increase productivity.

4. Humidification of blast.

5. High top pressure operation of blast furnace - By increasing pressure at the top of furnace, the speed of gases moving upwards through furnace decreases substantially by introducing a choke valve in outlet gas pipe of furnace. These results in higher pig iron production and decrease in dust losses.

**WROUGHT IRON**

Wrought iron is probably highly refined form of iron with a small amount of slag forged out in form of slag fibers. A typical representative analysis range of wrought iron is –

| | | | |
|---|---|---|---|
| Carbon | - 0.02 to 0.03% | Silicon | - 0.10% maximum |
| Manganese | - 0.02% maximum | Sulphur | - 0.01 – 0.02% |
| Phosphorous | - 0.05 to 0.25% | Slag | - 0.05 – 15% |
| Iron (Fe) | - Balance (Remainder) | | |

In olden days, wrought iron, the purest form of iron, was produced commercially by a process known as 'PUDDLING PROCESS'. In the year 1925 James ASTON developed a new process which is wholly mechanical and wrought iron can be manufactured quickly and economically. The process is known as ASTON or BYERS PROCESS.

The processes are described in brief as follows:

1. <u>Puddling Process</u>

In this process the pig iron is first subjected to a preliminary refining to remove silicon as completely as possible by using iron ore as refining agent. It is then cast into moulds. The refined pig iron is melted in a coal fired reverberatory type of furnace (Figure - 4). The oxidizing agent like iron ore are added with passing of a strong current of air. Thus, during the process of puddling most of carbon and other impurities are oxidized. The slag formed is removed and purified iron becomes thick and assumes the form of white spongy mass as balls. These balls are known as puddle balls.

The slag contained in puddle ball is removed by a process of “SHINGLING” using power hammers or passing the balls through squeezing machine to convert them into “blooms” having a cross section of 15 to 100 mm approximately. These bars are cut into short length, fastened together in piles, reheated to welding temperature and again “rolled” into bars to obtain wrought iron of desired quality.

2. <u>Aston or Byers Process</u>

In this process, pig iron is first melted in a cupola furnace and refining of molten metal is done in a Bessemer converter. The refined iron so made is poured into cooler ladle containing liquid slag prepared in an open hearth furnace at a predetermined rate.

The molten steel temperature drops and it results in a spongy mass. This Spongy mass is then given the treatment of shingling and rolling as described before. The hot bloom thus obtained is immediately passed through rolling mills to produce the products of wrought iron of different shapes and sizes.

The wrought iron is available in form of plates, sheets, bars, structural shapes, forging blooms and billets.

The melting point of wrought iron is 1510$^0$C. On heating at white heat it becomes soft enough to take any shape by hammer or press (forged). It cannot be heat-treated like steel but can be easily welded. During rolling slag particles elongate in direction of rolling. The presence of slag fibers improves strength, fatigue resistance and corrosion resistance of iron. It is tough, ductile and malleable. The presence of slag fibers in rolling direction work as reinforcing elements to improve tensile strength in longitudinal direction. Thus, it is like a composite material.

It is used for hooks, rivets, chains, railway couplings, water and steam pipes, bolts, nuts, horse shoe bats, boiler tubes, roofing sheets, armatures, electro-magnets, etc.

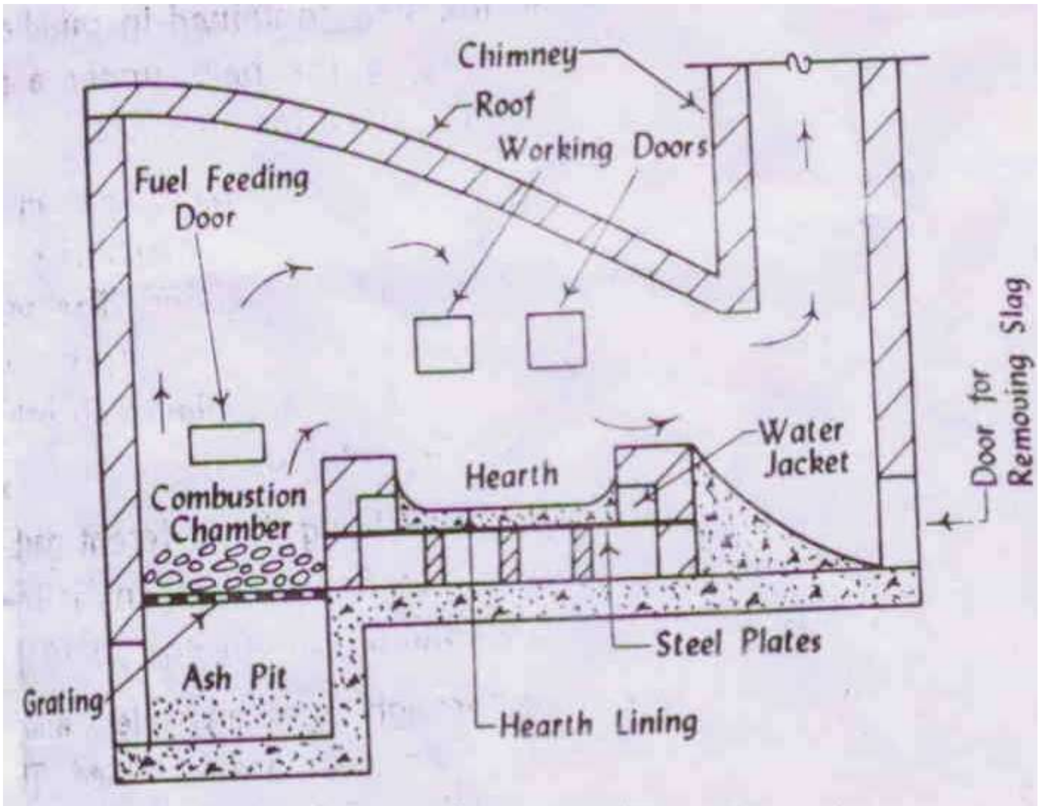



**Figure – 4 : Reverberatory furnace**

**CAST IRON**

Cast iron may be defined as an alloy of iron and carbon containing more than two percent carbon. In practice, most cast irons contain 2 to 4% of carbon and 1 to 3% silicon. In addition to carbon and silicon other elements such as sulphur (S), phosphorus (P) and manganese (Mn) are also present in cast iron.

Casting is the most convenient fabrication method to obtain metals and alloys in to the desired shape. There are several metals and alloys which cannot be mechanically worked. Cast iron being brittle material and because of its poor ductility and malleability it cannot be forged, rolled, extruded, drawn or pressed into desired shapes. However, because of its relatively lower melting point, it can be easily melted and cast with or without machining into required shape and size.

The most common furnace for melting of cast iron is cupola furnace which is the basic melting unit of cast iron foundry. It produces molten iron very inexpensively and yet allows for good compositional control. The furnace consist of a cylindrical steel shell, lined with high grade refractory and standing upright on four supporting pillars. The bottom of the furnace is closed with drop doors which support the entire charge during firing and allow easy removal of residues left after firing is complete. The section of cupola is shown in Figure – 5. The cycle of operation of cupola is as follows:

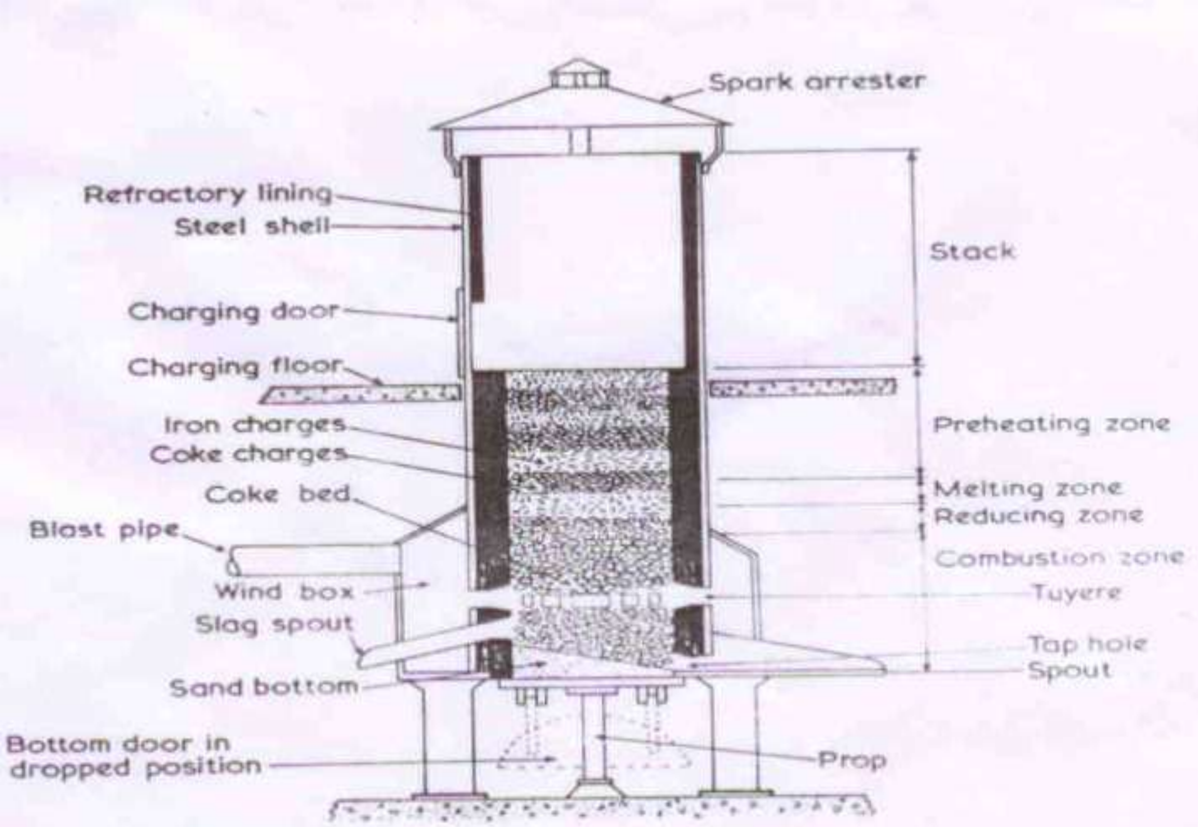



**Figure - 5 : Section through a cupola furnace**

1. The lower portion of the furnace is covered with Kindling wood and some coke which is charged to a height of about 75 cm above the tuyers. Then it is lit.

2. Alternate charges of pig iron, scrap (foundry returns) and coke are now added with a little lime stone to flux with ash of the coke to form slag.

3. The blast of air is turned on and charging of pig iron, coke and lime stone is repeated in successive layers.

4. The slag formed which float on molten metal is tapped off periodically when necessary.

5. The molten metal is also tapped off periodically every 10 – 15 minutes. The air blast is being turned off during this operation.

The inside diameter of cupola varies between 45 to 250 cm and melting capacity ranges between 1 to 10 tons per hour.

In "hot blast cupolas" the blast is preheated by hot outgoing products of combustion and this makes possible to achieve high temperature for melting steel scrap in larger proportions.

The composition of molten metal tapped in the ladle is checked prior to pouring into the moulds. For adjustment of final composition of the melt the special alloying elements are added into the ladle before pouring.

Finally bottom of the cupola is dropped and whatever is left out in cupola falls down. Next day cupola is cleaned and inside refractory work is checked, inside surface is given a clay wash, bottom is prepared and cupola is ready for a fresh charge.

**Recent Trends in Cupola Practice**

| | | | |
|---|---|---|---|
| 1. | Hot blast cupola | - | Explained above. |
| 2. | Balanced blast cupola | - | Ensures complete combustion and economy in coke rate combustion and uniform temperature. |
| 3. | Oxygen enrichment of blast | - | Enrich the blast with oxygen to achieve higher combustion rate and high temperature. This results in lower coke rate and high productivity. |

| | | | |
|---|---|---|---|
| 4. | Basic line cupola | - | Cast iron low in S and P produced. |
| 5. | Calcium carbide addition in cupola | - | Reduces amount of S in cast iron. |

**The Rotary Furnace**

In rotary furnace, temperature and composition of cast iron can be more closely controlled. A mixture of known compositions of pig iron and scrap can be charged. Rotary furnace designed for primarily for production of black heart malleable castings. Then later on, because of many advantages over cupola, it is used for wide range of gray irons and also for steel. In places like Gujarat and South India, where there is shortage of metallurgical coke, the Rotary furnaces are an advantage.

The furnace consists of a cylindrical drum of strong steel plates, with cone shaped ends closed by two circular plates, lined with refractory material. At one conical end is the oil burner and the opposite end is placed with exhaust pipe for removal of products of combustion, including ash. The drum is mounted on four rollers and slowly rotated by an electric motor through a suitable reduction gearbox at a speed of 1 rpm. The temperatures of $1500^0$C – $1550^0$C can readily be obtained. The rotary furnaces have capacity between 1/2 to 10 tons. The following figure - 6 shows the construction of Brackelsberg Rotary Furnace.

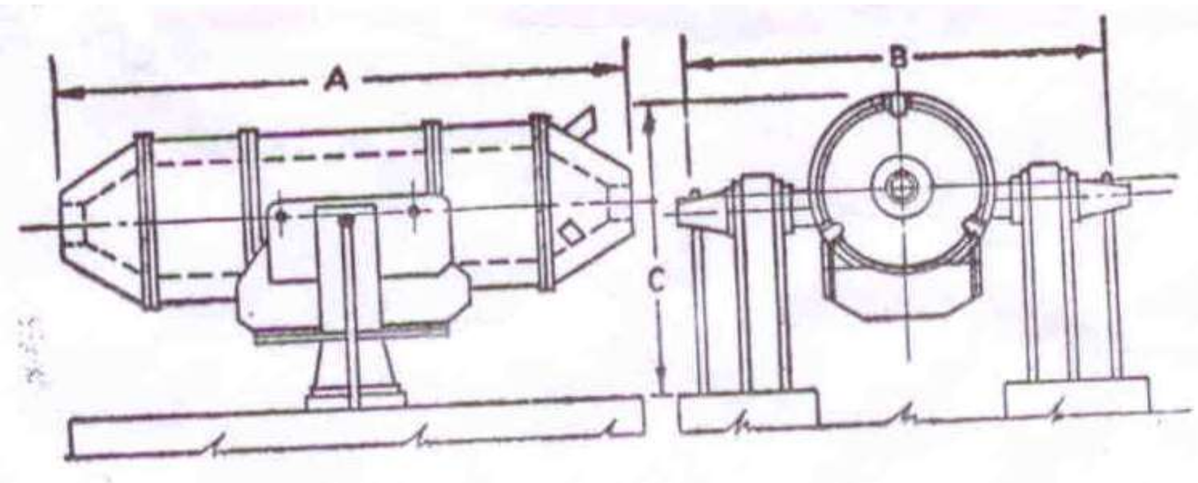



**Figure - 6 : Diagram showing construction of Brackelsberg furnace**

Steel castings are usually made in electric arc furnace and also in high frequency induction furnace.

**<u>Types of Cast Iron</u>**

The mechanical properties of cast iron depends not upon the absolute amount of carbon but upon the form of carbon and other elements present. The appearance of fractured surface gives a rough idea of mechanical properties. They are classified into following varieties:

1. White cast iron
2. Gray cast iron
3. Malleable cast iron
4. Nodular cast iron
5. Chilled cast iron
6. Mottled cast iron
7. Alloy cast iron
8. Mehanite cast iron

1. <u>White cast iron</u>

The fractured surface of white cast iron is white in colour and is a result of fast cooling, all the carbon is in the combined form (cementite). The iron is extremely hard and unmachinable. It is important raw material for production of malleable cast iron. It is not suitable for structural parts because of high brittleness. Common uses of white cast irons are in road roller surfaces, wearing plates, grinding balls, pump liners, dies, extrusion nozzles and rollers of rolling mills.

2. <u>Grey cast iron</u>

The fractured surface exhibits grey colour. Carbon is present in free form as graphite flakes. Grey cast iron is very important engineering material because of its low cost and versatile engineering properties. The mechanical properties depend upon the amount, size and distribution of graphite flakes. Grey cast iron is typically weak in tension, fairly soft, brittle strong in compression and possesses excellent casting properties. It has excellent vibration damping capacity.

The common applications of cast iron are - as machine basis, engine frames, clutch plates, brake drums, pump housing, cylinder and pistons of I.C. engines, fly wheels, gear housings, elevator counter weights, drainage pipes, man-holes etc.

3. Malleable cast iron

Malleable cast irons, combines excellent casting qualities with a measure of strength and ductility and are produced by suitable annealing of white iron castings. The process is known as "Malleabilization", on the basis of the appearance of fractured surface there are two types of malleable cast iron namely White heart and Black hearth malleable cast iron. Typical applications of Malleable Cast Irons are connecting rods, transmission gears, crank shafts axles, differential housing in automobiles, flanges, farm equipments, rail road, marine and machine parts, fittings for power transmission and distribution system, switch gear parts, railway electrification system etc.

4. Nodular cast iron

Also known as Ductile or spheroidal cast iron: - Nodular cast iron is produced by inoculating medium carbon cast iron melts with small amount of such materials as nickel – magnesium (2%), ferro-silicon or calcium silicide just prior to pouring. These additions cause graphite flakes to attain nodule or spheroidal shapes during solidification. This cast iron possesses high strength, ductility toughness, good fluidity, good castability with excellent machinability and good wear resistance. The sulphur and phosphorous content should be 0.02% maximum.

Typical applications includes railway couplings, friction blocks, impellers, valves, pumps, compressor bodies, crankshafts, suspension parts, gears and other automotive and machine components.

5. Chilled cast iron

Chilled cast iron is produced when the casting gets solidified by rapid cooling producing white cast iron at surface and grey cast iron at the core. Chilled cast iron possesses high hardness and wear resistance at surface and low hardness and strength at the core. It is used where high wear resistance is required. Typical application include grinding balls, extrusion nozzles, jaws for crushing ores, rolls, rail-road – freight – car wheels etc.

6. Mottled cast iron

It is an intermediate variety between grey and white cast iron. The fracture is mixed type known as mottled. This cast iron is used for small castings.

7. Alloy cast iron

Additions of alloying elements results in improvement in properties. Most common alloying elements are nickel, chromium, molybdenum and copper. Alloying additions improve corrosion resistance and other properties. Ni-hard, Ni-resist and Nomag are examples of some alloy cast iron.

8. Meehanite cast iron

It is special grade of cast iron and possesses excellent mechanical properties due to size, shape and distribution of graphite flakes. Calcium silicide is added to liquid melt before casting. It can be heat treated. It is used where high strength in grey cast iron is required.

In modern practice it is possible to obtain castings with comparable properties with those components manufactured by other manufacturing methods. Nearly ten percent of production of engineering metals and alloys is processed in foundries (ferrous and non-ferrous both).

The foundry plant is comprised of the following sections:

(a) Melting shop
(b) Raw material yard
(c) Pattern shop
(d) Moulding shop
(e) Core making bay
(f) Sand mixing and preparation section
(g) Finishing section - For cleaning, shot blasting, fettling and grinding of castings
(h) The heat treatment section - with furnaces, quenching media
(i) The inspection, painting and dispatch section
(j) Chemical and mechanical laboratory for testing sands, and finished castings.

**Steel Making**

Steel occupies the most important place among metals. The main reason for this is, it offers wide range of physical and mechanical properties. It is available cheaply and abundantly. It has specific property of magnetism. Indian annual production of steel is still very small compared to other advanced countries of the world in spite of abundant raw material available.

The pig iron is unsuitable for most industrial applications and needs further refining either to steel or cast iron. Steel is essentially an alloy of iron and carbon which varies from 0.008 to 2% maximum. The commercial steels, in addition to carbon contain some amount of manganese, silicon, sulphur and phosphorous. Sulphur and phosphorous are treated as undesirable impurities and are highly detrimental. Many other elements such as Nickel, Chromium, Vanadium, Tungsten, Molybdenum, Titanium etc. may be present in certain amounts depending upon their grades. These are known as alloy steels and special steels. They are used in space research and atomic energy programmes, defence, electronics, automobiles, petrochemicals and many other engineering applications.

The mechanical properties of steels and alloy steels can be improved by heat-treatment and surface hardening methods.

There are numerous steel making processes used for producing commercial and special steels. Ancient methods of steel making by crucible and cementation processes have now become extinct.

The commercial processes for making steels are –

(i) Bessemer process
(ii) Open-hearth furnace process
(iii) Oxygen processes
(iv) Electric arc furnace process
(v) Electric induction furnace process

Out of above processes open-hearth furnace and basic oxygen processes are most widely used practice for steel production. Bessemer process is now-a-days used to lesser extent. The electric furnace methods are used for production of special steels like stainless steels, tool steels, high quality low alloy steels.

Steel and its properties:

Suitable building material due to

Steel
- Higher strength to weight ratio
- Higher modules of elasticity
- Higher ductility
- Higher toughness
- Better uniformity

Equally strong in
- Tension
- Compression
- Shear

**Description of the processes in brief** :

(i) Open hearth (furnace) process

This is the oldest process of steel making and there are people, even today, who believe that Open-hearth steel has better mechanical properties than all new processes.

The major tonnage of steel produced is mainly by basic open hearth route. It is capable of producing steels of different varieties for major applications. The capacity of furnace ranges from 50 to 500 tonnes. Each batch of production is called HEAT and its duration may be up to 15 hours. The furnace consists of a shallow pan or hearth. The dimension of a 150 tonnes furnace may be as follows:

Length – 15 meters Width – 5 meters and Depth – 1 meter

Dead burnt magnesite refractory is used for hearth. Fuel may be pulverized fuel, blast furnace gas and coke oven gas mixture or petroleum oil. The air for combustion is preheated in the heat exchangers (Regenerators) which are below the furnace. They operate on regenerative cycle. Sometimes to facilitate the process oxygen is blown through pipe introduced through the roof of furnace (oxygen lancing).

Raw material for open hearth process :

(i) Liquid Pig iron and steel scrap or
(ii) Hot metal from blast furnace or Bessemer converter and
(iii) Lime stone as flux and slag former.

At the end of heat when C, Si, S, P, and Mn are reduced to desired level deoxidizers are added to reduce oxygen level in metal. After tapping the metal alloying is done by ferrochrome ferromolybdenum in the ladle.

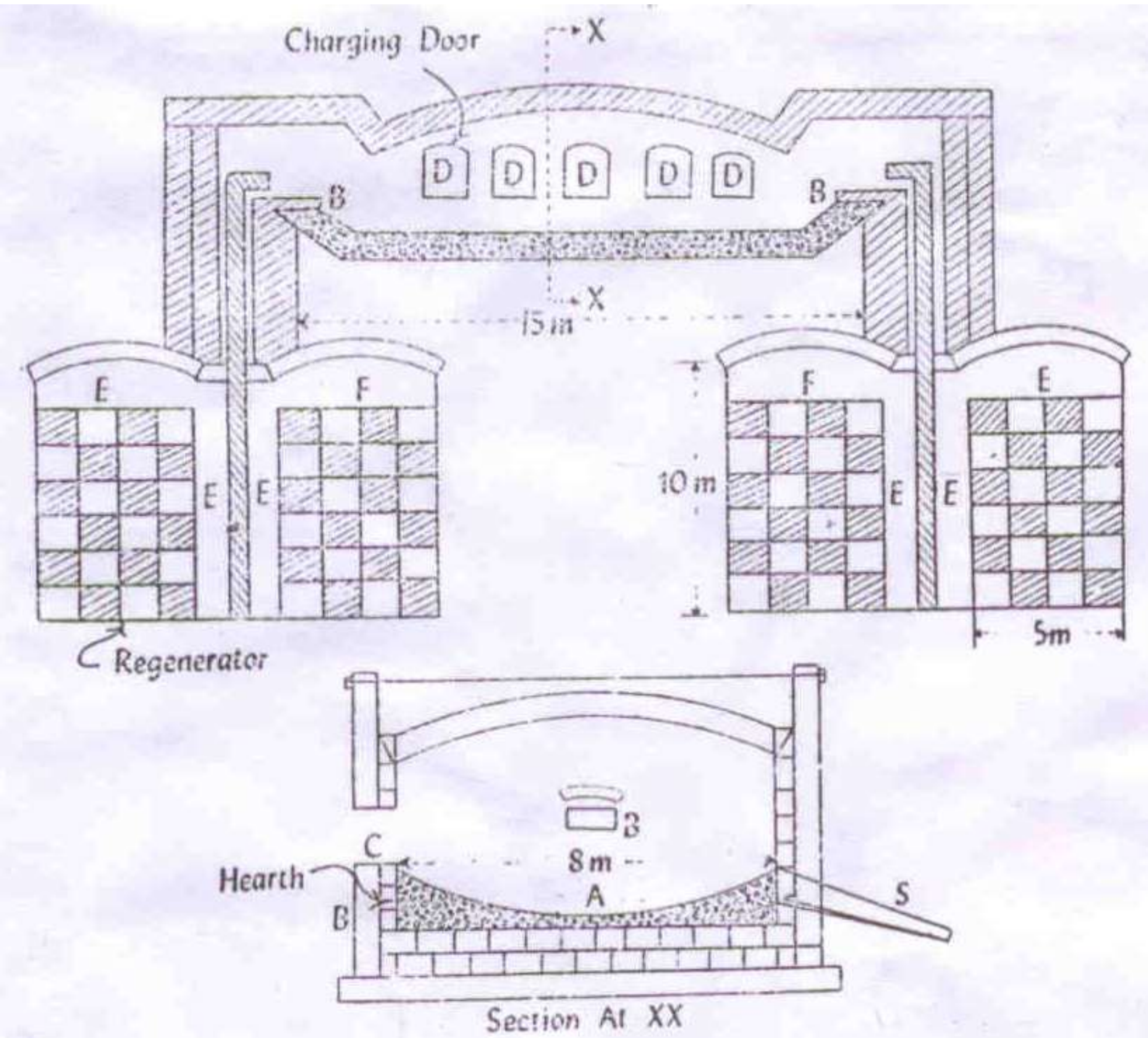



**Figure - 7 : Section of an open-hearth furnace**

(ii). <u>Bessemer process</u>

This is earliest modern device for production of steel by blasting air through molten pig iron for 15 – 20 minutes, patented in the year 1857 by Sir Henery Bessemer of England. This process is known after the inventor and was the first major step for mass production of steel. The figure – 8 shows a Bessemer converter which consists of the bottom and a pear shaped steel shell. From bottom, air (not preheated) is blown into the molten metal. The combustion of Silicon (Si), C and other elements oxidize and liberate sufficient amount of heat.

The carbon monoxide produced burns with a long blue flame at mouth of converter, when flame dies converter is emptied. The capacity of converter may range from 5 to 100 tonnes. The air blast pressure is 2.1 kg per sq. cm of converter area. The final composition of steel is made up by addition of deoxidizers, Ferro alloys and carbon in form of petroleum coke. The converter may be of acid or basic type depending on its refractory and final composition of steel to be produced. The high contents of P, S and Nitrogen in steel make the acid Bessemer steel a low grade material. Usually all Bessemer steels are plain carbon steels used for pipes, welding rods, tubes, tin plates etc.

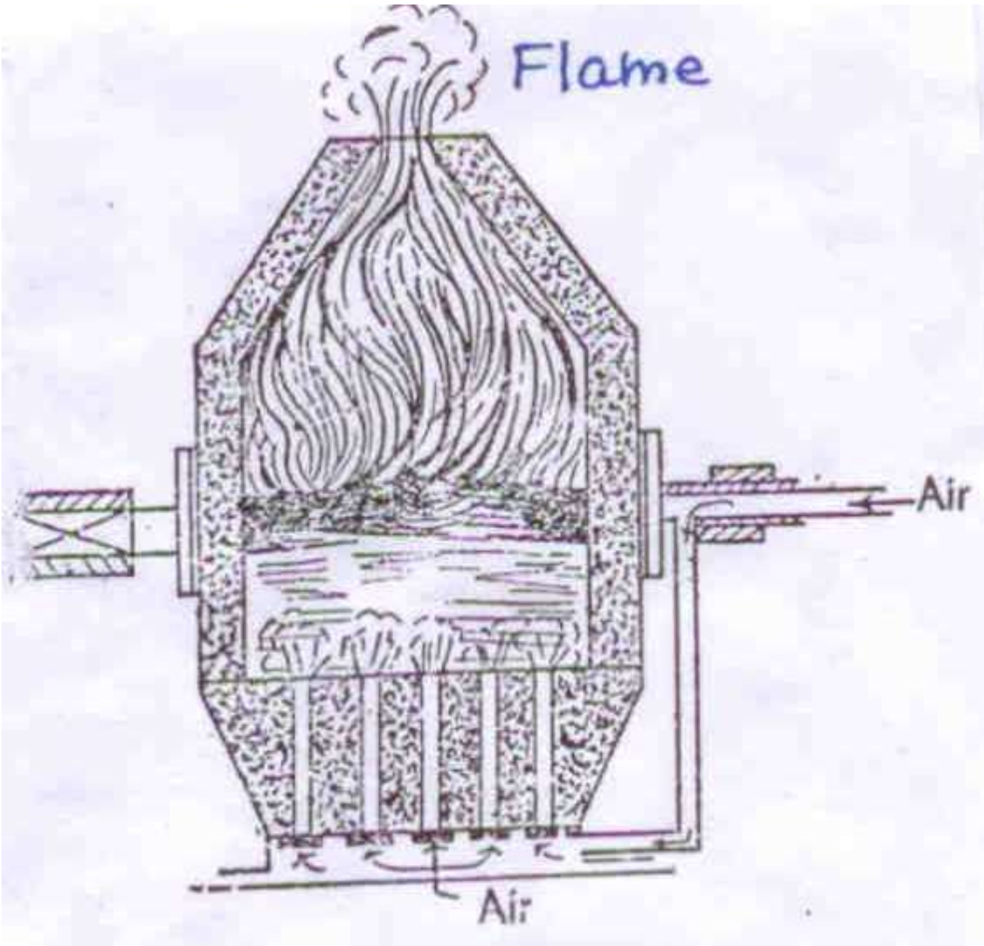



**Figure - 8 : Bessemer converter in operation**

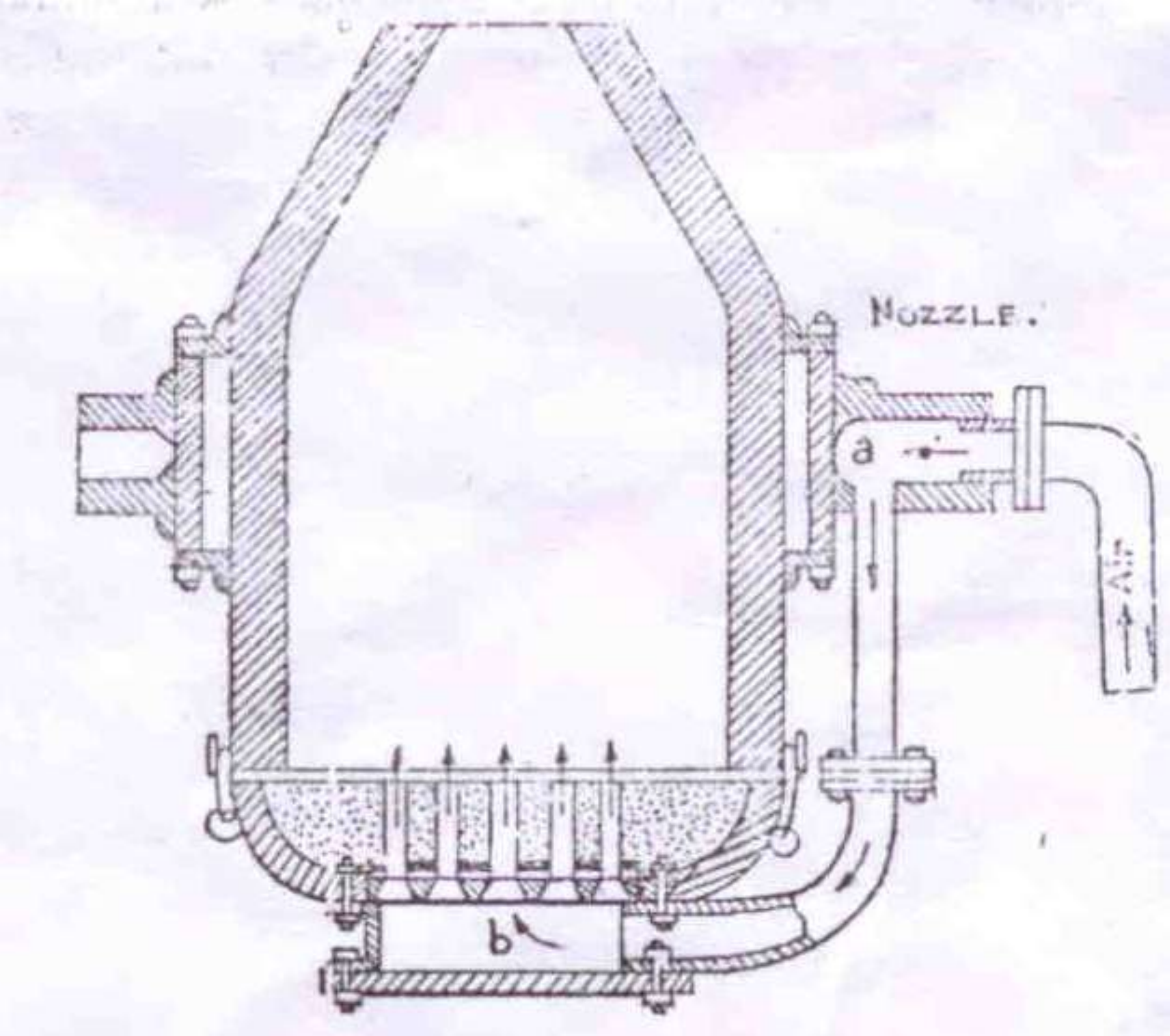



**Figure -9 : Section through Bessemer converter showing hollow Trunnion at ‘a’ for conducting air blast to wind-box ‘b’**

(iii). <u>Oxygen process</u>

This process is in a fact modification of Bessemer process – Oxygen is blown through the molten metal instead of air. Few important oxygen processes are:–

1. L.D. process (Linz – Donawitz process)
2. O.L.P. process (Oxygen – Lime Powder process)
3. Kaldo – process

L.D. process

This process was originated in 1953 in Austria and has already been adopted in many countries of the world. The productivity and high quality of steel are essential features for flat and plate products. The process consists of introducing very pure oxygen at a pressure of 7 to 10.5 kg per sq. cm. through a water cooled lance lowered through the mouth of vessel to within one meter from metal bath. The blowing time is about 20 minutes. The modern L.D. converters are of capacities ranging from 100 – 300 tonnes. The L.D. steel is low in hydrogen, oxygen and nitrogen. It is also low in phosphorous and sulphur. In this respect, it is much superior to Bessemer steel and basic open hearth steel. Such converters are now popular and major producer of steel. The L.D. process is cheap and economical.

The following figure - 10 shows two types of basic oxygen converters.

**A. Rotory Converter** **B. L.D. Converter**

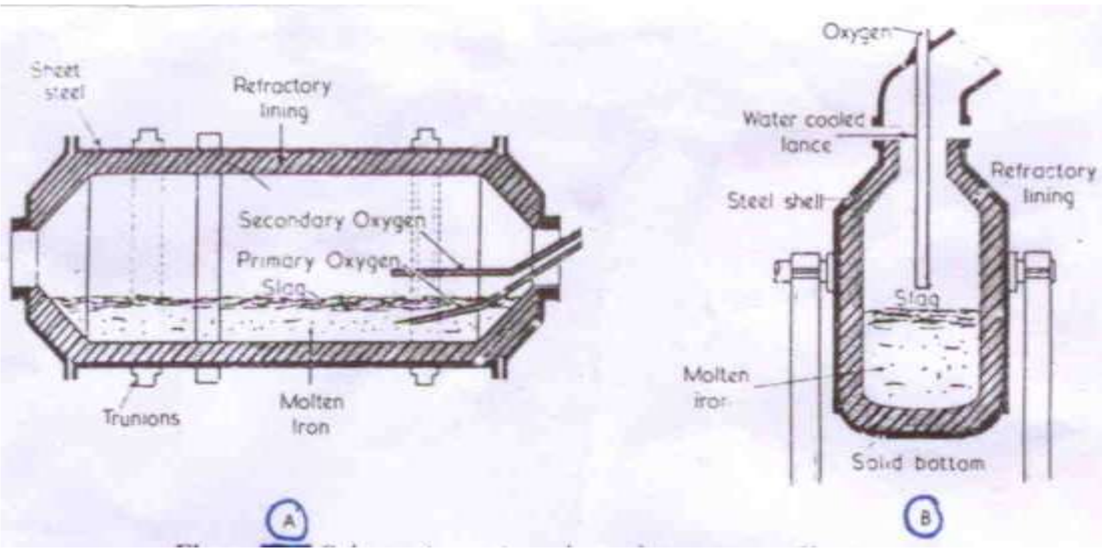



**Figure - 10 : Schematic sections through two types of basic oxygen Converters : (A) the rotor converter : (B) the L.D. converter**

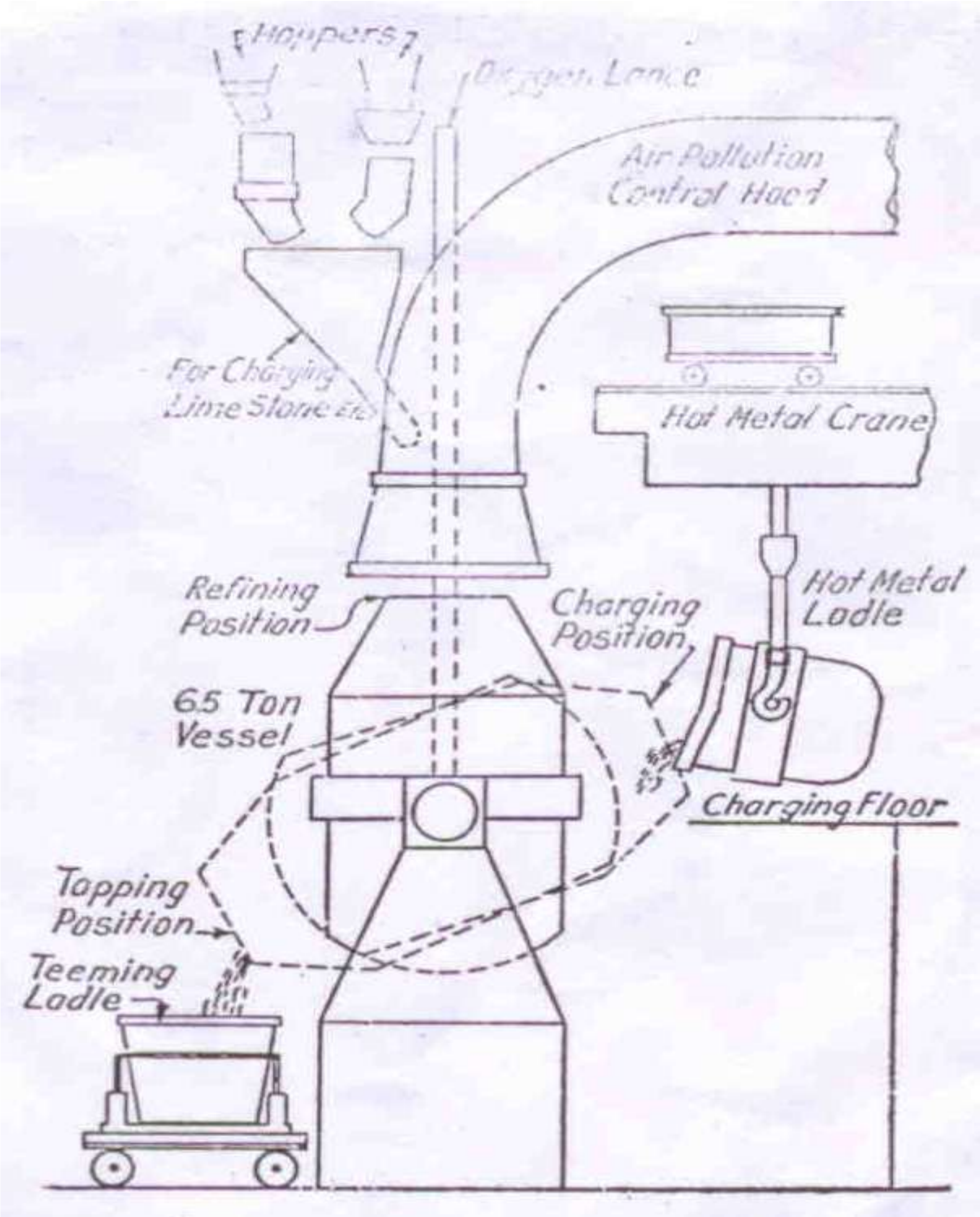



**Figure - 11 : L.D. process**

Kaldo process

The process is modification of L.D. process, developed in Sweden, now being employed in many parts of world.  The main advantage of process is, high phosphorous pig iron can be treated to produce steel containing as low as 0.02% P.

The converter is inclined at 15 – 20$^0$C with horizontal and is rotated at a speed of 20 – 30 revolutions per minute.  The oxygen lance is introduced through open end of vessel.  It also acts as outlet for exhaust gas.  The rotation of vessel ensures better slag-metal mixing and reaction.  Initial capacity was about 30-50 tonnes but higher capacity converters of about 130 tonnes are in operations now-a-days. Blowing-time is 40 minutes.  Tap to tap time is 80 minutes. Production rate is about 100 tonnes per hour.

The steel produced is low in S, $N_2$ and Oxygen.  The investment and operational cost is low.  The following figure - 12 shows Kaldo furnace.

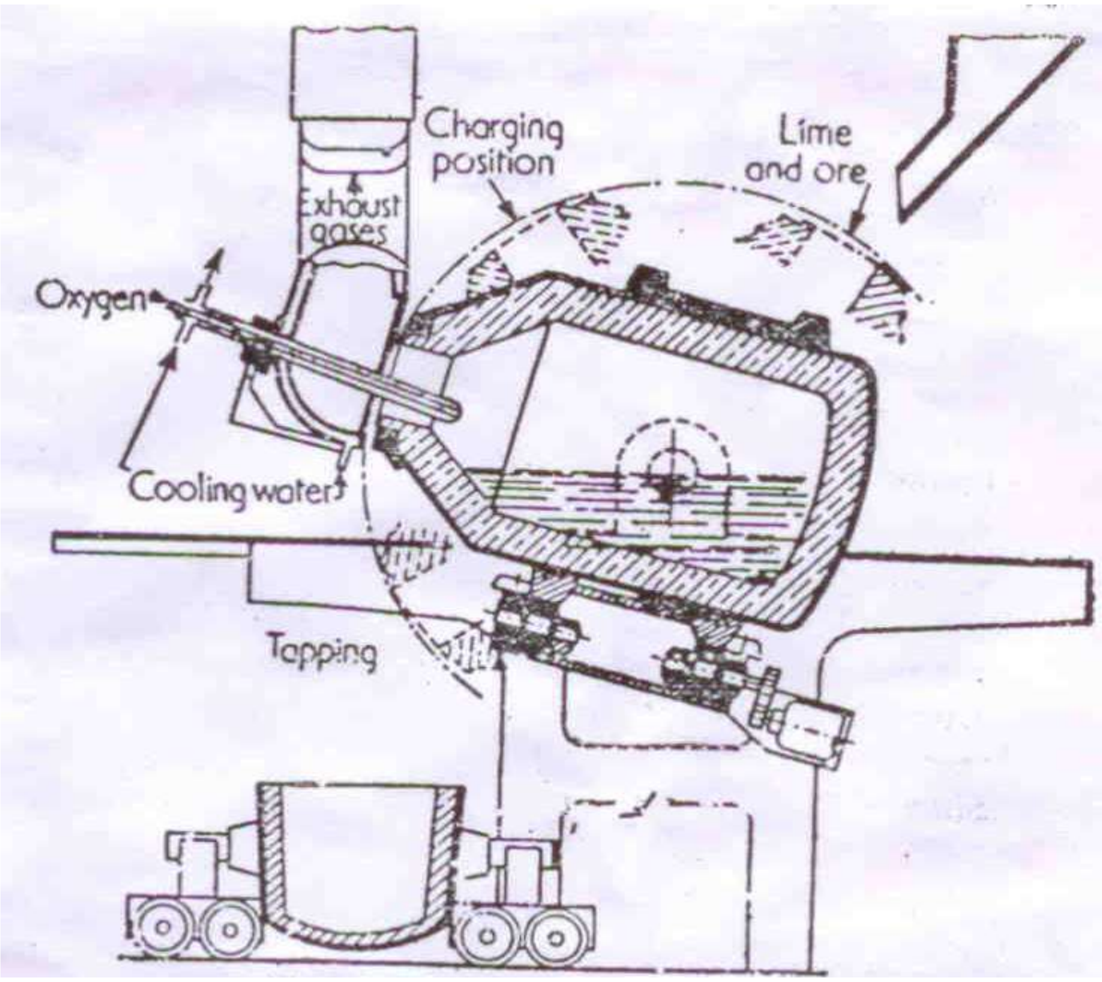



**Figure - 12 : The Kaldo furnace**

(iv) <u>Electric arc melting furnace</u>

This is basically a refining furnace where electricity is used for heating and melting the metal. The main advantages of process are:

1. It permits greater flexibility with neat and clean operation
2. Temperature can be controlled easily
3. Amount of slag formed is small
4. High quality of steel produced
5. 100% steel scrap can be used.

The only disadvantage is steel produced is more expensive. Electrical furnaces are of two types - ‘Arc type’ or ‘Induction type’.

The arc furnaces are of circular dished bottom with suitable lining of refractory. The carbon or graphite electrodes are introduced through the roof of the furnace. Special controls are incorporated to adjust the gap between electrodes and the metal for arc stability. The arc furnaces can be employed for 100% steel scrap charge. Sometimes oxygen lancing is also practiced to reduce power consumption, reduce carbon and such impurities. The Heroult arc furnace is used to produce most tonnage of steel in the world (Figure – 14). It varies in size from 1/2 to 100 tonnes. But sizes from 5 to 25 tonnes are common.

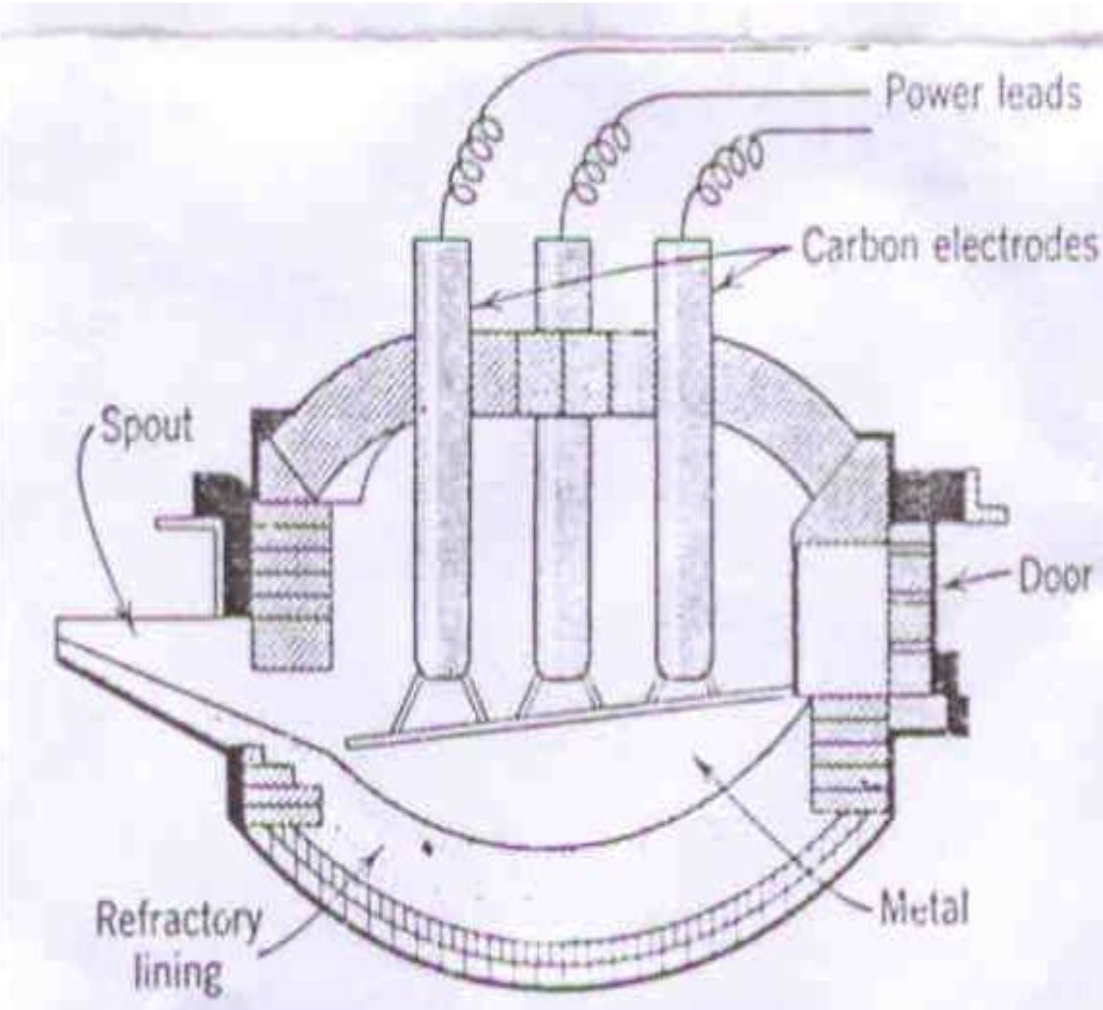



**Figure – 13 : Direct electric arc furnace**

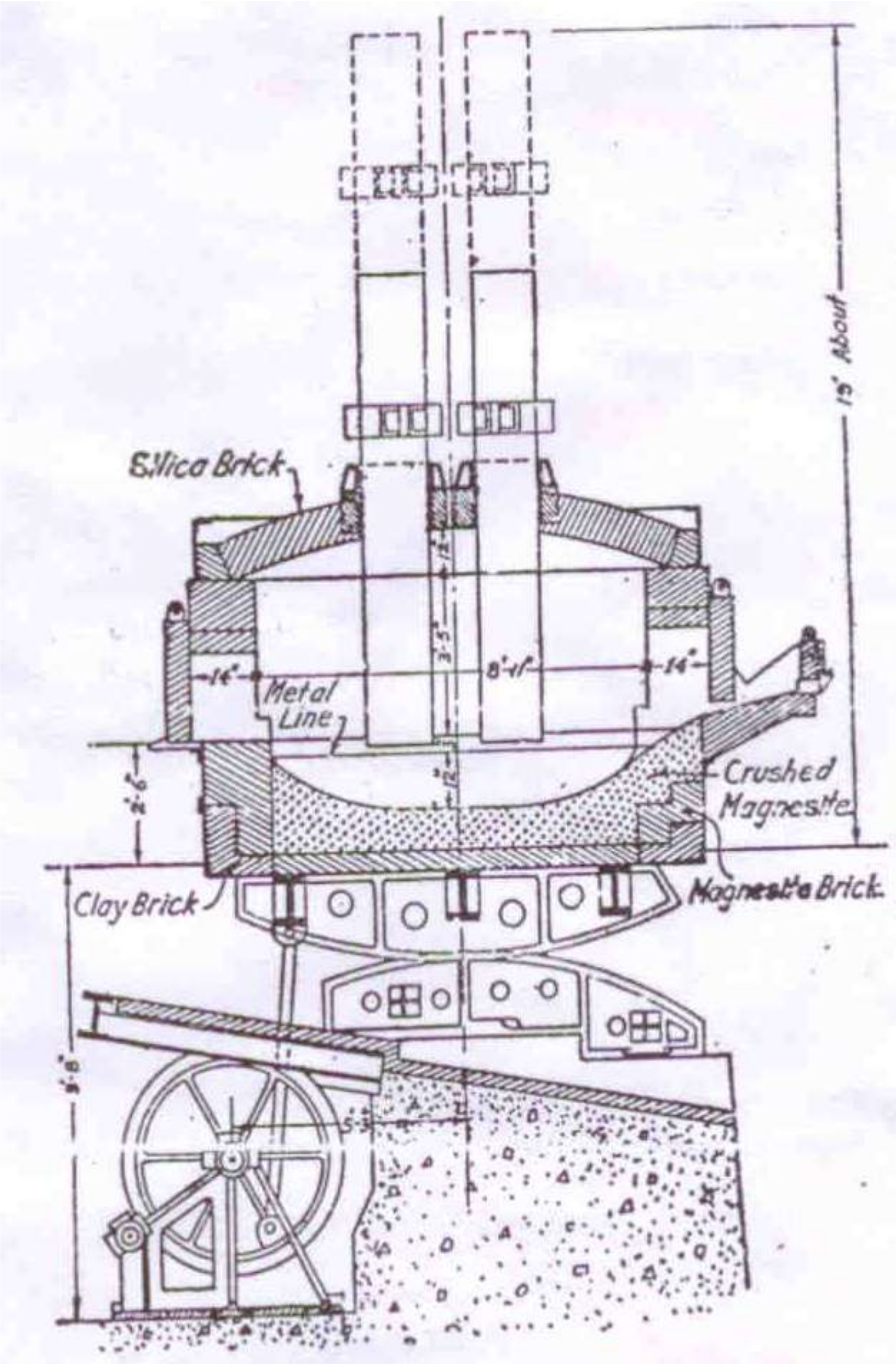



**Figure - 14 : The Heroult electric furnace**

(v) Manufacture of steel by electric Induction Furnace

The induction furnace consists of a hollow coil of water cooled copper tubing which acts as primary of transformer. The secondary is the metal to be melted which is kept in a refractory crucible inside the copper coil. A high frequency alternating current of frequency of about 1000 to 3000 cycles per second is passed through the coil which induces high frequency current in the metallic charge. The charge may melt in an hour or so. Because of strong stirring action created by high frequency current the refining process is complete in few minutes. The diagram of furnace is shown below.

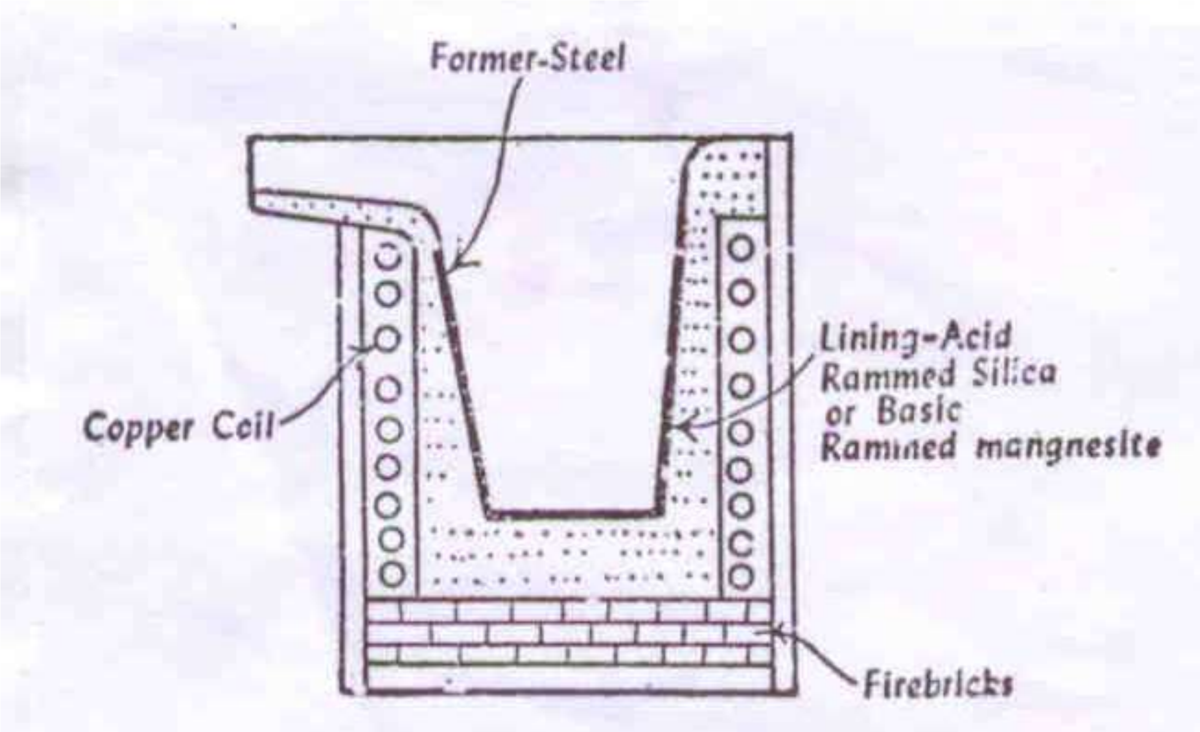



**Figure - 15 : Section of high frequency furnace**

The quick melting high frequency furnaces are adopted for manufacture of high alloy and special purpose steel, permanent magnet steels, stainless steels, die steels and tool steels.

<u>Other process of making steels are as follows</u>

(a) Duplex process - This process of steel making is combination of

1. Acid Bessemer process
2. Basic open hearth process

The pig iron is treated in acid lined Bessemer converter in which impurities like Si, Mn and C are eliminated. Then this steel is treated in Basic Lined open hearth in which S & P are eliminated.

Thus, a good quality of steel is produced economically and time is also saved.

(b) To improve the quality steel further Duplex process is extended to Triplex Process. The melt obtained from basic open hearth is further treated in Electric furnace to produce steel of High Quality.

(vi) There are other processes of steel manufacturing which are called refining processes which help produce very high grade ultra low impurity steels like maraging steels. They are:

(i) Vacuum Refining process
(ii) Electro-slag reefing process

Vacuum Refining Process : Here an induction furnace encased in vacuum chamber is used to remove impurities like production of non-magnetic steel used in motor/generator lamination strapping, pure iron used in magnetic applications.

Electro-Slag Refining Process : The equipment consists of an electric arc furnace of cylindrical shape with a water cooled starter plate, of same composition as final product, at bottom. The slag of precisely controlled composition is placed above starter plate. A solid bar of 150-300 dia steel acts as an electrode. With highly controlled mechanism, an arc is struck with the starter plate which melts the electrode as also the granulated slag, the refining and removal of undesired impurities take place.

The purified metal solidifies on the water cooled starter plate. The electrode is continuously raised. The refining speeds are around 5-10 mm/ min. The typical bar of 2500 mm takes about 4-6 hours.

**NON-FERROUS METALS AND ALLOYS**

Non-ferrous metals and alloys are not produced in large tonnage as ferrous metals but they are very important for industrial growth as they possess combination of properties not found in iron and steels. They have some important properties as follows:

Good formability
Low density
High thermal and electrical conductivities
Good corrosion resistance
Attractive colours

Non-ferrous metals are poor in weldability and strength and stiffness as compared to steel. Some non-ferrous alloys like Nimonic, Inconel are very popular due to their high strength at high temperature characteristics and hence used for automobile and aircraft industries. Basically non-ferrous alloys are those which do not contain iron as a base. The main non-ferrous group consists of Aluminium, Copper, Nickel, Titaniun, Lead, Tin and zinc etc.

**Manufacture of aluminium**

Aluminium occurs in abundance on earth surface in various forms like oxides, sulphates, silicates, phosphates etc. but commercially it is produced mainly from Bauxite ($Al_2O_3$, $2H_2O$) which is hard rated oxide of aluminium. Steps are as follows:

1. Bauxite is ground and then it is purified.

2. It is then dissolved in fused cryolite which is double fluoride of aluminium and sodium $AlF_3.3NAF$.

3. The above solution is transferred to electrical furnace known as aluminium reduction cell and then aluminium is separated out by electrolysis in Hoopes' cell.

Purification of bauxite is essential. Several methods are available for purification. The BAYER'S PROCESS is most common. The precipitated aluminium hydroxide obtained is washed, filtered and ready for calcinations. The calcination is carried out in tubular rotary Kiln which yields 99.5% $Al_2O_3$ with little impurities.

The calcined $Al_2O_3$ is converted to aluminium by electrolysis in electrolytic furnace as shown in Figure – 16. The furnace serves two important functions - keeps electrolyte in liquid form and causes electrolytic dissociation of alumina.

The furnace consists of rectangular open shell of 8 – 10 feet long and 4 – 5 feet wide and 22 feet deep made of 2/3" thick steel plate lined with fire brick. The coke lining of bottom serves as cathode and anodes etc. carbon electrode made of petroleum coke known as Soderberg type of electrodes. The metal accumulated at bottom is siphoned off at regular interval. For favourable conditions the bath composition should be maintained as $AlF_3$ – 59%, NaF – 21%, $CaF_2$ – 20%.

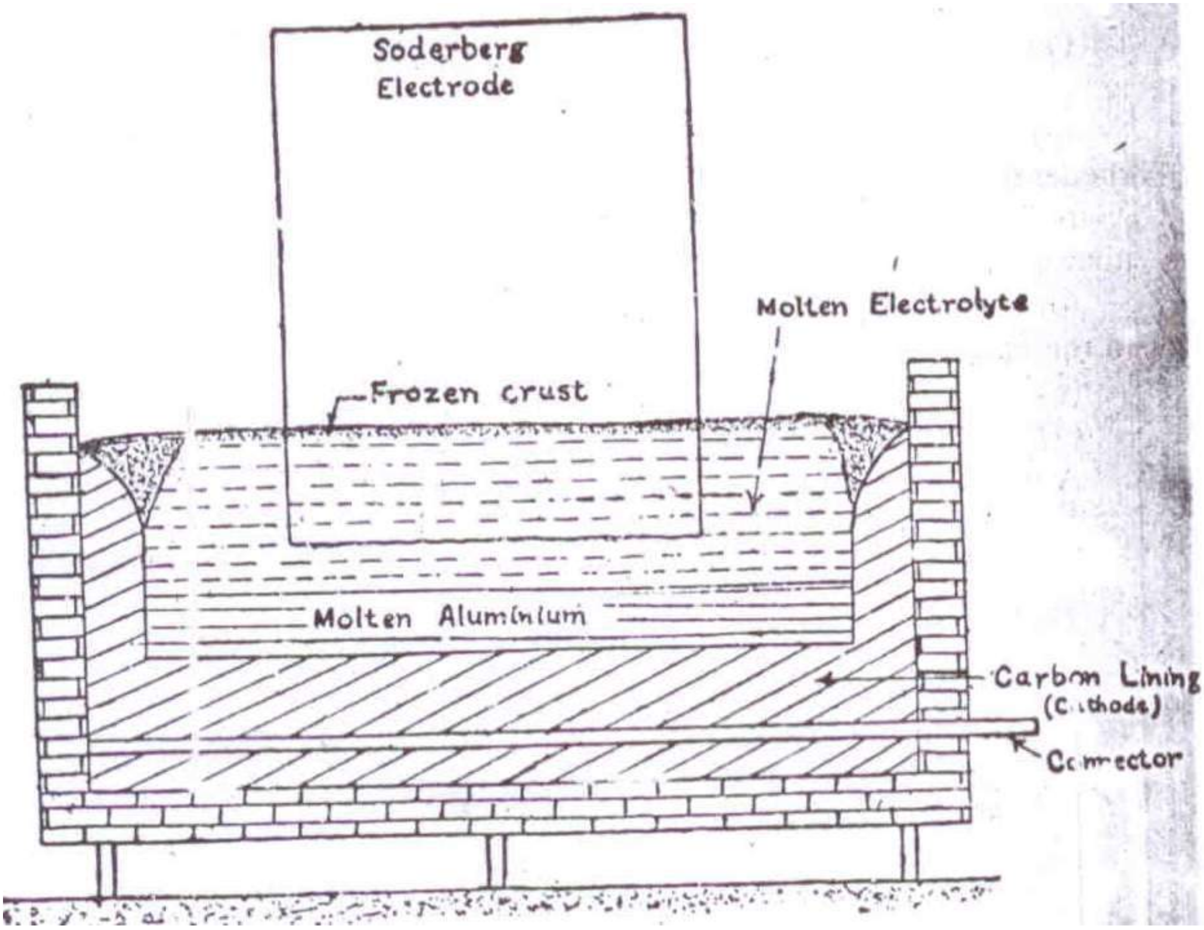



**Figure – 16 : Aluminium reduction cell**

**Refining of Aluminium**

Commonly used process of refining is by 'Hoopes' Cell' which is shown in Figure – 17 with different parts. The bath is operated at $900^0$ – $1100^0$C with a current of about 30000 amps at a voltage of 5 – 7 volts. The purity of product is 98 – 99%. The main feature of cell is electrolyte which consists of three layers of different material. The bottom most is fused anode and impure metal. Then layer of cryolite aluminium fluoride and barium fluoride. $Al_2O_3$ is added to have requisite specific gravity and fluidity on Top Pure Aluminium layer acting as cathode. Because of high temperature in Hoop's Cell refractory wear and tear is more. In recent Gadau process the operating temperature is about $700^0$C resulting better operation and separation of refined aluminium.

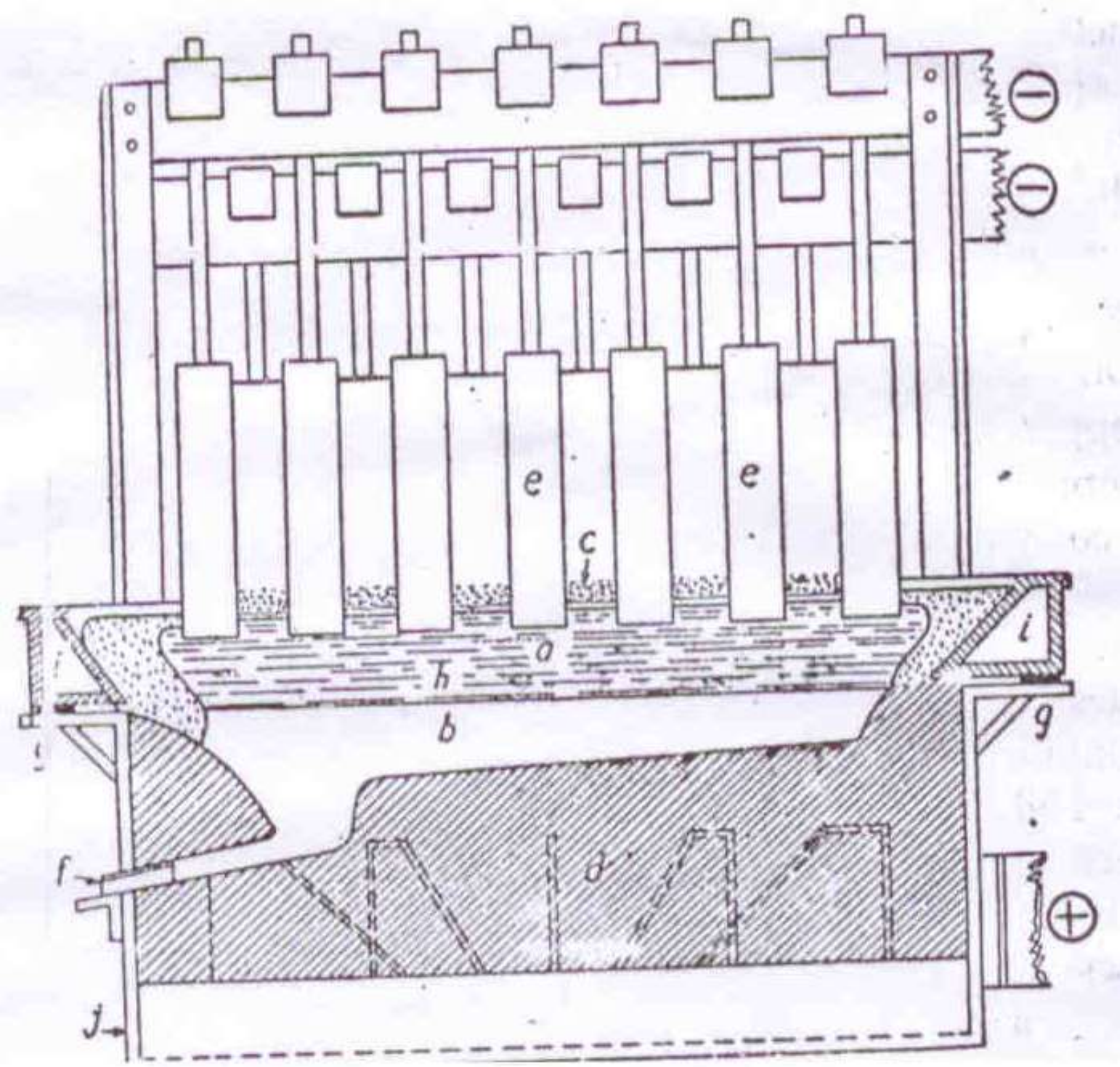



**Figure – 17 : The Hoopes' Cell**

**a – Molten electrolyte, b – Molten aluminium alloy (anode), c – Frozen crust, d – Carbon lining, e – Cathode, f – Tap hole, g – Insulator, h – Molten aluminium, i – Water jacket, j – Steel shell**

Because of many good properties the metal is used in aerospace industries, cooking utensils, electric wires, structural frames like windows, sheets, foils, posts, panels, furniture etc.

## Copper and Its Alloys

Ore occurs as native ores, oxidized ore and sulphide ores. The major production of world is obtained from sulphide ores. Copper content vary in ores is between 1 – 3%. The Copper metal is manufactured by laborious method and treatment is adopted depending on the quality of copper ore. A general outline of manufacturing Cu metal is as follows:

a. Ores (usually pyrites) are cleaned, crushed and then calcined in reverberatory furnace.

b. Calcined ores are mixed with silica and coke. The mixture is smelted in blast furnace.

c. Metal obtained is oxidized in Bessemer Converter giving blister copper.

d. The blister copper is refined by -

   1. Fire refining in reverbaratory furnace with the help of pulverized coal or oil as fuel.
   2. Electrolytic refining up to purity of 99.99%.

It is important that the ores of copper be ROASTED before smelting. There are different furnaces used for roasting of copper. Herreshoff's furnace (Figure – 18) is the most popular. During the process arsenic and antimony (As and Sb) volatilize and sufficient required amount of 'S' left to produce matte of required grade for smelting.

The object of smelting is to produce Fe matte consisting mixture of sulphides of Cu and along with gold and Ag and a slag which contains minimum of copper and it is being carried out in Reverberatory or Blast furnace Reverberatory furnace (Figure – 19). Size depends on capacity desired; commonly 120' long are used with silica lining. Fuels used are pulverized coal, oil or natural gas the blast furnace is rectangular rather than circular for better output with varying size of 8 – 80' long.

The matte thus obtained is converted into blister Cu by blowing air through it. A matte containing 40% Cu is best suited for conversion. The converter used resembles the

Bessemer converter for steel making (Figure – 20) with the difference of air blast entering through the side in case copper converter. The capacity varies between 7 – 70 tonnes. The refractory lining is magnesite. The blast pressure varies from 6 – 18 psi. When blow is over the molten metal is cast into moulds. The product is called Blister Copper. The time of blow is about 2 ½ to 3 hours.

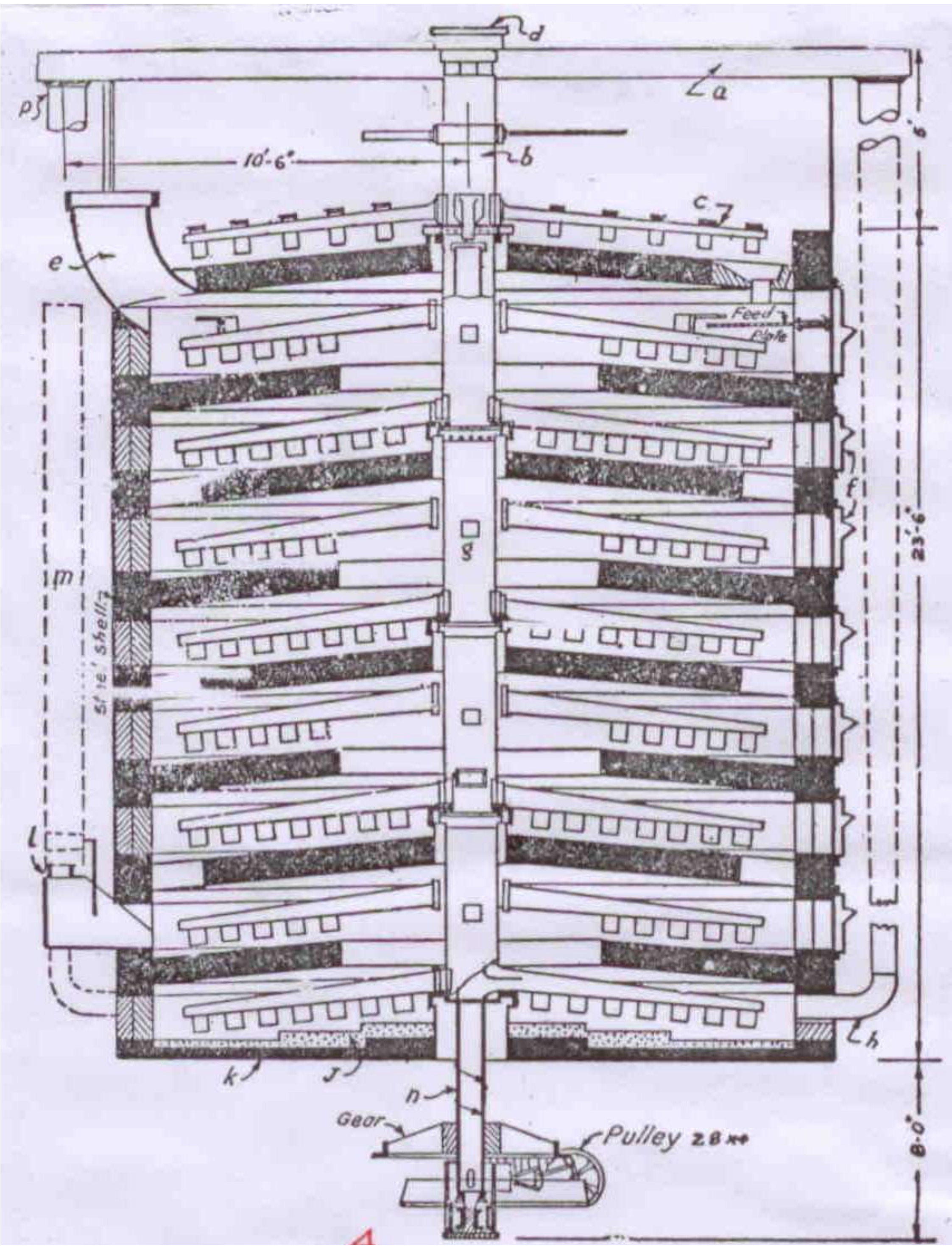



**Figure – 18 : Herreshoff roaster**

**(a) Top frame, (b) Shaft top, (c) Dry arm, (d) Thermometer opening, (e) Gas outlet, (f) Door, (g) Dia. of drop hole, (h) Hot-air blow, (j) fire-brick, (k) Insulation brick, (l) Limestone feeder, (m) Hot-air return pipes, (n) Shaft bottom, (p) Blast gate with charge**

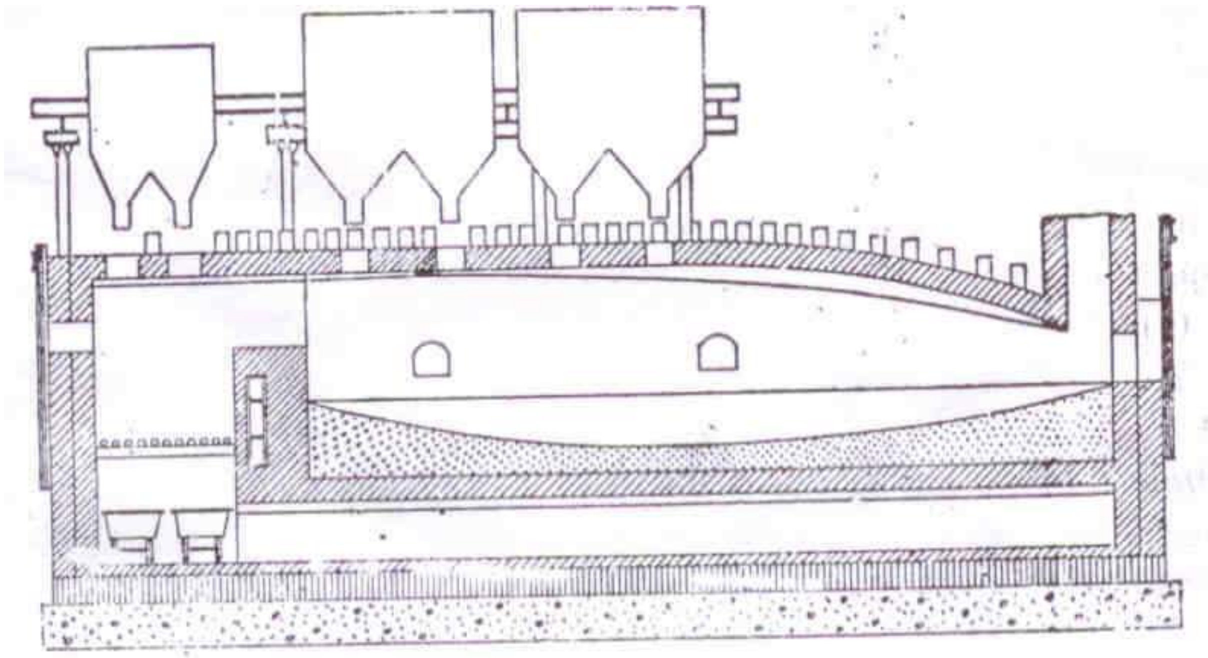


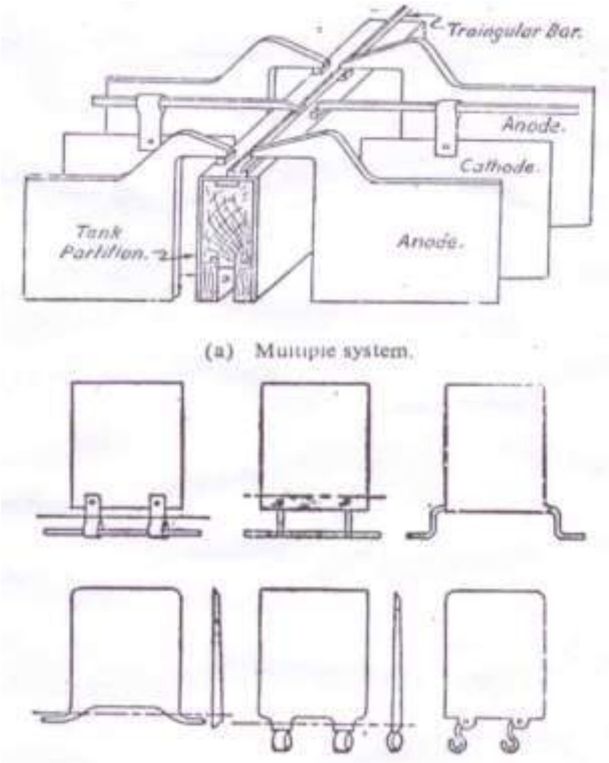
**Figure – 19: Reverberatory smelting furnace for copper ore**

The blister copper is refined by –

(i) Fire refining
(ii) Electrolytic refining

Fire refining is carried out in Reverberatory furnace in which S is removed as $SO_2$.

For electrolytic refining first refining is done up to 99.3% then final refining is done by – (i) Multiple system and (ii) Series system according to arrangement of electrodes. The first system is advantageous and most popular. The following Figure – 20 shows Electrorefining of Copper.




(a) Multiple system.

**(b) Electrode Shapes**

**Figure – 20 – Electro-refining of Copper**

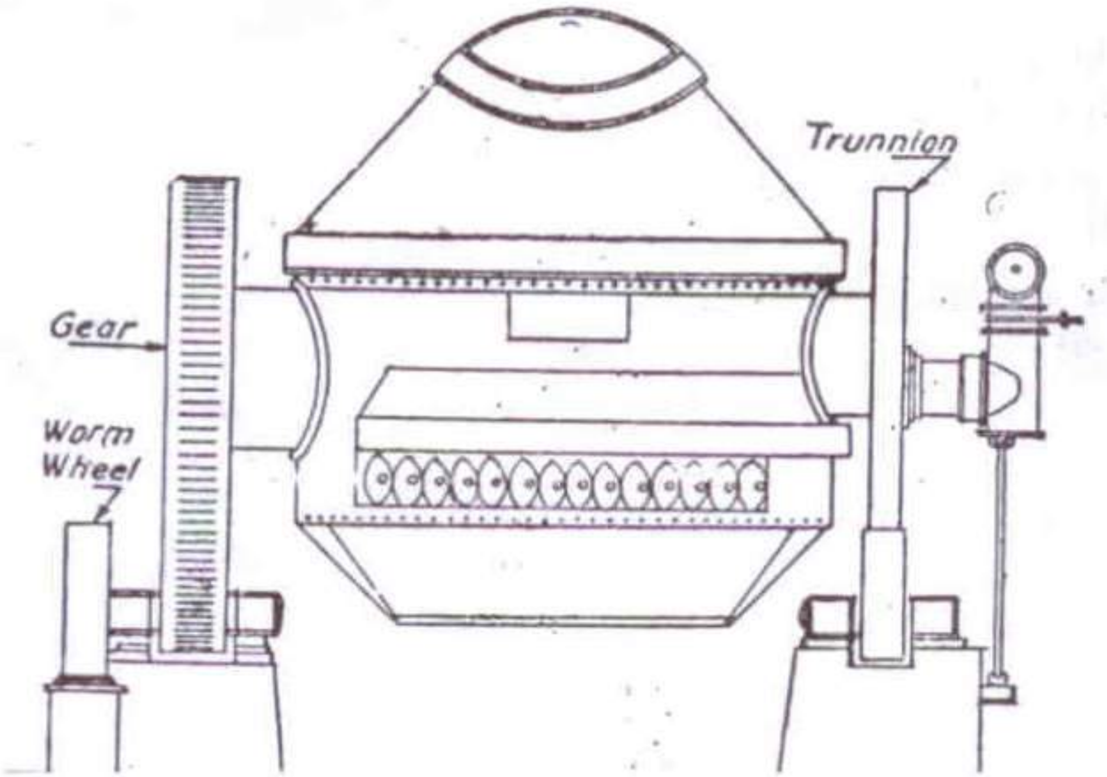



**Figure – 21 : Copper converter**

The other methods of extracting copper are –

(a) Using flash smelting technique (Figure – 22).

(b) Hydrometallurgy of copper (Figure – 23).
Manufacture of copper by Indian Copper Corporation Ltd.

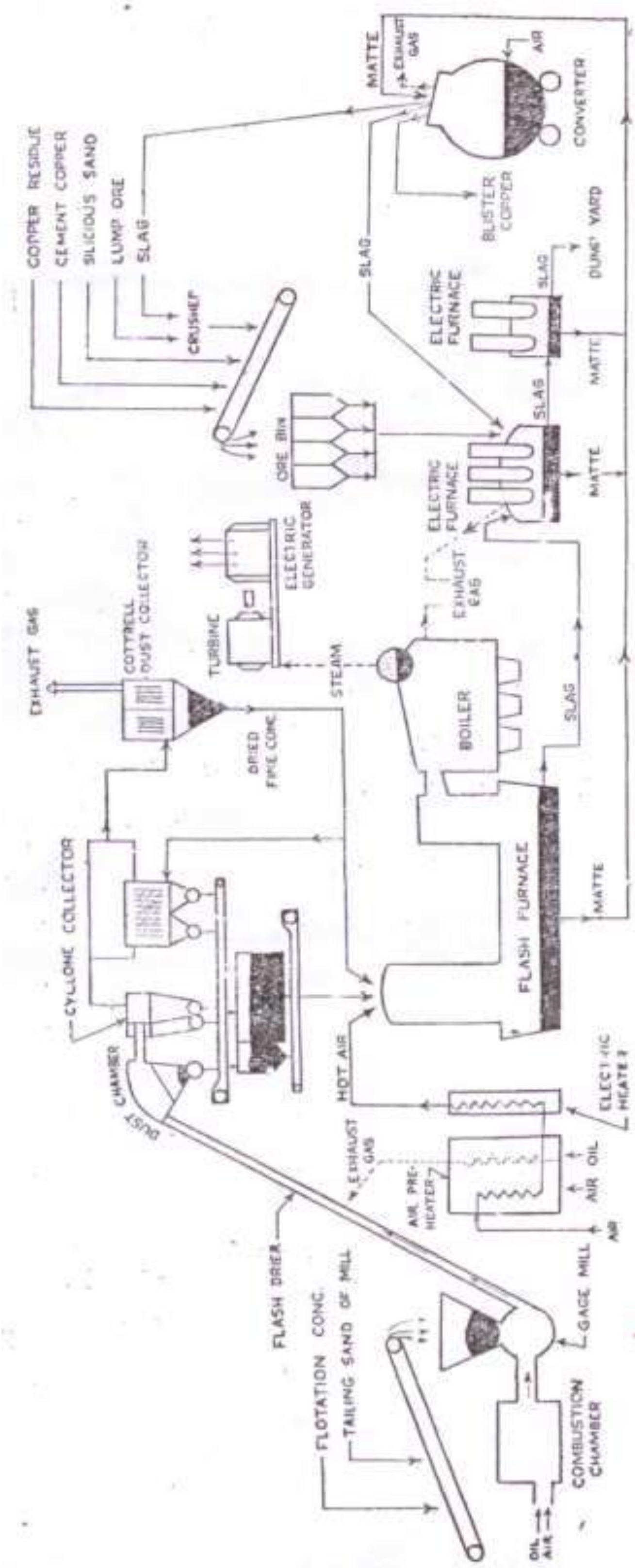



**Figure – 22 : Diagrammatic flow-sheet for extraction of Copper using flash-smelting technique**

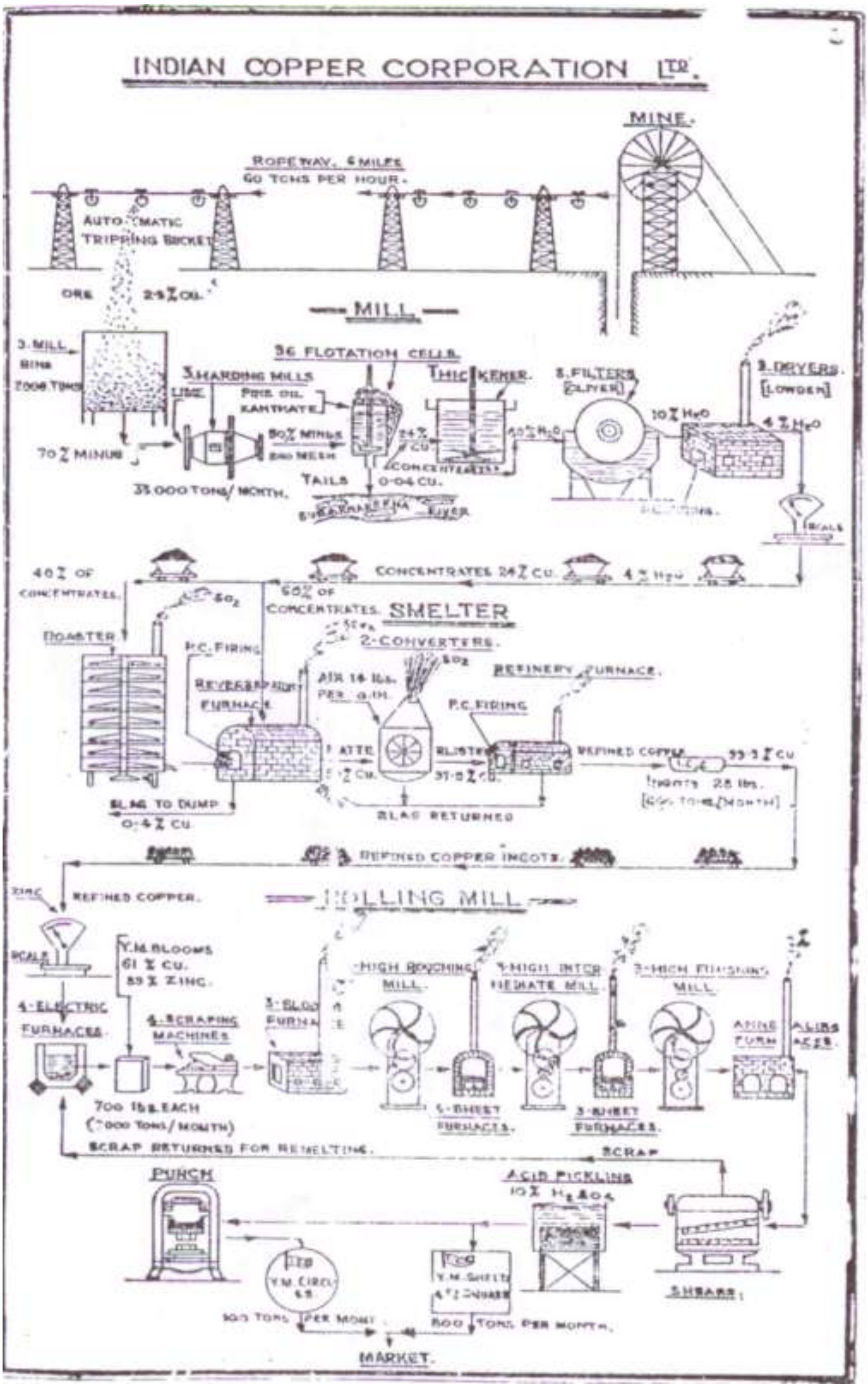



**Figure – 23 : Diagrammatic flow-sheet for extraction of Copper using Hydrometallurgy**

## Zinc

Main ores are Zinc – blende – Zns (67% Zn) and
Calamine – Smithsonite $ZnCO_3$ (52% Zn)

**Two methods of manufacture**

A. Pyrometallurgical
B. Hydrometallurgical

For Pyrometallurgical operations three steps are needed –

(i) Roasting of blende to ZnO
(ii) Distillation of ZnO with Carbonaceous materials to metallic zinc
(iii) Refining of metallic zinc

From Roasted ore, Zinc is obtained by three methods :

(1) Belgian, (2) Silesian and (3) Belgo-Silesian method

Belgian process is the oldest method for extraction of Zn. Zinc vapours are condensed to liquid Zn in condenser set in the mouth of retort. The whole operation takes 24 hours. The following Figure – 24 is of Belgian retort furnace.

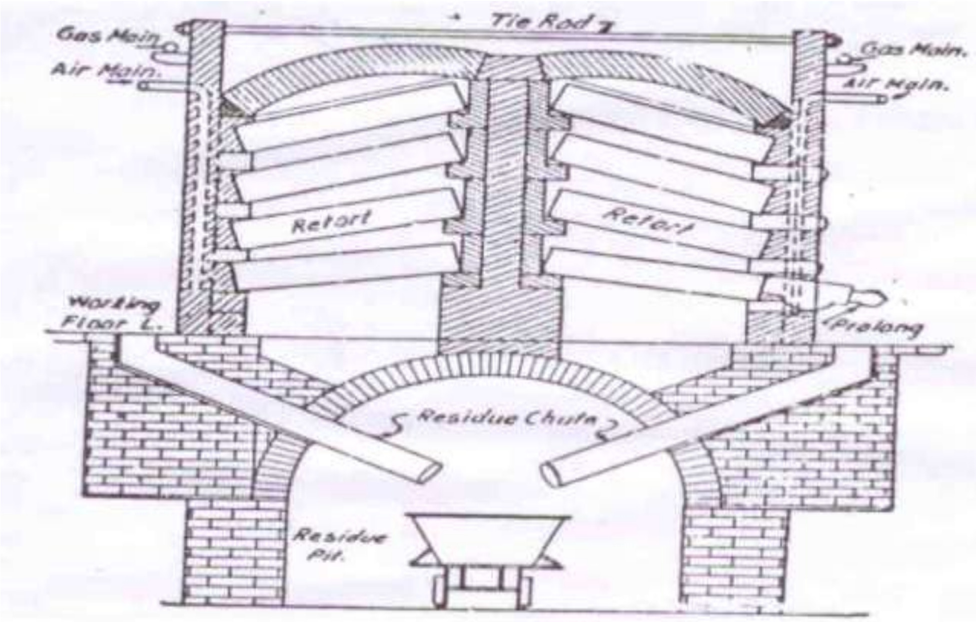



**Figure – 24 : Belgian retort furnace**

The most common methods employed are vertical retort method, electrolytic process or blast furnace process. Some methods are represented by **Figures 25 and 26**.

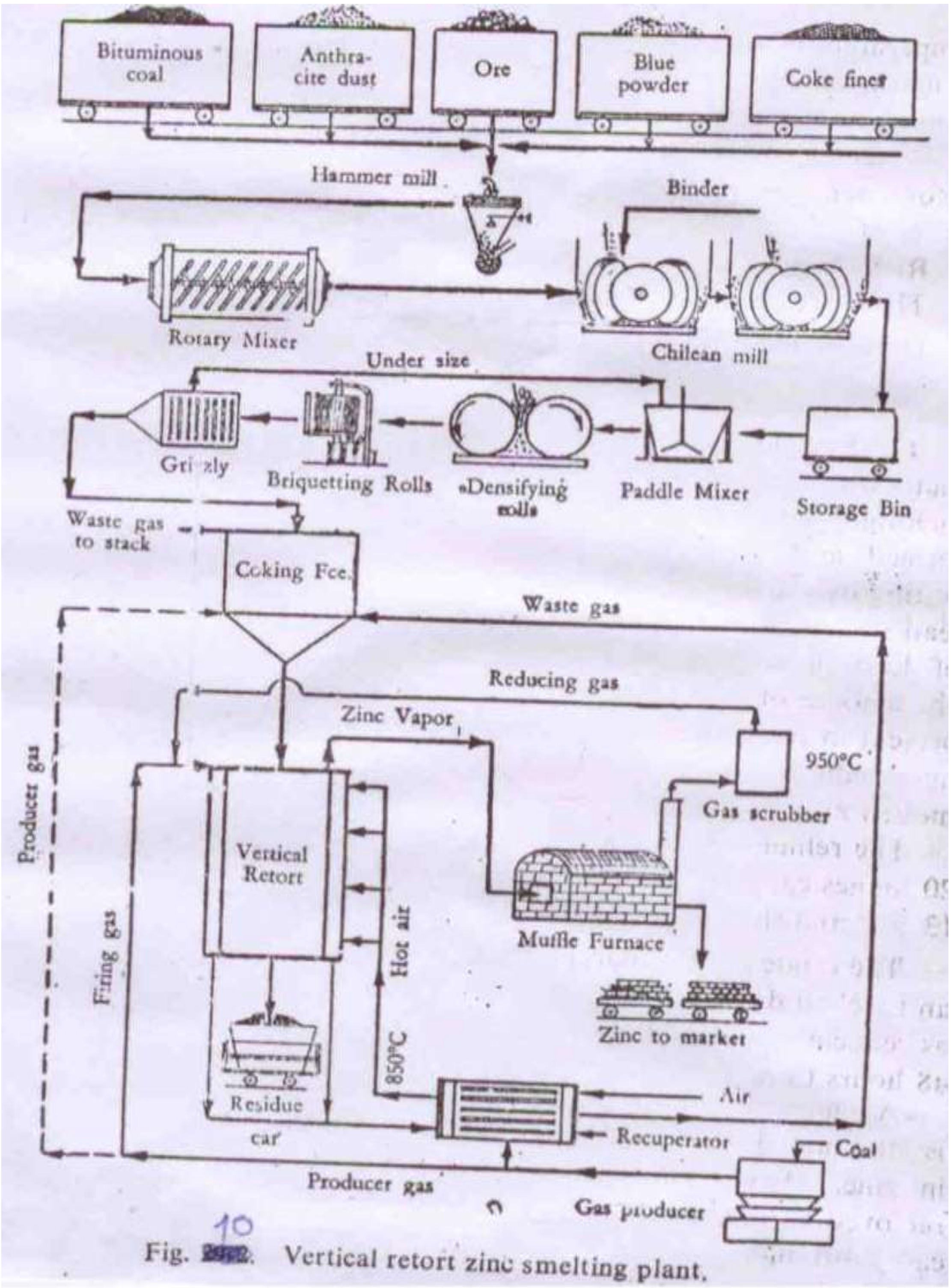



**Figure – 25 : Vertical Retort Zinc Smelting Plant**

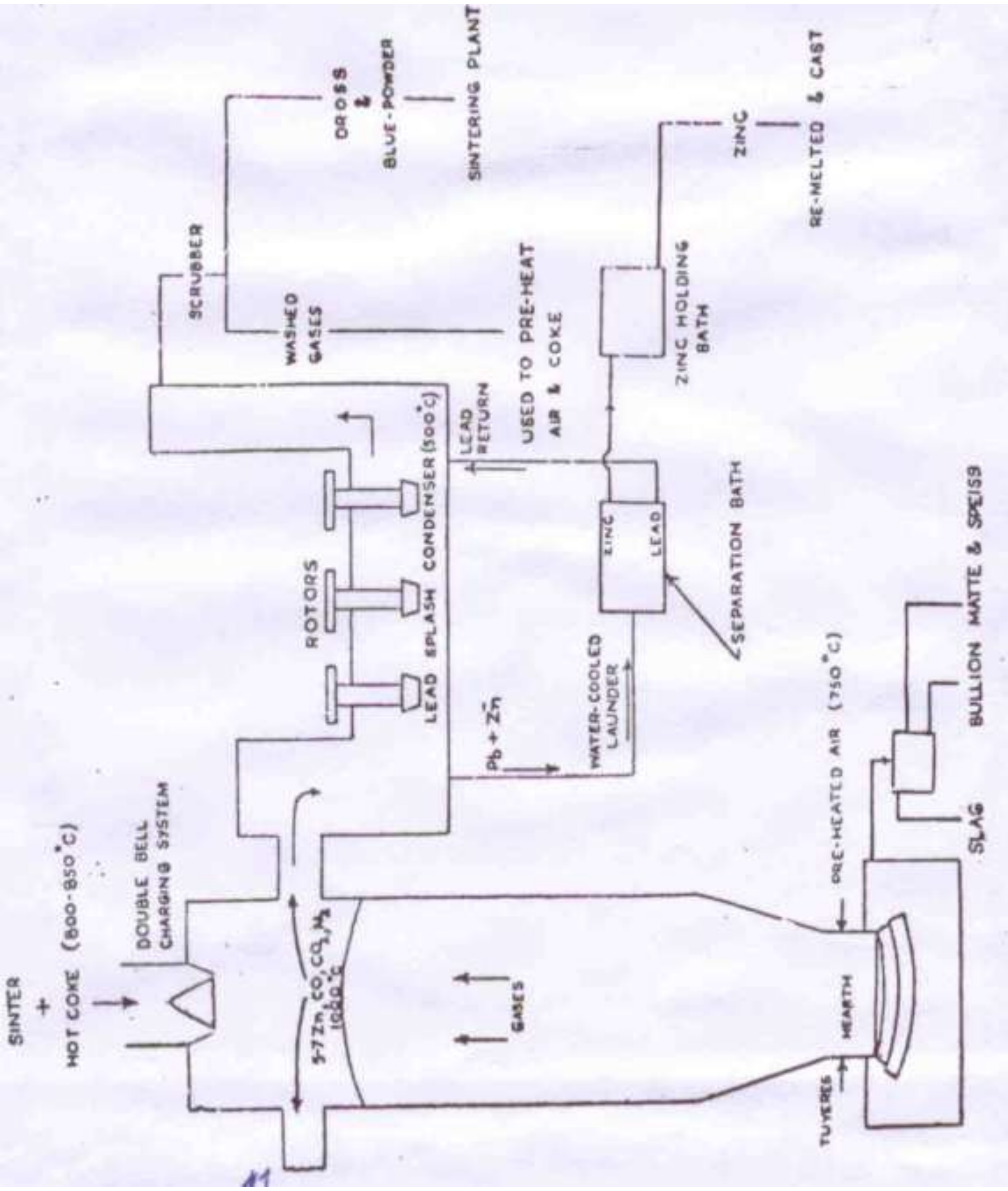



**Figure – 26 : Layout of a zinc blast furnace plant**

The main use of Zinc is in electric cells and for galvanizing iron sheets, and lining of drinking water storage tanks. Also used for preparation of Alloys, paints etc.

## Tin Metal Extraction

Main ore Tinstone or Cassiterite ($SnO_2$) contains 78.6% Sn. The following Figure – 27 shows the flow sheet of tin extraction carried out by dry methods wet or electrolytic method.

Tin is mainly used for plating, lining of lead pipes, preparation of alloys and solder. Also used for protective coatings to utensils, cans for food, fruits and milk industry. Tin foils are used for silvering, wrapping of cheese, chocolates, tobacco, toilet soaps etc.

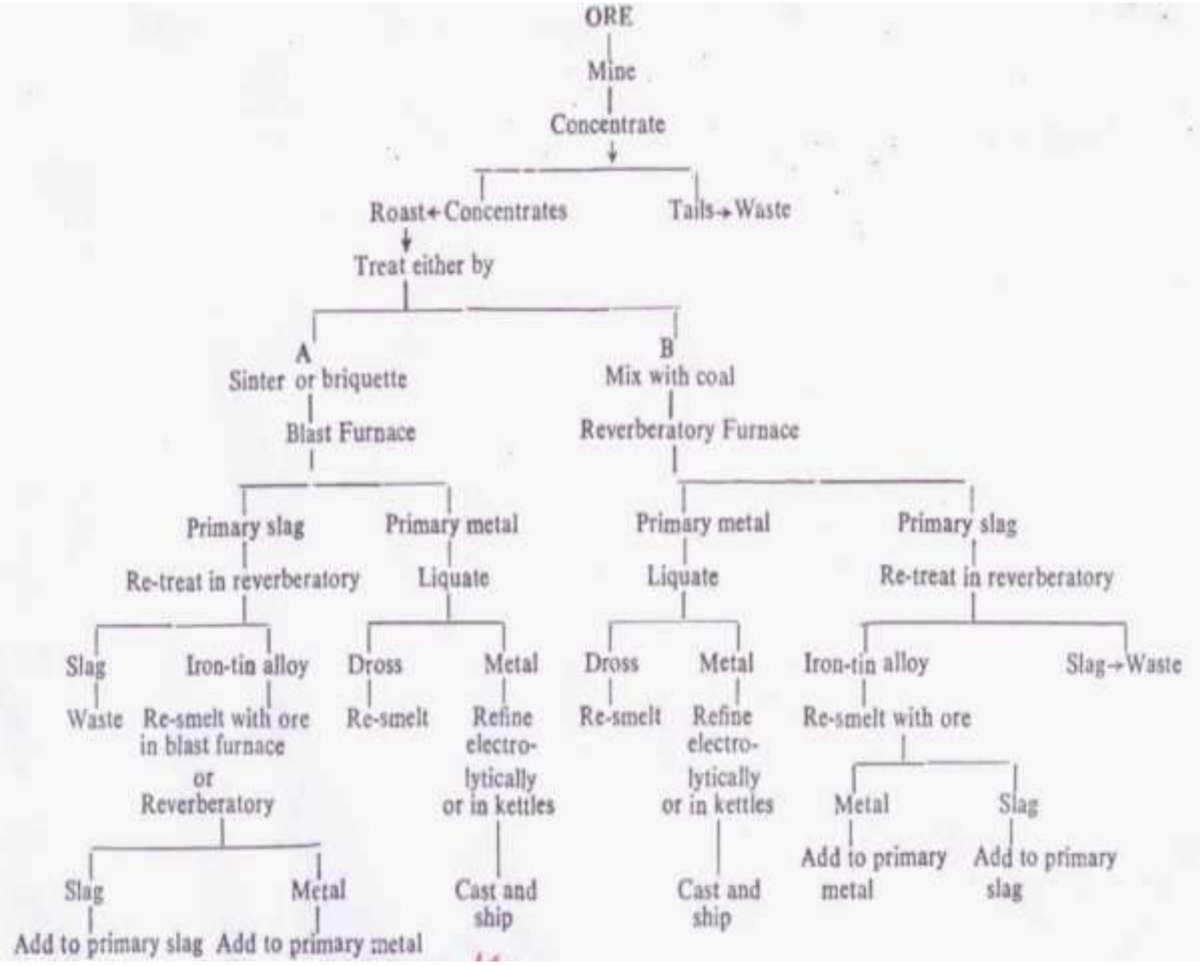



**Figure – 27 : Outline of tin extraction**

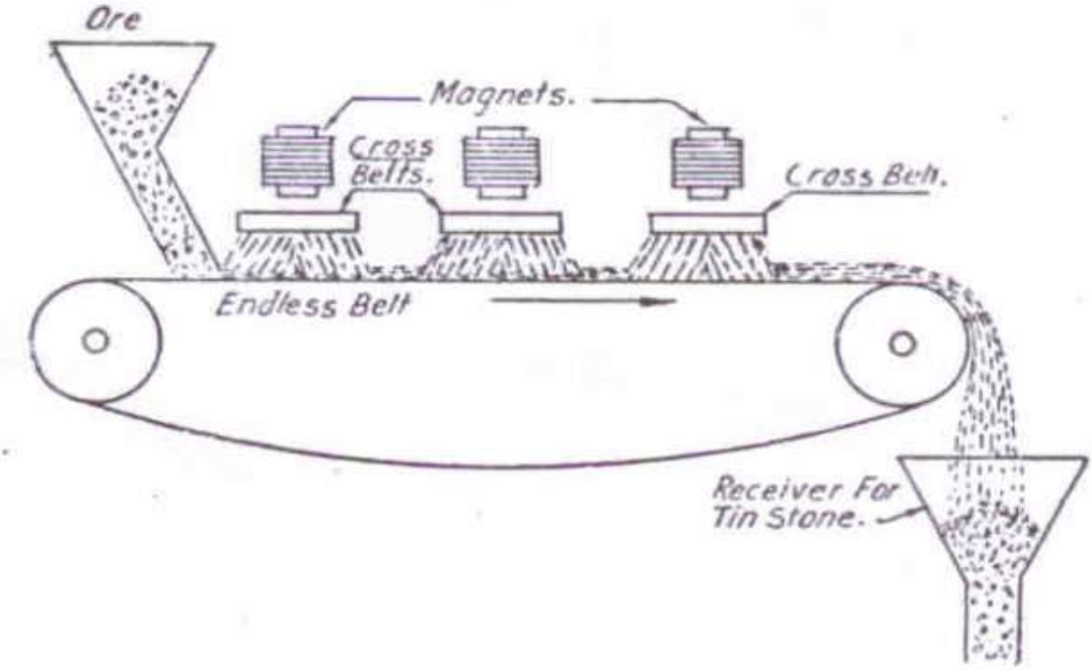



**Figure – 28 : Diagram of magnetic concentration for tin stone**

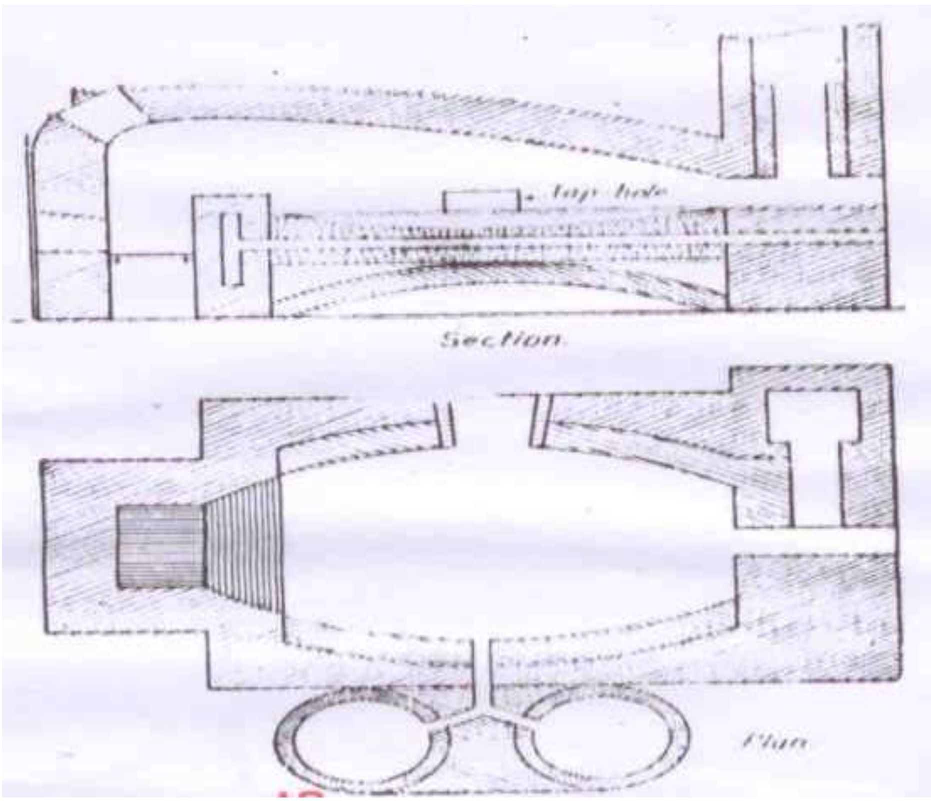



**Figure – 29 : The smelting furnace**

In general steps for manufacturing are as follows:

1. Ore crushed and washed to remove impurities (Figure – 28).

2. Then it is calcined and cooled and washed with water.

3. It is smelted in furnace with coal. Reduction temperature is 1000 – 1100$^0$C. It is shaft type of furnace or in reverberatories. Reverberatory furnaces have advantages (capacity 20 – 30 tonnes) (Figure – 29) oil/producer gas used for firing with preheated air. It is important to avoid loss of tin in slag operation is performed in two stages.

4. Refining of metal – carried out in stages as Liquation (melting and temperature maintained above fusion part of tin) Tossing i.e. operation of being ladled from one kettle to another (to oxidized some impurities) Finally Polling or boiling to obtain purer tin (one to three HRS).

**Lead – (Pb)**

Lead and zinc are commonly associated in mineral deposits. Mainly three basic ores of lead are –

(a) Galena – Pbs (Pb 86.6%)
(b) Anglesita – Pb $SO_4$ (Pb 68.3%)
(c) Cerussite – Pb $CO_3$ (Pb 77.5%)

ONLY lead smelting unit in India is at Tuhdoo near Asnosol. Except Zawar Mines no other area is identified for mining of lead and zinc.

There are various processes for manufacture of lead depending on types of ore. For Galena ore the process can be described in brief in following steps : (Figure – 30 Flow Sheet):

1. ORES – Ground and sieved for separation of impurities sent to floatation machine.

2. The concentrate is mixed with coke, iron ore, limestone and slag with high % of lead and this charge is smelted in Blast furnace at a temperature of 1200 – 1300$^0$C. The molten lead obtained is called 'BASE-BULLION' or work lead which is cast into pigs finally sent to refinery for desilverizing (Figure – 32).

3. the impure lead is further purified in a Reverberatory furnace or in lead blast furnace (Figure – 33).

   Lead is soft with melting point of 327$^0$C with specific gravity of 11.36 kg/m$^3$. It is widely used for making shots, bullets, alloys, gas pipes, storage cells, printing types, damp proof courses of buildings, cable coverings, lead oxide for paints, etc.

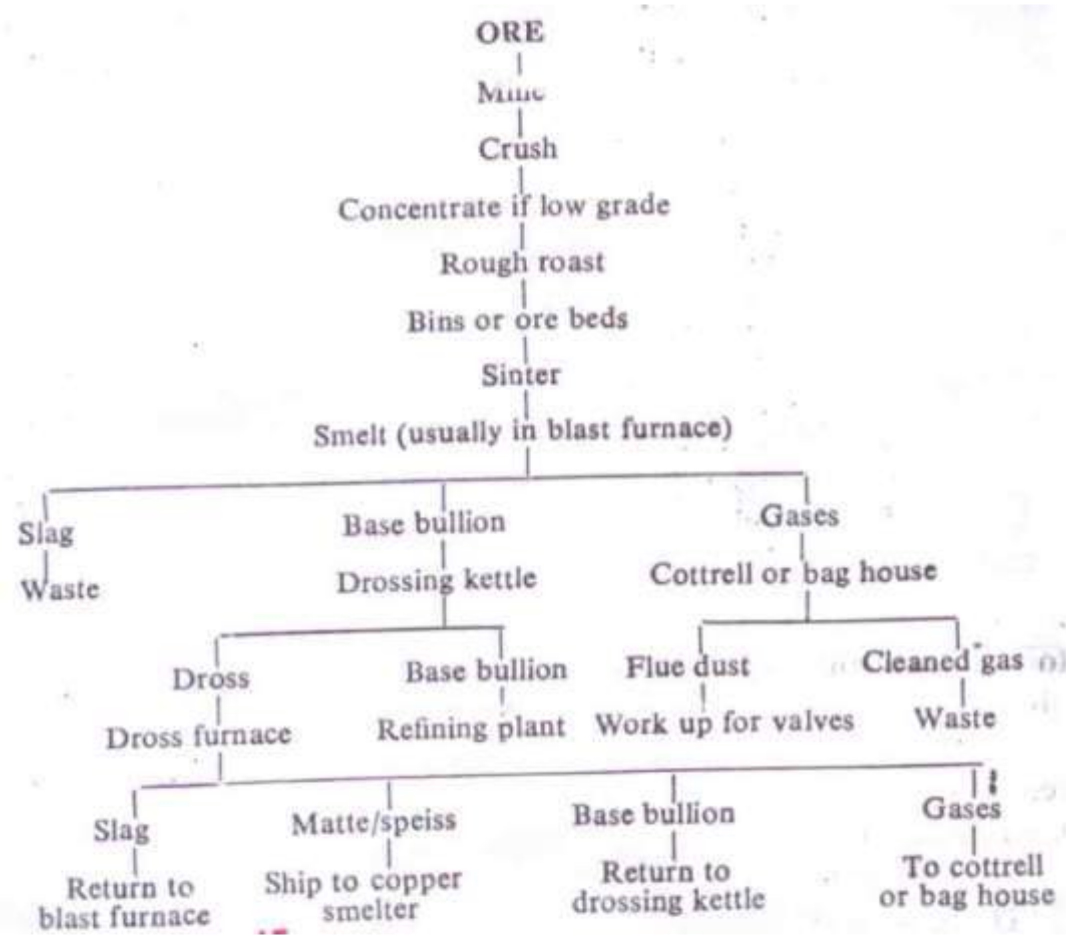
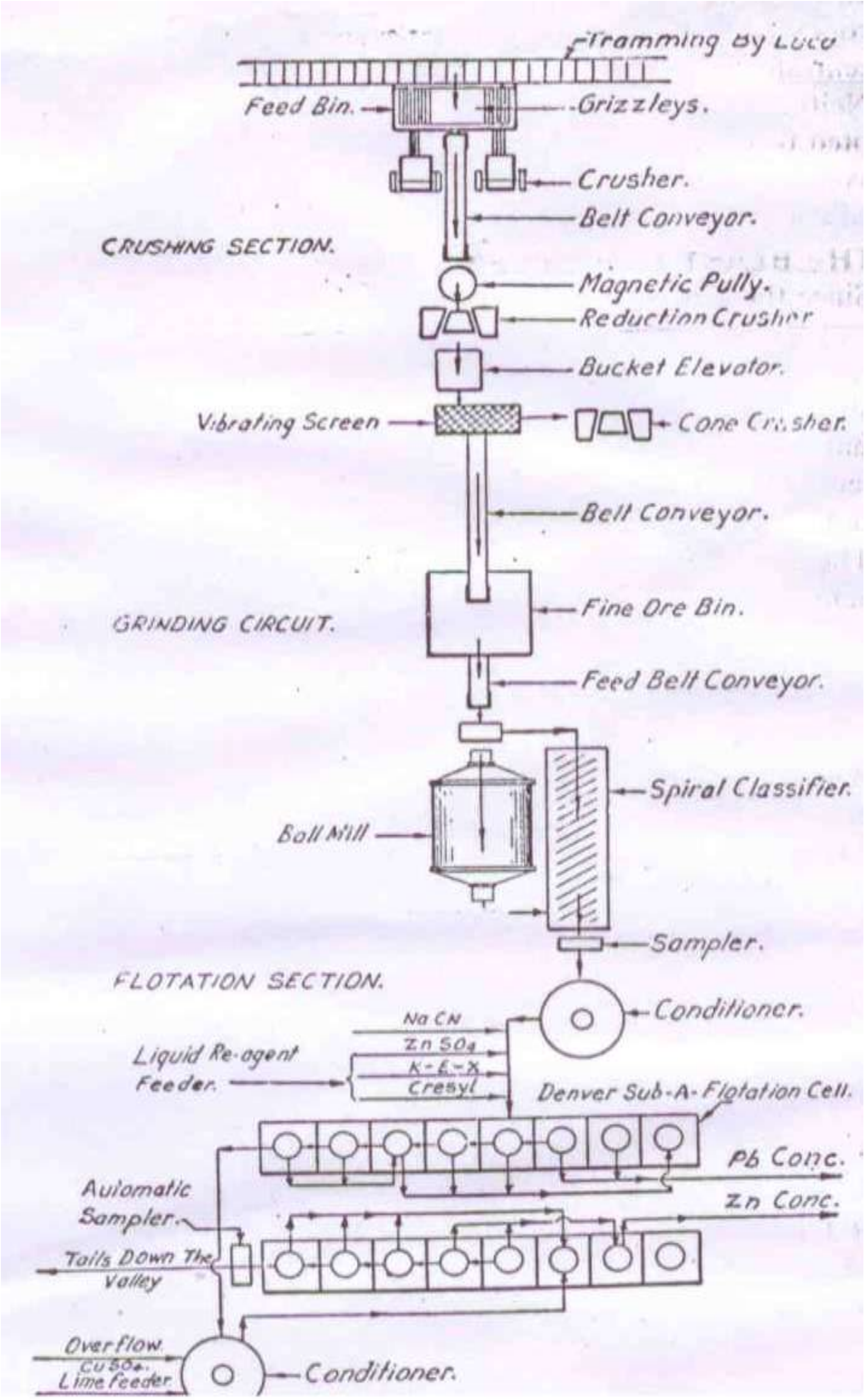



**Figure – 30 : Usual treatment of a sulphide lead ore (Flow Sheet)**




*Ca $CO_3$*

**Figure – 31 : Flow-sheet for lead-zinc differential floatation**

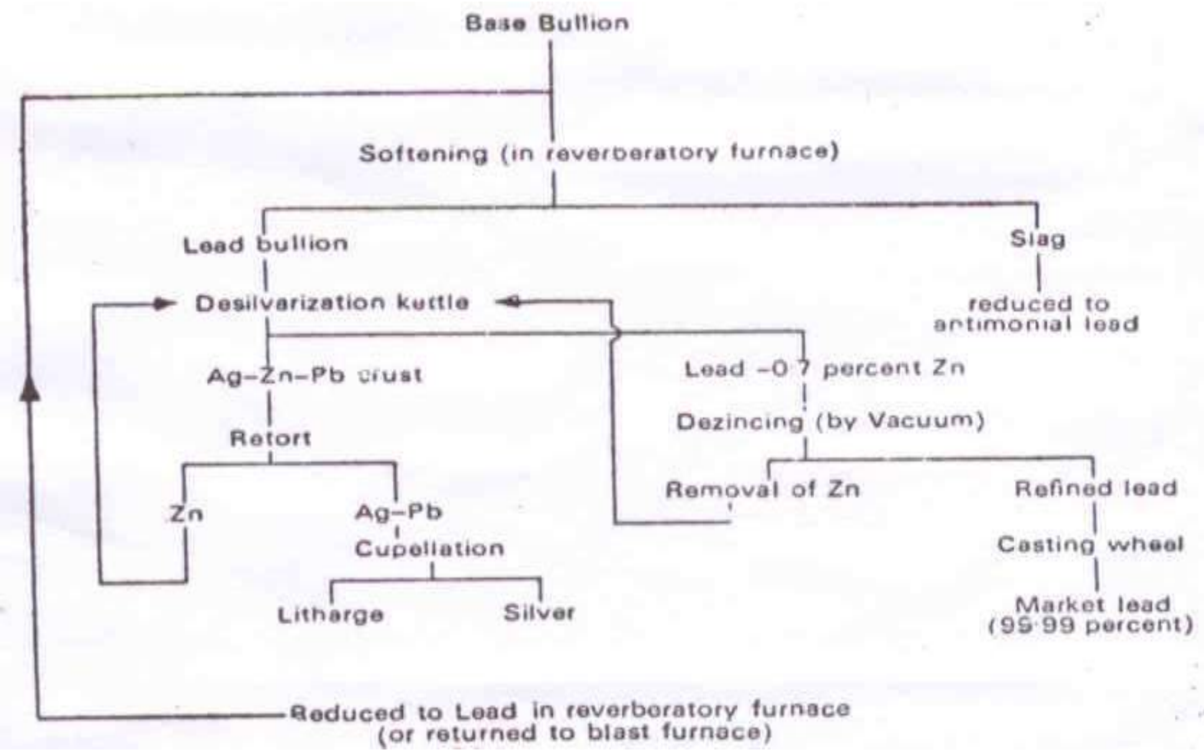



**Figure – 32 : Lead refinery flow-sheet**

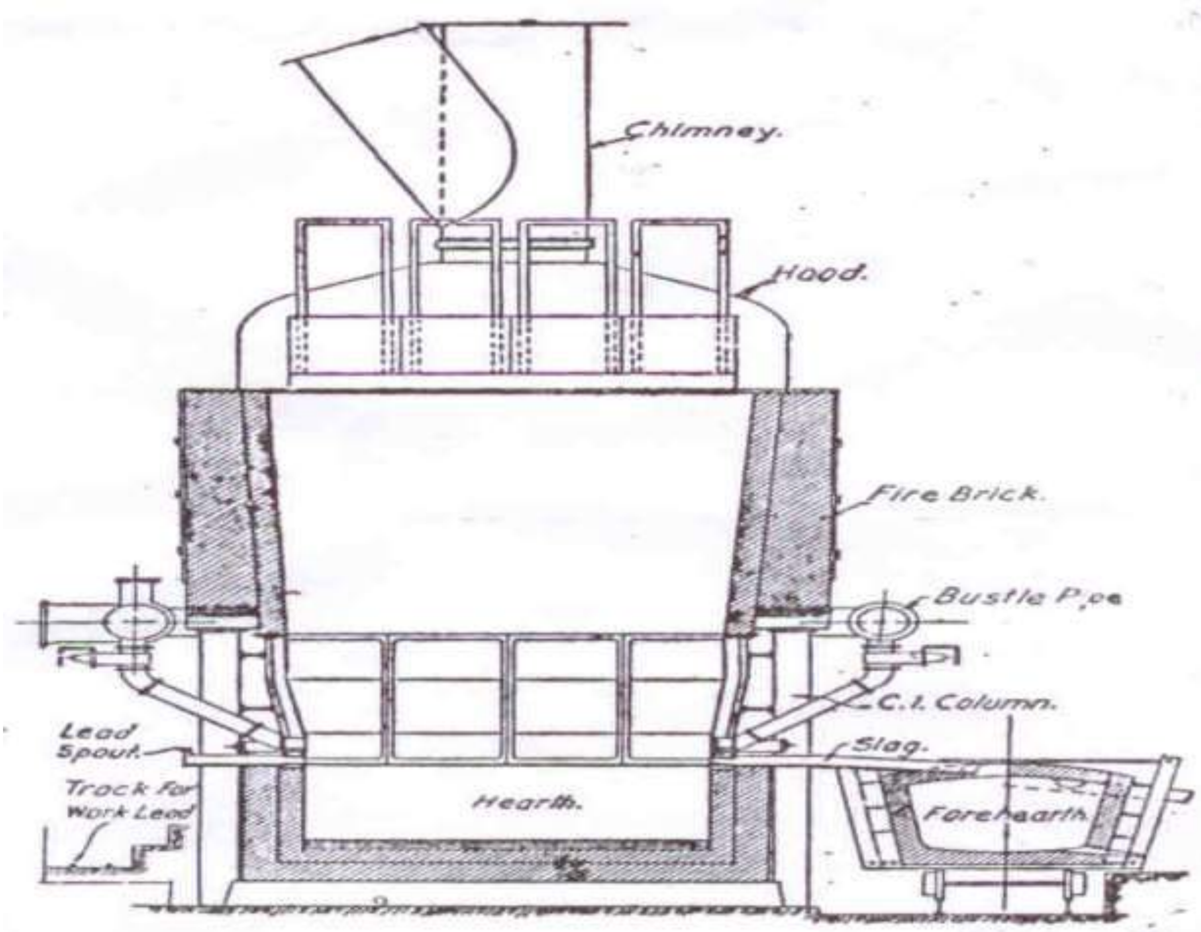



**Figure – 33 : Lead blast furnace**

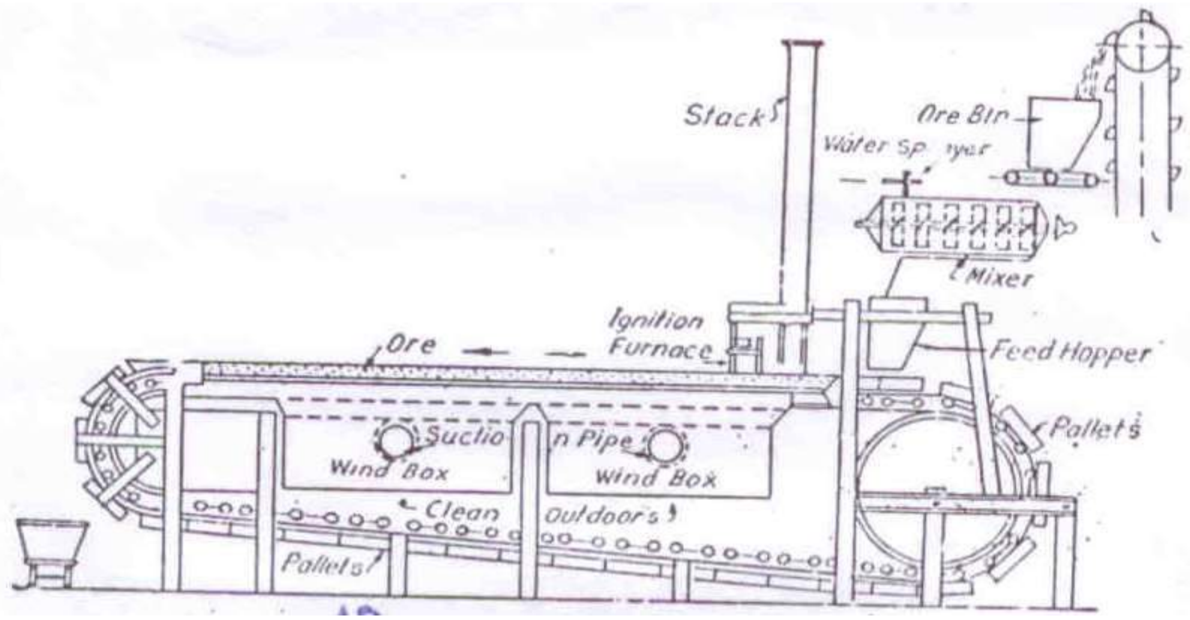



**Figure – 34 : Dwight-Lloyd sintering machine**

Sintering machine used for making big pallets from fines of ores so that their wastage be avoided. The dressing operation is also carried out and ore is agglomerated which is suitable for blast furnace charge.

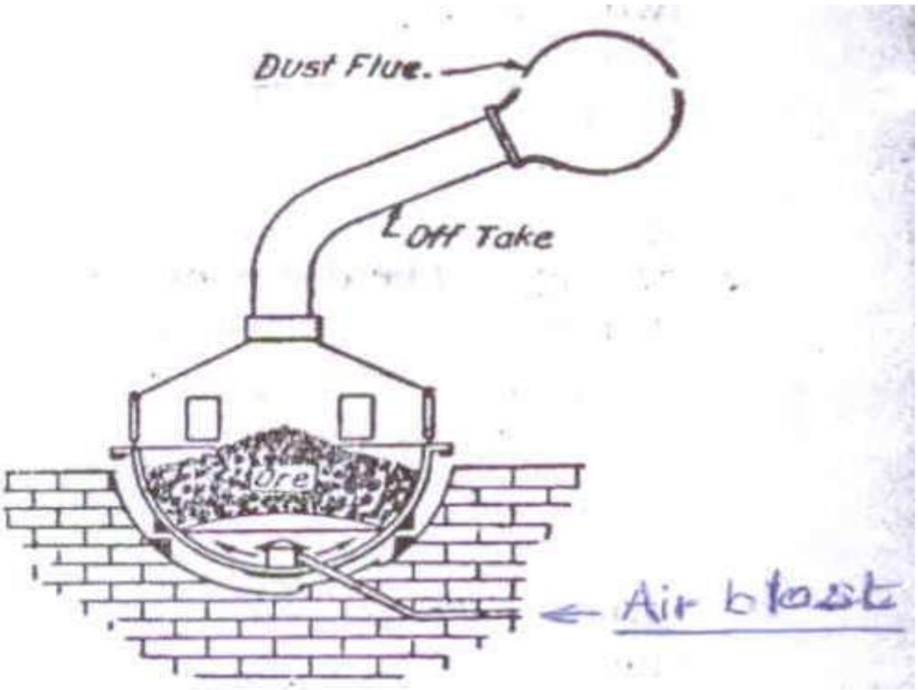



**Figure – 35 : Huntington – Heberlein roasting pot**

Roasting pot made of Cast Iron 10’ dia. and 5’ deep. Charge 8 – 10 tonnes. Time 4 – 6 hours. The charge is further charged into blast furnace.

## Few Non-Ferrous Alloys of Engineering Importance

### A. Aluminium Alloys

Aluminium alloys finds enormous uses in engineering industries for different components when alloyed with small amount of copper, silicon, manganese, iron and nickel.

Important alloys are –

(i) Aldural

Known as Alciad with a coating of 5% aluminium on duralumin to improve sea water corrosion resistance.

(ii) Aluminium Bronze

90 – 78% Cu and 10 – 22% of Al strong, hard, light, malleable yellowish brown and elastic, yellowish brown alloy. Good corrosion resistance used for pump rods and die casting as it is a substitute for Brass.

(iii) Duralumin

Very important alloy of aluminium. Composition – 94% Al, 4% Cu, Mg, Mn, Si and iron each 0.5%.

It possesses important property of 'Age hardening' used for aircraft, automobile industries, electric cables, surgical and orthopedic supplements or gadgets etc.

(iv) Y – Alloy

Compo 92.5% Al, Cu – 4%, Ni – 2% and Mg – 1.5%.

Good conductor of heat and possesses good strength at high temperature. Used for piston of engines, cylinder heads, gear boxes, propeller blades etc.

## B. Copper Alloys

Main Categories

Brasses | Bronzes

(i) **Brass**

Cu and Zn alloy with small amount of other elements except tin. Stronger than copper.

Common brass are :

- Cartridge brass
  70% Cu, 30% Zn with high tensile strength used for cartridges, tubes, springs etc.

- Muntz metal or yellow metal
  60% Cu, 40% Zn. High strength and used for castings and condenser tubes. Popular for hot working processes.

- Navel brass
  60% Cu, 39% Zn, 1% Sn. Used for marine and engineering castings condenser tubes, pump parts, motor boat shaftings etc.

- Red brass or red metal
  85% Cu, 15% Zn. Good corrosion resistance, superior to Cu and used for electrical sockets, plumbing lines.

- Yellow brass
  65% Cu, 35% Zn. Strong and also known as standard brass. Used for plumbing accessories, lamp fixtures, grille work, screws, rivets, tubes etc.

- <u>White brass</u>
  10% Cu, 90% Zn. Addition of Cu imparts hardness and strength. Mainly used for Ornamental work.

(ii) **<u>Bronze</u>**

The bronze is an alloy of Cu and Sn with other elements.

Common types of bronzes are :

- <u>Bell metal</u>
  82% Cu and 18% Sn. Hard and brittle and possesses property of resonance. Hence used for making bells.
- <u>Gun metal</u>
  88% Cu, 10% Sn and 2% Zinc. It is tough strong and hard. Good resistance to sea water corrosion. Suitable for castings. Used for bearings, bolts, nuts, bushings and for many items in navel constructions.

- <u>Manganese bronze</u>
  56 – 60% Cu, and remaining amount of Zinc with small amounts of Mn – 1% maximum Al, lead and iron each between 0.4 to 1%. Alloy has very good corrosion resistance to sea water and dilute acids. Used for various ship fittings, shafts, axles and other parts etc.

- <u>Phosphor bronze</u>
  89% Cu, 10% Sn and 1% phosphorous. Alloy is hard and strong. Alloy is highly resistant to sea water and has high endurance limit. Used for springs, gears, bearings, worm wheels, pump parts. It is easy to cast with sound castings.

## C. Lead Alloys

Lead Alloyed with Sn (tin) form solders. When alloyed with tin and antimony maked Bearings known as Babbits or White metal. With tin, antimony and copper it makes 'type metal'.

## D. Magnesium Alloys

These alloys are light and easily worked. Mainly used for construction of aeroplanes, chair frames, engine parts.

Two important alloys of magnesium:

| | | |
|---|---|---|
| Dow metal | - | 4 – 12% Aluminium, 0.1 – 0.4% manganese and balance magnesium. |
| Electron metal | - | 4% zinc, small percentage of Cu, Fe, Si and balance magnesium. |

E. **<u>Copper – Nickel Alloys</u>**

| | |
|---|---|
| Copper-Nickel | 2 – 30% Nickel and rest copper. These alloys are used for surgical instruments, coins, utensils, ornaments, condensers and heat exchanger tubes. |
| Nickel-Silver | 10 – 35% Nickel, 25 – 35% Zinc and 25 – 50% copper. Because of its silvery-white appearance it was known as German-Silver. They used for plumbing fixtures, camera optical parts, utensils, name plates etc., automobile fittings, food handling equipments. It has good resistance to atmospheric corrosion and organic acids. |
| Monel-metals | 65% Nickel, 30% copper and 5% other metals like iron, manganese. Properties of this alloy is maintained at high temperature. Available in various grades depending on its use. Mainly used for textile and chemical industries, valves, tubes, propeller shafts of ships etc. |

Technical Specifications :

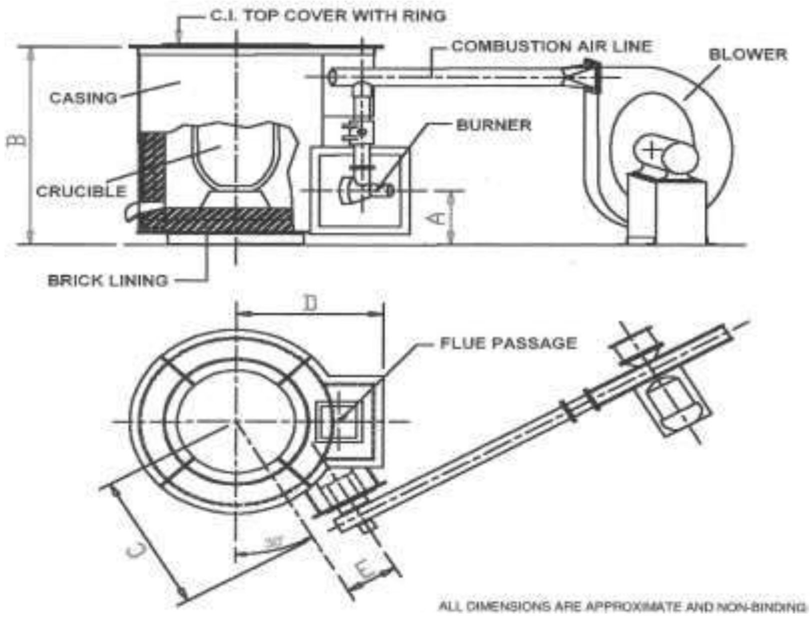
BALEOUT FURNACE WITH MELTING AND HOLDING UNITS FOR NON-FERROUS METALS :

The furnace is refractory-lined and supplied as complete package which includes blower, burner, and crucible. The durable body is constructed from thick reinforces mild steel plates. The crucible is available in options of either cast iron, graphite or silicon carbide.

The furnace is supplied with oil burner. Combustion air is provided by centrifugal blower. Preheated oil at constant temperature and pressure is supplied to the burner by a heating and pumping unit.

The burner fires tangentially inside the shell lining into a circular combustion space so that the hot gases surround the crucible, ensuring uniform heating. Waste gases pass out through a flue at one side, allowing reasonable working conditions for operator. Normally the flue discharge is upward for top exhaust. Optionally, waste gases can be collected in a fume extraction hood for discharge outside the production area.

Other accessories – Oil Service tank, Outflow heater, Fume extraction unit, Motor starter, Semi-rotary pump for oil tank.



| MODEL | CHARGE IN KG AL | MELT TIME IN MIN | | LITRES PER 100 KG AL | DIMENSIONS IN MM | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | FROM COLD | SUBSEQ CHARGE | | A | B | C | D | E |
| B-3 | 150 | 120 | 90 | 22-25 | 350 | 934 | 980 | 820 | 300 |

**ROTARY MELTING FURNACE :**

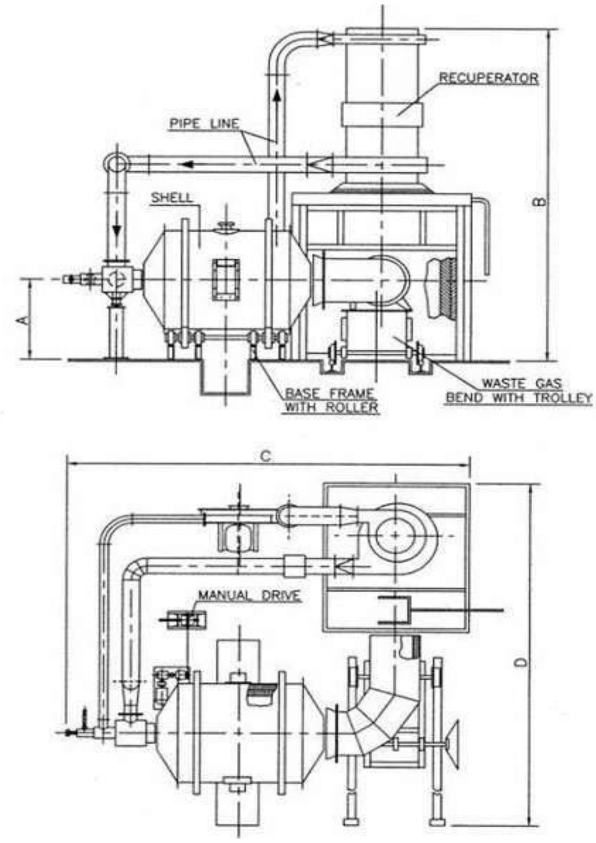
The furnace is designed primarily to melt iron but can also melt aluminium, copper, copper alloys, etc. When melting non-ferrous metals, the batch capacity as well as combustion system will change.

The furnace consists of a cylindrical shell fitted with two steel tyres supported on rollers mounted on a fabricated steel frame. The shell has two spouts and two lifting trunions and is rotated by friction between the tyre and rollers, which are driven by a motor via a worm reduction gear. Manual drive provision is optional.

A low air pressure burner capable of operation with preheated air is fitted. The burner can fire HSD, LDO, furnace oil or LSHS. Gas firing options are also offered.

A cylindrical radiation-type recuperator utilizing the waste products of combustion is provided to heat the combustion air. The recuperator is mounted either on fabricated structure or on brick-lined chamber. It receives the products of combustion from the furnace through a waste gas bend trolley. The furnace is charged by removing the trolley.

Other accessories – Oil Service tank, Outflow heater, Semi-rotary hand pump, Fume extraction unit, Motor starter, Lining material and ramming fixtures.




**Model** : RMF – 1000
**Charge** : 1000 Kg for Iron
**Dimensions**

| | | |
|---|---|---|
| **A** | **:** | 1390 mm |
| **B** | **:** | 6575 mm |
| **C** | **:** | 5820 mm |
| **D** | **:** | 7300 mm |

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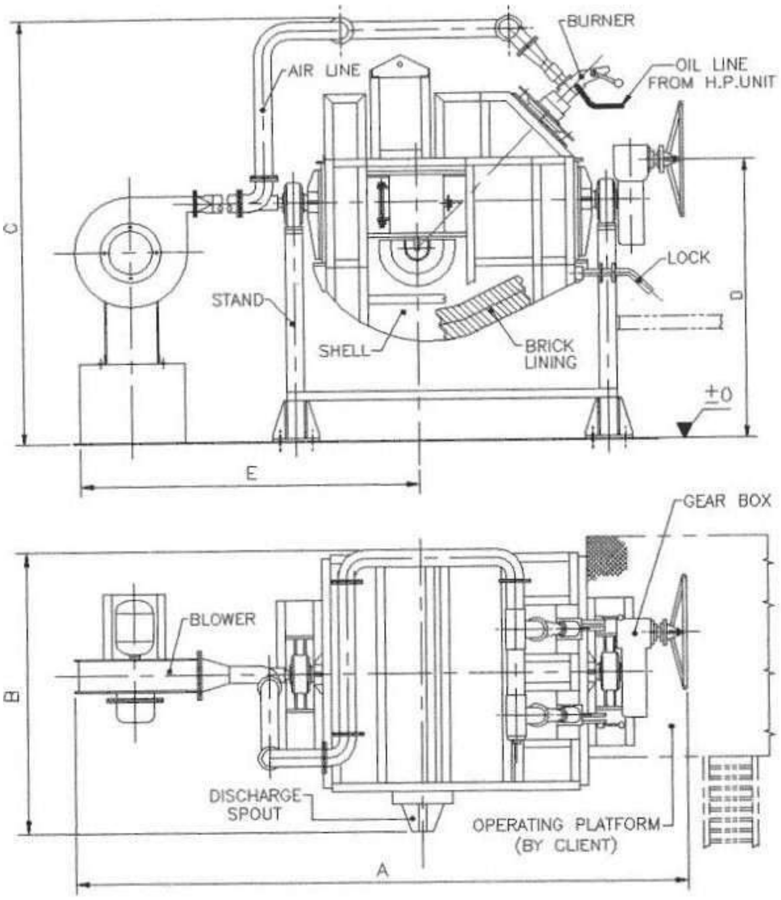
**REVERBERATORY FURNACE :**

Reverberatory furnaces are used primarily for melting copper and its alloys such as bronze and brass, and other metals such as aluminium, lead and zinc. The furnace is supplied with refractory lining, tilting gear arrangement, blower and burner.

The furnace is constructed from reinforces mild steel plates of substantial thickness, and is supported on a heavy fabricated stand through trunions on anti-friction bearings. The furnace is provided with tilting gear arrangement on one side shaft extension comprising a worm, worm wheel, bevel gears and large hand wheel for easy manual operation (motorized drive arrangement with inching facility is optionally available).

The furnace is fitted with self-proportioning oil burner. The burner is arranged to fire directly inside the shell lining. Waste gases pass out through vertical flue passage which also serves as a charging door, enabling the charge to be preheated before melting. Products of combustion may be collected in an optional fume extraction unit for discharge outside the shop.

Other accessories – Oil Service tank, Outflow heater, Semi-rotary pump for oil tank, Fume extraction unit.




**Model** : RV-10
**Capacity** :
Brass : 450 Kg
Aluminium : 150 Kg

**Dimensions**

**A** : 4800 mm
**B** : 1625 mm
**C** : 2500 mm
**D** : 1550 mm
**E** : 3050 mm

## ELECTRIC INDUCTION FURNACE :

| | | |
|---|---|---|
| 1. | Furnace Capacity | : 500 Kgs |
| 2. | MF Power (KW) | : 250 KW |
| 3. | Transformer Capacity | : 315 KVA |
| 4. | Solid State Power Panel Efficiency | : 95% |
| 5. | Frequency | : 1000 Hz |
| 6. | Maximum Mains | : 280 KVA |
| 7. | Mains PF | : 0.94 (min at rated mains voltage & max power setting) |
| 8. | Load Matching | : by automatic frequency shifting with constant power tracking |
| 9. | Steel Melting Rate @ 1675$^0$C for Steel Scrap 100% yield | : 440 Kgs/hr |
| 10. | Energy Consumption @ 1675$^0$C for Steel Scrap 100% yield | : 550 KWH/Ton |
| 11. | DM Water Requirement | : 500 Litre |
| 12. | Over Head Storage Tank Capacity | : 10000 Litre |
| 13. | Cooling Tower Duty in LPM for temp. drop from 42$^0$C to 32$^0$C | : 225 |
| 14. | Underground Storage Tank Capacity | : 30000 Litre |

**Questions :**

(a) Show classification of various ferrous alloys.

(b) Write note on manufacture of pig iron.

(c) Enumerate types of pig iron.

(d) Describe various processes of manufacture of wrought iron.

(e) Write short note on Cast Iron and its process of manufacture.

(f) Explain following :-

- Bessemer process
- Open hearth (furnace) process
- Oxygen process
- Kaldo process
- Electric arc furnace process
- Manufacture of aluminium
- Copper and its Alloys
- Zinc
- Tin metal extraction
- Ferrous and non-ferrous alloys of engineering importance.

# UNIT - 2

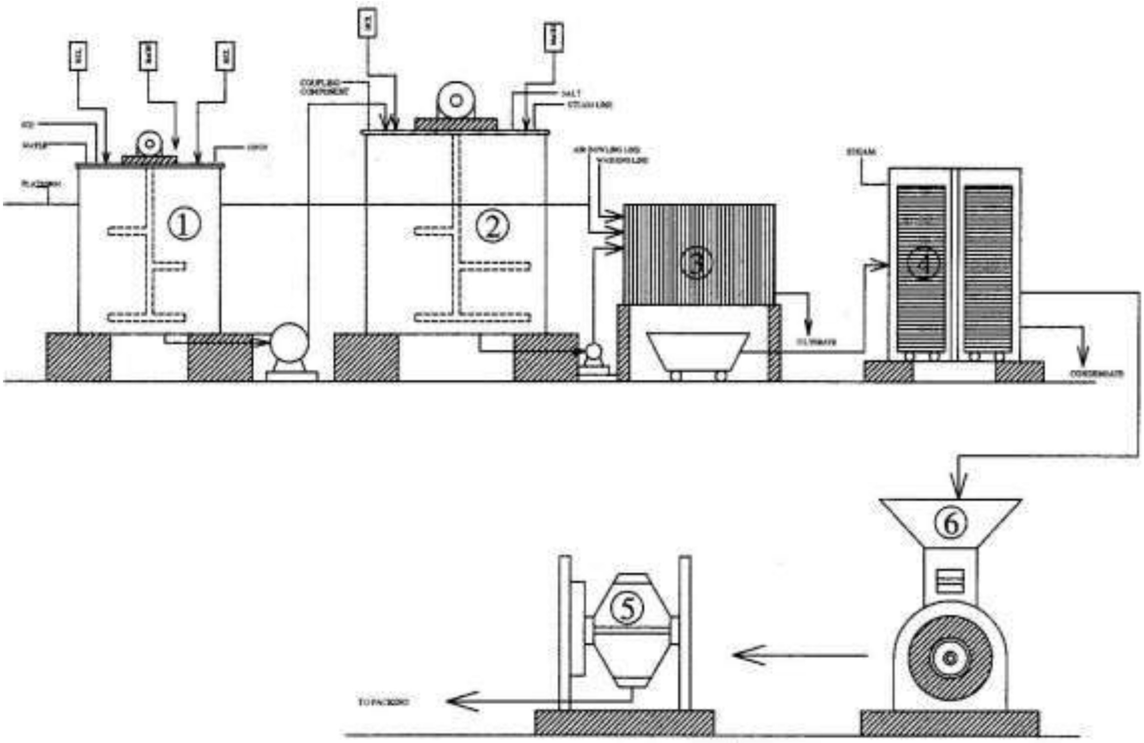
## CHEMICAL (DYES)

**OBJECTIVES :**

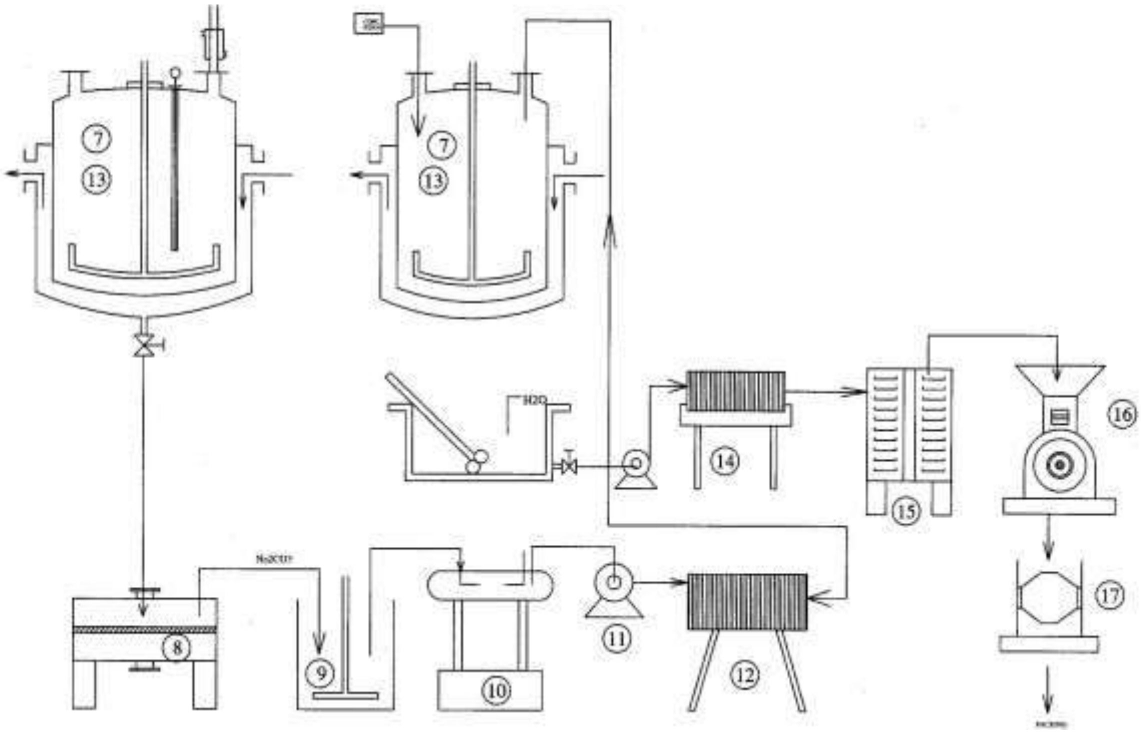
By the end of this chapter students will learn about :-

- Flow chart for manufacture of AZO dyes
- Flow chart for manufacture of VAT dyes
- Brief description of manufacturing process and products
- Process control and quality control
- Technical specifications of machines

**<u>Flow chart for the manufacturing of Azo Dyes</u>**



**Flow chart for the manufacturing of VAT Dyes**




1. Glass lined reactor for Diazotization Coupling
2. Glass lined reactor for
3. Wooden plate and frame filter press
4. Vacuum Dryer
5. Mixer
6. Pulveriser
7. Glass lined reactor
8. Filter Box
9. Dilution tank
10. Steam Distillation Unit
11. C.I. Pump
12. Wooden Filter Press
13. M.S. Reactor for Pasting
14. Wooden Filter Press
15. Tray Dryer
16. Pulveriser
17. Mixer

**Brief Description of Manufacturing Process and Products**

Dyestuff manufacture is extremely complex on account of the large number and variety of reactions, intermediates and final products involved. Depending on economics of the scale of operation and specialization, the big units manufacture most of the intermediates and also the end products. Smaller units manufacture only some of the intermediates and final products. Among the long series of reactions are Sulphonation, nitration, amination, catalytic reduction and oxidation, hydroxidation, alkylation, carboxilation, diazotization and coupling cyclizations and condensations etc. These are followed by unit operations such as precipitation, filtration, drying, grinding, blending and finally packing.

**Reaction Chemistry and Process Description**

In the Glass Lined reactors, the diazotization and coupling reactions takes place where the azo group i.e. N = N is formed. Azo dyes have the basic structure:

AR – N = N – AR’ where AR and AR’ are two aromatic groups.

The unit containing the nitrogen-nitrogen double bond is called an azo group. The nature of the aromatic substituents on both sides of the azo group controls the colours of the azo compounds as well as the water-solubility of the dyes and how well they bind to a particular fabric.

**e.g.** To prepare the azo dye 1-(4-hydroxyphenylazo)-2-naphthol by the diazonium coupling reaction of naphthalen-2-ol with the benzenediazonium ion obtained from 4-aminophenol:

There are several important steps in the experiment which have to be carried out carefully. The benzenediazonium salt solution is unstable and prone to deteriorate (decompose) upon standing at room temperature. The solution should always be kept at below 10 °C and should be used as soon as it is generated.

Naphthalen-2-ol dissolves poorly in acidic aqueous solutions. To prevent naphthalen-2-ol from precipitating out prematurely, the addition of the acidic benzenediazonium solution to the naphthalen-2-ol solution should be slow. The mixture forms a thick paste during addition. Stir the mixture efficiently to facilitate the reaction.

The black precipitate formed during the reaction is then filtered by passing through a filter press. The product is then washed thoroughly. Next Vacuum drying is carried out followed by various unit operations and finally our final product azo dye is obtained.

In view of the highly corrosive acids, alkalies and oxidizing agents used, high pressure reaction and hazards of toxicity, fire and explosions, specialized plant, machinery and equipment are needed and stringent precautions are followed in the operation of the plant and processes in dyestuff industry. Some of the plant and equipment used are listed below:

Reaction Kettles - Wooden Vats, M.S. rubber lined, brick lined, glass lined, cast iron or stainless steel.
Tanks of various types with heating and cooling devices.
High Pressure Autoclaves
Evaporation Units
Distillation Units
Heat Transfer Units
Crystallizers
Various types of Pumps for transferring liquids and semi-liquids
Various types of filters and filter presses
Driers of different types such as Air Driers, Vacuum Driers, Grinders, Pulverisers, Ball Mills.
Blenders or mixers

Some of the auxiliary equipment which provide the services or the utilities for the dyestuff industry are the following:

Boilers for Steam
Ice plants for providing Ice.
Brine and Chilled Water Plants to provide Brine and Chilled Water.
Cooling Water Units
Compressed Air Units

The above service equipment and the service lines for conveying the above services or utilities including electricity to different process points form a large proportion of the total value of Machinery and Equipment used in dyestuff industry.

The final and essential stage of the manufacture of a dyestuff is the standardization of shades, concentration and physical form on which depend the dyeing properties. In view of various intermediate stages involved, some variation in purity of the dye from batch to batch result in spite of rigid quality controls and process controls. Standardization may involve mixing different batches of the same dye to get the desired shade.

The desired market grades and shades may not be readily available in the final product and frequently a dye has therefore to be “shaded” with a second dye or sometimes even with two or three dyes keeping in mind the need for individual dye in a mixture to have a very similar dyeing fastness properties. The dilutants or reduction materials used in standardization should be such that they facilitate the application of the dyestuff or at least innocuous. Some of the dilutants added to finished dyestuff are:

Sodium Chloride
Sodium Sulphate
Sodium Bicarbonate
Sodium Carbonate
Other Dispersing Agents

**Process Control and Quality Control:**

In view of the requirement to obtain a product of standard quality and optimum yield, temperature, pH, concentration, pressure etc. need to be regulated rigidly and the material in process has to be tested in the plant laboratories at various stages. A well equipped laboratory is attached to each manufacturing plant. The final product, its shade and concentration, market grade etc. are tested and rated in the Quality Control Laboratories which are independent from the manufacturing plants.

TECHNICAL SPECIFICATIONS OF EQUIPMENTS & MACHINERY

1. Glass lined reactor for Diazorization

| | | |
|---|---|---|
| Model | : | AE 250 Glass lined reactor |
| Capacity | : | Vessel : 250 litres (nominal)<br>334 litres (total) |
| Dimension | : | OD 700 mm and overall height 1030 mm |
| Weight | : | Approximately 810 kg empty with accessories |
| Code | : | ASME VIII, Div 1 Unstamped |
| Design pressure | : | Inner vessel : F.V / + 6.0 Bar g<br>Jacket : F.V / + 6.0 Bar g |
| Design temperature | : | -25$^0$C to 200$^0$C |
| Material of construction | : | Inner Vessel Body Material as per DIN 17155H1/ EN 10028-2 P235 GH or equivalent, Jacket material DIN 17155H1/ EN 10028-2 P235 GH or SA516 Gr60 or equivalent, Nozzle necks on inner vessel are of forged steel 'C ' clamps for body flange and manhole flange of forged steel. |
| Exterior finish | : | Pre-treatment removal of rust by blasting<br>1 coat of red epoxy primer |
| Lining | : | Pfaudler 9100 Blue. |
| Process nozzles | : | Top Head : 2 nos. 50 mm dia.<br>3 nos. 80 mm dia.<br>1 no. 80 mm dia. for Agitator entry<br>1 no. 150 mm dia. for Handhole assembly with 50 mm dia. sight glass |

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| | | |
|---|---|---|
| | | Bottom Dish: 1 no. 76 mm x 50 mm Glass lined bottom outlet valve GPF – 202 |
| | | Main flange and all glass faces will be provided with PTFE envelope type gaskets with corrugated stainless steel ring and CAF inserts |
| Jacket nozzle | : | 2 nos. 40 mm dia. |
| Drilling standard | : | Split backing flanges – PN – 10 DIN 2673 |
| Supports | : | 4 nos. side bracket / leg supports |
| Hydraulic test pressure | : | Pressure tested in accordance with code. |
| Stress relief | : | All hearing cycles will be as required for glassing process. |
| Other NDT | : | In accordance with code. |
| Corrosion allowance | : | 1.5 mm external : Inner vessel<br>1.5 mm internal : Jacket |
| Agitator | : | Impeller agitator at 96 RPM |
| Baffle | : | Baffle Thermowell for impeller agitator. |
| Drive | : | Drive consisting of cast/fabricated box section leg type drive stool.<br>▪ Worm Reduction gear box, Radicon / Elecon make.<br>▪ Belt drive. |
| Shaft closure | : | Single dry mechanical seal of Hi-fab / Leakproof make. |
| Motor | : | 3.0 hp (2.2 kW0 Flame proof, Crompton / BBI make. |

**2. <u>Glass lined reactor for Coupling</u>**

**Same as Serial No. 1**

## 3. Wooden plate and frame Filter Press

* Material to be filtered (Ltrs.)

  Operating temperature ($^0$C)

  Operating pressure (kg / $cm^2$)

  Flammable / Non-flammable / Others

* Type of plate
  Chamber / plate & frame

* Plate size

* Cake thickness
* Number of chambers

* Material of filter press plate
  C.I. / P.P. / Wood

* Filter press body
  C.I. commercial / C.I. graded / M.S.

* Material of flanges
  M.S.R.L. / C.I. / S.S. / P.P.

* Type of closing device

  Ratchet closing

  Manually operated hydraulic closing mechanism with hand pump.

  Electrically operated hydraulic closing mechanism.

* Filtrate discharge
  Closed / Open

* Washing
  Simple / Thorough

* Dip collection tray
  M.S. / S.S. / P.P. / F.R.P. / Other

  Auto shifter
    Plate shifting device.

**4. <u>Vacuum Dryer</u>**

**Specifications:**

| | | | |
|---|---|---|---|
| 1. | Overall size | : | 1500 mm W x 2000 mm H x 1000 mm D<br><br>Dryer shall be mounted on channel legs. |
| 2. | M.O.C. | : | Outer shell is made out of 6 mm thick SS 316 plate with 50 mm thick glasswool insulation on the vacuum chamber outer surface, the insulation enclosed with tag welded 16 gauge SS 304 panels fitted in a SS 304 angle frame. |
| 3. | Design temperature | : | 100 Deg. C’ |
| 4. | Working temperature | : | 80 Deg C’ |
| 5. | Design pressure | : | Shell 1 kg per sq cm. to full vacuum<br>Jacket / hot plates 5 kg per sq. cm. |
| 6. | No. of hot plates | : | 12 nos. + 1 no. dummy shelf SS 316<br>Size: 1250 x 900 x 25 mm |

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| | | | |
|---|---|---|---|
| 7. | No. of trays | : | 36 nos. SS 316 size 16” x 36” x 1 ¼” with mirror buffing polishing. |
| 8. | Door | : | SS 316, 8 mm thick 1 no. door fitted with heavy duty hinges. |
| 9. | Locking arrangement | : | The door is locked to the dryer chamber with SS 304 “I” bolts. |
| 10. | Nozzle | : | All the nozzles are as per ASA 150, raised face<br>Vacuum inlet of 150 NB<br>Heating plates heeder inlet 1” and outlet ½”<br>Two no. view glass of 100 NB with toughen glass.<br>Vacuum chamber drain of ½” BSP<br>N2 purging for vacuum breaking of ½” BSP<br>Vacuum gauge connection of ½ BSP. |
| 11. | Testing | : | The vacuum dryer shelves are hydro tested at 5 kg per sq. cm. in assembled condition.<br>The vacuum chamber also tested for leaks under vacuum. |
| 12. | Finish | : | The door is buffed to a dull/matt finish from outside and inside all material contact part will be mirror buffing polishing. |

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## 5. Mixer

* Mixer used for
  Mixing Blending Dissolving
  Emulsion Solid suspension
  Gas dispersion Crystallisation
  Any other
* Degree of agitation
  Gentle
  Medium
  Violent

| Name | Solid/ liquid/ paste | % wt. | Bulk density gms/$cm^3$ | Specific gravity gms/$cm^3$ | Temp. $^0$C | Viscosity | pH |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

* Desired cycle time – charging / mixing / heating / cooling / discharge (minutes)

* Jacket – heating or cooling media
  Type temp $^0$C. pressure kg/$cm^2$

* Operating pressure Vacuum Type of seal

* Are the solids :

| crystalline | Crumbly | slimy | sticky | pasty | hygroscopic |
|---|---|---|---|---|---|
| | | | | | |

* Particle size analysis

| Percentage | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Micron | | | | | | | | |

* Is process

Continuous? If yes, production rate.

* Batch capacity

$M^3$, Batches per day

* Material of construction

**6. Pulverizer**

* Name of material

* Apparent loose density in cu. ft.

* Size of feed    Feed temperature $^0$ C    Specific heat

* Final moisture    Total $H_2O$. %

Surface moisture. %

* Product fineness

* Maximum permissible product temperature. $^0$C

* Type of heat    Direct    Indirect    kcal value of fuel

| | | | |
|---|---|---|---|
| * Source of heat | Gas | | pressure (psig) |
| | Oil | | kind |
| | Steam | | pressure (psig) |
| | Waste heat | | temperature $^{0}$C |

* Elevation above sea level

| | | | |
|---|---|---|---|
| * Electric supply | Phase | Cycles | Volts |

* Type of final dust collection equipment

## 7. Glass lined Reactor

**Same as Serial No. 1**

## 8. Filter Box

SS 316 conical type filter with dish type top lid and conical bottom fabricate with main body 6 mm thick and 5 mm thick plate jacket and inside perforated basket with 'J' type locking arrangement with silicon gasket with mirror buffing polishing.

Size: 420 mm OD x 700 mm H

## 9. Dilution Tank

| | | |
|---|---|---|
| Capacity | : | 6000 litres |
| Material of construction | : | S.S. 316 |
| Size | : | 1700 mm dia. x 2400 mm height |
| Thickness of shell | : | 5 mm |
| Thickness of dished ends | : | 6 mm |
| Dia. of manhole | : | 400 mm |
| Dia. of sight glass | : | 100 mm |
| Dia. of light glass | : | 100 mm |
| Dia. of vent | : | 50 mm |
| Dia. of outlet | : | 50 mm |

| | | |
|---|---|---|
| Spare nozzle | : | 32 mm dia., 25 mm dia. x 50 mm dia. with blind flanges. |
| Dia. of sampling | : | 15 mm |
| Supports | : | Channel supports |
| Finishing | : | All S.S. internal parts mirror polished and outer surface are satin polished. All M.S. surface painted with metal primer and coated with enamel paint. |

**10.** **Steam Distillation Unit**

| | | |
|---|---|---|
| Type | : | Sieve tray type vertical cylindrical sections. Material of construction of all contact parts S.S. 304 Body flant M.S. (Boiler quality) with S.S. 304 liner. Skirt support IS 226 |
| Nozzle necks | : | A 312 TP 304 seamless |
| Nozzle flanges up to 100 NB | : | S.S. 304 |
| Solid nozzle flanges 150 NB and above | : | CS plates flanges with S.S. 304 liner |
| Size | : | 700 I.D. x 6800 mm height |
| Thickness of shell | : | 6 mm |
| Thickness of dished ends | : | 6 mm nominal<br>5 mm minimum |
| Thickness of body flanges | : | 40 mm thick C.S. (Boiler quality) with 10 mm thick S.S. 304 liner. |
| Supports | : | Skirt support of size 700 mm x 4050 mm height x 6 mm thick. |
| Trays | : | 24 nos. S.S. 304 quality trays. Thickness 3 mm with 6 mm perforation trays supported on tie rods with appropriate spacers. |
| Radiography | : | Dished ends – full. |
| Other major butt welded joints | : | Spot (10%) |

| | | |
|---|---|---|
| Polish | : | Internals given mirror polish while dished ends have satin finish from outside. |
| Empty weight | : | 2200 kg |

**11.** **C.I. Pump**

* Capacity $m^3$ / hr

* Liquid to be pumped

Specific gravity
pH
Temperature ($^0C$)

Vapour pressure (at above temperature)
Viscosity

Aeration conditions

* Solids in suspension

Hard, soft, gritty, crystalline
Specific gravity
Quantity ( % by weight)
Particle size (mm)

* Duty

Continuous intermittent delivery head (m)

Suction head or lift (m)
Total dynamic head (m)
Pipeline, Material
Diameter Length
Fittings

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* Service conditions

Contamination

Crystal formation due to temperature drop

* Type of pump

| | |
|---|---|
| Direct coupled | Rubber lined |
| V-belt drive | Hard iron |
| Overhead V-belt drive | |

* Drive

Power supply
Volts
Phase
Cycle

**12. Wooden Filter Press**

**Same as Serial No. 3**

**13. M.S. Reactor for Pasting**

| | | |
|---|---|---|
| Capacity | : | 7000 litres |
| Type | : | Vertical cylindrical with welded top and bottom dished ends. |
| Material of construction | : | All contact parts in process fluid S.S. 316 L |
| Internal coil | : | S.S. 316 L seamless |
| Limpet coil | : | S.S. 304 |
| Nozzle necks up to 100 mm dia. | : | S.S. 316 L / S.S. 304 seamless pipe. |
| Nozzle necks above 100 mm dia. | : | Fabricated from plates provided with 100% radiography. |

| | | |
|---|---|---|
| Nozzle flanges for nozzles up to 100 NB | : | S.S. 316 L / S.S. 304 |
| Nozzle flanges for nozzles 150 NB and above | : | C.S. plates with S.S. 304 liner. |
| Size | : | 1800 mm ID x 2500 mm Tan to Tan height. |

**Thickness**

| | | |
|---|---|---|
| Shell | : | 8 mm |
| Dished ends | : | 10 mm nominal<br>8 mm minimum |
| Baffles | : | 2420 mm length x 85 mm width x 8 mm thick |
| Number of baffles | : | 2 |
| Limpet coil | : | 80 mm dia. x 3 mm thick ellipsoidal |
| Internal coil | : | 40 NB x Schedule 10S ASTM A312 TP S.S. 316 L seamless |
| Radiography | : | Dished ends – full |
| Other major butt weld joints | : | Spot (10%) |
| Polish | : | Internals given mirror polish while top dished ends have satin finish from outside. |
| Agitator | : | Driven by means of 15 hp, 1440/720 rpm dual speed flame proof (FLP) motor through a suitable speed reduction gear box to give final output rpm of approximately 100 and 50 to the shaft. Shaft is of 80 mm dia. and made out of S.S. 316 L bar. The shaft is provided with 2 nos. turbine type impellers fabricated out of S.S. 316 L plates. Agitator complete with necessary couplings, bearing, housing, water cooled stuffing box and M.S. support stool. |

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**14. Wooden Filter Press**

**Same as Serial No. 3**

**15. Tray Dryer**

| | | | |
|---|---|---|---|
| 1. | Size | : | 1450 mm L x 550 mm D x 1100 mm H<br>(1) Outer surface 12 swg M.S. sheet<br>(2) Inner surface 18 swg SS 316 sheet<br>With 1 no. door fitted with food grade neoprene gasket. |
| 2. | Insulation | : | With glass wool 60 mm thick. |
| 3. | Exhaust fan | : | 1 no. S.S. 316 fan fitted with 20 mm pedestal type bearing. |
| 4. | Fan drive | : | ½ hp, 1440 rpm, 3 phase motor 1 no. |
| 5. | Steam coil | : | SS 316 standard size ¾" OD, 16 gauge fin tube with header – 2 nos. |
| 6. | Thermometer | : | Standard make FLP digital indicator-cum-controller with PT-100 RTD sensor. |
| 7. | Trolley & tray | : | SS 316, 18 gauge size 16" x 32 x 1 ¼" 12 nos. tray with SS 316 angle fix type trolley. |
| 8. | Starter | : | Standard makes FLP push button type – 1 no. |
| 9. | Filter | : | SS 304 5 micron inlet air filter – 1 no. |
| 10. | Finishing | : | Outside enamel paint and inside all SS contact part will be mirror buffing polishing. |

16. **<u>Pulvarizer</u>**

**Same as Serial No. 6**

17. **<u>Mixer</u>**

**Same as Serial No. 5**

# UNIT - 3

## PHARMACEUTICAL

**OBJECTIVES :**

By the end of this chapter students will learn about :-

- Flow diagram for manufacturing of Tablet, Injection, Liquid oral, ointment and fine chemical department.
- Machinery used in manufacture of above products.
- Technical specifications of machinery used in manufacture.

**Flow Diagram :**

Raw material receipt at R.M. Stores and kept in Quarantine.

↓

Sample of raw material taken for quality control dept. and labeled as 'under testing'.

↓

Q.C. passed material – taken as stock – labeled as 'passed'.

↓

Q.C. failed material - labeled as Rejected to be returned to supplier

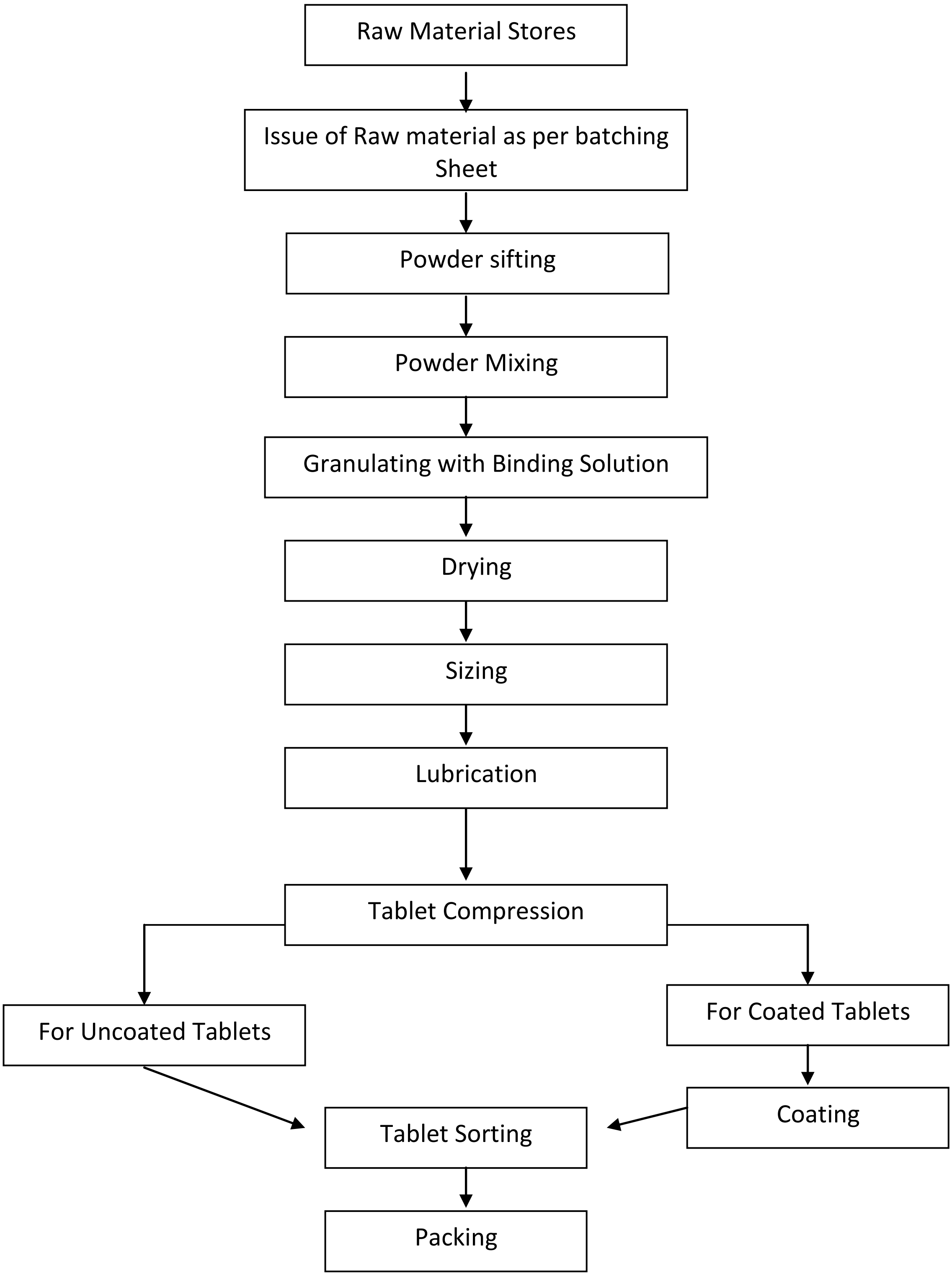
Raw material issue as per batching sheet in presence of production and quality control chemist.

↓

Raw material taken to manufacturing department and recheck weight.

Up to this, procedure is common for all – Tablet Manufacturing, Injection Manufacturing, Liquid oral, Ointment and Fine Chemical Department.

**Tablet Manufacturing Process**



**TABLET MIXING SECTION**

Raw material in powder form is weight checked and sieved in a sifting machine to remove foreign particles.

↓

Raw material mixed in a mixer and required binder added

↓

Passed through roll compactor (if required)

↓

Material dried using fluid bed or tray drier / if granulated using binder solution / paste

↓

Passed through fitz mill/granulator to have desired sized granules.

↓

Lubricated

↓

Kept in air tight drums for further dispatch to compression.

Here "In Process Quality Control" (I.P.Q.C.) is performed to get a better-desired result of the tablet. If need be, required reprocessing is carried out.

## TABLET COMPRESSION

Mixed powder is loaded to compression machine to have desired sized and shape of the tablets with required dose. Physical checking like – measurement, Dissolution Test (D.T.), friability test, Hardness etc are done intermittently. If necessary machine is reset/adjusted.

Tablets required to do coating is sent to coating departments for sugar coating /film coating.

Tablets are dried in tray drier if required

Tablets are sent for sorting to check – if broken/damaged in the handling. Good tablets are sent to quarantine

Final quality control is performed to give permission for packing.

## TABLETS PACKING DEPARTMENT

Tablets are strip packed / blister packed / container packed as per requirement of marketing.

↓

Packed in Transport worthy final pack and sent to finished goods stores for further dispatch to market.

## INJECTION MANUCTURING

Recheck the weights of raw materials before starting the solution preparation.

Start mixing of ingredients as per batching sheets in clean area under laminar flow units – in aseptic/bacteria free condition – air conditioned – positive pressure, filter the solution and keep ready for primary packing.

Quality control department – takes the sample for analysis and if approved – taken for primary packing. Failed material – either sent for reprocess or discarded.

Primary packing materials like – Ampoules – Vials, are washed with distilled water – dried and sterilized in an oven and kept ready for primary packing.

Q.C. approved solution/materials is taken for ampoule/vial – filling sealing machine.

Autoclaved for leak testing and final sterilization before secondary packing.

## INJECTION PACKING

Ampoules/Vials are visually inspected for suspended particles/any foreign material present and proper sealing.

↓

Good ampoules/vials are labeled – manual/machine and packed in secondary pack – carton with name of manufacturer, content of the material, batch no, license no, manufacturing date and expiry date etc.

After Q.C. release, the material is sent in a transport pack to finished good stores for further dispatch to market.

**PHARMACEUTICAL MANUFACTURING**

Pharmaceutical products are broadly classified for as follows :

(a) Tablets
(b) Syrups and suspension
(c) Capsules – soft sules and hard gelatin
(d) Injectables – intravenous and intra muscular
(e) Ointments – eyes and skin
(f) Dry powders for oral and injectables
(g) Eye, nose and eardrops.

For manufacturing, In Process Quality Control (I.P.Q.C.) and Quality Control (Q.C.) of above product, one need to satisfy following conditions : -

- Manufacturing licenses from Food and Drug Administrative (F.D.A.) authorities.
- A competent Chemist approved by F.D.A.
- I.S.O., W.H.O. & U.S.A. F.D.A. approval in appropriate cases.

Use of best raw material is prime requirement of any industries; pharmaceutical industries have to use the best available material for best quality product.

The raw material received from market is kept in quarantine in raw material stores till it is tested and approved by Q.C. department. Q.C. approves raw material as "**PASSED**". The passed raw material weight is checked, labeled and recorded as stock.

**TABLET MIXING**

| PROCESS DESCRIPTION | MACHINE USED |
|---|---|
| Weighing of raw material as per batching sheet | Weighing machine |
| Check weight of ingredients before mixing | Weighing Machine |
| Sieve it through shifter to remove foreign particles | Sifter |
| Prepare binder solution | Kettle with heating and stirring arrangement |

| **PROCESS DESCRIPTION** | **MACHINE USED** |
|---|---|
| Mix the ingredients with binder, lubricant to form granules. | S.S. Mixer / Blender |
| Pass through roll compactor/fluid bed drier/Tray drier | Roll Compactor<br>Fluid bed/tray drier |
| If need be, pass through colloid mill to have required particle size | Colloid mill/Fritz mill |
| Pass through granulator to have even size of granules | Oscillating Granulator |
| Keep in air tight container with proper label – batch no., name of product with date & weight for further processing to compression | |
| Ensure giving sample for Q.C. to test the consistency. | |
| After approval of Q.C. – forward the in process product to tablet compression. | |

**TABLET COMPRESSION**

For Coated and Uncoated tablets :

The entire area is under air conditioning and filtered air with local dust collector (at the point of dust generation)

| PROCESS DESCRIPTION | MACHINE USED |
|---|---|
| Tablet compression – double layer, two core, single core in different shape and size | Rotary machines – 16, 27,36 stations, Presscoata, Reciprocating and High speed machine |
| Tools used | Dies and punches of different sizes |
| Tablet testing | Friability test, hardness tester, D.T. machine, weighing balance |

After compression, the uncoated tablets are sent to I.P.Q.C. and if passed the tablets are forwarded to packing department in sealed containers labeled with product name, batch number, manufacturing date, I.P.Q.C. approval.

**TABLET COATING**

Tablets required to be coated are sent to coating section for sugar coating/film coating/enteric coating. The tablets are coated in coating pans with hot air supply system and spraying gun for film coating or manually. The coating pans are made out of S.S. plates with different sizes as per requirements.

Dust collection system is installed with water scrubber.

The coated tablets are checked by Q.C. department and after their approval sent for packing with proper label.

## TABLETS PACKING

Tablets uncoated/coated are sorted on sorting belt for breakage/damage or improper shape before it is packed. The packing is done as under :

- Container - Automatic counting machine is used or shovel counters are used.
- Strip packing (Aluminium or glass in foil) – strip-packing machine is used.
- Blister packing - Blister-packing machine is used.

Each container/strip or blister pack is marked with following:

– manufactures name,
– manufacturers license number
– ingredients used
– batch number
– date of manufacturing
– date of expiry
– maximum retail price.

The product is packed in shippers' bulk packing for further dispatch to finished product stores and to market.

## SYRUP DEPARTMENT

The procedure to get the raw material from raw material stores for preparation of syrup is the same as described for tablet department.

Most of syrup preparations are sugar based. For dissolving sugar, heated demineralised water collected in 1000 to 2000 litres of S.S. tank with mechanical stirrer is used for rapid mixing. Sugar syrup is filtered through filter press and collected in another tank to add different ingredients/vitamins. If need be, this mixture is passed through homogenizer to get the desired consistency. Quality control department again tests this and after their approval it is pumped to packing department.

By and large the machinery used in preparation of syrup department are S.S. tanks of different sizes with steam heating systems and mechanical stirrer, Filter press, Pumps, Homogenizer, Demineralised water plant.

**SYRUP PACKING**

By use of pump the syrup is transferred to liquid filling machine. Empty bottles are washed in the washing machine and made totally hygienic for filling the liquid. The bottles are thoroughly inspected to ensure that it is dirt free, without breakage or any abnormality. The bottles are filled with two head, four head, six head or multi head filling machines. In case of suspensions, the product is kept under stirring to prevent settling down of material in tank.

The filled bottles are sealed with capping machine, inspected for the right quantity of liquid and proper sealing before passing through labeling machine.

The following data is in corporated on the labels of filled bottles :

– manufactures name,
– manufacturers license number
– ingredients used
– batch number
– date of manufacturing
– date of expiry
– maximum retail price.

After labeling the bottles are packed in cartons with necessary insert – further packed in shippers bulk packing. Final Q.C. check is carried out before sent to finished product stores and dispatched to market.

## CAPSULES

Empty gelatin capsules are stored in air conditioned rooms.

The required dry powder is prepared in a form of a mixture by blending in air-conditioned-filtered air controlled area.

The empty gelatin capsules are opened by the capsule filling machine; dry powder is filled in and the capsules are cap/sealed as per batching sheet.

Randomly checking for correct weight is carried out on a micro-balance.

Cleaning and polishing is carried out on polishing belt and further checking for any defect and sorting is carried out on inspection belt. These capsules are taken for quality control and approved capsules are packed in sealed drums and sent to packing department.

The filled capsules are either strip packed/blister packed or container packed as per requirement.

The machinery involved in this process are:-

- Mixer / blender
- Capsules filling and sealing machine
- Capsules polishing machine
- Inspection belt

## INJECTABLE PRODUCTS

The entire department is fully air conditioned, under positive pressure and the conditioned air is passed through HEPA filters and guarded with micro V filters, not only to have dust free air but air free from bacteria.

The air flow is graded to have + + + pressure at solution preparation, filtration, ampoules/vials filling and sealing under Laminar flow unit to + + pressure in the internal passage to + cloth change room. The air-filtration system is classified as class 1000, 10000 & 100000 based on filtration capability.

Apart from all this, U.V. tubes are used at critical places to ensure bacteria free environment.

Before entering the injection department, it is mandatory to change the dress including footwear (sterile and germ free) with headgear.

The entire department is fumigated and made germ/bacteria free before starting the department after holiday. In case of any power failure in between, this procedure is followed.

Only after obtaining the assurance from Q.C. department that the area is bacteria free (count is nil) then only the manufacturing activity in the department is commenced.

Machinery involved are:-

(1) Double distilled water unit
(2) Ampoule filling sealing machine\
(3) Vial filling sealing machine.
(4) S.S. body Transfer pumps.
(5) Laminar flow unit.
(6) Bulk sterilizer / Autoclave
(7) Seitz filter and membrane filters
(8) S.S. vessels, filter holders
(9) Glass wares
(10) D.M. water plant.
(11) Ampoules washing machine with double doors (inter locking) drier.
(12) Vials washing machine with double doors (inter locking) drier.
(13) Weighing balance
(14) Ph meter and conductivity meter

This being a sterile area, any product going inside the area, has to be sterilized in autoclave at 121°C for 30 minutes to make it bacteria free and fit for use in sterile area.

The raw material is passed through hatch under U.V. light.

The special garments - boiler suit, head gear, mask, hand gloves, shoes, ampoules and vials are steriled through double door autoclave – one opening from non sterile and another opening from sterile area. In order to avoid air contamination provision is made to open these doors one at a time - either from inside or from outside.

Certain eye drops and eardrops are also prepared here in vials. Glucose bags/bottles are also prepared in sterile area and sent for individual and bulk packing.

Filled ampoules and vials are taken out from sterile area and tested for its leakage if any. Good ampoules and vials are washed and dried and checked/inspected on machine or manually for any leakage or suspended particles.

Only good quality ampoules and vials are taken for labeling with following information :

– manufactures name,
– manufacturers license number
– ingredients used
– batch number
– date of manufacturing
– date of expiry
– maximum retail price.

**INJECTION PACKING**

Ampoules and vials are taken for individual and bulk packing with insert if any to packing department and delivered to finished goods stores after Q.C. release for further dispatch to market. Here automatic ampoules and vial labeling machine are used and the rest of the packing is done on belt conveyer.

**OINTMENTS**

S.S. vessel with stirrer and S.S. jackets are used to prepare ointments. The ointment prepared is than filled in collapsible tubes on tubes filling machine and crimped on crimping machine.

Sterilized eye ointments are prepared in same way, but all the activities are carried out in sterile conditions as is the case with injectable products.

The label on final product contains following information :-

- manufactures name,
- manufacturers license number
- ingredients used
- batch number
- date of manufacturing
- date of expiry
- maximum retail price.

**DRY POWDER**

Dry powder if sterile, is manufactured and packed in sterile area. Mixing, filling and packing is carried out and packed in washed and sterilized vials. The label on final product contains the information as above.

**FINE CHEMICAL PLANTS**

Different sized, shaped and capacity S.S., M.S., Lead lined, S.S. lined, Glass lined reaction vessels with stirrer, jacket are used as per the need of the chemical reactions, grouped together and installed as per the need to have benefit of gravity feed and minimized transport. Hazardous chemicals are transferred and taken to reactor under vacuum/pressure to prevent any hazard to the operator/chemist. Maximum care is taken to train the operator to handle various chemicals under supervision of approved chemist to avoid any hazards. Use of acid and alkaline proof hand gloves, safety goggles aprons, safety shoes are mandatory.

For exothermic reaction the addition of chemicals is precisely controlled by addition funnel with valve and cooled with refrigerated brine/water through its jackets. Wherever crystallization is involved suitable material of construction, crystallizers are used to carry out the activity. As soon as the reaction is completed, as per the need/suitability of chemicals, mixer is taken to different types of filters like Buckner filter, can filter, centrifuge/hydro extractor having suitable material of construction. Here the powder is separated from the liquid (mother liquor). The powder is dried in fluid bed drier/tray drier and the mother liquor is taken for solvent recovery/distillation section for its further recovery of chemical. Maximum care is taken that no effluent is generated. If this is unavoidable than the waste chemicals are collected in huge effluent treatment plant – gets neutralized and treated for its B.O.D./C.O.D. (Biological and chemical oxygen demand). Coagulated, aerated and harmless chemicals are either used in garden or thrown in the nearby nalah or sent to the effluent disposal yards maintained by Government/Industrial Associations.

High pressure autoclave is used for hydrogenation or under pressure reaction with necessary service lines and desired speed drive to get reaction and end product.

Useful byproduct is made to sell to avoid effluent generation.

**UTILITY SERVICES**

Utility services consist of :

- Steam boiler
- Thermic fluid heater
- Air Compressors
- Vacuum pumps
- Water/barometric ejector
- Refrigeration/air conditioning plant
- Cooling towers
- Diesel generator

**TECHNICAL SPECIFICATIONS :**

**Tablet Manufacturing :**

1. Vibrating sifter with 8, 10, 12, 20, 30, 40, 60 and 100 numbers sieves – 2 nos.

| | | |
|---|---|---|
| Model | : | 30 GMP |
| Size | : | 30” |
| Make | : | Sam Techno Mechanical Works |

2. Multi mill (granulator) with 0.5 mm, 1 mm, 1.5 mm, 2 mm, 2.5 mm, 4 mm, 8 mm and 10 mm screens.

| | | |
|---|---|---|
| Model | : | STD |
| Make | : | Sam Techno Mechanical Works |

3. Fluid bed dryer

| | | |
|---|---|---|
| Capacity | : | 60 kgs |
| Make | : | Grovers Pvt. Ltd. |

4. Planetary mixer

| | | |
|---|---|---|
| Model | : | 350 S |
| Capacity | : | 350 litres |
| Make | : | Sam Techno Mechanical Works |

5. Oscillating granulator

| | | |
|---|---|---|
| Make | : | Shruti Industries |

6. Octagonal blender

| | | |
|---|---|---|
| Capacity | : | 800 litres |
| Material of construction | : | S.S. 304 |
| Make | : | Bectochem Engineering |

7. Single rotary tablet compression machine

| | | |
|---|---|---|
| Type | : | CMD4 |
| No. of station | : | 20 |
| Make | : | Cadmach Machinery Co. Pvt. Ltd. |

8. Dust extraction unit

| | | |
|---|---|---|
| Type | : | 700 B – 1 |
| Make | : | Cadmach Machinery Co. Pvt. Ltd. |

9. "Cad-Clean" Tablet cleaning system

| | | |
|---|---|---|
| Make | : | Karnavati Engineering Ltd., Mehsana |

10. Tablet friability tester

| | | |
|---|---|---|
| Make | : | Cambell |

11. Tablet disintegration tester

| | | |
|---|---|---|
| Make | : | Ketan |

12. Table hardness tester

| | | |
|---|---|---|
| Make | : | Ketan |

13. Tablet inspection belt

| | | |
|---|---|---|
| Length | : | 1 mtr |
| Make | : | V. Raghunathan Engineering Works |

14. Strip packing machine

| | | |
|---|---|---|
| Model | : | 6A – B – 72 A |
| No of tracks | : | 6 |
| Make | : | Hemsons Pvt. Ltd. |

15. Industrial vacuum cleaner

| | | |
|---|---|---|
| Make | : | Eureka Forbes Ltd. |

16. Weighing balance

| | | |
|---|---|---|
| Capacity | : | 150 kgs |
| Make | : | Essae Terakode Pvt. Ltd. |

17. Automatic high speed line bottle washing machine

| | | |
|---|---|---|
| Capacity | : | 120 units per minute |
| Make | : | Harsiddh Industry |

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| | | | |
|---|---|---|---|
| 18. | Tray dryer | | |
| | No. of trays | : | 48 |
| | Make | : | Grovers Pvt. Ltd. |
| 19. | Automatic dry syrup powder filling machine | | |
| | Capacity | : | 100 units per minute |
| | Make | : | Amba Engineers |
| 20. | Automatic ROPP cap sealing machine | | |
| | Capacity | : | 120 units per minute |
| | Make | : | Balaji Pharmaceuticals |
| 21. | Automatic high speed bottle labeling machine | | |
| | Model | : | AVL – 200 |
| | Capacity | : | 100 units per minute |
| | Make | : | Amba Engineers |
| 22. | Automatic dry syrup bottle drying machine – 2 nos. | | |
| | Capacity | : | 10,000 bottles per dryer per 8 hours |
| | Make | : | Excellent Engineers |
| 23. | Bottle inspection table / conveyor | | |
| | Capacity | : | 60 – 100 bottles per minute |
| | Make | : | Lakshmi Engineering Works |
| 24. | Strip defoiler | | |
| | Model | : | GMP |
| 25. | Carton shredding machine | | |
| 26. | P.P. Strapping machine | | |
| | Model | : | EMC – 011 |
| | Make | : | Eagle Manufacturing Co. |

27. Capsule filling machine – 2 nos.

| | | |
|---|---|---|
| Model | : | SA 9 |
| Make | : | Pam Pharmaceutical & Allied Machinery Co. Ltd. |

28. Dehumidifier

| | | |
|---|---|---|
| Model | : | TNV 2000 |
| Low pressure | : | 200 psi |
| High pressure | : | 600 psi |
| Motor HP | : | 1.5 |
| Make | : | Tropical Nortex |

29. Weighing scale

2 nos.

| | | |
|---|---|---|
| Capacity | : | 800 gms |
| Make | : | Penta |

4 nos.

| | | |
|---|---|---|
| Capacity | : | 1 kg |
| Make | : | Omega |

2 nos.

| | | |
|---|---|---|
| Capacity | : | 100 gms |
| Make | : | Omega |

30 Rotary tablet machine :

| | | |
|---|---|---|
| Number of stations | : | 16 |
| Maximum operating pressure | : | 6.5 p.s.i. |
| Maximum tablet diameter | : | 19 mm |
| Maximum depth of fill | : | 20 mm |
| Maximum thickness of tablet | : | 12 mm |
| Output of tablets per minute | : | 260 to 466 |
| Diameter of dies | : | 38.100 mm |
| Length of dies | : | 23.812 mm |
| Diameter of punch body | : | 25.349 mm |
| Length of upper punch | : | 133.6 mm |
| Length of lower punch | : | 133.6 mm |

| | | |
|---|---|---|
| HP | : | 2 |
| Motor | : | 960 rpm, 50 c/s, 440 V, ac |
| Height of the machine | : | 1700 mm |
| Floor space | : | 870 x 1200 mm |
| Net weight | : | 950 kg |
| Gross weight | : | 1125 kg |
| Case dimensions | : | 1300 x 1200 x 1800 mm |

31. Double rotary tablet machine :

| | | |
|---|---|---|
| No. of tablets per minute | : | 760 – 1580 |
| Maximum tablet diameter | : | 15.8 mm |
| Maximum depth of fill | : | 17.4 mm |
| Pressure | : | 10 psi |
| HP of motor | : | 3 |
| Speed of motor | : | 1420 rpm, 3 ph, 5 c/s, ac |
| Height of the machine | : | 1670 mm |
| Lubrication | : | By oil pump and oil cups |
| Floor space | : | 1140 x 1400 mm |
| Net weight | : | 1170 kg |
| Gross weight | : | 1420 kg |

32. Press coat machine :

| | | |
|---|---|---|
| Output (coated tablets per minute) | : | 176/496 |
| Output (uncoated tablets per minute) | : | 352/992 |
| Maximum diameter of coated tablet | : | 20.6 mm |
| Maximum diameter of core | : | 14.2 mm |
| Maximum thickness of core | : | 4.7 mm |
| Maximum fill core side (when used as a single compressing machine) | : | 20.6 mm |
| Maximum fill coating side (when used as a single Compressing machine) | : | 11.1 mm |

| | | |
|---|---|---|
| HP of motor | : | 3 |
| Motor speed | : | 1440 rpm |
| Height | : | 1830 mm |
| Floor space | : | 1670 x 1440 mm |
| Weight : | | |
| Net | : | 1727 kg |
| Gross | : | 2089 kg |

33. Tablet coating machine :

Capacity :

| | | |
|---|---|---|
| 750 mm pan | : | 45 kg |
| 900 mm pan | : | 80 kg |
| 1050 mm pan | : | 100 kg |
| Speed of pan | : | 15 to 31 rpm |
| Air flow at outlet | : | 90 cu.ft./min |
| Heater | : | 1 kw |
| Motor | : | 2 hp, 940 rpm, 440 V, 3 ph, 50 c/s, ac |
| Height | : | 1600 mm |
| Floor space | : | 1420 x 1370 mm |
| Net weight | : | 345 kg |

34. Fluid Bed Drier :

| | | |
|---|---|---|
| Capacity | : | 60 kg |
| Type | : | Steam heated |
| Size of the shell | : | 2290 high x 1220 wide x 1525 mm deep |

The shell is manufactured from 16 G. thick mild steel sheets and is reinforced with mild steel sheets, mild steel angles and sections having plain external finish. All the mild steel components of the drier are painted in mist grey enamel paint and all the stainless steel components are buffed to a bright finish.

**Fluidization retarding chamber :**

The chamber is having a diameter of 940 mm x 350 mm high and is manufactured from 18 G. thick S.S. 304 sheets. It has an observation window and clamped to the discharge finger bag chamber with the help of four sturdy clamps. The chamber is provided with static absorption rings having sharp tapered spokes and provisions is made to earth the same.

**Discharge finger bag chamber :**

The chamber is having a diameter of 940 mm x 600 mm high and is manufactured from 16 G. thick mild steel sheets. It is provided with a ducting which is fitted with an excess pressure flap manufactured from rubberized asbestos sheets. The chamber also houses a set of discharge finger bags manufactured from special cotton cloth. The bags hang on a cage and can be shaked by operating a handle fitted outside the shell.

**Product container :**

The drier has a product container having top internal diameter 940 mm x lower diameter 710 x 400 mm high. It is provided with a S.S. 304 diffuser plate fitted with S.S. 304 sieve of Dutch weave type. The container is manufactured from 18 G. thick S.S. 304 sheets and mounted on a mild steel tubular stand fitted with sturdy shiveling castors.

**Heating :**

Air inside the drier is heated by tubular steam heaters manufactured from copper tubing having bronze rectangular fins. These finned tubes are silver brazed to copper headers on both sides and are provided with 12 mm flanged steam inlet and condensate outlet connections. The heater battery is hydraulically tested to withstand 250 p.s.i. pressure and can be suitable for operation on 40 p.s.i. steam pressure. The maximum temperature attained in the drier is $80^0$C and is indicated by 100 mm dial type thermometers.

**Air circulation :**

Air from drier is discharged to the atmosphere by a curved blade induction fan which is driven by a 10 hp vertical electrical motor. The fan is dynamically balanced to avoid vibrations.

The unit is complete with steam heaters, electric motor, product container, discharge finger bags and a switch board all internally connected suitable for operation on 440 volts, 3 phase, 50 c/s, ac supply.

**INJECTION DEPARTMENT**

1. Horizontal rectangular sterilizer :

| | | |
|---|---|---|
| Type | : | Double door – direct steam operated |
| Size | : | 600 x 900 x 1200 mm |

Double wall glass wool insulated and S.S. 304 covering consisting of :

*Jacket :*
The jacket of mild steel except for a portion of 300 mm width on the sterile side of stainless steel 304 quality.

*Chamber :*
The Chamber made of stainless steel 316 quality and highly polished.

*Door :*
The door on the sterile side made of 12 mm thick S.S. 304 plate and the shooting boots and hub and all other parts of the door made of S.S. 304 quality.

The door on the non-sterile side made of 12 mm thick mild steel plate and the inside of the door clad with S.S. 304 quality. The doors fitted with pressure locking arrangement, so that the doors will not open when the chamber is under pressure.

The baffle is provided for a spreading steam into the chamber.

The sterilizer is operated by steam.

The steam is supported on a sturdy mild steel tubular stand.

The sterilizer is hydraulically tested as follows :

| | | |
|---|---|---|
| Jacket | : | 40 psig |
| Working pressure | : | 16/18 psig |
| Working temperature | : | $121^{o}C$ |

The following accessories are fitted to the unit :

- Pressure gauge and compound gauge.
- Dial thermometer.
- Safety valve.
- Ejector for 125 mm of mercury vacuum.
- Steam trap along with steam strainer and check valve.
- Connector for insertion of multiple probes.
- Provision of sterile air inlet pipe with ball valve and non-return valve for breaking vacuum.
- S.S. loading carriage made of S.S. 304 quality with three shelves.
- S.S. 304 Trolley with locking arrangement on the sterile side.
- M.S. Trolley with locking arrangement on non-sterile side.
- S.S. 304 flush mounting panel on the sterile side with visual indicating lights on both sterile and non-sterile side.
- Pneumatic door interlocking arrangement.
- Thermograph unit.
- Pressure reducing valve.

2. Rotary vial washing machine

| | | |
|---|---|---|
| Model | : | ARVW – 120 |
| Capacity | : | 120 vials per minute for 2 ml to 15 ml vials<br>90 vials per minute for 30 vials |
| Capacity of distilled water tank | : | 350 litres per minute |
| Make | : | Ambica Engineering Works |

3 Dry heat sterilizer with double door (DHS-4)

| | | |
|---|---|---|
| Size | : | 80” x 72” x 52” |
| Capacity | : | 48 trays |
| Temperature | : | 0 – 300$^0$ C |
| Make | : | Lester & Dynamics (India) |

4. Super ultra clean semi-automatic ampoule washing machine suitable for 1, 2, 3, 5 ml ampoules

| | | |
|---|---|---|
| Model | : | SUC – 2000 SAR |
| Make | : | Supersonics Associated Industries |

5. Jet Wash for Jet ultrasonic cleaning machine with S.S. transfer pump and tank

| | | |
|---|---|---|
| Capacity | : | 100 litres |
| Make | : | Supersonic Industries |

6. Ampoule inspection machine for 3 ml ampoules with S.S. loading hopper

| | | |
|---|---|---|
| Type | : | AVI |
| Make | : | Saral Engineering Co. |

7. Ampoule inspection machine for 2 ml ampoules with S.S. loading hopper

| | | |
|---|---|---|
| Type | : | AVI |
| Capacity | : | 6 objects at a time |
| Make | : | Saral engineering Co. |

8. Vial inspection machine for 2 ml vials with S.S. loading table

| | | |
|---|---|---|
| Type | : | AVI |
| Make | : | Saral Engineering Co. |

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9. High speed automatic sterile powder filling and rubber stoppering machine

| | | |
|---|---|---|
| Model | : | AHPF – 250 |
| Container size | : | 19 to 38 mm |
| Container height | : | 1” to 3” |
| Stopper size | : | 20 mm |
| Electricals | : | 230 / 440 V, 50 Hz, 3 phase, 35 KVA |
| Air supply | : | 30 psi at 1 cfm |
| Vacuum | : | 18” Hg at 1 cfm free air |
| Make | : | Ambica Engineering Works |

10. Automatic high speed 8 head aluminium cap sealing machine

| | | |
|---|---|---|
| Model | : | AHCS – 350 |
| Capacity | : | 100 – 300 vials per minute |
| Vial size | : | Diameter 14.5 to 80 mm |
| | | Height 30 to 180 mm |
| Cap sizes | : | 13, 20, 30 mm diameter |
| Make | : | Ambica Engineering Works |

11. Automatic single head aluminium cap sealing machine

| | | |
|---|---|---|
| Model | : | SH80 |
| Capacity | : | 80 vials per minute |
| Make | : | Fabrica Steel Corporation |

12. Semi automatic vial sealing machine for autofil machine

| | | |
|---|---|---|
| Make | : | Precitech Enterprises |

13. Semi automatic double head ampoule filling and sealing machine for 1, 2, 3, 5 and 10 ml ampoules – 2 nos.

| | | |
|---|---|---|
| Model | : | OP/AFS/SS/2 |
| Capacity | : | 2400 – 3600 ampoules per hour |
| Filling range | : | 0.5 to 10 ml |
| Make | : | S.P. Automatics |

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14. Fully automatic triple head ampoule filling and sealing machine

| | | |
|---|---|---|
| Type | : | CAF/300 |
| Capacity | : | 40 – 75 ampoules per minute |
| Filling range | : | 1 ml to 25 ml |
| Make | : | Cadmach Machinery Co. (P) Ltd. |

15. Laminar air flow unit – 2 nos.

| | | |
|---|---|---|
| Model | : | 1006 |
| Options | : | 021, 031, 033, 037, 041 |
| Blower | : | 7 x 4 |
| Motor | : | ¼ - 2 hp, 1440 rpm, 230 V, 4.4 amp |
| Prefilter size | : | 16” x 24” x 2” – 2 nos. |
| Final filter size | : | 36” x 24” x 6” – 2 nos. |
| Make | : | Klenzaids Engineers Pvt. Ltd. |

16. Air curtain with 3 phase induction motor of 5’ 3” size.

| | | |
|---|---|---|
| Make | : | R.P. Products |

17. S.S. Manual membrane filter holder with Teflon screen – 3 nos.

| | | |
|---|---|---|
| Size | : | 142 mm |
| Make | : | K.N.K. Engineers |

18. Semi automatic vial sealing machine
MUS-1 for 20 mm vials

| | | |
|---|---|---|
| Make | : | Master Mechanical Works |

19. Electrically heated vertical Autoclave with perforated basket

| | | |
|---|---|---|
| Size | : | 18” x 30” |
| Make | : | Monita Industrial Corporation |

20. Automatic single head sealing machine

| | | |
|---|---|---|
| Model | : | SRS – 80 |
| Make | : | Fabrica Steel Corporation |

**SYRUP DEPARTMENT**

1. Complete liquid line for 2500 to 3000 bottles per hour comprising the following machinery:

- **Rotary bottle washing machine :**

  Rotary bottle washing machine is designed to clean various types of bottles or similar containers by subjecting each to a series of distinct processing operations.

  The washing is by means of powerful water jets in four different sections of varied durations. The first section provides fresh water jet that removes floating dirt particles. The containers are then subjected to hot detergent wash in the second section. The next operation is with fresh water and is of little longer duration, so that the bottles are completely washed from inside. The fourth section is meant for D.I. water-rinsing for a short duration. There is also a continuous water spray from the top to wash the bottles from outside.

  The rotary platform which carries the bottles completes one revolution in one minute. There are 16 manifolds each having four bottle holders each with a jet nozzle in centre. The rated capacity is approximately 3000/3500 bottles per hour.

  The machine is provided with two S.S. 304 tanks, one for hot detergent and the other for fresh water, both fitted with an independent monoblock transfer pump with 1/2 hp electric motor to work on ac, 440 volts.

  The hot detergent tank is fitted with thermostatically controlled heaters. After the wash the detergent is collected back in the tank and re-circulated, through an appropriate filter mesh.

The second tank has a fresh water inlet with float valve. The D.I. connection is provided on the machine. The machine is fitted with pump.

The driving mechanism is arranged at the bottom in a closed cabinet. The friction drive transfers the motion to an aluminium larger pulley mounted on the main shaft. The machine works on 1/2 hp, ac, 440 volts electric motor.

The machine is suitable for different size of bottles with neck diameter up to 50 mm and body diameter from 32 mm to 75 mm maximum.

- **Automatic liquid filling machine :**

Volumetric as per standard specifications with four S.S. 304 filling units of 260 cc capacity fitted with 1.5 hp electric motor for the main drive and 1/2 hp electric motor (dc) for the conveyor drive. The machine works on ac, 440 volts, 3 phase supply. The capacity of the machine is about 40 to 80 fills per minute. All the contact parts are made out of stainless steel AISI – 304 quality with PDP Cheveron ring piston complete. The movement of the bottles are arranged from left to right on the conveyor.

- **Stainless steel filling tank :**

S.S. 304 filling tank is for the automatic liquid filling machine. The tank is provided with 4 outlet nozzles fitted with feeding pipe. A float arrangement is also provided for maintaining constant level complete with cover. The capacity of the vessel is approximately 150 litres. The size of the tank is 600 x 600 x 450 mm.

- **Fully automatic R.O.P.P. round bottle capping and sealing machine :**

Fully automatic R.O.P.P. round bottle capping and sealing machine complete with rotary hopper with a chute for any standard size between 22 and 28 mm diameter.

Head-set and pressure blocks are specially designed and made of hardened steel spinning rollers and fitted with ball bearings.

A suitable star plate ensures synchronized movement of bottles to the sealing head and carries sealed bottles to the outlet conveyor. The machine is provided with a conveyor belt with guide rails, which can be adjusted for different size of bottles. The movements of the bottles are arranged from left to right on the conveyor.

An unscrambler unit with independent drive is provided on the incoming side.

The electrical equipment consists of 1.5 hp main drive and 1/2 hp motor drive for the hopper as well as a 33 hp drive for the head-movement, complete with suitable starters and also pilot lights mounted on a panel board.

The machine is complete with hopper chute to take 22 mm to 28 mm diameter caps and pressure block for any size of cap diameter between 22 and 46 mm and star wheel for one size of bottle from 25 to 80 mm diameter.

- **Inspection table :**

Inspection table consists of a slat conveyor drive which bifurcates at the centre for double line inspection and again combined into single outlet. Complete with an independent drive with variable speed control and light arrangement.

- **Gumming and labelling machine :**

Gumming and labelling machine is a fully automatic round the bottle labelling machine with mechanical conveyor system designed to label cylindrical containers of various sizes. The speed of the machine is controlled by turning the hand wheel fitted by the side of the machine.

The rated speed of the machine is 60/90 per minute depending on the size and type of the bottles.

The machine consists mainly of gumming turret label magazine and vacuum turret (Delivery Turret) synchronised with a rotating drum mechanism.

The movement of the bottle is timed into the machine by a feed worm screw fitted near the entry of the bottles to the labelling mechanism. The movement of the bottles are arranged from left to right on the conveyor.

A repressing belt arrangement is provided on the further end of the conveyor which presses the label to stick properly.

A no bottle no label arrangement is also provided. The machine is driven by one hp electric motor, which in addition to the principle drive to the label gum turret and label transfer turret.

An unscrambler unit with independent drive is also provided on the inlet side. The machine is suitable for the following minimum and maximum size of bottles and labels.

| | | |
|---|---|---|
| Label size | : | Minimum 50 x 25 mm |
| | | Maximum 120 x 90 mm |
| Bottle size | : | Minimum 30 mm dia. |
| | | Maximum 80 mm dia. |

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**PACKING DEPARTMENT**

1. Vertical automatic vial labeling machine with vacuum pump, motor with gear unit, SS 316 conveyor belt.

| | | |
|---|---|---|
| Model | : | AHL 150 |
| Capacity | : | 60 to 150 vials per minute |
| Vacuum | : | 15 mm |
| Size of container | : | 20 to 70 mm |

Size of label

| | | | |
|---|---|---|---|
| Length | : | Minimum | 20 mm |
| | | Maximum | 130 mm |
| Height | : | Minimum | 16 mm |
| | | Maximum | 90 mm |
| Make | : | Ambica | |

2. Horizontal ampoule / vial labeling machine – 3 nos.

| | | |
|---|---|---|
| Model | : | AHL – 100 |
| Capacity | : | For 1 ml to 25 ml ampoules |
| Make | : | Amba Engineers |

3. Wonder shrink pack machine with cooling fan

| | | |
|---|---|---|
| Model | : | SW TC 148 VSD |
| Brand | : | IDEM |
| Height of passage | : | 200 mm |
| Length of heating zone | : | 1500 mm |
| Heater capacity | : | 9.8 kw |
| Total power | : | 11 kw |
| Exhaust fan motor | : | 1 hp |
| Motor make | : | Remi |
| Make | : | Wonderpack Industries Pvt. Ltd. |

4. Automatic cartooning machine

| | | |
|---|---|---|
| Model | : | CP 120 |
| Cartoon size | | |
| Minimum | : | 25 mm W x 20 mm H x 75 mm L |
| Maximum | : | 100 mm W x 70 mm H x 220 mm L |
| Output | : | Up to 120 cartoon per minute with 25 x 20 mm size |
| Electricals | : | 4 kw, 10 amps, 230 V, AD, DC 24 V |

<u>Attachment</u>

a. Leaflet arrangement
b. Turn table feeding
c. Ampoule feeding arrangement
d. Electro pneumatic skip feeding arrangement

Make : Pam Pac Machines Ltd.

5. Inspection conveyor belt of 7 feet length and 32” width of S.S. table with S.S. channel and independent drive.

Width of PVC belt : 12”

Packing conveyor belt of 16 feet length and 32” width of S.S. table with independent drive.

Width of PVC belt : 9”

Conveyor belt with wooden table of 18 feet length and width of 32”

Conveyor belt – 5 nos.

Width : 9”

Conveyor belt – 3 nos.

Width : 72”

Visual inspection belt

| | | |
|---|---|---|
| Size | : | 6’ 6” |
| Make | : | Ambica Enterprises |

6. High speed cartoon coding machine – 2 nos.

| | | |
|---|---|---|
| Type | : | AU-2 |
| Capacity | : | 120 cartoons per minute |
| Make | : | Nimach Engineering Co. |

7. Hand operated cartoon / label coding machine – 2 nos.

| | | |
|---|---|---|
| Make | : | Magumps |

8. High speed label coding machine – 2 nos.

| | | |
|---|---|---|
| Type | : | AU – 1 |
| Capacity | : | 120 labels per minute |
| Make | : | Nimach Engineering company |

9. Bag sealing machine – 2 nos.

1 no.

| | | |
|---|---|---|
| Model | : | PISH 200 |
| Capacity | : | 200 mm |

1 no.

| | | |
|---|---|---|
| Model | : | PISH 300 |
| Capacity | : | 300 mm |
| Make | : | Pack-O-Matic |

10. Vertical high speed automatic vial labeling machine with turn table and gear unit

| | | |
|---|---|---|
| Model | : | AHL – 300 |
| Capacity | : | 300 vials per minute |

Vacuum pump

| | | |
|---|---|---|
| Model | : | VPF 10 |

| | | |
|---|---|---|
| Capacity | : | 5.88 Cfm, 1420 rpm, 0.5 hp |
| Make | : | Ambica Industrial Corporation |

11. Pilot shredding machine for cartoon / label

| | | |
|---|---|---|
| Model | : | IM |
| Brand | : | Pilot shredder 4000 |

12. Semi auto P.P. box strapping machine – 2 nos.

| | | |
|---|---|---|
| Model | : | EMC 011 |
| Strapping speed | : | 3 seconds per strap |
| Maximum package size | : | 60 mm to any size |
| Tightening strength | : | 25 kgs (maximum) |
| Width of strap | : | 6 mm to 15 mm |
| Electrical load | : | 1/3 hp, 240 V, 50 Hz |
| Make | : | Eagle Manufacturing Company |

13. Automatic sticker labeling machine (microprocessor based)

| | | |
|---|---|---|
| Model | : | Fixoname – HSC |
| Capacity | : | 80 to 150 container per minute |
| Compressed air required | : | 4 kg/sq. cm. |
| Attachment | : | Pneumatic IM Printer (EPP-RC) |
| Make | : | maharshi Udyog |

14. Scorpio semi auto capsule counter

| | | |
|---|---|---|
| Disc size | : | Size 0 – 100's with machine<br>Size 2 – 100's with machine<br>Size 0 – 15's extra<br>Size 2 – 15's extra |
| Make | : | Magnose Engineering Company |

15. Semi automatic R.O.P.P. bottle sealing machine

| | | |
|---|---|---|
| Size | : | 38 mm |
| Capacity | : | 30 to 50 bottles per minute |
| Make | : | Master Mechanical Works |

16. Strip packing machine – 2 nos.

| | | |
|---|---|---|
| Model | : | G4V |
| Capacity | : | 30 to 40 strip per minute |
| Number of track | : | 4 |
| Motor | : | ½ hp, 1440 rpm |
| Motor make | : | Remi |

<u>Gearbox</u>

| | | |
|---|---|---|
| Gearbox | : | Reduction Gearbox |
| Size | : | 17 |
| Ratio | : | 15 |
| Make | : | C.P.E.C. |
| Diameter of motor pulley | : | 5” |
| Diameter of gearbox pulley | : | 5” |

‘V’ belt B-28, vibrator no. 659 with 3 nos. rubber bushes, S.S. hopper with standard assembly.

Foil holder assembly, S.S. chute channel, release pin, S.S. bowl, dust tray, M.S. grille guard, vibrator control box, sealing rollers with back gear, conveyor arrangement with PVC belt.

| | | |
|---|---|---|
| Make | : | Gansons |

17. Wall thermometer – 4 nos.

| | | |
|---|---|---|
| Temperature range | : | 0 – $110^0$ C |

18. Blister packing machine for capsule packing – 2 nos. with

a. PVC heat roller
Capacity : 60 to 240 blister per minute

b. Blister formation roller by vacuum and cooling

c. Vibrating hopper of S.S. 316 with photosensing unit

d. Coding unit

e. Digital display control panel

f. Rotary vacuum pump
Capacity : 100 LPM

g. Changeover part for embossing

h. Changeover part for size '0' and size '2' capsule

Type : Pharma-pack 240 CH
Make : Precision Gears Pvt. Ltd.

19. Blister packing machine for capsule packing with screen heating and chilled water supply arrangement
Type : Pharma-pack 240
Capacity : 60 to 240 blister per minute
Make : Precision Gears Pvt. Ltd.

20. Capsule recovery machine from rejected strip
Type : Blipstrip
Make : PLH Enterprises
Supplied by : Expo Colourpacks Pvt. Ltd.

21. Shrink wrapping machine with

a. S.S. 316 frame

b. S.S. 316 panel and entire closing

c. S.S. 316 rod for conveyor

d. Nickel chrome plated sockets

| | | |
|---|---|---|
| Model | : | TC/104 |
| Length of inlet | : | 400 mm |
| Width of tunnel passage | : | 400 mm |
| Height of the passage | : | 250 mm |
| Standard length of heating zone | : | 750 mm |
| Length of outlet cooling zone | : | 300 mm |
| Maximum pack size | : | 750 mm L x 250 mm B x 100 mm H |
| Temperature | : | 30 – $250^0$ C |
| Material | : | PVC / LDPE (shrinkable) |
| Power load | : | 6.7 kw |
| Make | : | IDEM, Wonder Pack Industries |

22. Fully automatic tube packing machine

| | | |
|---|---|---|
| Type | : | PAC |
| Make | : | Wimco Ltd. |

23. Hand operated aluminium trayer sealing machine – 6 nos.

24. Labeller – 10 nos.

| | | |
|---|---|---|
| Make | : | Monarch & Integrated Innovators |

25. Portable belt conveyor

| | | |
|---|---|---|
| Make | : | J.T. Jagtiani |

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## QUALITY CONTROL DEPARTMENT

1. Ultra violet visible recording spectrophotometer with Graphic printer and plotter

| | | |
|---|---|---|
| Model | : | UV 240 |
| Printer model | : | PR-1 |
| Make | : | Shimadzu |
| Supplied by | : | Sanjay Scientific Corporation |

2. Single pan balance

| | | |
|---|---|---|
| Model | : | HS 1AR |
| Capacity | : | 160 gm |
| Accuracy | : | 0.1 gm |
| Make | : | Mettler |

3. Gas chromatograph

| | | |
|---|---|---|
| Model | : | Omega-Vir |
| Make | : | Netel Chromatographs |

4. Chromatograph's Integrator with printer

| | | |
|---|---|---|
| Integrator model | : | CI-10 |
| Printer model | : | LDC/Milton Ray |
| Make | : | Anamed Instruments Pvt. Ltd. |

5. Penitometer

| | | |
|---|---|---|
| Range | : | 0 – 400 mm |

6. Gas station with three gas purification panels

   Nitrogen panel consists of oxygen trap, moisture and hydrocarbon trap

   Hydrogen and air panel consists of only moisture trap.

| | | |
|---|---|---|
| Make | : | Chromatopak Analytical Instrumenta-tion India Pvt. Ltd. |

7. Hot air drying oven

| | | |
|---|---|---|
| Size | : | 18” x 18” x 18” |
| Power | : | 1.5 kw |
| Make | : | Expo |
| Supplied by | : | Mehta Pharma Chem |

8. Muffle furnace with digital temperature controller

| | | |
|---|---|---|
| Model | : | TC-60 |
| Size | : | 9” x 4” x 4” |
| Electricals | : | 1.6 kw, 230 V, 1 phase |
| Make | : | Shivani Scientific Industries |

9. Colony counter

| | | |
|---|---|---|
| Make | : | Cintex Industrial Corporation |

10. Spectro photometer (Turbidmeter)

| | | |
|---|---|---|
| Model | : | Spectronic – 20 |
| Electricals | : | 230 V, 50 Hz, 0.5 amps |
| Make | : | Bauch & Comb |
| Supplied by | : | Ketan & Co. |

11. Incubator

| | | |
|---|---|---|
| Capacity | : | $32^0$C to $35^0$C |
| Electricals | : | 1 kw, 230 V, 1 phase |
| Make | : | Shivani Scientific Industries |
| Supplied by | : | Ketan & Co. |

12. B.O.D. Incubator with digital temperature controller

| | | |
|---|---|---|
| Range | : | $22^0$C to $25^0$C |
| Make | : | I.E.C. |
| Supplied by | : | Ketan & Co. |

13. Laboratory autoclave

| | | |
|---|---|---|
| Size | : | 12” dia. x 12” |
| Maximum pressure | : | 7 kg per sq. cm. |
| Watt | : | 2 |
| Make | : | Excellent Engineers |
| Supplied by | : | Shivani Scientific Industries |

14. High performance liquid chromatograph with U.P.S.

a. Intelligent UV/VIS detector
   Model : UV – 975

b. Intelligent HPLC pump – 2 nos.
   Model : PU – 980

c. Two line degasser
   Model : DG – 980 – 51

d. Integrator
   Model : 80 T 17

Make : Jasco

15. Digital polarimeter

| | | |
|---|---|---|
| Model | : | DIP 370 |
| Make | : | Jasco |

16. Hot air drying oven

| | | |
|---|---|---|
| Electricals | : | 2 kw, 230 V, 1 phase |
| Make | : | Shivani Scientific Industries |
| Supplied by | : | Ketan & Co. |

**OINTMENT DEPARTMENT**

1. Wax melting pan with lid

| | | |
|---|---|---|
| Capacity | : | 300 litres |

Jacketed vessel for essential oil heating arrangement.

| | | | |
|---|---|---|---|
| Material of construction | : | Inside | S.S. 316 |
| | | Outer side | M.S. |
| Capacity | : | 300 litres | |
| Size | : | 700 mm dia. x 800 mm | |
| Make | : | Hitendra Metal & Allied Industries. | |

2. Ultra violet portable water filtration unit with 2 micron and 5 micron filters and Ultra violet lights.

| | | |
|---|---|---|
| Head | : | 30 mm |
| Disc | : | 40 LPM |
| Motor | : | 0.5 hp, 250 V, single phase |
| Make | : | Polar |
| Supplied by | : | Saam D. Mehta |

3. Fully automatic ointment mixer with agitator, homogenizer, pump, control panel, devacuumisation arrangement and S.S. 316 ladders stand and online S.S. 316 filter.

| | | |
|---|---|---|
| Capacity | : | 1,000 litres |
| Material of construction | : | S.S. 316 |
| Type of agitator | : | Anchor type |
| Type of homogenizer | : | Steam jacketed |
| Motor | : | 10 hp, 3 phase |
| Motor make | : | Bharat Bijlee |
| Make | : | Tapasya Engineering Works Pvt. Ltd. |

4. Colloidal mill with S.S. 304 water jacket, S.S. 304 stand and 4 nos. of castor wheel

| | | |
|---|---|---|
| Type | : | R – HMG – J |
| Electrical load | : | 3.7 kw, 6.5 Amp, 2850 rpm, 415 V, 3 phase |
| Make | : | Kamavati Engineering Ltd. |

5. Automatic tube filling and closing machine with S.S. jacket, hopper of 50 kg capacity with electrical heating arrangement and one extra S.S. jacketed hopper of 50 kg capacity without electrical heating arrangement.

| | | |
|---|---|---|
| Model | : | Linbus / 150 |
| Type | : | Double head |
| Capacity | : | 150 tube per minute |
| No. of station | : | 10 |
| Make | : | Subnil Packing Machines Pvt. Ltd. |

6. Tube filling, closing and crimping machine – 2 nos. with S.S. hopper of 50 kg. capacity and 24 nos. cap.

| | | |
|---|---|---|
| Type | : | G A B |
| Capacity | : | 60 tubes per minutre |
| No. of station | : | 6<br>3 stations for pressing<br>2 stations for folding<br>1 station for coding |
| Make | : | Wimco |

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## CAPSULES DEPARTMENT

1. Tray dryer with thermostatic control

| | | |
|---|---|---|
| Capacity | : | 24 trays |
| Make | : | Magumps |

2. Roll compactor

| | | |
|---|---|---|
| Type | : | CMRC – 200 / 100 |
| Capacity | : | 100 to 300 kg/hour |
| Roll size | : | 200 mm dia. x 100 mm width |
| Roll surface | : | Corrugated |
| Roll RPM | : | 6 to 22 rpm (by step pulley drive) |
| Feed screw speed | : | 16 to 50 rpm (by PIV drive) |
| Roll motor | : | 10 hp, 960 rpm, 415 V, 3 phase, 50 Hz |
| Make | : | Cadmach Machinery Co. Pvt. Ltd. |

3. S.S. 316 Drum mixer

M.S. Frame with 1 hp motor and gear box – 2 nos.

S.S. 316 Drums of 200 litres capacity water – 3 nos.

| | | |
|---|---|---|
| Make | : | Moinita Industrial Corporation |
| Make | : | Magumps |

4. Multi mill unit with round S.S. screens

| | | |
|---|---|---|
| Screens | : | 0.5, 1, 1.5, 2.5, 6 mm |
| Capacity | : | 200 kg per hour |
| Motor | : | 3 hp |
| Make | : | Magumps |

5. Semi automatic capsule filling machine

| | | |
|---|---|---|
| Model | : | S A8 - 105 |
| Capsule size | : | 0, 2 |
| Output | : | 21,600 to 28,000 capsules per hour |
| Hard gelatine capsule size range | : | 00 to 5 |

| | | |
|---|---|---|
| Compressed air | : | 140 litres per minute at 7 kg per sq. cm. |
| Vacuum | : | 1,000 litres per minute displacement and 22” Hg vacuum. |
| Make | : | Pam Pharma & Allied Machinery Co. Pvt. Ltd. |

6. Automatic capsule filling machine

| | | |
|---|---|---|
| Model | : | AF – 040 |
| Capacity | : | 40,000 capsules per hour |
| Capsule size | : | 0 and 2 |

<u>Accessories</u>

a. Capsule sorter elevator

| | | |
|---|---|---|
| Model | : | SE – 100 |
| Size | : | ‘O’ |

b. Auto sorter for loose caps

| | | |
|---|---|---|
| Size | : | ‘O’ |

c. Automatic De-dusting and polishing machine

| | | |
|---|---|---|
| Model | : | DP – 100 |

d. Air displacement unit

e. Filled capsule elevator

| | | |
|---|---|---|
| Model | : | FCE – 100 |

f. Empty capsule sorting unit

| | | |
|---|---|---|
| Model | : | ECS – 100 |

g. Interchangeable section for AF 40

h. Interchangeable section for SE 100

| | | |
|---|---|---|
| Size | : | ‘2’ |

i. Interchangeable section for auto sorter
Size : '2'

j. Auto sampling and auto control unit for AF 40

Make : Pam Pharma & Allied Machinery Co. Ltd.

7. Automatic capsule de-dusting and polishing machine

<u>Accessories</u>

a. Filled capsule sorter
Model : FS – 100

b. Polishing and de-dusting unit
Model : DP – 100

c. Air displacement unit

Make : Pam Pharma & Allied Machinery Co. Pvt. Ltd.

8. Digital weighing scale

| | | |
|---|---|---|
| Model | : | DS 410 |
| Capacity | : | 150 kgs |
| Minimum capacity | : | 400 gms. |
| Lease count | : | 0 – 60 kg x 20 gm<br>60 – 150 kg x 50 gm |
| Temperature range | : | 0 – 45$^0$C |
| Electrical load | : | 5 W, 220 V, 50 Hz |
| Make | : | Essae – Teroaka Pvt. Ltd. |

9. Automatic capsule line

Consists of:

a. Automatic sorting machine

S.S. 316 hopper

Change part for capsule size : ‘0’ and ‘2’

b. Filled capsule elevator

c. De-dusting and polishing unit with thyristor controlled D.C. drive

Model : DP – 100

d. Empty capsule sorter

e. Air displacement unit (ADU) with DOL starter

| | | |
|---|---|---|
| Make | : | Pam Pharma & Allied Machinery Co. Pvt. Ltd. |

10. Air dry unit

| | | |
|---|---|---|
| Model | : | D50 – 0025 |
| Inlet flow | : | 25 Scfm |
| Inlet air pressure | : | 100 psig |
| Inlet air temperature | : | $100^0$ F |
| Air flow at O/P port | : | 18 Scfm |
| Cabinet | : | M.S. duty powder coated |
| Tower and body | : | Aluminium |
| Desicont | : | Activated alumina |
| Elostomers | : | Nitrite and polyurathyne |
| Make | : | Shavo – Norgren (India) Pvt. Ltd. |

## FINE CHEMICALS

1. Reactor complete with internal coil and accessories.

| | | |
|---|---|---|
| Capacity | : | 7000 litres |
| Type | : | Vertical cylindrical with welded top and bottom dished ends. |
| Material of construction | : | All contact parts in process fluid , S.S. 316 L |
| Internal coil | : | S.S. 316 L seamless |
| Limpet coil | : | S.S. 304 |
| Nozzle neck up to 100 mm dia. | : | S.S. 316 L/S.S. 304 seamless pipe. |
| Nozzle neck above 100 mm dia. | : | Fabricated from plates provided with 100% radiography. |
| Nozzle flanges for nozzle up to 100 NB | : | S.S. 316 L/S.S. 304 |
| Nozzle flanges for nozzle above 150 NB and above | : | C.S. plates with S.S. 304 liner |
| Size | : | 1800 mm ID x 2500 mm Tan to Tan height. |

Thickness :

| | | |
|---|---|---|
| Shell | : | 8 mm |
| Dished ends | : | 10 mm nominal<br>8 mm minimum |
| Baffles | : | 2420 mm L x 85 mm W x 8 mm thick with level marking on 1 no. |
| No. of baffles | : | 2 |
| Limpet coil | : | 80 mm dia. x 3 mm thick ellipsoidal. |
| Internal coil | : | 40 NB x Schedule 10S ASTM A312 |
| Radiography | : | Dished ends – full |
| Other major butt wells joints | : | Spot (10%) |
| Polish | : | Internals given mirror polish while top dished ends have satin finish from outside. |

| | | |
|---|---|---|
| Agitator | : | Driven by means of 15 hp, 1440/720 rpm dual speed flame proof (FLP) motor through a suitable speed reduction gear box to give final output rpm of approximately 100 and 50 to the shaft. Shaft is of 80 mm dia. and made out of S.S. 316L bar. The shaft is provided with 2 nos. turbine type impellers fabricated out of S.S. 316 L plates. Agitator complete with necessary couplings, bearing, housing, water-cooled stuffing box and M.S. support stool. |

2. Centrifuge machine

| | | |
|---|---|---|
| Type | : | Three pendulum suspension |

**Specifications :**

6 mm thick S.S. 304 basket 1500 mm dia. x 500 mm height riveted to C.I. cone dynamically balanced.

C.I. cone lined by 2 mm S.S. 304 sheet on top and bottom face.

5 mm thick S.S. 304 outer cover.

3.2 mm thick S.S. 304 fully opening cover.

C.I. bottom main base liner with 2 mm S.S. 316 sheet at contact parts.

20 hp flame proof motor.

D.O.L. starter.

Flame proof limit switches – 2 nos.

Lifting bag arrangement.

Canvas bag.

Oil seals.
Fluid coupling unit.

3. Glasslined reactor

| | | |
|---|---|---|
| Design and manufacturing code | : | ASME Section VIII Division – I |
| Glass lining code | : | JIS – R – 4201 |
| Design pressure | : | Vessel - F.V./7 $kg/cm^2$<br>Jacket - F.V./ 7 $kg/cm^2$ |
| Design temperature | : | Vessel – 200°C / 2600°C<br>Jacket – 200°C / 2600°C |
| Maximum operating pressure | : | Vessel - F.V./6 $kg/cm^2$<br>Jacket - F.V./ 6 $kg/cm^2$ |
| Maximum operating temperature | : | Vessel – 100°C / 2600°C<br>Jacket – 100°C / 2600°C |
| Corrosion allowance (base metal) | : | Vessel – 1.5 mm<br>Jacket - 1.5 mm |
| Final hydrotest pressure | : | Vessel – 6 $kg/cm^2$<br>Jacket - 6 $kg/cm^2$ |
| Radiography | : | Vessel - Full<br>Jacket - L & C Spot except sealer joint. |
| Weld joint efficiency | : | Vessel – 100%<br>Jacket – 85% |

| | | |
|---|---|---|
| Stress relief | : | Vessel - By process<br>Jacket - No |
| Glass | : | OCTA 88-200 |
| Glass lining thickness | : | 0.8 mm to 2.0 mm |
| Spark test | : | At 10000 volts |

<u>Material and specifications :</u>

| | | |
|---|---|---|
| Plate material | : | SA 516 or equivalent |
| Forgings | : | SA 105 or equivalent |
| Pipes | : | SA 106 Gr. B or equivalent |
| Gaskets | : | PTFE with CAF inserts (for glasslined nozzles) |
| Supports, drive stands & others | : | IS 2062 |
| Painting | : | Zinc Chromate primer – 2 coats. |

<u>Agitator :</u>

| | | |
|---|---|---|
| Type | : | Three blade propeller |
| RPM | : | Regular - 96<br>Maximum - 120 |

**Or**

| | | |
|---|---|---|
| Type | : | Anchor |
| RPM | : | Regular - 48<br>Maximum - 48 |
| Shaft sealing | : | Gland packing \ stuffing box<br>or<br>Single dry running seal<br>or<br>Double mechanical seal |

| | | |
|---|---|---|
| Thermometer pocket | : | a. Finger type baffle-cum-thermowell for propeller type reactors.<br>b. Straight thermowell for anchor type reactors. |
| Support | : | Agitators are self supported on intermediate bearing assembly consisting double taper roller (back to back) bearing. |
| Drive system | : | Agitator is coupled with reduction gear box with flexible coupling.<br>Reduction gear box is coupled to motor by flexible coupling or pulley. |
| Reduction gear box | : | Elecon / Radicon / CPEC or equivalent. |
| Flame proof motors | : | Crompton / Siemens or equivalent. |
| Other features | : | - Spring loaded opening device for manhole.<br>- Handhold assembly where manhole is not possible.<br>- M10 / M6 nuts are welded on jacket for holding insulation with suitable means.<br>- Glasslined blind flanges are fitted on all open glass lined nozzles.<br>- Agitating nozzles are fitted on jacket inlet nozzles used for entry of steam / water.<br>- Temperature sensing facility through flush bottom valve.<br>- Different type of jackets (limpet coil / spiral / double jacket).<br>- Conical bottom vessels. |

- Hastelloy ot Tantalum Tip for thermometer pocket for better temperature sensing.

4. S.S. 316 Centrifugal transfer pump

| | | |
|---|---|---|
| Capacity | : | 6 $m^3$/hr |
| Type | : | CHP – MTH – 25 |
| Size | : | 2 x 1 – 10.5 |
| Motor | : | 5 hp, 1700 rpm |

5. Vertical holding tank (cylindrical type) with accessories,

| | | |
|---|---|---|
| Capacity | : | 6000 litres |
| Material of construction | : | S.S. 316 |
| Size | : | 1700 dia. x 2400 mm ht. |
| Thickness of shell | : | 5 mm |
| Thickness of dished ends | : | 6 mm |
| Diameter of manhole | : | 400 mm |
| Diameter of sight glass | : | 100 mm |
| Diameter of light glass | : | 100 mm |
| Diameter of vent | : | 50 mm |
| Diameter of outlet | : | 50 mm |
| Spare nozzle | : | 32 mm dia., 25 mm dia. x 50 mm dia. with blind flanges. |
| Diameter of sampling | : | 15 mm |
| Supports | : | Channel supports |
| Finishing | : | All S.S. internal parts mirror polished and outer surface are satin polished. |

All M.S. surface painted with metal primer and coated with enamel paint.

6. Condenser :

| | | |
|---|---|---|
| Capacity | : | 15 $m^2$ |
| Type | : | Shell and tube |

Material of construction :

| | | |
|---|---|---|
| Shell side | : | S.S. 316 L |
| Bonnet side | : | S.S. 304 |
| Size | : | Shell 300 dia. x 3000 mm long x 5 mm thick. |
| Tube sheets | : | 32 mm thick S.S. 316 L – 2 nos. |
| Baffles | : | 5 mm thick – 8 nos. |
| Tie rods | : | 12 mm – 4 nos. |
| Bonnet side flange | : | 28 mm thick S.S. 304 - 2 nos. |
| Tubes | : | 80 nos. x 20 mm dia. x 2 mm thick x 3 m long S.S. 316 L seamless. |
| Radiography | : | Spot (10%) |
| Polish | : | All external surface of bonnet side given satin finish. |

7. Nautadryer complete with all accessories :

| | | |
|---|---|---|
| Working Capacity | : | 1000 litres |
| Maximum load | : | 600 kg of wet pharmaceutical powder having average bulk density of around 0.6 gm/cc. |
| Container | : | 6 mm thick S.S. 316 |
| Swing arm | : | S.S. 316 casted |
| Mixing screw | : | S.S. hollow pipe with S.S. lining. |
| Cover | : | 6 mm thick S.S. 316 welded dished top. |
| Nozzles and fittings | : | 500 mm dia. S.S. manhole with cover. Cover provided with 125 mm dia. sight glass.<br>323 mm dia. S.S. flanged nozzle for vapour outlet/mounting of dist filter.<br>125 mm dia, light glass.<br>150 mm dia. full port S.S. ball valve pneumatically operated for discharge. |

| | |
|---|---|
| | 25 mm NB S.S. flanged nozzle connection for mercury type manometer / vacuum gauge.<br>50 mm dia. S.S. nozzle.<br>S.S. flanged nozzle with matching blank near apex of cone for mounting lump breaker.<br>S.S. flanged nozzle for mounting gear box. |
| Jacket : | Carbon steel 15 mm pipe limpet coil 75 mm NB pitched for circulating hot water at maximum pressure of 3 kg/sq. cm. gauge complete with water inlet, water outlet, airvent, drain etc. |
| Support : | 4 nos. of M.S. legs. |
| Gearbox : | SKX 85 L |
| Drive of screw : | 5 hp, 1440 rpm, foot mounted FLP motor suitable for group IIA and IIB gases working on 415 V, 3 phase, 50 cycles, ac supply. |
| Drive of arm : | 0.75 hp, geared FLP motor suitable for group IIA and IIB gases working on 415 V, 3 phase, 50 cycles, ac supply. |
| Special feature : | Mixer designed for full vacuum. The rotary joint of swing arm and the rotary joint of swing arm head provided with mechanical seal of DURASEALOL. |

| | | |
|---|---|---|
| Lump breaker | : | Comprising of specially designed S.S. impeller mounted on S.S. shaft, driven by means of 5 hp motor through belt and pulley arrangement. Unit complete with bearing housing, mechanical seal, tie rods etc. |
| Dust filter | : | Comprising of S.S. vessel with M.S. jacket provided with adequate number of cartridges offering filter area of approximately 2.4 sq. m. provided with FLP solenoid valves and timer. |
| Condenser | : | Shell and tube type condenser having surface area of 4 sq. m. Tubes, shell and baffles of S.S. 316 and bonnets of carbon steel. The vapours on shell side and cooling water/brine on the tubes side. The tube side has two passes complete with necessary nozzles and fittings provided with saddle support. |
| Receiver | : | Gross capacity - 400 litres, vertical, cylindrical shell with welded top and bottom dished end complete with suitable nozzles, light glass, sight glass and M.S. leg supports. All contact parts fabricated out of S.S. 316. |

8. Distillation Tower :

| | | |
|---|---|---|
| Type | : | Sieve tray type vertical cylindrical sections. Material of construction of all contact parts S.S. 304. Body flange M.S. (Boiler quality) with S.S. 304 liner. Skirt support IS 226. |

| | | |
|---|---|---|
| Nozzle necks | : | A 312 TP 304 seamless |
| Nozzle flanges up to 100 NB | : | S.S. 304 |
| Solid nozzle flanges 150 NB | : | C.S. plates flanges with S.S. 304 |
| and above | : | liner. |
| Size | : | 700 I.D. x 6800 mm height |
| Thickness of shell | : | 6 mm |
| Thickness of dished ends | : | 6 mm nominal<br>5 mm minimum |
| Thickness of body flanges | : | 40 mm thick C.S. (Boiler quality) with 10 mm thick S.S. 304 liner |
| Supports | : | Skirt support of size 700 x 4050 height x 6 mm thick |
| Trays | : | 24 nos. S.S. 304 quality trays. Thickness 3 mm with 6 mm perforation trays supported on tie rods with appropriate spacers. |
| Radiography | : | Dished ends – full |
| Other major butt welded joints | : | Spot (10%) |
| Polish | : | Internals given mirror polish while dished ends have satin finish from outside. |
| Empty weight | : | 2200 kg |

**EXERCISE**

1. Draw flow diagram for manufacture of Tablets, Syrup (Liquid oral) and Injections.

2. Write short notes on :
   - Tablet mixing
   - Tablet compression
   - Tablet coating
   - Tablet packing
   - Injection manufacturing
   - Syrup manufacturing
   - Ointment and eyemide
   - Fine chemical plants

3. Provide data to be collected while taking inventory of following machinery to get current prices :-
   - Rotary tablet machine
   - Press coat machine
   - Tablet coating machine
   - Fluid bed dryer
   - Horizontal rectangular sterlizer
   - High speed automatic sterile powder filling and rubber stoppering machine
   - Laminar air flow unit
   - Rotary bottle washing machine
   - Automatic liquid filling machine
   - Stainless steel filling tank
   - Fully automatic R.O.P.P. round bottle capping and sealing machine
   - Vertical automatic vial labelling machine with vacuum pump, motor with gear unit
   - Automatic cartooning machine
   - Blister packing machine for capsules
   - Shrink wrapping machine
   - Wax melting pan
   - Fully automatic ointment mixer

- Colloidal mill
- Roll compactor
- Automatic capsule filling machine
- Reactor with internal coils and accessories
- Centrifuge
- Glass lined equipment
- Condenser
- Nautadryer
- Distillation tower

# UNIT - 4

## PLASTICS

**Objective :**

By the end of this chapter students will learn about :-

- Compression and transfer moulding
- Thermoforming
- Rotational moulding
- Extrusion
- Coating
- Monofilaments
- Calendering
- Blow moulding
- Injection moulding
- Techincal specifications of equipment

### MOULDING AND FORMING OF PLASTICS

There are many processes used to mould a plastic product. In each process, the plastic must be softened or plasticized. It is then formed or moulded in a mould. The mould does the actual shaping of the plastic. After the part has cooled, it is removed from the mould. Each process has certain advantages and disadvantages. The process selected will usually be determined by the design of the part. The product’s use and the volume of parts to be sold per year will also affect the type of process chosen.

### Compression and transfer moulding

Most thermoset plastics are processed by compression or transfer moulding. The injection moulding of thermosets will eventually replace compression and transfer moulding. Typical compression moulded parts include dinnerware and switch and outlet plates. Buttons and cooking utensil handles are also compression moulded. Phenolics, ureas, and melamines are typical thermosets that are compression or transfer moulded.

## Compression moulding

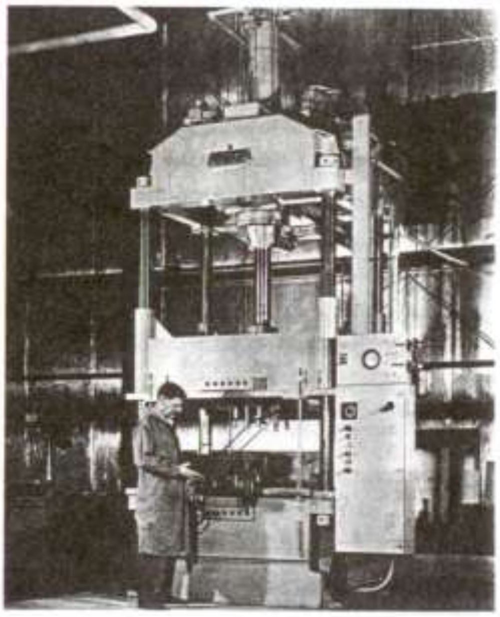


**Figure 4-1**

**Figure 4-1** shows a typical hydraulic press used for *compression moulding*. The mould is mounted to the platens of the hydraulic press. The platens and mould are usually heated by electricity. The mould cavity is usually sprayed with a mould release prior to moulding. A mould release helps to keep the moulded part from sticking to the mould cavity.

A premeasured amount of moulding material is placed in the mould. The mould is closed under pressure for about 15 seconds. It is then opened to allow gas to escape. The mould is again closed under pressure for 5 to 10 minutes, as shown in **Figure 4-2**. After the cure , the mould is opened and the part is removed. The part is not cooled in the mould. In thermosets, a chemical reaction takes place. The part hardens in the mould.

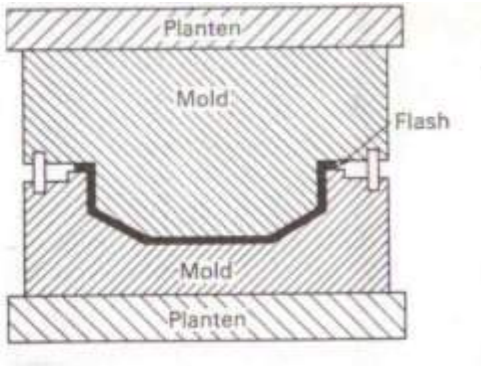



**Figure 4 -2.**
**A flash mould is a typical mould used for compression moulding.**

Time, pressure, and temperature are variables. They vary depending on the design of the part and the material used. Temperatures vary from $275^0$F to $400^0$F ($135^0$C to $205^0$C). Cycles may be as short as 5 minutes or as long as 15 minutes. Pressure will vary from 1,000 to 8,000 pounds per square inch.

Some thermoplastics are compression moulded. Vinyl phonograph records and many acrylic lenses are compression moulded. A big advantage to compression moulding is that very accurate parts can be moulded because of the high pressures. The grooves of a record must be accurate for proper sound reproduction.

Single or multiple – cavity moulds for compression moulding are expensive to produce. Equipment for the process is not as expensive as other processing methods such as injection moulding. There is usually flash around the part that must be removed. This operation adds to the cost of the product. *Flash* is a thin fin of plastic that leaks out of the mould where the mould halves go together. A thermoset part will not soften again. Scrap parts cannot be reused as with thermoplastics. Cycle times are longer in compression moulding than in other processes. This is why many thermosets are now being injection moulded.

**Transfer moulding**

*Transfer moulding* is a variation of compression moulding. It is shown in **Figure 4-3**. Parts that have thin sections or metal inserts must be transfer moulded. Automobile distributor caps are transfer moulded because of the metal contact points. Automobile coil tops are also transfer moulded.

A preheated *perform* or tablet is placed in the transfer chamber. As the mould is closed, the plastic melts in the chamber. The plunger forces the melted plastic into the mould cavity. Since the plastic is melted as it flows into the mould, it will flow around inserts and into thin sections. If a powder were placed in the mould cavity, it would not flow properly.

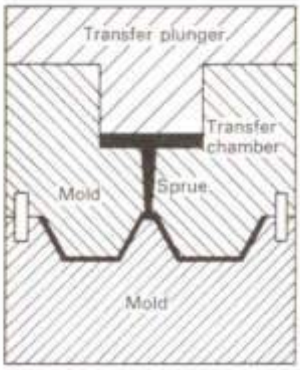



**FIGURE 4-3**
**A mold used for transfer molding. Note the transfer chamber used to melt the plastic before it is forced into the mold cavity.**

**Thermoforming**

*Thermoforming* is the oldest and easiest method used to form a plastic product. Typical thermoformed products are luggage, briefcases, and utility trays. Thermoforming techniques can be classified as mechanical, vacuum, or pressure forming. Thermoplastic sheet is used for thermoforming. The type of plastic selected depends on the product to be moulded. The plastic is softened or plasticized by radiant electric heater. The plastic is forced into or over a mould by pressure. Any thermoplastic can be formed by thermoforming. Cellulose acetate, high-impact polystyrene, and ABS are the most common.

**Mechanical forming**

*Mechanical forming* uses a mould made up of two parts. This type of mould is called a *matched mould.* Matched moulds are very expensive because they must fit perfectly together. The mould halves must be highly polished so that the surface of the part will be smooth. The mould can also be engraved to give a textured finish to the part. Other thermoforming techniques require only one half of a mould.

In mechanical forming, a piece of softened plastic is placed between the open mould halves. The mould is closed in a press to mechanically form the product. Production matched moulds are usually cored for cold water. This will speed up the time for cooling the formed part. The part is then removed and trimmed.

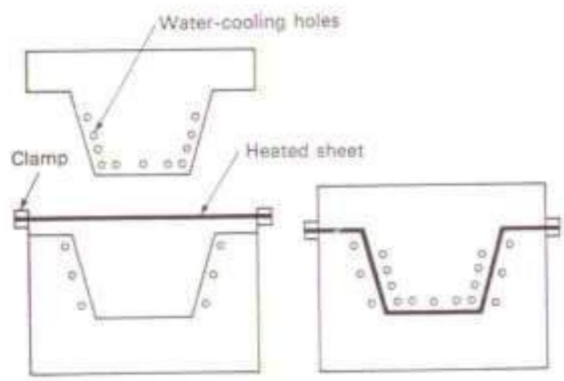



FIGURE 4-4
Mechanical forming is used to form very accurate parts.

**Figure 4-4** shows a typical matched mould. This technique of thermoforming is used to make accurate parts. Excellent detail such as lettering or texturizing can be done with mechanical forming.

**Vacuum forming**

*Vacuum forming* is the most common method of thermoforming. A plastic sheet is plasticized and then clamped over a mould. A vacuum is drawn through small holes in the mould. The plastic is formed against the shape of the mould. The vacuum does not do the forming. The vacuum removes the atmospheric pressure from below the sheet of plastic. There is a pressure differential developed by the vacuum. The atmospheric pressure above the sheet, 14.7 pounds per square inch, forces the plastic over or into the mould.

The biggest disadvantage to thermoforming is that the sheet thins out as it is stretched during forming. The amount of thinning depends on the shape of the mould. Many different techniques have been developed to cut down on the nonuniform wall thickness caused by stretching. Straight, draped, plug-assist, and snap-back forming are techniques of vacuum forming.

**Straight vacuum forming**

**Figure 4-5** shows *straight vacuum forming*. In this technique, the plastic is drawn into a mould cavity. The plastic is softened and clamped to the mould. Atmospheric pressure is removed from the mould cavity by the vacuum. Atmospheric pressure above the sheet forces the plastic into the mould. The wall thickness of the product is very uneven in straight vacuum forming.

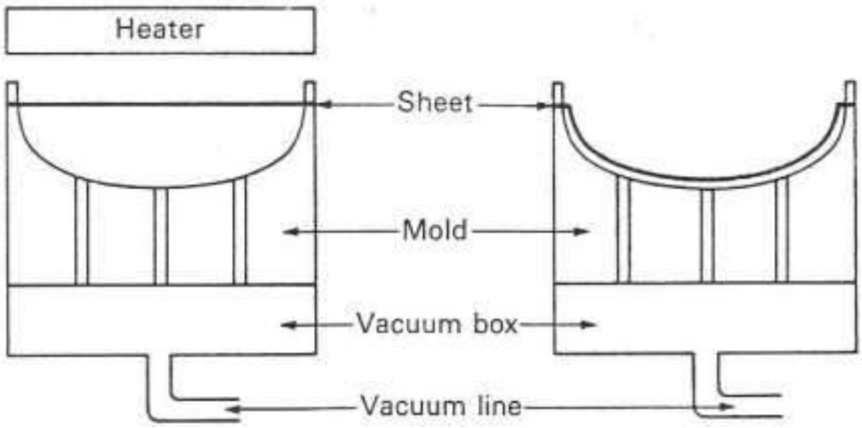



**Figure 4-5**
**Straight vacuum forming.**
**The plastic is formed into the mould**

**Drape vacuum forming**

*Drape vacuum forming* is shown in **Figure 4-6**. In drape forming, the softened plastic is draped over the mould and then the vacuum is drawn. Atmospheric pressure forces the plastic over the mould. Drape forming has the advantage of a more uniform wall thickness in the moulded part.

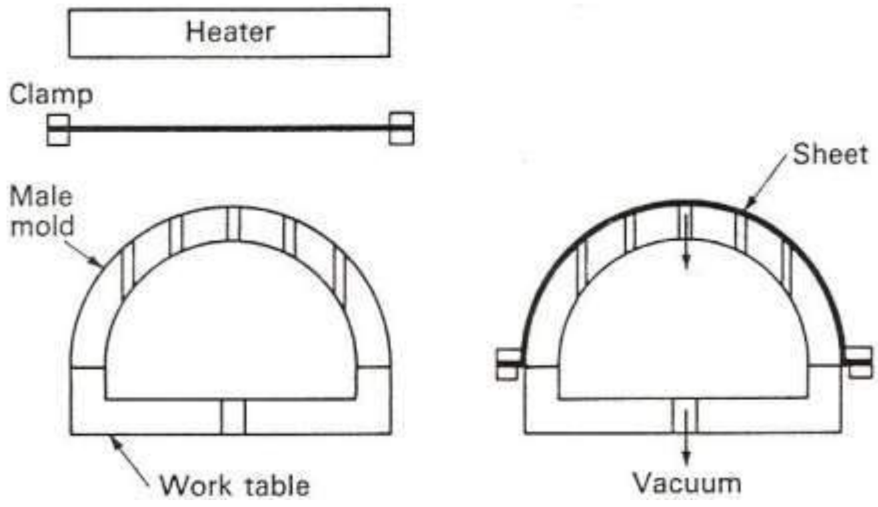



**Figure 4-6**

**Drape vacuum forming.**

**The plastic is draped or stretched over the mould prior to pulling the vacuum.**

**Plug-assist forming**

The deeper the mould cavity, the more the plastic has to be stretched. The plastic thins out more in the corners than on the sides. For deep draws, a *plug-assist* technique is used, as shown in **Figure 4-7.**

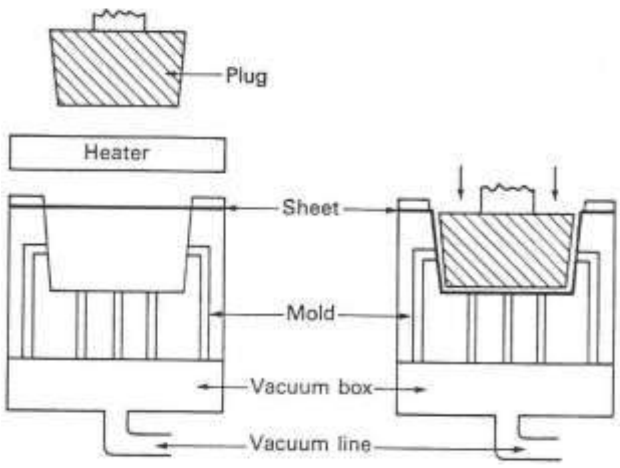



**Figure 4-7**

**Plug-assist forming.**

**The plug prestretches the plastic into moild cavity prior to forming.**

**This technique eliminates thinning in the corners.**

Electric heaters are used to soften the plastic. After heating, the sheet is clamped and sealed to the mould cavity. A plug comes down from above and prestretches the plastic. The vacuum is then drawn to remove atmospheric pressure below the sheet atmospheric pressure above the sheet forces it into the mould cavity. The plug has the same general shape as the mould cavity.

**Snap-back forming**

Even material distribution in deep draws can also be done by *snap-back forming,* as shown in **Figure 4-8**. The softened plastic is sealed to a vacuum box. A vacuum pulls the sheet partially into the box. The mould comes down from above into the box. The vacuum in the box is shut off and the plastic snaps back onto the mould. A vacuum is then applied to the mould to completely form the product.

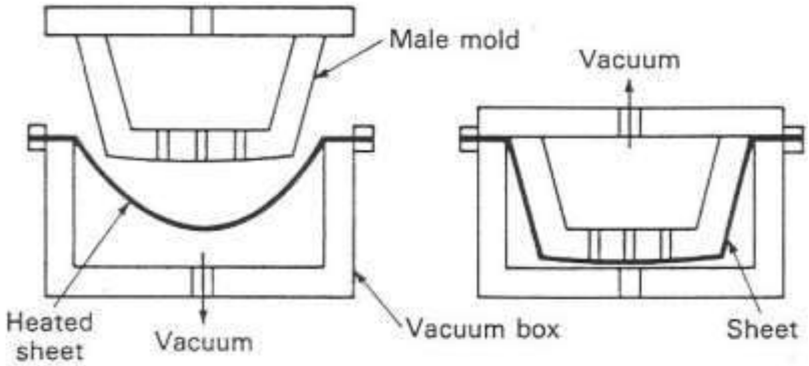



**Figure 4-8**

**Vacuum snap-back forming is another method to help eliminate thin corners. The plastic is drawn into the vacuum box and then snapped back to the mould.**

Drape, straight, plug-assist, and snap-back forming are the most common forming techniques. Slip-ring and billow snap-back forming are other techniques used in thermoforming.

## Pressure forming

*Pressure forming* uses air pressure to form the product. It is shown in **Figure 4-9.** The plastic is clamped between the mould cavity and a hot blow plate. A slight amount of air pressure through the mould cavity holds the sheet against the hot blow plate. After the sheet is softened, the air pressure is shut off. Air pressure is forced through the hot blow plate, which forces the plastic into the mould activity.

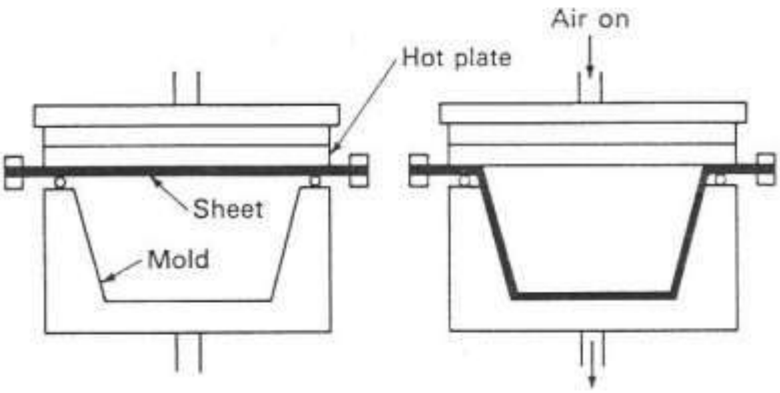



**Figure 4-9**

**Pressure forming uses air pressure to form a product after the sheet has been heated by a plate.**

A variation of pressure forming is called *free-blow forming*. A plastic sheet is heated and clamped over a pressure box. Air is forced through the bottom of the box and blows the plastic into a bubble. The size of the bubble is controlled by the amount of air pressure. Clear acrylics are used in this process to make airplane canopies and sky lights.

Even with the various techniques of thermoforming, the product always will have a nonuniform wall thickness. Other methods of moulding a product will make a more accurate part. Accurate products cannot be thermoformed. Another disadvantage of thermoforming is the secondary trimming operation. The excess plastic must be trimmed from the part, as shown in **Figure 4-10**. This operation adds to the cost of the product, and creates a lot of scrap plastic. The scrap plastic cannot be reused as easily as in other processes.

**Figure 4 – 10**

**All thermoformed products must be trimmed after forming. This adds to cost of the product.**

Sheet plastic is an expensive secondary product. An extrusion company buys plastic pellets and makes the sheet. A thermoformer buys the sheet to make his finished product. An injection moulder buys pellets to make his finished product.

Equipment and mould costs are less expensive for thermoforming than for other process. The moulds can be made out of wood, epoxy, cement, or cast aluminum. Other processes require expensive steel machined moulds.

Generally, thermoforming is a low production process. But small plastic cups can be produced at very high rates. When the demand for a thermoformed product becomes high, a higher production process such as injection moulding is usually selected. Some parts, because they are large, cannot be made except by thermoforming.

Many large products such as gasoline service station signs can only be made by thermoforming because of their large size. Large thermoformers can handle a 9 feet x 36 feet sheet of plastic. Boats as large as 8 feet x 23 feet are now being thermoformed. See **Figure 4-11**.

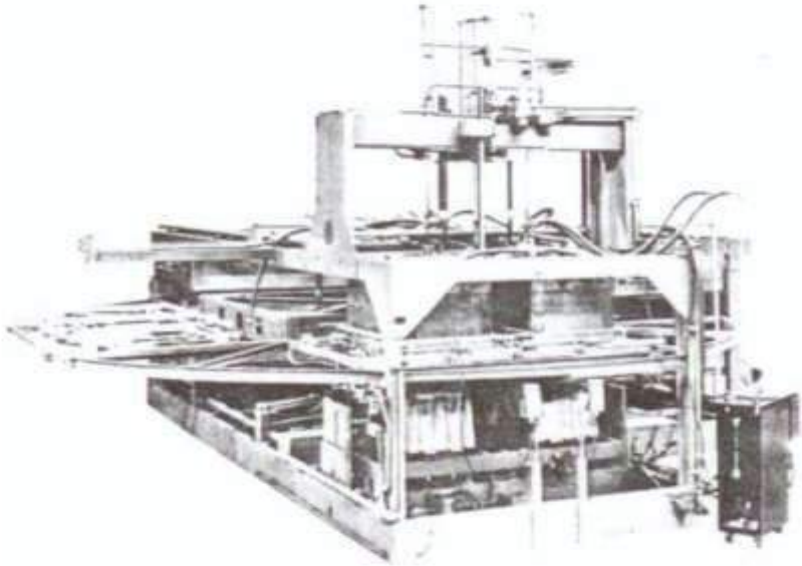


**Figure 4 – 11**

**An industrial rotary thermoformer. The stations rotate from the loading-unloading station heating and forming stations.**

A big market for thermoforming is in packaging. Many kinds of meat trays, cups, and egg cartons are thermoformed. Thermoformed tubs are used for cottage cheese, butter, and margarine. Skin and blister packaging are done on thermoforming equipment. In skin packaging, the item is placed on a printed perforated card. A thin plastic sheet is softened and vacuum formed tightly over the entire surface. Plastic bubbles are thermoformed for blister packaging. The product is placed in the bubble, which is heat sealed to a printed card.

Small products such as margarine tubs and cups can be thermoformed at very high rates. An extrusion unit extrudes the sheet plastic that is fed to the thermoformer. Multiple moulds are used to form the product. The product then goes to a trimming station where it is die cut and decorated. It is then boxed for shipment automatically.

## Rotational moulding

*Rotational moulding* is often called *rotomoulding, rotocasting, or rotational casting.* Rotational moulding is unique in that it is the only moulding process where a completely closed, hollow, seamless product can be made. Open products can be made by trimming away the unused areas. Parts of the mould can also be insulated to mould open ends. This will eliminate cutting and trimming. Typical products that are rotationally moulded are mannequins, balls, footballs, and hobby horses. Many musical instrument cases are also made by rotational moulding.

In rotational moulding, a premeasured amount of plastic is placed into the open mould. The mould halves are then clamped together. The mould is rotated in an oven for a period of time and then cooled. The amount and type of plastic, temperature, and time are determined by the design of the product.

The plastic used in rotational moulding must be a liquid or a material that acts like a liquid. *Plastisols* are generally used for inflatable products such as footballs. Plastisols are vinyl dispersions. Powdered plastics will act like a liquid. Almost any kind of powdered plastic can be used. Polyethylene and polypropylene do not have to be inflated. They are stiff enough to support themselves.

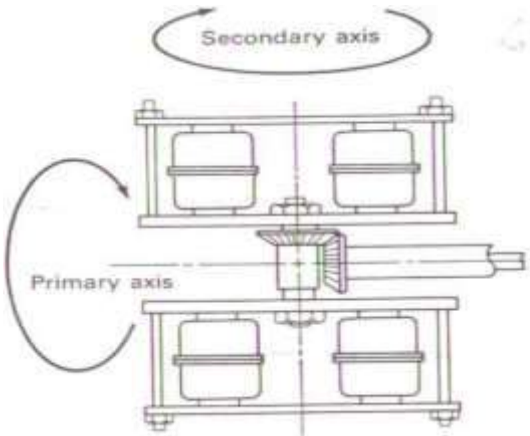



**Figure 4 – 12**

**A dual rotational mould holder showing the primary and secondary axes. The two directions of rotation will mould the hollow part.**

**Figure 4-12** shows a typical mould assembly. A premeasured amount of plastic is placed into each mould. The moulds are then closed and clamped in the mould holder. The entire unit is placed into the oven. Temperature ranges are $325^0$F to $900^0$F ($165^0$C to $465^0$C). Most polyethylenes and vinyls are processed at about $400^0$F ($205^0$C). After the unit is in the oven, it is rotated in two axes. These axes are at right angles to each other. A ratio of 4:1 is a general purpose ratio. This means that the primary axis rotates 4 times to 1 rotation of the secondary axis. Generally, the primary axis rotates about 10 to 12 revolutions per minute while the secondary rotates at about 2 to 3 revolutions per minute. The heat causes the plastic to melt and coat the inside of the mould as it is rotated. After the plastic fuses on the inside of the mould, the moulds are sprayed with water to cool the plastic.

A big disadvantage to rotational moulding is that it is a low production process. The average moulding cycle will run about 15 to 20 minutes. The process is used for products that are too large for other processes. It is also used for small products that do not have a large demand. Multiple moulds called *spiders* can be used to increase production for small parts. The cut-off point is generally 10,000 parts. If the demand for the part is less than 10,000 annual units, injection or blow moulding would be more economical.

One limiting factor in rotational moulding is the practical size of the oven. The amount of weight the rotating arm can support will also determine size. Containers as large as 6½ feet in diameter by 10½ feet high are now moulded. Containers from 300 gallons to 2,400 gallons are moulded by rotational moulding.

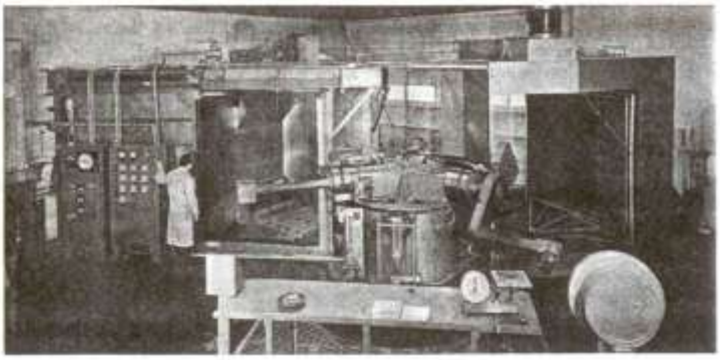


**Figure 4 – 13**

**A three-arm rotational moulder. The oven is located to the right and the cooling chamber is to the left. The mould loading-unloading station is in the centre.**

An industrial rotational moulder is shown in **Figure 4-13**. this unit has three rotating arms. Some units have four arms. With a four-arm unit, two arms are in the oven at the same time. This is because the heating part of the cycle is the longest. In the three-arm unit, one arm is at the loading and unloading station. Here the moulded parts are removed. A mould release may be applied prior to filling the moulds. At the same time, the second arm is rotating in the oven. The third arm is in the cooling chamber. The rotation is controlled by timers. At the proper time, the arms move to the next station. The arm in the cooling chamber moves to the loading and unloading station. The arm in the oven moves to the cooling chamber, while the arm from the loading station goes into the oven.

One big advantage of rotational moulding is that inexpensive moulds can be used. Very little pressure is used in rotational moulding. Sheet metal and cast aluminum moulds can be used. The first plastic trash can was made using a galvanized trash can as the mould.

There is little or no waste in rotational moulding. There are no sprues or runners as in injection moulding. The thickness of the part can be easily controlled. If the part is too thin, more material can be added. Less material can be added if the wall is too thick. Many processes require a new mould to change wall thickness. Parts can be moulded with thickness ranging from 1/32 to 1 inch (0.8 to 25 mm). Parts with intricate contours can be easily moulded. Since there is no pressure, there will be no stresses moulded into the part.

There are other processes similar to rotational moulding. One is called the *rock and roll* method. The mould is rotated in one plane or direction. At the same time, it is rocked up and down in the other direction. In the *Engle process*, the mould is not rotated. The mould is filled with powder and placed in an oven. The plastic begins to fuse to the walls of the mould from the heat. After the desired thickness is obtained, the mould is removed from the oven. The excess powder is dumped from the mould. The mould is placed back into the oven to fuse the inside surfaces of the part.

## EXTRUSION

The extrusion process converts raw thermoplastics in powdered or granular form into a continuous melt stream which is formed by a die into a variety of shapes. End products include pellets packaging fibers; sheet; pipe; tubing; profile for the construction, automotive and appliance industries; fibers; insulation covering; extrusion coated webs; parisons for extrusion-blow moulding; and foam for cups, insulating sheet, packing material, and other uses.

### Single-screw extruder

By far the most common and most versatile extruder in use today is the single-screw extruder. A schematic of a typical single screw extruder is shown in figure 4-14 given below.

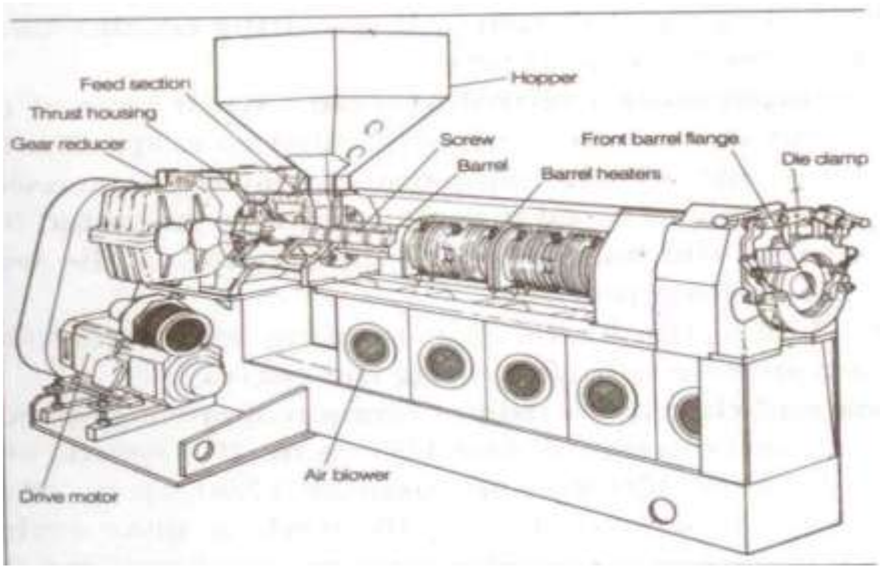



**Figure 4-14**

Single screw extruders are characterized by two dimensions; the bore diameter (D) and the length of the barrel in bore diameter of L/D ratio. For example a 2½ in 20:1 L/D extruder has a barrel bore of 2½ in ID and a barrel length of 50 in. (2½ x 20 diameters in length).

Common commercial sizes of extruders range from 2 to 8 in. Machines are available as small as ¾ in. for laboratory or specialized use and as large as 24 in. or more on special order. Common L/Ds range from about 5:1 minimum through 34:1 and to 40 + :1 for some multiple venting application. Generally the shorter machines (through 20:1) are applied to elastomer processing; the longer one (20:1 L/D and above) are applied to thermoplastic processing.

**Extruder barrel and feed section**

The section barrel of single-screw extruder usually is a long thick-walled tube of alloy steel into which a hard, highly crystalline wear resistant alloy has been centrifugally cast. After the casting the bimetallic tube is straightened and honed, usually to a tolerance of $\pm$ 0.001 in. on the ID. The barrel must tolerate an internal pressure of 10,000 p.s.i. without elastic deformation above the 0.15% strain at which the internal alloy will cack in tension.

Attached to the feed end of the barrel (often as a separate casting) is an opening into the barrel bore for raw material feeding. It usually is jacketed for room temperature water cooling to prevent premature melting of polymer.

**Barrel heat input and extraction mechanisms**

The barrel must be provided with means to both add and extract heat. Though heaters vary in design, the most common ones are cast aluminum. The heater halves are clamped to the barrel to provide intimate contact between the steel of the barrel and the aluminum of the heater. The heat sink is either air of a liquid coolant.

The heaters are arranged in zones, often 4 to 5 on a 24:1 L/D extruder. Auxiliary systems provide heat sinks for heat absorption. Probably the simplest is a blower mounted under each zone heater to blow air over the surface of the heater extracting heat from it and depositing it into the plant ambient air. The blowers are switched on an off either by automatic controllers or manually.

Where greater heat extraction is needed, a liquid cooled system is used. The preferred liquid is distilled water which may or may not be boiled into steam depending upon design and operating conditions. Alternatively, organic heat transfer fluids may be used.

**Barrel temperature control system**

Each zone of the extruder, and also the head or die, must be controlled to a specific temperature, depending on the process. The temperature usually is sensed with a tip sensitive thermocouple or resistance thermometer mounted in hole drilled through the steel of the barrel just to the outside of the wear-resistant layer close to the melting polymer.

**Screw**

Inside the barrel is a rotating feed screw that picks up polymer and advances it into and along the barrel.

**Gearbox and thrust bearing**

Common operating speed of medium size extruders range between 50 and 150 rpm. The speeds of medium hp drive motors i.e. 40 to 200 hp are usually 1750 rpm. Motor speed is reduced to the screw speed usually with a gear reducer which simultaneously increases the available torque as it reduces the speed.

The gearboxes supplied by extruder manufacturers may be horizontal or vertical. They may have helical, herringbone or worm gears, 2½ in. and larger extruders use helical or herringbone gearboxes.

**Drives**

The most common extruder drives are statically rectified d.c. drives operating on 460 V, three phase power. As the armature voltage is reduced from nameplate rating to zero, the speed reduces linearly to zero, while maintaining full load torque capability.

D.C. drives usually are equipped with tachometers and drive regulators which hold speed within 1% regulation and 2% long-term drift. The signals from these tachometers can be fed into coordinate modules and master references to drive the extruder speed up and down with process line speeds, tandem extruders, co-extrusion extruders, etc.

Though the power factor drops off materially. D.C. drives tend to be relatively efficient in energy use. Other types of drives that are used include eddy current a.c. motors, and hydraulic drives.

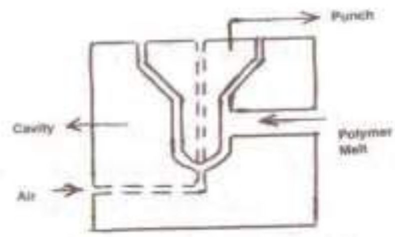
**Venting**

Some polymers contain small amounts of volatile monomer moisture or entrapped gases which adversely affect the extruded product. These may be removed through vents in the barrel.

## TYPE OF DIES FOR FILM EXTRUSION

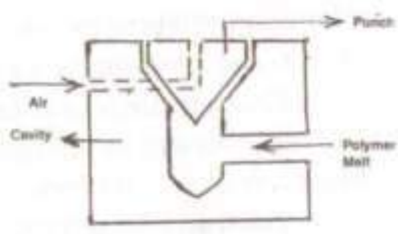
1. **Side-fed die for blown film**

In such die, polymer melt is fed to die from side and melt is divided in two streams. This has disadvantage of Joint/weld line, where film can be weak in strength.



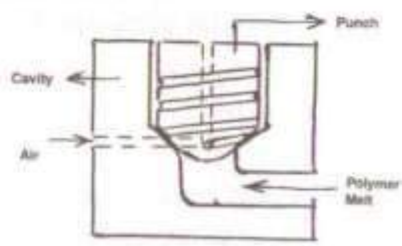

2. **Bottom-feed die for blown film**

In such die, polymer melt is fed to die from bottom of punch and hence does not involve any weld line problem. This is most common type of die.




3. **Spiral flow die**

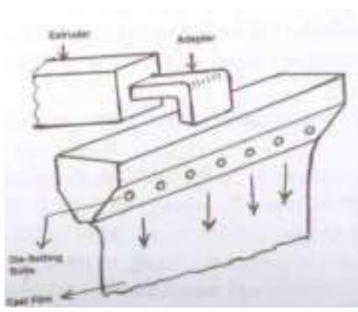
There are different varieties such as 2 start, 4 start, 8 start, spiral flow dies. This spiral flow die gives distinct advantage of better homogeneity of melt, even distribution of melt pressure and better melt stability.




4. **T-die (coat hanger die)**

This type of die is generally used for:

- Cast film extrusion
- Stilt tape extrusion for woven sacks
- Extrusion coating
- BOPP film co-extrusion



# EXTRUSION OF PLASTIC FILMS

## Introduction

The use of plastic films in India has shown phenomenal growth during past decades especially in packaging. Films play a major role in not only packing the product, but also protecting and displaying the products.

Most common films that we come across are made from LDPE, HDPE, HMHDPE, LLDPE, PVC, PP, etc. which form the commodity films. These films have good mechanical properties and reasonably good water barrier properties and medium shelf life of product packed.

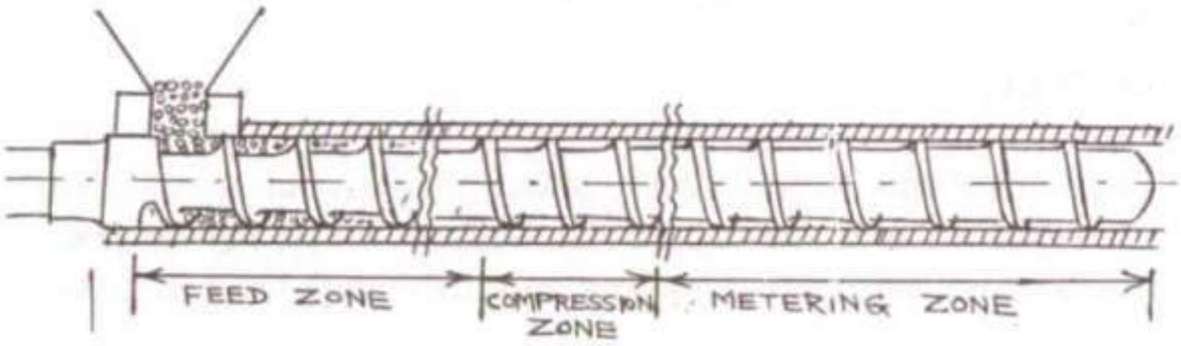
There are specialty films which are higher priced and high performance i.e. superior water and gas barrier properties giving longer shelf life and also aesthetic appearance of printed films. These are made from Biaxially oriented polyester (BOPET), bi-axially oriented polypropylene (BOPP), Mono-axially oriented polypropylene, Cellophane, Oriented nylon (OPA), Oriented polystyrene (OPS).

There are high specialty plastics which impart excellent barrier properties to extend shelf life of production packed. They are very expensive and are normally used in combination with other commodity plastic films. Such plastics include polyvinylidene chloride (PVDC), Ethylene vinyl alcohol (EVOH) and Ionomers. These plastics are used with commodity plastics by way of blown film co-extrusion 3,5 and 7 layers.

## Processing

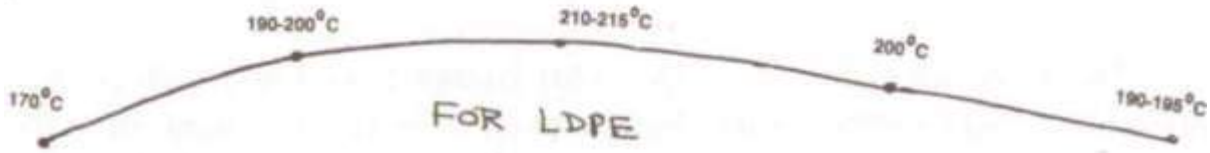
Films are produced by a process called Extrusion, which comprises of converting plastic granules into a continuous uniform melt and forcing the melt through a die into various desired shapes such as film, sheet, tubing, pipes and rods. The process of extrusion is carried out in an extruder. Extruder consists of cylindrical barrel in which a screw rotates and help to convert solid plastic granules into homogenous molten plastic mass and to convey the same to the die continuously. The size of extruder is defined by diameter of its screw.

## SCHEMATIC DIAGRAM – EXTRUSION PROCESS




HOPPER COOLING HELPS TO AVOID BRIDGING

**TEMPERATURE PROFILE (CAMEL BACK)**




For MDPE - $180^0$C to $220^0$C For HDPE - $190^0$C to $230^0$C

For PP - $190^0$C to $240^0$C For LLDPE - $190^0$C to $240^0$C

| POLYMERS | SCREW DETAILS | | |
|---|---|---|---|
| | L/D RATIO | COMPRESSION RATIO | |
| LDPE<br>LLDPE<br>MEPE<br>HDPE<br>PP | 24:1 to 30:1<br>24:1 to 26:1<br>24:1 to 26:1<br>24:1 to 26:1<br>24:1 to 26:1 | 3.40:1<br>2.5:1 to 3:1<br>3.4:1<br>3:1 to 3.4:1<br>3.5:1 to 3.8:1 | PITCH = DIAMETER<br>HELIX ANGLE = $16.5^0$ to $17^0$ |

| | | |
|---|---|---|
| Mixing sections | - | Maddock type |
| For better melt | - | Mixing pins / rings |
| Homogenisation | - | Grooved barrels |

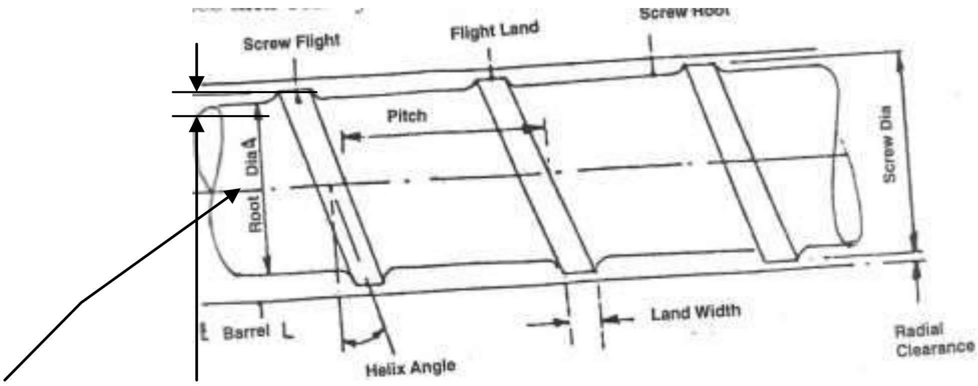
**Material of construction**

| | |
|---|---|
| Screw : | Nitrided steel or carbide metal |
| Barrel : | Nitrided steel |

New superior materials : (A) Titanium carbide composites (FERROTIC)
For hard facing (Trade name "FERRO-TIC")
Cobalt - Nickel alloys are gaining acceptance for wear resistance.
No abrasion screw - Xaloy, Pulasky, USA, have deposition process for metalurgically bonding tungsten carbide to surface of screw.
Xaloy – 800 barrel with tungsten carbide bonding has superior resistance to wear and corrosion.

**Components of extruder are described below**

| | |
|---|---|
| Hopper | It is mounted at the opening end of the barrel for the entry of raw material. The raw material passes through the vertical opening in the feed section into the extruder barrel. |
| Barrel | Barrel is a cylindrical housing, which is heated and cooled externally and in which the screw rotates. |
| Screw | Screw is a helical flighted shaft which when rotated mechanically homogenizes and conveys the material being processed. |




Screw Axis   Screw flight depth

| | |
|---|---|
| Screw flight | The helical metal thread of the screw. |
| Flight land | The surface at the radial extremity of the flight constituting the periphery or outside diameter of the screw. |
| Screw diameter | The diameter developed by rotation of flight land about the screw axis. |
| Root diameter | Diameter at the root of the screw flight. |
| Helix angle | The angle of the flight at the periphery relative to a plane perpendicular to the screw axis. |
| Pitch | Distance in axial direction between two consecutive flights. |
| Flight depth | Distance in the radial direction from the periphery of the flight to the root. |
| Diameteral screw clearance | The difference in diameter between screw and barrel bore. |
| Radial screw clearance | Half the diameteral screw clearance. |

**Screw zones**

A typical screw is divided into three zones:

1. **Feed zone**

   The function of this zone is to receive material coming from hopper and feed it to compression zone. The root diameter in feed zone is minimum and is generally constant over the entire zone length.

2. **Compression zone**

   This zone has a gradual decreasing depth or decreasing pitch of screw, because of which material is gradually compressed and compacted. Transition of material from solid form to molten form takes place in this zone, because of heat and shearing action.

3. **Metering zone**

   This portion of screw acts as a pump and it delivers molten material to the die at a constant rate. Flight depth in this zone is generally less than that in feed zone and is constant throughout.

**Important terms associated with the screw design**

| | | |
|---|---|---|
| Compression Ratio (CR) | : | It can be expressed as a ratio of volume of the screw channel at feed opening to volume in the metering zone. In case of screws with constant pitch, CR is the ratio of depths at feed end metering end. |
| L/D Ratio | : | It is the ratio of length of the screw, which is the distance from the forward edge of feed opening to the screw tip, to the barrel bore diameter. |

These two design parameters are specific to the type of polymer. The recommended values of L/D and CR for PE are 24 to 28:1 and 2.5 to 3.0:1 respectively. Many a times mixing sections in the screw are recommended for processing LLDPE.

**Heating and cooling systems**

Controlled heating is provided using external electrical resistance or induction heaters arranged in several groups or zones along the barrel. Thermocouples are fitted at regular intervals on barrel for temperature measurement and control. Cooling is done using blowers of cooling water jackets to remove excess heat from the polymer melt.

**Breaker plate and screens**

Breaker plate is to break spiral motion of melt and support screen pack.

Screen pack, which is a combination of screens with different mesh sizes, is used as a filter.

The screen pack combinations, which generally used are 40/60/40, 60/80/60 or 40/60/60/40 mesh.

**Downstream equipments**

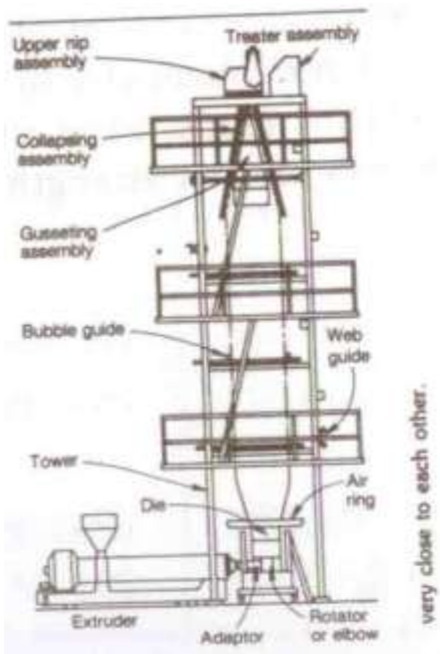
Blowers, quench tank, guides, winders, cutter slitter etc. constitute the downstream equipments for an extruder, which change according to the type of extruder and also the product being processed.

Now film extruders with either oscillating platform, rotating die or oscillating haul-off (take up) assembly are developed, which enable to obtain better quality hump free film rolls.

**Different types of film processing techniques**

**1. Blown film process**

It is a process in which a plastic tube after extruding through an annular die is inflated by air to desired diameter, cooled collapsed and wound in the form of rolls.




**2. Blown film extruder**

In India, blown film extrusion process is found economical and is used by most of the processing units. In this process, there are two types:

(a) Single layer blown film extrusion and
(b) Multi-layer (2 to 5 layers) blown film co-extrusion

The film properties achieved in this process are dependant on various processing conditions, such as Blow Ratio, Processing Temperature Profile, Draw Ratio, Relation of screw speed and haul-off speed, film thickness uniformity. Frost line height (FLH) and adjustment of cooling air through air ring, etc.

(i). **Blow-up Ratio (BUR)**

This is the ratio of diameter of film bubble to diameter of die. This is calculated by simple formula:

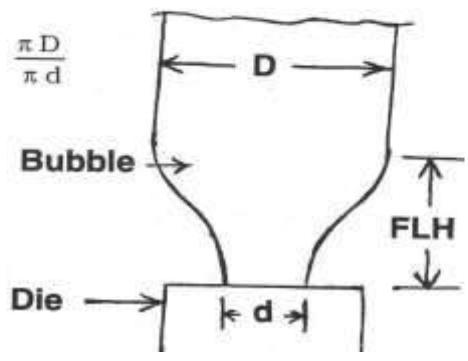
$$\text{BUR} = \frac{\textit{Perimeter of bubble}}{\textit{Perimeter of die}} = \frac{\pi D}{\pi\ d}$$

where,

D = Diameter of bubble
d = Diameter of die

$$\pi = \frac{22}{7} = 3.14$$

Simplified approx formula is $d \sim \dfrac{LFW}{1.5\ x\ BUR}$



Higher the blow ratio, better are mechanical properties (Tensile, Impact etc.) due to better orientation of molecules in cross direction (transverse direction). For LDPE and LLDPE films, Ideal BUR is 2:1 to 2.5:1 which results in good balanced mechanical strength of film in both machine and cross directions.

Following table give ready values of Blow Ratio in relation to size of diameter of die and lay flat width (LFW) of blown film. LFW of film is half of cut open width of blown film.

| Die Diameter | Blow Ratio | | | | |
|---|---|---|---|---|---|
| Inch (mm) | 1:1 | 1.5:1 | 2:1 | 2.5:1 | 3:1 |
| | Values of Lay Flat Width, inch (mm) | | | | |
| 2 (50) | 3.14 (80) | 4.71 (120) | 6.29 (160) | 7.86 (200) | 9.43 (240) |
| 3 (75) | 4.72 (120) | 7.07 (180) | 9.43 (240) | 11.80 (300) | 14.15 (360) |
| 4 (100) | 6.29 (160) | 9.43 (240) | 12.58 (320) | 15.72 (400) | 18.86 (480) |
| 6 (150) | 9.43 (240) | 14.15 (360) | 18.87 (480) | 23.58 (600) | 28.30 (720) |
| 8 (200) | 12.60 (320) | 18.87 (480) | 25.16 (640) | 31.45 (800) | 37.73 (960) |

For LDPE, LLDPE and HDPE films, processing at Low Blow Ratio, (sometimes less than 1:1) is not advisable, since orientation of molecules is insufficient and unbalanced, which results in inferior mechanical strength of the resultant films.

For TQPP film, normal blow ratio used is 1.2:1 to 1.5:1 for HMHDPE films, high blow ratio of 4.5:1 to 5.5:1 is used.

(ii). **Processing Temperature Profiles**

Adequately high temperature profiles results in good mechanical properties of blow films. Normally camel back profile is found useful i.e. lower in feed zone and gradually increasing in compression and metering zones and then gradually reducing in cross head and die zones.

Typical temperature profiles for film extrusion for popular plastic materials are as under:

| LLDPE Film Grades | Barrel Zones | Crosshead | Die Zones |
|---|---|---|---|
| Heavy duty (0.2 MI) | 170/195/205 | 200/190 | 185/180$^0$C |
| Milk packing (0.5 MI) | 160/185/195 | 190/85 | 180/170$^0$C |
| General purpose Packing (2 MI) | 160/180/185 | 185/180 | 170/160$^0$C |
| (4 MI) | 150/170/170 | 160/155 | 150/145$^0$C |
| Heavy duty (1.0 MI) | 160/185/195 | 190/185 | 180/170$^0$C |
| General purpose (2 MI) | 160/180/185 | 180/175 | 175/170$^0$C |
| HMHDPE film grade | 170/220/230 | 210/220 | 200/190$^0$C |
| TQPP film grade (10 MI) | 170/195 to 200/205 | 200/190 | 190/180$^0$C |

(iii). **Frost Line Height (FLH)**

This is the distance between the die and the zone where the bubble solidifies and assumes it's final diameter. This FLH is dependent on the rate of cooling by air from cooling ring. Higher the rate of cooling, lower is FLH and vice-versa.

Normally recommended FLH for various plastic blown film materials are as under:

1. For LDPE and LLDPE blown film extrusion, one foot to two feet, depending on diameter of the bubble.
2. For PP blown extrusion, 6 inches to 10 inches.
3. For HDPE blown film extrusion, 6 inches to 15 inches.
4. For HMHDPE blown film extrusion, FLH is as high as two feet to four feet, depending on diameter of bubble.

(iv). **Film Thickness Control**

Film thickness is controlled by adjusting screw speed and Nip Roll speed.

(v). **Thickness Variation Control**

It is very essential to control film thickness in narrow range, preferably within $\pm$ 5%. This variation is controlled by –

(a) Setting the die gap uniform all along the periphery, with help of the die setting bolts. It is ideal to have 8 to 10 nos. die setting bolts.

(b) Adjusting air flow of air cooling ring.

The film with low variation in thickness has superior and reliable mechanical properties and is free from thick bands or humps on the roll, which enhances the printing quality of the film.

**3. <u>Cast Film Process</u>**

Polymer melt is extruded through a flat die either onto a rotating chilled roll or into a water quench tank, where the melt is rapidly cooled and frozen to form a film called the cast film.

Advantages of this process over blown film extrusion are:-

(1) Superior transparency and clarity of film
(2) 4 to 5 times higher output, since no limitations on cooling of film.

The only limitation of cast film process is relatively lower orientation and strength of film in transverse direction.

## 4. Co-extrusion Film Process

It is a process in which two or more polymers processed on separate extruders are passed together through a common die to form a film. It can be either a blown or cast film process. This process is widely used for producing barrier films, stretch films etc. Co-extrusion film process leads to a co-extruded film or multilayer film.

Such films offer specific advantages such as higher shelf-life superior mechanical properties of the film and pouches (tensile strength, puncture resistance, impact strength), better heat seal strength, better hot track strength etc. due to the combination of different plastic materials used in the multi-layer structures.

Some of the multiplayer structures based on polyethylene and their applications.

| | Material combination | | Important fields of application |
|---|---|---|---|
| 1. | LDPE + LLDPE in 2 or 3 layers | | Milk film, carrier bags, general packaging |
| 2. | LDPE / EVA<br>LLDPE / EVA<br>LLDPE / LEPE | | Heavy duty bags, stretch packaging, medical articles. |
| 3. | HDPE / EVA | | Blood plasma, bakery goods, foodstuffs |

| | | | |
|---|---|---|---|
| 4. | HDPE / LDPE or LLDPE<br>LDPE / HDPE / LDPE<br>LLDPE / HDPE / LLDPE | | Bakery goods, foodstuffs, tomato concentrate, pet food, cornflakes. |
| 5. | LDPE / TL / Nylon-6 / TL / LDPE<br>or<br>LLDPE / TL / Nylon-6 / TL / LDPE | | Packing of meat, sausage, cheese, ham, fish, ready made meal |
| 6. | LDPE / HDPE | | Vanaspati ghee pouches |
| 7. | LLDPE / LDPE / HDPE | | Edible oil pouches – short shelf life |
| 8. | LLDPE / TL / Nylon-6 / TL / Ionomer | | Edible oil pouches – longer shelf life |

**STRETCH – EXTRUSION PROCESS**

In this process, after primary extrusion, the product is again reheated and stretched / oriented in one or two directions (machine and transverse directions) in order to impart superior mechanical properties to final products.

Examples of such stretch extruded products are :

1. Biaxially oriented PP films and polyester films, having superior mechanical properties and barrier properties.
2. Flat tapes for HDPE and PP woven sacks also known as 'Raffia'.
3. PP and HDPE monofilaments, twines and sutli.
4. PP, Nylon-6 box strappings.

In above process, the extruded product is re-heated and then stretched in machine direction and transverse direction. The stretch ratio depends on type of plastic, for example for PP it is 1:7 to 1:8 and for HDPE it is lower 1:5 to 1:6. After stretching the product is again heated (PP to about 130$^0$C to 135$^0$C and HDPE to 100$^0$C to 120$^0$C) for purpose of stress-relaxation in the product. After this, the product is ready for final winding.

In secondary operations, flat tapes are taken on looms for weaving, monofilaments on rope making machine, etc.

**Flat tape stretch extrusion line** : This is versatile line, since with only the change of die other products monofilaments or box strappings can also be produced.

Popular applications of BOPP film are :-

- Wrapping of cigarette cartons and tobacco packing
- Packing of potato chips, noodles, sevia, etc.
- Packing of bakery products.
- Paper print laminations
- Pressure sensitive adhesive tapes.
- Printed synthetic paper applications, visiting cards, invitation cards, calendars, technical brochure etc.

Popular applications of HDPE woven sacks and cloth are :-

- Packing of fertilizers and chemical powders.
- Tarpaulin (black or blue) covers for protection on trucks.

Polypropylene woven sacks are preferably used for packing of cement, since same are more suitable to withstand hot-filling of cement powder. PP woven cloth is also preferred for bulk bags (250 kg, 500 kg bags) since the same is stronger than HDPE woven cloth.

**BLOWN FILM EXTRUSITON : TROUBLE SHOOTER'S GUIDE**

| Faults | Remedies |
|---|---|
| Gels and fish eyes | - Increase the back pressure by using finer screen/adding another screen to improve homogeneity.<br>- Prevent decomposition inside the system and burnt particles on die lips. Clean die often.<br>- Increase the processing tempe-ratures. |
| Black / foreign particles | - Check for contamination in material.<br>- Keep hopper covered and full, to prevent dusty air entering the extruder.<br>- Carry out purging or cleaning of die set in case of suspected oxidation of polymer. |
| Die lines and scratches | - Check and remove nick and burrs on die lips, if any.<br>- Clean the die and also the head when necessary.<br>- Purge sufficiently when changing to a material of different melt-flow index.<br>- Increase the head temperature.<br>- Avoid internal decomposition. |
| Orange peel appearance | - Increase extrusion temperature.<br>- Check the heaters which may be defective. |

| | |
|---|---|
| | - Increase the back pressure by adding screens. |
| Pot marks | - Usually due to high moisture content. Avoid stocking granules in open air, damp and cold buildings. |
| Ripples on film | - Check moisture in freshly opened bag and pre-dry granules in case of moisture content at 70-80$^0$C.<br>- Check land length of die and increase the same if necessary.<br>- Inspect temperature profile.<br>- Maintain proper freeze line height.<br>- Control excessive output. |
| Uneven thickness around circumference | - Adjust die opening with the help of centering screws.<br>- Check the uniformity of cooling air flow throughout the circumference of the bubble.<br>- Check for defective heaters of other hot / cold spots on die.<br>- Always maintain proper freeze line height (FLH). |
| Variation in thickness of film in machine direction | - Check regularity of screw speed.<br>- Check regularity of haul-off speed.<br>- Maintain optimum processing tempe-ratures. |
| Bubble instability (vibrating or shaky bubble) | - Check temperature and thickness uniformity of melt at the die.<br>- Check constancy of air pressure inside the bubble.<br>- Add additional bubble guide bars. |

| | | |
|---|---|---|
| | - | Decrease the air flow to the cooling ring. |
| | - | Avoid outside drafts, shield the system from doors, windows and other air currents. |
| Wrinkles and creases | - | Check uneven thickness |
| (A) In blow film | - | Check variation in width |
| | - | Reduce freeze line height |
| | - | If film is too cold, reduce cooling or increase extrudate temperature or lower take-off rolls. |
| | - | Adjust and clean collapsing boards, check for smooth and drag-free passage through flattener and nip rolls. |
| (B) On the reel of finished film | - | Align the nip rolls correctly ensure that two nip rolls are parallel and the pressure across the face of rolls is uniform. |
| | - | Ensure that the winder shaft pulls the film at even and just adequate tension. |
| | - | Use anti-crease or smoothing foils for removing creases. |
| | - | In case of wrinkles due to static electricity on passage of film. Use static eliminator. |
| Blocking | - | Improve the cooling of bubble. |
| | - | Reduce the temperatures at die and head. |

| | | | |
|---|---|---|---|
| (A) Internal surfaces | - | Reduce pressure at nip rolls. |
| | - | Supply cooling water to one of nip rolls. |
| (B) External surfaces | - | Discharge the static electricity before wind up rolls. |
| | - | Check for excessive intensity of corona treatment. |
| Poor strength | - | Adjust relation of linear speed and blow ratio to correct balance. Extrude with a blow ratio of 2:1 to 2.5:1 |
| | - | Lower the frost line |
| | - | Check for die lines which may weaken the film. |
| | - | Use the polymer with lower melt flow index, if possible. |
| Poor optical properties | - | Increase blow ratio between 2 to 2.5:1 |
| | - | Raise frost line. |
| | - | Raise melt temperature. |
| | - | Reduce cooling rate by passing a lower volume of air. |

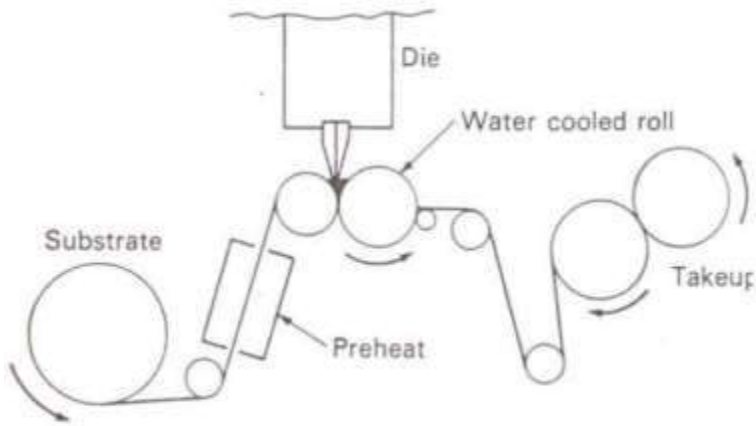



**Figure 4-15**

**A coating unit to place a plastic coating on cloth or paper.**

## Coating

**Figure 4-15** shows the process of coating. Many different materials can be coated with plastic. Paper used for milk cartons is coated with a plastic. The back of carpeting in automobile is coated with plastic. This prevents salt and water from rusting the floor of the car. In the process, the *substrate, or* material to be coated, is preheated to about $200^0$F ($93^0$C). The heated substrate passes through several rollers where plastic is extruded and rolled onto the material. A water-cooled roller is used to cool the plastic. The substrate is then wound up into a roll on the take-off unit.

## Wire and cable coating

Copper and aluminium wire can be insulated with plastic. A group of plastic insulated wires can be made into a cable with extrusion. The wire is pre-heated and then pulled through a die. As it goes through the die, plastic is extruded around the wire. The wire is then drawn through a water bath to cool the plastic.

## Monofilaments

*Monofilaments* are threadlike strands of plastic. The plastic is extruded through a die that has many fine holes. As the monofilaments are extruded, they are drawn through a water bath and then wound on spools. Polystyrene monofilaments are used for toothbrushes and scrub brushes. Nylon is used for fishing line. Polypropylene monofilaments can be woven into rope. The plastic rope is stronger than a natural fiber rope of equal diameter. It is used around swimming pools and for tying up boats. The plastic rope floats and will not rot. Many shirts, slacks, and sport coats are woven with cotton and polyester monofilaments.

## Calendering

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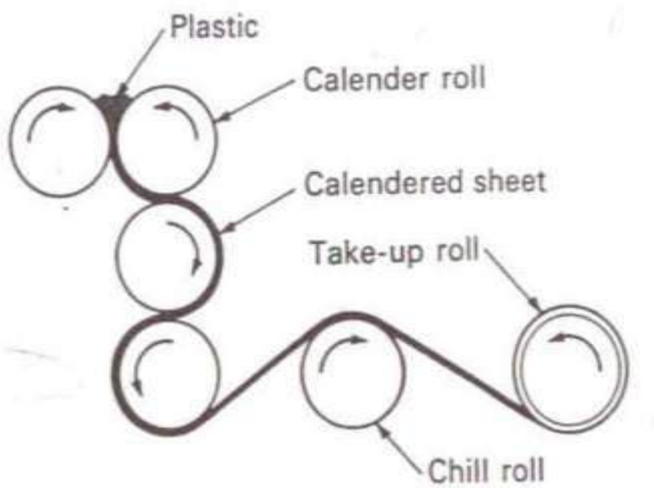



**Figure 4-16**
**Calendering is another process to make plastic and sheets**

*Calendering* is not an extrusion process. It is another process to make plastic film and sheeting. **Figure 4-16** shows the calendaring process. A hot rubberlike mass of plastic is forced into a sheet in the first set of rollers. The plastic is gauged to the proper thickness by the gauging rollers. A chill roll is used to cool the plastic. The thickness of the sheet can be controlled better by calendaring than extrusion. Color and material changes are easier than in extrusion.

Electrical tape, window shades, and shower curtains are calendered. Calenders can also be used to coat paper and fabric with plastic. The rollers could be embossed to give the plastic a textured pattern.

## Blow moulding

*Blow moulding* is the second most important plastic processing method. Plastic bottles are rapidly replacing glass ones. All plastic bottles are made by blow moulding. It is a very high production process. Many small products that are uneconomic for rotational moulding can be blow moulded.

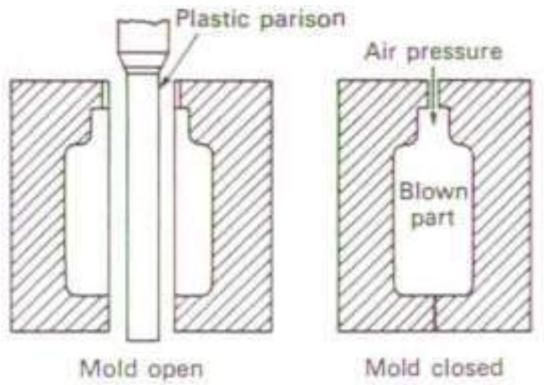



**Figure – 4-17**

In blow moulding, a tube or a *parison* is extruded between an open mould, as shown in **Figure 4-17**. the mould closes and pinches off or seals the top and bottom of the parison. Air is injected into the parison and blows it up to take the shape of the mould cavity. After the part cools, the air is shut off and the part is removed from the mould. The parison is formed by using a ram or a screw extruder. A newer process injection moulds the parison.

One problem with an extruded parison is that it thins out. As the parison gets long, gravity begins to take over. The upper part of the parison next to the die opening thins out. Bottles that have irregular shapes present problems. The bottle will be thinner in the larger diameters of the bottle. To help eliminate both problems, the parison can be programmed. This method of programming will make the parison thicker where the larger diameter of the bottle will be. As the parison thins out from gravity, the programmer will automatically make the parison thicker.

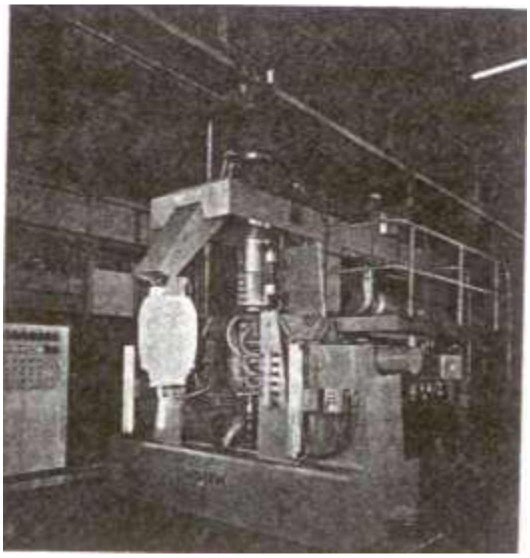


**Figure 4-18**

**An industrial blow moulder with a completed 30 gallon container (Fischer-Voith Plastics Machines Incorporated)**

There are many different types of blow moulding set-ups. The machine can vary from a single cavity to a rotary system with over 20 moulds. **Figure 4-18** shows a typical production extrusion blow moulder. Very large products will usually require an *accumulator*. While the bottle is being blown and cooled, the extruder fills an accumulator or storage chamber with a very large volume of plastic. After the part is removed from the mould, a ram forces the plastic out of the accumulator and through the parison die. Blow moulders range in size from very small to a moulder which will extrude a 220 pound parison. The unit takes only 10 seconds to extrude the parison, which is then blown into a 300 gallon conainer.

The injection moulding of a parison or preform for blow moulding is a new process. It is limited to bottles that are one quart or smaller. The bottle is more accurate because the preform is injection moulded to the general shape of the finished bottle. The bottle wall thickness is very uniform compared to an extrusion blow moulded bottle. The threaded neck and top of extrusion blown bottle require trimming. The pinch-off on the bottom of the bottle also must be removed. This additional trimming operation adds to the cost of the product. The trimmed plastic must be granulated and reused. This will consume additional energy. An injection blow moulded bottle does not require any trimming operations.

At least two moulds are needed for injection blow moulding. One mould is needed to mould the preform and another for blowing the bottle. Even with the added cost for moulds, injection blow moulding is more economical for small bottles than extrusion. Bottles will also have better gloss and clarity than extruded blown bottles.

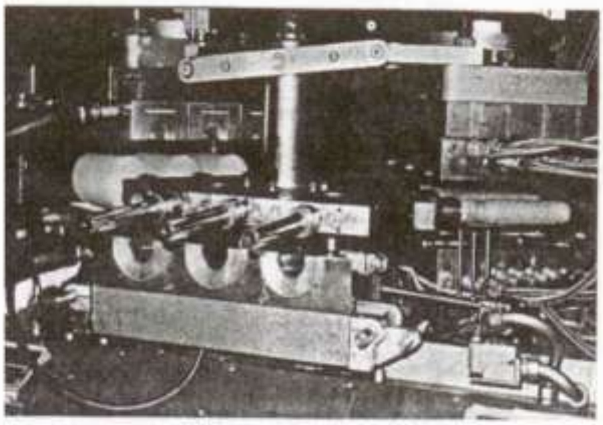


**Figure 4-19**

**An Injection blow moulding machine. The bottles have been stripped from the front mandrels. The injection moulded parisons are coming out of mould to right. The parisons are blown in the mould to the left.**

**Figure 4-19** shows an injection blow moulding machine. Notice that there are two sets of moulds and three sets of *mandrels.* Each set has three mandrels. The completed bottles have been stripped from the center set of mandrels. The preform mould is located to the right. The mould on the left is used to blow the bottles.

The mandrels move in a counter-clockwise direction. The preform from the right mould will move to the blowing mould. At the same time, the empty mandrels will move to the perform mould. The blown bottles then move to the unloading station.

Many thermoplastics can be blow moulded. The most popular plastics are polyethylene and polypropylene. Vinyl is used for clear bottles. There is very little pressure involved in blow moulding. Mould costs are less for blow moulding than compression or injection moulding. Cast aluminum moulds are the most common. Some high production moulds are machined from steel. The moulds are cored for water cooling.

CVSRTA

**Injection moulding**

Injection Moulding is a process of forming an article by forcing the molten plastic material under pressure into a closed metal structure known as mould where it is cooled and solidified into the countours of the mould and subsequently released by unmeshing two halves of the mould.

It is the most important plastics processing method. Over 60 percent of all thermoplastics are injection moulded. It is a very fast high production process. Thermosets are now being injection moulded. Injection Moulding is used for the formation of intricate plastic parts with excellent dimensional accuracy. Typical injection moulded products include pails, refrigerator containers, and chair seats and backs. Disposable products such as plastic cups, knives, forks, and spoons are injection moulded. Radio and television cabinets and control knobs are also injection moulded.

Injection moulding is used to mould many furniture parts using high-impact polystyrene. The fronts of drawers and door panels for dining room and bedroom furniture are injection moulded by many companies. Mirror and picture frames are also injection moulded. The mould is engraved with a wood grain pattern. The moulded part is then finished to match the rest of the furniture. Plastics have the advantages of being less expensive. Also, plastics do not warp or split as wood sometimes does.

**ADVANTAGES OF INJECTION MOULDING**

i. Accuracy in weight of moulded articles.
ii. Choice of desired surface finish and colours.
iii. Choice of ultimate strength of moulded articles.
iv. Faster production and lower rejection rates.
v. Faster start-up and shut-down procedures.
vi. Minimum wastage.
vii. Stability of processing parameters.
viii. Versatility in processing different raw materials.
ix. Option in article sizes by changing the mould.
x. Minimum post-moulding operations.

**INJECTION MOULDING MACHINES**

Injection moulding machines can be classified by the type of injection unit and clamping unit used.

**CLAMPING UNIT (Locking Unit)**

Many types of locking unit have been divised, most of which can be classified into two types namely :

1) Direct Hydraulic Locking Systems.
2) Toggle Systems.

**1. Direct Hydraulic Locking Systems :**

The basic hydraulic locking system is shown in figure 4-20. This system uses a large diameter hydraulic cylinder mounted in the rear platen. The moving platen of mould is attached to the cylinder ram which both opens and closes the mould and provides clamping force.

The advantage of the system are :

- The cylinder is self lubricating and the system has few moving parts.
- Variation in mould heights are easily accommodated.
- The ram speed is controlled by varying the oil flow rate.

Main disadvantage of this system is that it is frequently necessary to move around large quantities of pressurized oil which is wasteful both in terms of power consumption and time.

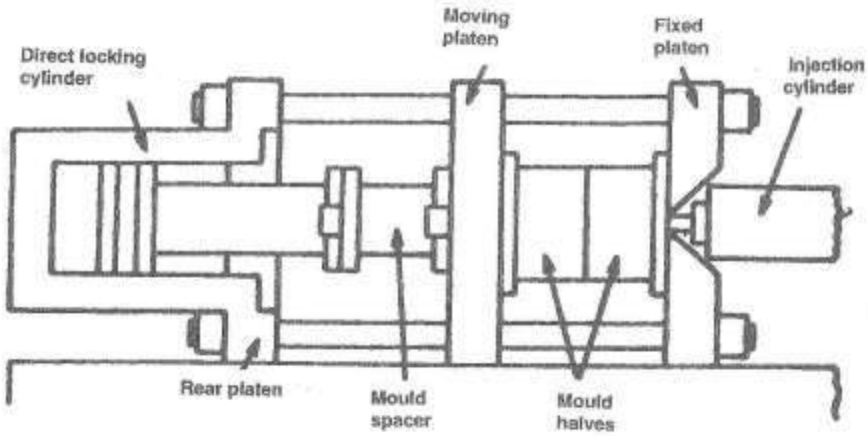



**Figure 4-20 Simple Direct Hydraulic Locking System**

***(The design illustrated incorporates a mould spacer which is useful in reducing the length of stroke of the ram, which is limited to the mould opening necessary to eject the moulding.)***

**2. Toggle Systems :**

A simple form of toggle mechanism is shown in Figure 4-21. By means of the toggle, rapid mould closing may be effected by a small locking cylinder. However, as the toggle bars come into line, the rate of movement of the mould platen slows down to protect the mould surfaces from damage.

If the unit has been properly set only a small force is required to keep the bars in position to provide high clamping force.

The main disadvantage of toggle systems are greater susceptibility to wear and tear of moving parts and the greater care needed to set the system for the correct mould height.

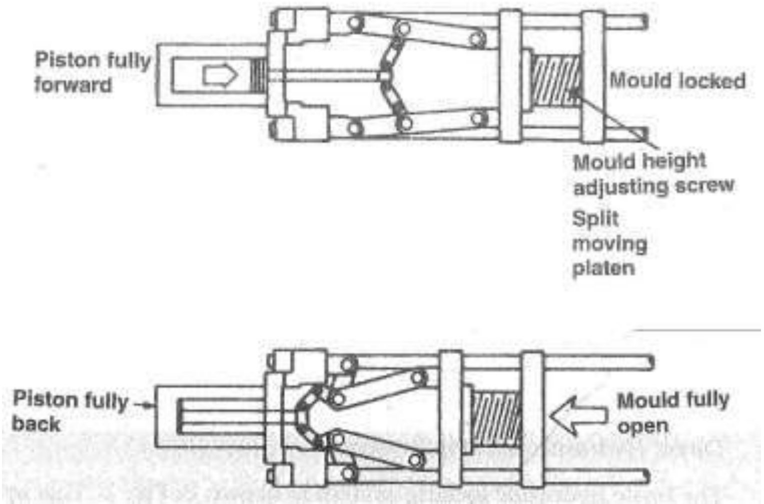


**Figure 4-21 Simple Double Toggle Mould Locking System**

**Injection Unit**

Two injection units can be used at the same time to mould two-color parts such as adding machine and typewriter keys. Foams can also be injection moulded for structural parts in furniture.

An injection moulder is made up of a barrel which is heated to the desired temperature by electrical band heaters. The plastic is stored in a hopper which feeds plastic to the barrel. Cold water is circulated around the base of the hopper so that the plastic does not melt. If the plastic were to melt, it would clog the hopper opening.

There are two basic types of injection moulders. The old type is called a *plunger or ram injection moulder*. The newer type is called a *reciprocating screw injection moulder.* The plunger or the screw moves the plastic through the barrel and out the nozzle into the closed mould.

**Plunger injection moulder**

**Figure 4-22** below shows a *plunger injection moulder.* The plunger or ram is in the forward position and has just filled the mould cavity. The plunger moves back and plastic pellets drop into the barrel. The plunger then moves forward to pack the barrel. Heater bands are used to melt the plastic. After the part has cooled, the mould is opened and the part is removed. After the mould is closed, the plunger moves forward. As the plunger moves forward, melted plastic is forced past a torpedo and out the nozzle into the closed mould. While the part is being cooled, the cylinder is refilled for the next shot. This cycle is repeated over and over.

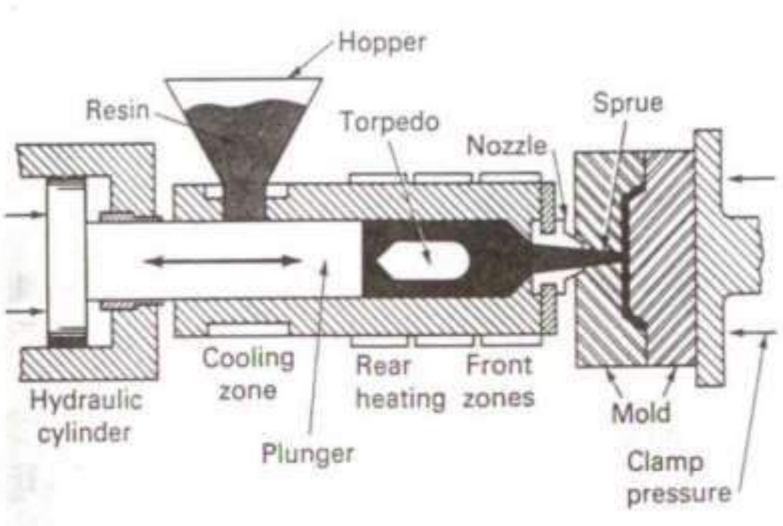



**Figure 4-22**
**A cross-section of a plunger injection moulder showing the main parts.**

The *torpedo* is used to force the plastic tightly against the heated barrel to melt the plastic. It also helps in the mixing of color into the plastic. Even with the torpedo, the plastic is not mixed or melted as well as with the screw injection moulder.

## Reciprocating screw injection moulder

A *reciprocating screw injection* moulder is similar to the plunger injection moulder. The difference is that the plunger and torpedo have been replaced by a reciprocating screw. The screw is called reciprocating because it will move back and forth. The advantage of the screw is that it will mix color into the resin better than a plunger type. The screw also creates frictional heat in the plastic as it rotates. The amount of plastic that is forced into the mould can be controlled more accurately in a screw machine.

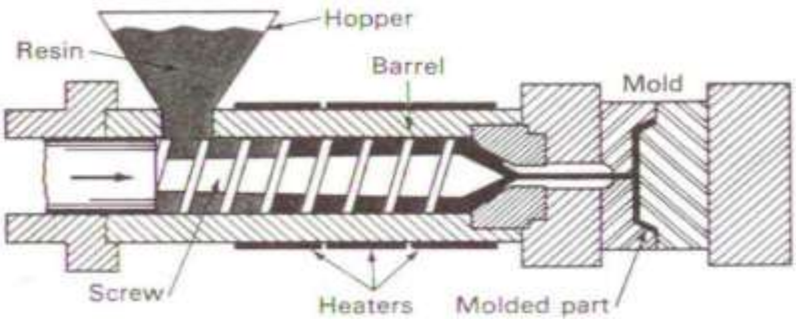



**Figure 4-23**

**A cross-section showing a reciprocating screw injection moulder and the main parts.**

A reciprocating screw injection moulder is shown in **Figure 4-23**. The mould has just then filled and is in the forward position. While the part is being cooled, the screw begins to rotate. The plastic pellets drop into the feed section of the screw from the hopper. As the screw rotates, the pellets are fed from the feed section to the compression section where they begin to melt. The plastic continues past the metering section and is fed in front of the screw. Since the mould is filled, the plastic cannot go out the nozzle. Pressure is built up between the screw and the nozzle. This pressure begins to push the screw back until the required amount of plastic for the shot is in front of the screw. A special tip on the screw keeps the plastic from leaking back over the screw.

The mould is opened after the part has cooled and is removed. The mould is closed and the screw moves forward forcing the plastic into the mould. The cycle is repeated over and over. Very accurate parts can be moulded on a screw machine. Less external heat is needed from the band heaters because of the frictional heat generated in the plastic by the screw.

Small injection moulders may use air pressure to move the plunger and a mechanical method to hold the mould closed. Large injection moulders use hydraulic pressure to move the plunger or screw. Hydraulic clamping devices are used to hold the moulds closed. The moulded part can be removed by hand or automatically from the mould. The design of the part and mould will determine which method of part removal is used.

All machines can be run by manual operation. But this type of operation is usually done on only small machines. Each part of the cycle must be controlled by the machine operator. The moulded parts will not be consistent with manual operation. Semiautomatic operation is used where the part must be removed from the mould by hand. The cycle is automatic until the mould opens. The operator must open the gate to remove the part. Closing the gate will cycle the machine again.

Automatic operation usually eliminates the need for an operator. In automatic operation, the mould opens and the part is ejected from the mould. The machine continues to the next cycle without interruption. Much higher production rates can be achieved on automatic operation. Timers are used to control all parts of the cycle. Higher production rates and fewer machine operators will result in a lower cost of production.

**MACHINE SPECIFICATIONS**

To determine suitability of moulding machine for an injection moulded product, the following machine specifications need to be checked :

- Maximum shot weight capacity of the machine should be more than total weight of article/articles (in case of multicavity mould) plus the runner system.
- Injection pressure should be sufficient to fill the cavities without any short shots.
- Clamping Tonnage required to hold the mould in locked condition should be adequate (otherwise there will be flashes).
- Daylight opening of the machine should be higher than sum total of mould height, plus space required for removal of articles.
- Minimum mould height for the machine should be less than actual height to be mounted.
- Distance

**Equipment and moulds**

The size of an injection moulder is determined by the size of the shot and the clamping pressure. The *shot size* is the maximum amount of plastic by weight that can be delivered at one time. General purpose polystyrene is used to determine shot capacity of a machine. Sizes of machines vary from ¼ ounce to 800 ounces. The larger the capacity, the larger the pressure needed to fill the mould. As injection pressure goes up, so must clamping pressure. If injection pressures overcome clamping pressures, the plastic will leak out or flash between the mould halves. Clamping pressures may go as high as 3,000 tons on large machines. Injection moulding equipment is very expensive. Large machines may cost up to half a million dollars. See **Figure 4-24**.

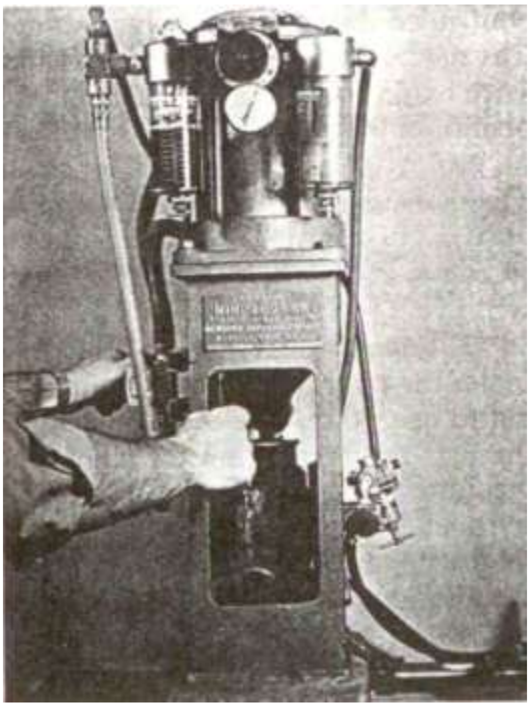


**Figure 4-24**
**A 3/4 ounce laboratory injection moulder**

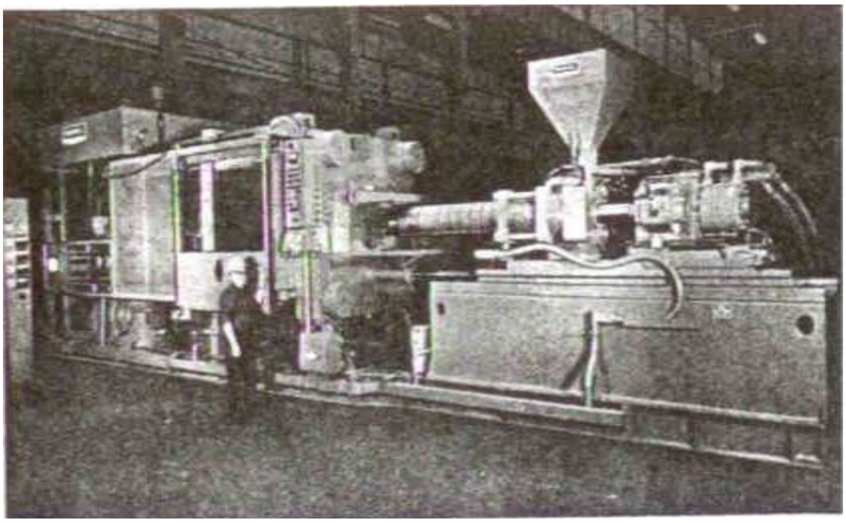


**Figure 4-25**
**An industrial 250 ounce, 1500 ton clamp injection moulder. (Farrel Company)**

Moulds are also very expensive for injection moulding. Because of the very high pressures, moulds must be made out of heavy steel. Machining and polishing costs are high. To increase production, many moulds have more than one cavity. During one cycle, several parts are made instead of one. Moulds are cored for water heating or cooling. See **Figure 4-25**.

**Moulded parts**

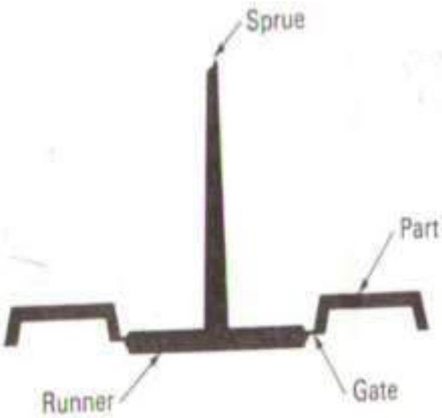



**Figure 4-26**
**An injection moulded two-cavity part showing the sprue, runner, and gate.**

The plastic leaves the barrel through the nozzle. The plastic flows from the nozzle through a tapered sprue bushing in the mould. A runner is used to channel the plastic to each mould cavity. There is a small restriction between the runner and the cavity called the *gate.* **Figure 4-26** shows the parts of a moulded shot. The sprue and runner must be removed. If the part is thermoplastic, it can be granulated and reused again. Some moulds are designed to eliminate the sprue and runner.

**Moulding variables**

There are three major moulding variables that must be controlled for good parts. The variables are temperature, pressure, and cycle time. On large automatic machines, these variables are easier to control than on small machines. Most moulding problems can be corrected by adjusting the variables. All are interrelated and changes should be made one at a time. Sufficient time must be allowed for each change to take effect. Ten or fifteen parts should be moulded before another change is made.

The temperature of the material and mould are very important. If the material temperature is too high, the plastic may burn or degrade. A high temperature will also cause flashing. *Flash* is a fin of plastic around the part. The plastic leaks out between the mould halves. A longer cooling time will be needed if material temperature is too high. The mould cavity will not fill if the material temperature is too low.

The temperature of the mould will affect cooling time. As the mould heats up from each part, the cooling time must be increased. If mould temperature is too cold, the plastic may not flow into the mould properly. The proper mould temperature is determined by the material and design of the mould. Mould temperature may vary from almost freezing to about $160^0$F ($71^0$C).

Injection pressure is another important variable. If pressure is too high, it will overcome the clamping force and cause flashing. If the pressure is too low, the cavity will not fill. Temperature and pressure are very closely related. Temperature will vary for thermoplastics from $375^0$F to $500^0$F ($184^0$C to $260^0$C). If the cavity is not filling, an increase in temperature or pressure or both may be needed to fill the cavity. If the mould is flashing, a lower temperature or pressure or both may be needed.

The cycle time is the third moulding variable. A *cycle* is the total time required to mould a part from start to finish. The machine is adjusted as to temperature and pressure. The barrel is first purged. Purging is done to clean the barrel. The cycle is then set up. The cycle time is dependent on the material and the design of the part. On large machines, all parts of the cycle are controlled by timers.

The object of injection moulding is to make a good product in the shortest possible time. Each part of the cycle can be varied to produce a good part. A typical cycle is made up of: (1) injection, (2) dwell, (3) extrusion, (4) cooling, and (5) ejection.

The time needed to fill the mould cavity is called *injection time*. As the part cools, it shrinks and pulls additional material from the sprue. It will pull in additional plastic if dwell or pressure is maintained until the gate cools. *Extrusion* is the part of the cycle where the barrel is refilled for the next shot. Adequate time must be allowed so that the part cools. If the part is removed too soon, it will warp. Time is also required to open the mould, remove the part, and close the mould. The cycle then starts over again.

A uniform cycle must be set up to mould good parts. If 40 seconds is spent on one cycle and 20 seconds is spent on the next cycle, the parts will not be the same. If the parts are not good using the cycle, then parts of the cycle must be changed. Make one change at a time and mould 10 to 15 parts. Remember that the cycle time is also related to the other moulding variables.

**Moulding thermosets**

Thermosets can be moulded using an injection moulder that has been modified. In the moulding of thermoplastics, the barrel is heated over 500$^0$F (205$^0$C) and the mould is cooled to about 150$^0$F (66$^0$C). The opposite is done for the moulding of thermosets. The barrel heaters are fastened to the mould. Heated water lines from the mould are connected to the barrel. The barrel is heated to about 130$^0$F to 240$^0$F (55$^0$ to 116$^0$C). A special screw is also needed to mould thermosets. Thermosets can be moulded much faster on an injection moulder than on compression or transfer presses.

**Activities**

1. Build your vocabulary:

| | | | |
|---|---|---|---|
| a. | compression moulding | e. | rotational moulding |
| b. | flash | f. | calendaring |
| c. | thermoforming | g. | injection moulding |
| d. | vacuum forming | h. | moulding variables |

2. Obtain a mould and compression mould six acceptable parts.

3. Set up a display of at least ten extrusion products.

4. Obtain two moulds and thermoform two acceptable products.

5. Mould two different products in rotational moulding using plastisol and a powdered plastic.

6. Write a report on either extrusion or blow moulding. Include a description of the process, advantages, disadvantages, and product applications.

7. Set up and injection mould two different products using different plastics. Mould at least six acceptable parts from each mould.

8. Collect at least six plastic products. See if the group can determine which process was used to mould the products.

9. Design and make a mould for thermoforming.

10. Using a rod die, set up and extrude at least 10 feet of acceptable plastic rod.

11. Using your phone book or one from a nearby city, make up a listing of companies according to the products that they mould.

12. Visit a local moulding company and make a report to the group.

13. Design and mould a blister package for the parts that you have injection moulded.

14. Make up a display of the materials that are used for injection moulding.

15. Make a list of the six moulding processes and list at least five product applications for each process.

**TECHNICAL SPECIFICATIONS**

**1. Plastic Injection Moulding Machine**

| | | |
|---|---|---|
| Type | : | Plunger |
| International size | : | 54 – 25 |
| System | : | Hydraulic |
| Standard injection plunger dia. | : | 26 mm |
| Theoretical short capacity in poly sterine | : | 40 gm |
| Injection force | : | 3.0 tonnes |
| Injection plunger stroke | : | 150 mm |
| Injection position | : | Centre |
| Plasticising capacity | : | 4 kg/hr |
| Hopper capacity | : | 5 kg |
| Barrel heating wattage maximum | : | 0.600 x 3 kw |
| Nozzle heater | : | 0.200 kw |
| Temperature controller blind electronic probe F.e. | : | 50 to 400$^{o}$C |
| Electronic timer | : | 0 – 30 sec. |
| Barrel retraction | : | 6 mm |
| Nozzle retraction | : | 3 mm |
| Die locking position convertible H x V | : | Convertible position |
| Injection system horizontal | : | Direct cylinder |

**Clamping unit :**

| | | |
|---|---|---|
| Die clamping force theoretical | : | 20 tonnes |
| Die mounting space V x H | : | 250 x 160 mm |
| Die mounting pattern H x V | : | 250 x 250 mm |
| Die opening stroke | : | 150 mm |
| Die height maximum | : | 250 mm |
| Die height adjustment | : | 50 mm |
| Day light | : | 400 mm |
| Tie rod hard chrome plate | : | 35 mm dia. x 2 |
| Die opening and closing speed | : | Adjustable |
| Free cycle | : | 5 seconds |
| Built in power pack | : | Hydraulic |

| | | |
|---|---|---|
| Pump motor | : | 3 hp |
| Hydraulic oil required | : | 120 litres |
| Heat exchangers | : | 3 hp |
| Hydraulic pump | : | Gear pump model 8 R |
| Directional controlled valve | : | Electrical |
| Valve mounting system manifold | : | 3 CETOP |
| L x W x H of the machine | : | 2.1 x 0.55 x 1.6 m |
| Machine weight | : | 450 kg |
| Total electrical load | : | 6 kw |

**2. 75 mm PP/HDPE slit film plant**

| | | |
|---|---|---|
| Output | : | 60 kg per hour of a single screw 75 mm extruder |
| **Extruder** | : | 75 mm single screw extruder mounted on a sturdy frame of heavy steel sections. |
| Capacity | : | 80 kg |
| Screw diameter | : | 75 mm |
| Material | : | Nitro alloy steel and Nitrided |
| L/D ratio | : | 24:1 |
| Barrel | : | To suit 75 mm diameter screw |
| Material | : | Nitro alloy steel – nitrided |
| Heating system | : | Band type heaters |
| No. of zones | : | 3 zones on barrel |
| Total heating load | : | 19.50 kw |
| Hopper | : | Steel fabricated with glass window for visual inspection of raw material level. |
| Cooling arrangement | : | Feed section cooled by water recirculation through a jacket. Blowers for barrel cooling in $2^{nd}$ and $3^{rd}$ zones. |

| | | |
|---|---|---|
| Main drive | : | 30 hp, dc motor with thyristor control for infinite speed variation. |
| Transmission system | : | 'V' belts from motor to reduction gear box. Chain and sprocket drive from gear box to screw. Safety guards are provided. Screw is mounted in a cast bearing housing having thrust bearings which are so designed so as to withstand the thrust developed during extrusion. |

**Cross-head and die**

| | | |
|---|---|---|
| Die size | : | 175 mm dia. hard chrome plated. |
| Die setting | : | Centering screws provided to adjust die lip gap. |
| Type | : | Bottom fed type |
| Heating zones | : | 2 nos. |
| Heating system | : | Band type heaters |
| Total heating load | : | 5.00 kw |

**Air cooling ring and blower**

| | | |
|---|---|---|
| Construction | : | Aluminium cast air cooling ring for cooling the film bubble. The ring has a circular casing with many air entries and circular insert as an air guide for air impinging on the film bubble. |

| | | |
|---|---|---|
| Blower | : | One number with damper valve for air flow control. |
| Blower drive | : | 5 hp, ac motor. |

**Air compressor**

One number for blowing of the film (complete with pipeline and air flow control cock).

| | | |
|---|---|---|
| Compressor drive | : | 1 hp, ac motor. |

**Control cabinet**

Fabricated from steel sheets and mounted on a robust fabricated frame. It includes :

Solid state temperature controllers

Thermocouples

Ammeters

Main isolator switch with fuse unit

Voltmeter for main supply voltage

Energy regulator

Fuse units, connector plates for heaters outgoing connections.

Controller switches, contactors, relays, pilot lamps, etc.

On-off push-buttons for the motors of blower and compressor.

**Vertical take-off unit :**

| | | |
|---|---|---|
| Nip rollers | : | Mounted in ball bearings |
| Material of construction (Nip rollers) | : | Ebonite roller<br>Rubberised roller |
| Nip roller's length | : | 600 mm |
| Nip roller drive | : | 0.5 hp, dc motor with reduction gear box and rectifier control. |
| Speed variation | : | From 2 to 20 m/min (infinite variation) |
| Bubble guide | : | Collapsible wooden flattening boards to guide bubble into nip rollers. |

| | | |
|---|---|---|
| Vertical tower structure | : | Fabricated from steel sections. Guide rollers fitted in tower to guide layflat downwards. |
| Height of tower frame | : | 4500 mm from floor |

**Preliminary take-off :**

Provided with guide rollers to maintain proper tension of film.

| | | |
|---|---|---|
| Sitting arrangement | : | Multi slitter with required number of blades to slit 96 tapes for side slitting arrangement. |

**First goddet :**

Consists of a robust fabricated stand on which the rolls are supported on heavy bearings.

**Rolls :**

| | | |
|---|---|---|
| Material of rolls | : | M.S. chrome plated |
| Upper rollers : | | |
| Diameter | : | 300 mm |
| Length | : | 600 mm |
| Bottom rollers : | | |
| Diameter | : | 150 mm |
| Length | : | 600 mm |
| Goddet drive | : | 3 hp, dc motor and gear box with chain and sprocket arrangement. |
| Speed variation | : | Infinite variation through rectifier control. |
| Range | : | From 2 to 20 m/min |

| | | |
|---|---|---|
| Pressure roller | : | Rubberised roller mounted on first goddet roller and last goddet roller to prevent slippage of tape during operations. |

**Orientation hot plate :**

Specifically designed for orientation of PP and HDPE tape. It consists of a robust stand, fabricated from a heavy steel sections and S.S. 304 plates. Heating to the hot plate is through hot oil circulation to ensure uniform heat distribution and uniform temperature throughout the plate. Suitable gear pump for hot oil circulations, one temperature controller, heating and pumping unit, are provided.

| | | |
|---|---|---|
| Width of S.S. 304 plate | : | 600 mm |
| Length of plate | : | 1800 mm |
| Pump | : | 5 hp, ac |
| Heating load | : | 12 kw |

**Second goddet :**

Consists of a robust fabricated stand on which the rolls are supported on heavy bearings.

**Rolls :**

| | | |
|---|---|---|
| Material of rolls | : | M.S. chrome plated |
| Upper rollers : | | |
| Diameter | : | 300 mm |
| Length | : | 600 mm |
| Bottom rollers : | | |
| Diameter | : | 150 mm |
| Length | : | 600 mm |
| Goddet drive | : | 7.5 hp, dc motor and gear box with chain and sprocket arrangement. |

| | | |
|---|---|---|
| Speed variation | : | Infinite variation through rectifier control. |
| Range | : | From 15 to 150 m/min |
| Pressure roller | : | Two nos. rubberised roller one each on first and last goddet rollers to prevent slippage of tape during operation. |

**Stabilization oven :**

The oven is fabricated from heavy steel sections and sheets. It is specially designed to function at maximum efficiency with reduced power consumption and insulated to minimize heat loss. Air flow is from a high pressure blower driven by a suitable ac motor. Heating is by electric open coil heaters arranged in the lower chamber. The baffling arrangement of air provided ensures maximum utilization of heat energy. Hot air is recycled. Solid state temperature controllers ensure the maintenance of constant temperature by automatic on-off control of heaters.

| | | |
|---|---|---|
| Blower drive | : | 2 hp, ac motor |
| Heating load | : | 18 kw |
| Oven dimensions | : | 600 mm width x 2440 mm long |

**Third goddet :**

It consists of a robust fabricated stand on which the rolls are supported on heavy bearings.

**Rolls :**

| | | |
|---|---|---|
| Material of rolls | : | M.S. chrome plated |

Upper rollers :

| | | |
|---|---|---|
| Diameter | : | 300 mm |
| Length | : | 600 mm |

Bottom rollers :

| | | |
|---|---|---|
| Diameter | : | 150 mm |
| Length | : | 600 mm |
| Goddet drive | : | 3 hp, dc motor and gear box with chain and sprocket arrangement. |
| Speed variation | : | Infinite variation through rectifier control. |
| Range | : | From 15 to 150 m/min |
| Pressure roller | : | One no. rubberised roller on last goddet roller to prevent slippage of tape during operations. |

**Master head :**

It consists of one rotating drum mounted on a sturdy structure, driven by the third goddet drive by belt and pulley arrangement. All the tapes are taken onto this drum at start up and then onto the cheese winders.

**Cheese winders :**

A set of 96 cheese winding units designed fro uniform criss-cross winding of tape. Each winding unit is driven by an individual torque motor with independent on-off switch control. The automatic traverse arrangement consists of hardened cam and follower. The traverse drive is by special timer belt.

Individual torque control is provided for each cheese winding unit for precise and independent adjustment of winding tension. In addition to this group controllers are provided.

The cheese winders are mounted on a sturdy structure. The cheese base is a plate on which the complete assembly is made.

## 3. HM-HDPE blow film plants

| | | |
|---|---|---|
| Screw diameter | : | 45 mm |
| Main drive | : | 15 hp, dc |
| Extrusion cpacity | : | 22 kg/hr |
| Layflat width | : | 150 to 600 mm |
| Minimum gauge | : | 40 g |
| Dies (spiral type) | : | 25, 50, 75 mm |
| Nip roll size | : | 750 mm |
| Winder | : | Type – Four station<br>Drive – Torque motors |
| Connected load | : | 27 kw |
| Overall dimensions | : | 6300 x 2400 x 4500 mm |

## 4. Plunger type injection moulding machine

| | | |
|---|---|---|
| Plasticizing capacity (Polystyrene) | : | 18 kg/hr |
| Shot capacity (Polystyrene) | : | 75 gm |
| Diameter of injection plunger | : | 32 mm |
| Maximum load on injection plunger | : | 7.5 tonnes |
| Stroke of injection plunger | : | 228 mm |
| Maximum no. of shots per shift | : | 1200 nos. |
| Space between tie-bar | : | 241 x 241 mm |
| Mould opening | : | 241 mm |
| Maximum mould thickness | : | 241 mm |
| Day light opening | : | 482 mm |
| Minimum mould thickness | : | 150 mm |
| Mould clamping force | : | 45 tonnes |
| Capacity of hopper | : | 12 kg |
| Electric motor | : | 3 ph, 1440 rpm, 5.6 kw/7.5 hp |
| Heating unit consumption | : | 2 kw |
| Heat controlled by (thermotrols) | : | 3 nos. |
| Nozzle diameter | : | 19 mm |
| Ejector in platen | : | Side and centre |
| Diameter of locating ring | : | 110 mm |

| | | |
|---|---|---|
| Depth of locating ring | : | 5 mm |
| Capacity of oil tank | : | 160 mm |
| Floor space | : | 2540 x 560 mm |
| Total height of the unit | : | 1660 mm |
| Gross weight | : | 1500 kg |

**5. Semi automatic blow moulding machine**

| | | |
|---|---|---|
| Capacity | : | Minimum – 1 litre |
| | : | Maximum – 10 litres |
| Screw diameter | : | 65 mm |
| L/D ratio | : | 20:1 |
| Motor | : | 12.5 hp |
| Heating load | : | 9.850 kw |
| Plasticizing capacity | : | 40 – 50 kg/hr(normal) |
| Parison control in stages | : | 3 |
| Gross weight | : | 2.5 tonnes |
| Net weight | : | 1.5 tonnes |

**Questions :**

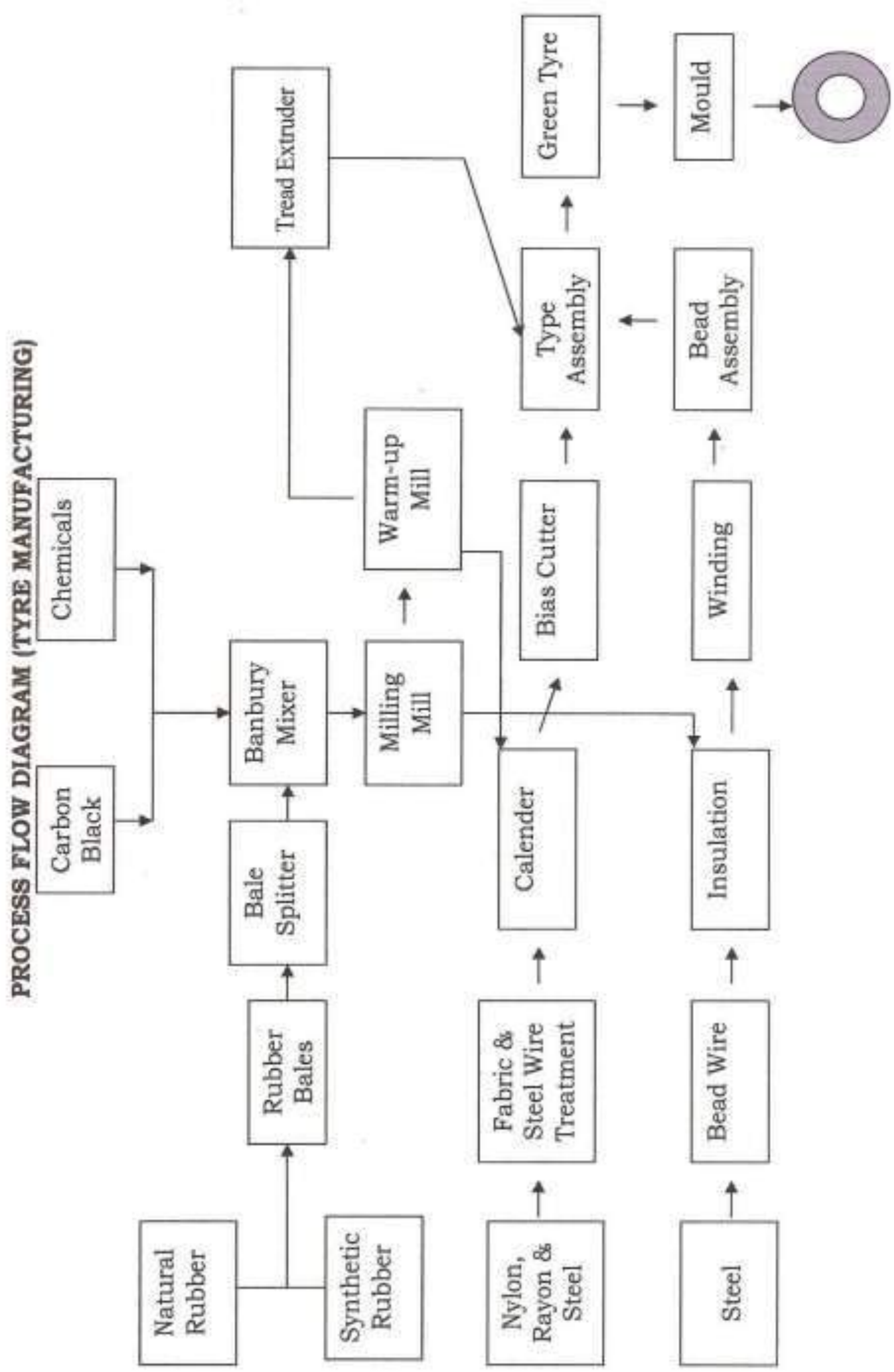
(a) Explain moulding and forming of plastics.

(b) Write short notes on
- Extrusion
- Blown film
- Coating
- Monofilaments
- Blow moulding
- Injection moulding

(c) Provide data to be collected while taking inventory of following machines to get current prices :
- Plastic injection moulding machine
- PP/HDPE slit film plant
- HM-HDPE blown film plants

# UNIT – 5

## RUBBER (AUTOMOBILE TYRE)



**Automobile Tyre Manufacturing Process**

In the tyre industry the finished product is not obtained by assembling different components as is observed in most other manufacturing.

In the tyre industry, the assembled components need to be further processed before obtaining a final finished product.

A tyre is made of 3 important components : (1) Tread Rubber (outer portion)

(2) Carcass (inner portion)

(3) Bead (side of the circular portion)

The manufacturing of a tyre is a four stage process:

* Component processing
* Component making
* Component assembling
* Moulding, curing and finishing

**Component processing:**

The two processes are:

* Preparation of rubber compound
* Preparation of fabric by dipping in latex

**Preparation of rubber compound:**

Large bales of raw rubber are cut into smaller pieces which are masticated and mixed with chemicals.

Common chemical compounds like Carbon-black sulphur, accelerators, retarders, processing aids, etc. are mixed with rubber or masticated rubber. This is known as mother stock or master batch. As per the technical specifications, mother stock is mixed with carbon black and other chemicals. This process of mixing is carried out in large mixers or open mills. This rubber compound is used for making tread, under tread, insulation and as topping for fabric preparation and bead.

In preparation of the rubber compound both natural and synthetic rubber is used as per specifications of the Rubber Manufactures Association and as per the end use. Normally for truck tyres, Natural Rubber is used & for Car tyres Synthetic Rubber is used. This is due to the various properties of these rubbers.

**Preparation of fabric:**

The fabrics used in tyre industry are cotton, rayon polyester and nylon and for Radial tyres high tensile steel belt known as Beakers are used. The rayon and nylon fabrics are first dipped in a latex mix to obtain better adhesion of cord/rubber. It is then given a cover of rubber compound by passing it though a 3 or 4 roll calenders. Cotton fabrics just need to be dipped and topped with rubber compound to meet requirements for different products. Nowadays cotton & Rayon usage has been stopped due to less strength of these fabrics compared to Nylon or Polyester fabric.

**Dipping:**

A dipping mixture consists of latex and chemicals. The chemicals are mixed with soft water and are treated at specific temperature and then blended with latex and water. This is known as DOPE. Fabric rolls are passed through a tank of DOPE and the amount of coating depends on the speed of the roll of fabric passing through the tank. The treated rolls are dried and are kept in a hot cellar to remove any trace of moisture before they are taken out for toping or calendaring.

**Spreading:**

A coating of certain types of cotton fabrics is not carried out by the process of dipping but spreading. Rubber compound is cut into small pieces and is placed in containers filled with solvents until a semi-liquid mass is obtained. This is passed through a mixing machine in which a required quantity of solvent is added till a smooth dough of consistent viscosity is obtained. The fabrics are dried in a separate eight drum drier and then fed into a spreading machine where it is coated with dough. At present this process is rarely used due to fire hazards, less productivity, quality, consistency, etc.

**Topping:**

The dipped or spread fabrics are then given a coating of thin film in a calendar machine by a compound first warmed up in a warming and feeding mill. A calender machine consists of 3 or 4 rolls with a very thin opening through which fabric roll is passed. In a 3 rolls Calender the fabric is topped up with rubber only on one side and again it has to be passed through the Calender to top up the other side. whereas in a 4 roll calendar both the sides gets topped up simultaneously.

**Frictioning:**

A topping compound is pressed on top of fabric but in a frictioning process, the compound is pressed between the textile cord in fabric rolls. The frictioning fabric is usually used as CHAFER for covering the beads.

Cotton, nylon, polyester, steel belt and rayon are used according to the strength required for the type of tyre. In India, Nylon is most widely used as fabric in manufacturing a tyre.

**Making components:**

Rubber compound, fabrics and wires are converted into components of tyres by

* Extrusion
* Calendering
* Fabric / Steel Wire Cutting
* Bead making.

**Extrusion:**

In the extrusion process a rubber compound is forced through a die of an Extruder after warming it up and tyre treads are produced as per the required dimensions. Rubber tube is also produced in this manner. Components such as treads & tubes are produced by this process.

**Calendering :**

A calendaring process is used for producing coated fabric & coated steel wire fabric. Components such as plies, breaker, chafer, etc. are produced by cutting of calendered fabric & steel wire fabric.

**Component assembling:**

It consists of two major processes –

- Bead making
- Cover making

Bead making:

A ring of bead wire coated with a rubber compound is formed on a former machine. It is then wrapped with fabric and then it is covered with bead filler to obtain a complete bead.

Cover making:

In cover making, fabric, plies, insulation, bead breaker, chafer, undertread are placed on a former to give a raw cover. The amount of fabric piles etc. needed to produce a raw cover depends upon the specifications required for the type of cover.

**Tyre Building**

All these components like tread, plies, beads are now joint together to make a green tyre in the shape of a drum. First the beads are fitted on the sides of the tyre building machine drum. Over these, plies are fixed which are already cut as per the requirement on the Bias cutter. The no. of plies usually varies from 4-16 as per the size and strength of the tyres. Once the plies are stuck one over the other then the tread is fixed over the plies.

After fixing up all the components the green tyre in shape of a drum gets produced.

In the case of Radial tyre, before application of belts, the green tyre is expanded from cylindrical to a torodial shape. The belts and the tread are then assembled. This can be done in two stages or in one stage where drum can be expanded to the torodial shape in the same stage.

**Moulding, curing and finishing:**

A process of vulcanizing is known as curing. The green tyres are cured in moulds and the method used depends on the technological requirements.

The process of moulding is carried out in three stages –

* Bagging
* Moulding and curing
* Debagging and finishing

A curing bag is placed inside the green tyre which is then put into hydraulic moulds. In small tyres, the process of bagging and debagging is carried out manually. For big tyres the bagging and debagging process is carried out by machines. The mould is heated from outside by steam & the inside portion is heated by passing stream/hot water. The cured tyre is trimmed and the finished product is packed after inspection. In modern machines, bagging and debagging is not required. The inside curing of a green tyres is done through a diaphragm attached to the moulding press known as Bag-o-matic Press. The cured cover coming out is taken to the finishing section for trimming and inspection.

In good old days the moulding was done in an autoclave and the curing time and pressure depended on the size of the cover. This process has been stopped as it affects the productivity & quality of the tyres.

Radial Tyre Curing :

Radial tyres with wire cord bodies are vulcanized in special segmented moulds to avoid distortion of tyre components.

**Manufacturing process of tube making:**

In the process of tube making, the rubber compound is heated and passed through extruding machines and the tubes coming out are cut into specific lengths. Rubber tubes need the fixing of valves on them and their ends needs to be joined. The valves are attached to the tubes by special adhesives and ends are joined in a joining machine. Curing of tubes is then carried out by slightly inflating them with air. The tubes are then ready for inspection and packing.

- **Brief description and function of major machines :**

**Banbury mixer:**

Banbury mixers are of two types:

(i) Tangential (ii) Intermeshing rotor type

A tangential mixer is similar to a two roll mill with an enclosed chamber. Its main purpose is to mix carbon black oil, processing aids & chemicals into the rubber compound. But today they are designed to increase the output and control properties of rubber which is fully automotised.

Modern day mixers are both manual and automatically controlled units with monitoring capability for each phase of mixing. The latest mixers provide excellent quality, uniformity and output.

Mixers can be batch or continuous type. The advantage of a batch mixer is that it can accept materials of various shapes and forms. A continuous mixture requires continuous weighing and feeding of the ingredients and are used to provide pellets or a granular form of rubber.

**Open roll mills:**

Open roll mills are used for uniform dispersion of ingredients in rubber as per specifications and formula. The rubber compound is warmed up and then fed to internal batch mixers.

**Extruder:**

Extruders are mainly screw type. The screw pushes the material through a die for making rubber compound in the form of pellets or rubber sheets after passing through a pair of rollers. Extruders are designed with respect to diameter, length, speed of screw and pressure needed for extrusion. The extruders are also designed for minimum temperature rise and decrease in temperature of compound during the time it is passing through the extruder.

**Calender:**

A calender consists of three iron rolls.  Calenders are used to provide rubber sheeting of different lengths and thickness.  Calenders are also used for coating fabrics, cord and wire with rubber for construction of tyres and conveyor belts.  The temperature control of rolls is carried out by using cored or rolls drilled with holes. An automatic temperature control device used with drilled rolls provide excellent temperature control.  The speed of roll is controlled by a single motor drive with gears or a variable speed motor for each roll is used.  Modern calendars have built in provisions for bending rolls and altering the relative position of rolls.  It provides for a uniform thickness of material.  Automatic adjustment of the roll position and bending produce an accurate thickness of the rubber sheets.

**Vulcanizers:**

Vulcanizers are press curing type devices.  It moulds articles by compression transfer or injection methods.  A saturated steam, electrically heated platens or radio frequency waves are used as heat sources.  The pre-heated compounds are press cured without scorching so that proper desired shape is obtained with minimum time consumption and after removing from the mould it should have an attractive surface in finished form.

**DESCRIPTION OF AUTOMOBILE TYRE MANUFACTURING PLANT**

1. **Banbury Mixer**

A Banbury mixer size & dimensions depend on its capacity. It varies from 45liters – 165 liters.

Body

| | | |
|---|---|---|
| Size | : | 11 |

Mixer equipped with drop type discharge door and a conversion drive for processing rubber.

Mixer specifications

| | | |
|---|---|---|
| Floating weight | : | Cylinder diameter 400 mm |
| Design type | : | Double cable 'V' bottom |
| Finish | : | Chromium plated |
| Design type | : | Standard feed |

Dust stops

| | | |
|---|---|---|
| Design type | : | 'SSA' TH & CP |
| Wearing ring material | : | Steel plated |

Chamber sides

| | | |
|---|---|---|
| Design type | : | DR. SIDE 562 mm |
| Bore surface | : | Farrel Alloy 13 |

Rotors

2 Wiring

| | | |
|---|---|---|
| Surface material | : | Chromium plated |
| Type of motor bearings | : | Roller |
| Lubrication by | : | Circulating oil system |

End plates

| | | |
|---|---|---|
| Design type | : | 'SSA' |
| Finish | : | Farrell Alloy 10 |
| Type of cooling | : | By water |

Discharge door

| | | |
|---|---|---|
| Design type | : | Drop construction radial |
| Door surface | : | Farrell Alloy 10 |

Gear drive

| | | |
|---|---|---|
| Type | : | Standard drive |
| Rating | : | 500 hp |
| Input | : | 992 rpm |
| Output | : | 162 rpm |
| Shaft rotation | : | Anti-clockwise |
| Input shaft dia. | : | 156 mm |
| Key way | : | 45 mm W x 19 mm D x 340 mm L |
| Main drive motor | : | 500 hp, 992 rpm, 440 V |

**2. <u>2100 mm Mixing Mill</u>**

Equipped with Bull gear pinion drive.

| | | |
|---|---|---|
| Drive motor | : | 250 hp at 1000 rpm |

Rolls

Drive (back) roll

| | | |
|---|---|---|
| Material | : | Chilled C.I. |
| Design | : | Coned |
| Finish | : | Smooth |
| Maximum temperature | : | 120 deg. C |
| Speed | : | 20 rpm |

Adjustable (front) roll

| | | |
|---|---|---|
| Material | : | Chilled C.I. |
| Design | : | Drilled |
| Finish | : | Smooth |
| Maximum temperature | : | 120 deg. C |
| Speed | : | 22.5 rpm |

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Journal boxes

| | | |
|---|---|---|
| Lining material | : | Copper Alloy |
| Friction ratio | : | 1.14:1 |
| Base plates | : | Fabricated |
| Mill base | : | Fabricated |
| Drive base | : | Fabricated |
| Guide mechanism type | : | Fixed |

Roll adjustment mechanism

| | | |
|---|---|---|
| Type | : | Manual connected to journal box by pull back arrangement<br>Oil re-circulating |
| Emergency stop device | : | Overhead type |
| Stockpan | : | Steel fabricated with rollers underneath |

Drive specification

| | | |
|---|---|---|
| Gear drive | : | Flender S2N – 320 |

Drive method

| | | |
|---|---|---|
| Bull gear pinion | : | 140 T/26 T |
| Gear pinion ratio | : | 1.14:1 |

**3. <u>Cracker Mill</u>**

| | | |
|---|---|---|
| Size | : | 1500 mm |
| Working roll size | : | 560 mm dia. x 1524 mm face width |
| Bak roll surface speed | : | 30.5 m/min maximum |
| Friction ratio | : | 1:1.3 |

Rolls

Chilled cast iron rolls internally cored, fully machined working face and journal diameter ground finished with necessary galvanized iron spray pipe with spray holes. Each roll end is equipped with open bell mouth piece. Surface hardness is 500 ± 25 BHN having a chill depth of 15 – 20 mm. The back roll is corrugated with contours.

Roll housing and caps

Roll housing and caps are of heavy duty cast steel. The necessary machined surfaces are provided on the top caps to accommodate various mill accessories. Frames are bored to accept nip adjustment mechanism.

Roll journal boxes

Roll journal boxes are of close grained cast iron with wear resisting full bronze bushes. The bearing surfaces have high surface finish to suit the clearance of the individual roll journal. Aluminium labyrinth oil seal is provided at both ends of bearing boxes.

Base frame

Base frame is fabricated by heavy duty steel. Base frame is separate for main machine and drive but are combined through dowels for ease of alignment and assembly at site. The machine and the drive is bolted down to this frame.

Guides

Guides are of fixed design mounted on bearing boxes with a provision for raising and lowering to adjust the gap between roll and guide. The guides are machined from single steel section and the curved contours coming in contact with the roll working surface is provided with Polyamide type material.

Roll adjustment

The front roll journal boxes are provided with pull back type arrangement along with adjusting screw for the movement of front roll. The adjusting screw is of carbon steel while the nut is cast steel. Shear pins fabricated in steel is supplied and provided between the journal box and nip adjusting screw to safeguard the rolls when overloaded.

Mill pan

Mill pan is fabricated from heavy gauge sheet steel mounted on rollers or fixed in position.

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Lubrication system

Lubrication system comprising of oil tank with strainer, level gauge, oil circulating motorized pump, filter, heat exchanger, pressure switch and relief valves with necessary distributing headers. Inter-connecting piping is provided for lubricating the bush bearings in the bearing boxes.

Grease nipple lubrication is provided for nip adjustment screw assembly.

The lubrication return lines have drain manifolds for visual inspection. The lubrication unit is with rotary gear pump driven by motor. Splash type lubrication is provided for bull gear and pinion.

Safety device

Safety device is overhead wire type. The limit switch is mounted on the mill caps and connected to the control panel.

Gearbox

The helical gearbox with a service factor of minimum 1.5. The gearbox is with hardened and ground gears and complete with splash lubrication system.

Bull gear, pinion and connecting gears

The bull gear is of high grade cast steel with hob cut teeth. The pinion is of EN Alloy forged steel with hob cut teeth. The connecting gears are of Cast Steel Grade-I with hob cut teeth having friction ratio of 1:1.3. These gears are mounted on Mill Housings and is totally enclosed in a heavy gauge sheet steel enclosure.

Motor and control panel

150 kw, 990 rpm, AC motor and controls.

Coupling

All input/output couplings including brake drum is provided.

Brake unit

Pneumatically operated brake including brake drum is provided. Control voltage for all solenoids is 110 volts.

## 4. <u>Tyre Building Machine</u>

Function

This machine is ideally suited for building green tyres of bead size from 500 mm to 750 mm. The stitching of beads, ply and bead done by means of a cam controlled triaxial stitcher.

Capacity

| | | |
|---|---|---|
| Drum diameter | : | 530 to 990 mm |
| Drum shoulder set | : | 400 to 900 mm |
| Drum centre line from floor | : | 950 mm |
| Maximum ply width | : | 1400 mm |
| Bead dia. range | : | 500 to 750 mm |
| Drum shaft speed | : | 280/140 rpm |
| Electrical supply | : | 415 V, 50 Hz, 3 phase |
| Air supply | : | 7 kg/sq. cm. (100 psi) |

**Machine details**

Head stock assembly

The drum shaft is supported on adequate capacity bearings for the overhang and the lead, in a fabricated head stock. The drum shaft is driven by a two speed AC motor through 'V' belts. A quill with necessary brake drum for collapsing the drum is supported on the drum shaft so as to rotate freely over the drum shaft. An adapter is provided at the end of the drum shaft for outer head setting. A pneumatically operated inner head adapter can also rotate and allows the bead setter ring to take any position, radially pneumatically operated shoe type brakes are provided for drum collapsing.

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Stitcher

A triaxial stitcher mounted on the opposite side of the operator is connected to the base by a bracket. The stitcher rolls mounted on the lever of an integrally cast pneumatic cylinder move in all three axis at different speeds. The movement of stitcher rolls is guided to stitch over the correct profile of drum by means of cam and limit switch arrangement.

Control panel (electrical)

A machine mounted control panel consisting of a control transformer, protective fuse and switch fuse unit mounted on the top of head stock. A push button panel is mounted at the front of the driving head for operator’s convenience. A joy stick is mounted on the front side to control all the movement of the stitcher unit.

Instruments and controls

A filter regulator and lubricator unit and the solenoid valves are mounted at the rear of the driving head and complete piping is provided for the air cylinders. A set of foot switches are mounted at the front of the machine to control the machine operation and a set of limit switches and cam controls the stitches movement.

**5. <u>Three Roll Calender with Conveyor Belt System</u>**

| | | |
|---|---|---|
| Design | : | 3 rolls |
| Roll diameter | : | 650 mm |
| Width of roll body | : | 1650 mm |
| Processing speed | : | 6-24 m/min |
| Control range | : | 1:4 |
| Principle of drive | : | Central drive |
| Drive side | : | Right hand drive in processing direction |
| Roll adjustment rate | : | 2.2 mm/min |
| Press roll dia. | : | 260 x 1550 mm |
| Lubrication | : | Central grease lubrication other than bearings. |

| | | |
|---|---|---|
| Foundation plate | : | Grey cast iron connected to each other by means of bolted cross connection stone bolt are raised to secure the foundation bolt. |

Motor

| | | |
|---|---|---|
| Main motor | : | 150 kw, DC |
| Installation output | : | 5 kw, DC |
| Secondary drive | : | 8 kw, DC |

Leonard set consisting of:

| | | |
|---|---|---|
| Control generator | : | 188 kw |
| Driving motor | : | 235 kw |
| Exciting generator | : | 8 kw |
| Total connecting output | : | 245 kw |
| Kind of protection | : | 1P 445 TRA-II |
| Operating voltage | : | U = 440 V, 50 c/s |
| Control voltage | : | U = 230 V, 50 c/s |
| Direct voltage produce | : | U = 440 V |
| Armature | : | 220 V |

## 6. Truck Tyre Curing Press

| | | |
|---|---|---|
| Size | : | 2200 mm |
| Size of tyres being vulcanized | : | From 18 – 24 up to 30.5–32R |
| Tyre maximum external diameter | : | 1820 mm |
| Tyre maximum internal diameter | : | 610 mm |
| Tyre profile width (maximum) | : | 745 mm |
| Maximum pressing strength | : | 740 t |
| Steam chamber inside diameter | : | 2200 mm |
| Mould height | : | From 600 up to 900 rpm |
| Production capacity when building tyres size 30.5-32R pcs. per hour | : | 0.32 |

Working media

| | | |
|---|---|---|
| Steam for shaping in bladder: | | Not more than 4.5 kg/sq.cm. |
| Steam for vulcanization in steam chamber | : | 6 kg/sq. cm. |
| Steam for vulcanizing in bladder | : | 16 kg/sq. cm. |
| Superheated water for vulcanization in bladder | : | 25 kg/sq. cm. |
| Water for bladder cooling | : | 4 kg/sq. cm. |
| Water for hydraulic drive | : | 25 kg/sq. cm. |
| Air in control system | : | 2 kg/sq. cm. |
| Vacuum in bladder | : | Not more than 400 mm Hg |
| Superheated water temperature | : | 185 $\pm$ 5 deg. C |
| Mould closing and opening time | : | 90 seconds |

Motor power

| | | |
|---|---|---|
| Vertical stroke reducer | : | 33 kw |
| Inclined stroke reducer | : | 23 kw |

Overall dimensions

| | | |
|---|---|---|
| Length without diaphragm valve post | : | 4632 mm |
| Length together with a post | : | 5900 mm |
| Width | : | 3515 mm |
| Height in open position | : | 4810 mm |
| Height in close position | : | 4995 mm |
| Maximum | : | 5620 mm |

| | | |
|---|---|---|
| Weight without diaphgram valve post | : | 56370 kg. |

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**7. Horizontal Bias Cutter**

| | | |
|---|---|---|
| Fabric width | : | 1524 mm |
| Conveyor belt width | : | 1610 mm |
| Machine frame width | : | 1750 mm |

Features of the machine

Let-off unit, liner re-rolling, festooner, conveyor, cord winding unit.

Nylon cord cutting for motorcycle tyre, scooter tyre, industrial tyre, passenger tyre, bus and truck tyre.

Fully automatic operation

Photocell for cord width

Rotary cutter driven by cable cylinder

| | | |
|---|---|---|
| Cutting angle | : | 45 degree – 90 degree |
| Cutting speed (maximum) | : | 18 pcs. per minute |
| Cutting accuracy (maximum) | : | $\pm$ 1.5 mm |
| Power source | : | 415volts, 3 phase, 50 Hz, AC |

**8. Extruder with 8" Cooling Line complete with**

Stamping conveyor including swinging portion, shrinkage conveyor, table above cushion mill, automatic weighing frame solution applicator, upward conveyor, downward conveyor, conveyor before skiver, acceleration table, gravity roller table.

Flap conveyor chain made out of S.S. 304 quality.

110 kw, DC, 1500 rpm motor for 8" hot feed extruder.

DC motors for cooling line – 7 nos.

Thyristor converter panels for 8" hot feed extruder with conveyor line and 24" cushion mill.

8” Hot feed extruder with tread head

| | | |
|---|---|---|
| L/D ratio | : | 6:1 |
| Screw speed | : | Variable up to 60 rpm |
| Motor | : | 150 hp, 1500 rpm, DC motor with thyristor control drive panel. |

The extruder is comprised of the following assemblies:

Bead plate assembly.

Feed hopper housing and screw/barrel assembly.

Tread head.

Drive transmission assembly.

Bead plate assembly

Bead plate fabricated from steel sections and plates for mounting drive motor, transmission gearbox and extruder assembly.

Feed screw assembly

The screw is machined from alloy steel, heat treated and hard welded flights having been duly ground finished. The screw is also hollow bored for cooling/heating and fitted with delivery pipe along with necessary support spiders and rotary joints.

Cylinder barrel/liner assembly

Cast steel barrel liner with bi-metallic liner having hardened inner bore to provide high wears resistance. Helical baffles are provided in the liner bore to provide for efficient steam heating/water cooling.

Feed hopper assembly

Feeding section of the barrel with an undercut to facilitate continuous taking up of the feedstrip by screw. The feed hopper is fabricated from cast steel.

The feed hopper assembly provided with a power feed roll geared directly from the feed screw mounted on bush bearings to uniformly feed the extruder.

A clear gap between the rear end of the barrel and the thrust bearing housing provided to preclude extruder feed stock or oil leakage/seepage from creeping either way.

Tread head

The tread head complete with die plate, clamping arrangement pneumatically operated by cylinders mounted on top as well as bottom wedges along with necessary piping and manually operated valves, suitable for an opening of 800 mm (W) x 35 mm (H). The head of horizontal split is designed to facilitate cleaning of rubber. The size of the air cylinder is such that positive clamping pressure is exerted on the die at all times and suitable for operation on a minimum air pressure of 5.5 kg/sq. cm. and maximum pressure of 7 kg/sq. cm.

Gearbox

Gearbox is totally enclosed with parallel shaft, double reduction type with heavy duty, heat treated and ground gears of helical design and shaft mounted on heavy duty radial and thrust antifriction bearings. The gearbox output shaft is of special design to carry thrust bearings and also hollow to mount the screw and provide access for heating/cooling system. The thrust bearing has full flow lubrication with a sight glass in the return line to monitor the flow. Suitable lube failure pressure switch is incorporated. The lubrication pump is provided.

**9.** **<u>Cushion Mill</u>**

The mill consists of:

Rolls, mill housing and caps, roll journal boxes, base frame, guides, roll adjustment, mill pan, lubrication system, safety device, gearbox, bull gear, pinion and connecting gears, motor and control panel, brake unit, etc.

Rolls

Chilled cast iron rolls internally cored, fully machined working face and journal diameter ground finished with rotary joints for heating and cooling. Surface hardness of 500 $\pm$ 25 BHN having a chill depth of 16-21 mm. Both rolls are plain.

Mill housing and caps

Heavy duty cast iron. The necessary machined surfaces provided on the top caps to accommodate various mill accessories. Frames bored to accept Nip adjustment mechanism.

Roll journal boxes

Close, grained cast iron with wear resisting full bronze bushes. The bearing surfaces have high surface finish to suit the clearance of the individual roll journal. Aluminium labyrinth oil seal is provided at both ends of the bearing boxes.

Base frame

Base frame is made out of heavy duty steel and common for main machine and drive. The machine and the drive bolted down to this frame.

Guides

Fixed design mounted on bearing boxes with a provision for raising and lowering to adjust the gap between roll and guide. The guides machined from single steel section and the curved contours coming in contact with the roll working surface are provided with polyamide type material.

Roll adjustment

The front roll journal boxes are provided with the pull back type arrangement along with adjusting screw for the movement of front roll. The adjusting screw is made out of carbon steel while the nut is made out of cast steel. Shear pads are made out of cast iron.

Mill pan

Fabricated from heavy gauge sheet steel and fixed in position.

Lubrication system

Lubrication system comprising oil tank with strainer, level gauge, oil circulating motorized pump, filter, heat exchanger, pressure switch and relief valves with necessary distributing headers. Inter-connecting piping is provided for lubricating the bush bearings in the bearing boxes.

Grease nipple lubrication is provided for nip adjustment screw assembly.

The lubrication return lines have drain manifolds for visual inspection. The lubrication unit is provided with rotary gear pump driven by a motor. Splash type lubrication is provided for bull gear and pinion.

Safety device

Overhead wire type. The limit switch is mounted on the mill caps and is connected to the control panel.

Gearbox

The worm reduction gearbox has a minimum service factor 1.6.

Bull gear, pinion and connecting gears

The bull gear to high grade cast iron with hob cut teeth.

The pinion of EN Alloy forged steel with hob cut teeth. The connecting gears of Cast Steel Grade-I with hob cut teeth having friction ratio of 1:1.3. These gears mounted on Mill Housings and totally enclosed in a heavy gauge sheet steel enclosure.

Motor and control panel

40 hp, 1500 rpm, DC motor and controls.

Brake unit

Pneumatically operated brake including brake drum is provided. Control voltage for all solenoids are 110 volts.

| | | |
|---|---|---|
| Working roll size | : | 300 mm dia. x 600 mm face width |
| Front roll surface speed | : | 2-25 m/min |
| Friction ratio | : | 1:1.3 |
| Size | : | 600 mm |

**10. <u>Light Truck Radial Type Tyre Building Machine – 1 Stage</u>**

The machine consists of:

Head stock assembly, tail stock assembly, stitcher, service (front and back), hydraulic unit, control panel and operation panel, piping and wiring inside machine, side tread splice press, building drum body, building drum spacer, ply lock unit, bead setting ring, light marking projector, etc.

Applicable tyre size

| | | |
|---|---|---|
| Bead size | : | 375 mm, 385 mm, 400 mm, 410 mm, 430 mm |
| Drum shoulder width | : | 300 – 600 mm |
| Drum diameter | : | 434 – 518 mm |
| Maximum ply overhand (each side) | : | 125 mm |
| Tyre construction | : | 2-0, 1-1, 3-0, 2-1 ply lock. |
| Building drum | : | 10 segments expanding drum |
| Main motor | : | 3.7 kw, DC |
| Main shaft center line height | : | 840 mm |

Ply lock system : Plate finger ply down bladder turn up

Stitcher

| | | |
|---|---|---|
| Tread stitcher | : | Traverse type |
| Under stitcher | : | Bladder roller type |
| Chafer stitcher | : | Rotary type |

Servicer

| | | |
|---|---|---|
| Front rack | : | 4 stories |
| Back rack | : | 1 storey |

Dimension of shell

| | | |
|---|---|---|
| Carcass | : | 32 x 900 mm |
| Chafer | : | 32 x 300 mm |
| R.C. | : | 32 x 900 mm, 32 x 450 mm |

| | | |
|---|---|---|
| Hydraulic unit | : | 18.5 kw, 6 pole, AC motor |
| Hydraulic pressure | : | 70 kg/sq. cm. and 40 kg/sq. cm. |

Control

Operation made according to automatic sequence set by Pin board.

Utility sources

| | | |
|---|---|---|
| Electric power source | : | 415 V + 5%, - 10%, 50 Hz + 2%, 3 phase |
| Compressed air | : | 7 kg/sq. cm. |

# UNIT – 6

## PAPER AND PAPER PRODUCTS

**PULP SECTION**

**OBJECTIVES :**

By the end of this chapter students will learn about :-

- Process flow and functions of machines used in pulp and paper machine sections.
- Paper manufacturing process
- Technical specifications of machinery

| | NAME OF MACHINE | | FUNCTION |
|---|---|---|---|
| 1. | Hydropulper | : | Slushing waste paper. Waste paper is fed in the pulper along with water and pulp slurry is being made. Rotor of pulper is fitted with knife which is being driven by motor. Pulping time differs for raw material to raw material as per product to be made. |
| 2. | Pump | : | For lifting stock from one place to other place. |
| | Sand Trap | : | To pass stock through the channel. Heavier particles are settled down by gravity. |

| | | | |
|---|---|---|---|
| 3. | Dump chest ↓ | : | Storage facility. |
| 4. | Pump ↓ | : | Stock lifting. |
| 5. | Dilution pit ↓ | : | For water addition to get a better effect at later stage for sand separation. |
| 5A. | High Density Cleaner ↓ | : | Here sand/pins is being separated out by the action of centrifugal force developed with the stock. It is of vertical cone shape. |
| 6. | Turbo Separator ↓ | : | Plastic is being separated from the stock. As plastic is unwanted material, its removal is a must. Screen is fitted inside and stock is being passed through the screen. As its reject contains some pulp so again it is being passed through one vibrating screen. From this screen only plastic is separated. Turbo Separators are in series – Two/Three nos. as required. Last separator has fine hole in screen. |

| | | | |
|---|---|---|---|
| 7. | Centricleaner stage | : | This is also one type of cleaning equipment. Fine particles like sand etc. are being separated out downward from the stock by the same principle i.e. centrifugal force. As pulp slurry is lighter, it will go upward and unwanted material is being separated out from bottom cone. |
| 8. | Thickner | : | From the name itself it is clear that its purpose is to thicken the stock. As in centricleaner stage we need diluted stock so it is needed to thicken. The stock again for better refining effect at a later stage. |
| 9. | Thickner chest | : | Storage chest |
| 10. | Pump | : | Used for lifting stock |
| 11. | Refiner | : | Before refiner pulp is in lumps form so its cutting/shearing is required to achieve a better formation of the paper. Refiner is used to solve this purpose. It is just like a grinder and to achieve homogenous slurry. It also increases the water retention capacity of pulp. |

| | | | |
|---|---|---|---|
| 12. | Refiner chest ↓ | : | It is a storage chest. It has agitator-propeller type at the bottom to keep the mass homogeneous. |
| 13. | Service or mixing chest ↓ | : | This is a storage chest. Here, the required chemicals like Rosin, Alum, Gum, Dyes etc. are mixed with certain proportion as required as per quality. It has agitator/stirrer at bottom to get homogenous pulp. |
| 14. | Pump ↓ | : | For carrier |
| 15. | Machine chest | : | This is the final chest in pulp section. From this chest, pulp is being supplied to machine house. |

**PAPER MACHINE SECTION**

| | NAME OF MACHINE | | FUNCTION |
|---|---|---|---|
| | Machine chest | | |
| 1. | Pump | : | Used for lifting pulp. |
| 2. | Constant level box | : | From the name itself, it is clear that pulp is being fed at constant head to get a proper head and to avoid fluctuation in quality of stock. |
| 3. | Fan pump | : | This is the main pump where GSM etc. is being controlled. Proper percentage of water and stock is being mixed here as per GSM of paper required. |
| 4. | Three stage centricleaner | : | This is second stage cleaning equipment to get better result as far as cleaning is concerned. |
| 5. | Pressure screen | : | This is screening equipment, oversize material is being taken back by the screen. Pulp, knots etc. is being separated out. |

| | | | |
|---|---|---|---|
| 6. | Head box ↓ | : | In the head box diluted stock is being stored at a certain height to get proper velocity of the slurry which is being fed to the moving wire. It has holly roll (perforated) rotating to keep stock homogeneous. |
| 7. | Wire part ↓ | : | This is an endless wire. Moving continuously and paper web is being formed here itself. Maximum water from the stock is being drained out by gravity and vacuum boxes to achieve dry content gradually. |
| 8. | Press section (three stage) ↓ | : | Here water is being separated out by passing the paper webs between two rolls nip without affecting the formation of the web. Water being squeezed out from the web. The bottom press roll has felt circuit – endless, running with synchronized velocity of paper machine. |

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| | | | |
|---|---|---|---|
| 9. | Pre dry section ↓ | : | Paper web is being dried out gradually by passing through these steam heated cylinder. Steaming is being done gradually to get proper drying. Condensate is collected in cylinder which is removed continuously by syphon or bucket system from inside.<br><br>To achieve glaze in the paper, it is being passed through this big diameter steam heated cylinder (Machine Glaze Cylinder). It has felt circuit – endless. |
| 10. | Size press or M.G. Cylinder<br>(option for coating unit) ↓ | : | Coating is being done to improve the print-<br>ability effect on the paper. |
| 11. | Post dryer section ↓ | : | This is another section of dryer for gradual removal of moisture from the web. |
| 12. | Coating section<br>(Coating for Duplex Board or<br>other one or two side boards/paper) ↓ | : | In this section also coating is being done to<br>achieve uniform surface to improve print-<br>ability, chemicals like china clay etc. is being used as chemicals here. Coating process has more than one layer. Coating process has more than one layer. Coating thickness is 6 GSM to 11 GSM. |

| | | | |
|---|---|---|---|
| 13. | After dryer section ↓ | : | Dryer section to remove remaining moisture which is being added in the coating section. |
| 14. | Cylinder stack<br>(Calender Stack) ↓ | : | Its purpose to flatten the sheet to get a uni-<br>form caliper (thickness) which is very essential in printing purposes. |
| 15. | Pope reel ↓ | : | paper is being wind up continuously and it is being removed after certain interval and another reel is being fitted. |
| 16. | Online cutter or reel winder | : | For sheet order. This is online sheet cutter. Sheet is being cut as per the requirement of the customer and wind on the reels. |

**Paper Manufacturing Process**

Manufacturing of paper is broadly divided into –

* Pulp making from basic raw materials
* Converting pulp into paper according to the required quality

Additionally, there is a subsidiary process which recovers the alkali originally used in the process of pulp making. This is known as soda recovery(only for Cooking plant).

**Manufacturing process for pulp from raw materials**

In India, bamboo is the main raw material used for pulp and papermaking. Other Raw materials are bamboo, wood of the broad leaf species known as hard wood, soft wood, sabai grass, bagasse, rice straw etc. The bamboo or other wood is chipped into small size by chippers. Grass and rice straw are also cut into small lengths in order to facilitate cooking in digesters.

The raw material after chipping is cooked in the pressure vessel known as a digester. For the purpose of cooking, liquors containing sodium hydroxide, sodium sulphate and sodium carbonate are used. In the pulp industry this liquor is known as '**white liquor**'. This white liquor is recovered back from the spent liquor obtained after digestion; white liquor once utilized is not fully lost. This spent liquor is termed as '**black liquor**' in the industry. The digestion/cooking is carried out under steam pressure ranging from 3.5 to 7.5 kg/sq.cm. for a duration of 3 to 6 hours. Pulping can also be carried out with different processes with different chemicals. By this cooking process, about 55% of raw material is extracted in the form of spent or black liquor as mentioned above. By this process lignin and other wood components are removed leaving behind cellulose fibre. The remaining material after cooking is known as unbleached or brown pulp.

The mixture of unbleached pulp and black liquor as obtained after cooking undergoes a process of 'Screening' by passing it across screens having large size round perforations. This is required to catch undigested bamboo or any other foreign material and their knots. These screens are known as knotters.

The pulp and black liquor when free of impurities like knots and other foreign particles is passed through Brown Stock Washers consisting of a number of washers. Spent liquor is almost completely washed out of pulp and collected in large storage tanks. From these storage tanks it goes to soda recovery section for conversion into white liquor so that it can be used in digestion.

Unbleached or brown pulp is used for products falling under the category of unbleached paper. In order to manufacture white and coloured paper, unbleached paper needs to be bleached further. The washed unbleached pulp is passed through equipment known as Sand Traps, Rifflers, Screens and Centricleaners in order to remove impurities like sand, grit, foreign material and other specky material. This provides cleaned pulp which is further bleached.

Chlorine is the chemical used for bleaching of unbleached pulp. It can be either used as such, or in combination with lime; when used in combination of chlorine and lime it is known as bleaching powder if it is in the solid form, or bleaching liquor if in liquid form. Bleach liquor is prepared on site by all paper mills. Pulp and chlorine or bleach liquor after mixing are retained in tall bleaching towers. These towers are made out of concrete and have a glazed tile lining on the interior surface. Until the chlorine or bleach liquor has reacted with impurities in the pulp they are retained in towers. In order to wash out impurities from pulp it is passed through rotary washers. The pulp is bleached in three stages :

* Chlorination
* Caustic extraction and hypo stages or chlorination
* Hypo and Hypo

This can be extended to further stages; the more the stages, the better is the quality of pulp.

The unbleached and bleached pulp obtained above needs further treatment and therefore it is taken to a Stock Preparation Section. In this section, pulp is treated as required based upon the quality of the finished product. The treatment involves the following stages :-

* Physical treatment known as 'Beating'
* Chemical treatment to mix certain chemicals and dyes

Beating imparts strength whereas the adding of chemicals and dyes give the desirable characteristics, such as, surface for a good writing and printing, smoothness and/or pleasing appearance to the paper.

The equipments used for beating :

- Beaters / refiners of different designs and make.

The chemical mixed with pulp are :-

- China clay, soap stone powder, rosin size and alum, whitening agents, such as, tinopal and dyes.

Even starches and vegetable gums are used depending on the quality of paper required.

China clay and soap stone powder impart smoothness and opaqueness to the sheet so that it prints well on both the sides. In order to give partial water proofing to the sheet so that paper becomes impervious to the water contained in the ink, rosin size and alum are used.

Tinopal and dyes give whiteness. Starches and gums increase strength of the paper sheet. The pulp, after beating and mixed with chemicals, is called STOCK or STUFF.

**Conversion of pulp into paper :**

Actual paper making starts after preparation of STOCK. Stock passes through stock chest before feeding it to the paper machine. It is passed through centricleaner and centriscreens to remove all undesirable particles. The stock travels through machines in a very diluted state, approximately 99% of water to one part of fibre. The paper machine consists of an endless web of woven wire cloth where the stock flows. Bulk quantity of water from stock is removed by wire by gravity, suction and pressure. A dandy roll between the suction boxes acts as to shut the web end to impress any required watermark, and for including any laid lines.

The wet web of paper is passed in between a pair of rolls placed one over the other, while doing so, the wet paper is supported on a woolen blanket. The pair of rolls is known as wet press and the woolen blanket is known as felt. Generally, there are three sets of presses. The function of the presses is to extract water further as far as possible from the wet paper sheet and to smoothen out the sheet. The paper sheet contains 60% to 65% moisture when it comes out of the press. In order to get air dry paper, the wet sheet is passed on the heated surface of a rotary dryer. The sheet is then passed through highly polished rolls stacked one over the other. The stack of rolls is known as calender. The process of passing the paper through it is called calendaring. This gives a smooth finish to paper. The paper sheet is then wound and a reel is made. Reels of different sizes are made with a slitter and rewinder.

**Soda recovery process :**

The spent liquor obtained after digestion of bamboo and other raw material is not drained as it contains soda. The soda content from spent liquor can be recovered by a process known as the soda recovery process. The spent liquor is stored in big storage tanks and pumped from the pulp mill to the soda recovery plant for manufacturing white liquor. The white liquor so recovered is re-used for cooking bamboo in the pulping section as discussed earlier and this process is continuous in a closed system.

The spent liquor stored in big storage tanks is first passed through a fine screen to remove the fibrous material. It is then concentrated, thickened by evaporating it in multiple effect evaporators. Due to this, the solid contents of spent liquor are increased from about 15% to 55%. This liquor is very viscous like honey at room temperature but is in fluid state at 94 – 101$^0$C. The required quantity of salt cakes known as sodium sulphate are mixed with this thickened liquor and the mass is then fed to the hearth of a specially designed recovery boiler. In this process, lignins, resins and pitch extracted from bamboos and other raw materials burn out and large quantities of steam produced from heat, generates soda and other salts which are incapable of burning and are thrown out in the form of smelt in the hearth of the boiler. This smelt is a mixture of soda ash, sodium sulphide and caustic.

Since the temperature prevailing in the hearth areas of the boiler is very high, the ash of this recovered salts gets fused and is let out from the boiler in a molten form. The cooking liquor is prepared from this by any of the suitable methods. The steam and white liquor as recovered above are again used for cooking bamboo and other raw materials indefinitely with small additions of salt cake in spent liquor as make-up chemicals.

The recovery of alkali by the above process is not 100%. There are losses at various points of process both in the Pulp Mill as well as the recovery section; losses are in the range of 7% to 13%.

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## TECHNICAL SPECIFICATIONS

## PULP SECTION OF A PAPER PLANT

### 1. Rotary Spherical Digester

| | | |
|---|---|---|
| Capacity | : | 28 cu.m. |
| Diameter | : | 3810 mm |
| Working pressure | : | 7.5 kgs/sq.cm. |
| Design pressure | : | 8.0 kgs/sq.cm. |
| Rotation | : | 0.33 rpm |
| Power requirement | : | 10 hp |
| Hydraulic testing pressure | : | 16.5 kgs/sq.cm. |
| Welding joint efficiency | : | 0.85 |
| Shell wall thickness | : | 20 mm |
| Manhole size | : | Elliptical 1000 mm x 750 mm |

Materials of construction

| | | |
|---|---|---|
| Shell | : | Boiler quality tested steel plates IS-226 |
| Bearing housing | : | Cast iron |
| Bearing | : | Phosphorous bronze |
| Manhole cover | : | IS 226 |
| Trunnion | : | Cast steel fitted with carbon ring |

Accessories

- Safety, relief and blow off valves
- Rotary steam glands
- Non-return liquor valve – 2 nos.
- Non-return steam valve – 1 no.
- Non-return water valve – 1 no.

Drive

Reduction gearbox, ratio 1:50. A worm gear and worm wheel for final rotation of 0.33 per minute.

Manhole

Manhole with quick opening type cover in elliptical shape with a sealing ring.

Balance

Digester is statically balanced.

Liquor inlet and outlet arrangements

Liquor feed arrangement is through trunnion. A 50 mm dia. C.I. pipe is provided inside the shell and liquor is sprayed through 6 mm dia. nozzles.

Trunnion

A cast steel trunnion with 325 mm O.D. fitted to the digester shell by bolts at the either ends with trunnion to save steam leakage.

**2. <u>Hydropulper</u>**

| | | |
|---|---|---|
| Effective capacity | : | 4.5 cu.m. |
| Total volume | : | 6.0 cu.m. |
| Batch capacity | : | 250 kg. per charge |
| Defibrate time of waste paper | : | 30 minutes |
| Defibration efficiency | : | 80-90% |
| Capacity | : | 10 BD tonne per day |
| Consistency with re-circulation arrangement | : | 4% |
| Total height | : | 1200 mm |
| Diameter | : | 2500 mm |
| Power requirement | : | 50-60 hp |
| R.P.M. | : | 200-225 |

Material of construction

| | | |
|---|---|---|
| Trough | : | M.S. plates, thickness 8 mm in a polygonal (with 12 sides) shape. Four supporting legs in cylindrical shape fitted with base plates. |
| Strainer | : | Stainless steel 304 quality |

| | | |
|---|---|---|
| Stationery blades | : | Carbon steel (CR-40 hard over-lays by electric arc welding) |
| Impeller | : | Cast steel / Steel fabricated |
| Housing | : | Grey cast iron fitted with two roller bearing – one thrust bearing with stuffing box. Glands, water sealing arrangement pulley 'V' belt, 4 grooves, D – Section. |
| Size | : | 750 mm O.D. |

Circulation device

Stock pump KMW type size 200 mm / 125 mm

Materials of construction

| | | |
|---|---|---|
| Body | : | C.I. |
| Shaft | : | EN8 |
| Impeller | : | S.S. 304 |
| Inlet distance pieces | : | S.S. 304 |

Hydropulper is fitted with stand for motor with adjusting plate.

**3. <u>Blow Tank</u>**

| | | |
|---|---|---|
| Capacity | : | 100 cu.m. |
| Dia. of the tank | : | 4500 mm |
| Height of the tank | : | 8000 mm |
| Thickness of the shell | : | 15, 16, and 18 mm |
| Vapour outlet dia. | : | 500 mm |
| Cooked material inlet dia. | : | 200 mm |

Materials of construction

| | | | | |
|---|---|---|---|---|
| Shell | : | M.S. plates | | |
| Headers | : | M.S. | | |
| Block liquor injection nozzles: | | S.S. 304 | | |
| Heads | : | Bottom | - | Torispherical |
| | | Top | - | Elliptical |
| Supporting beams | : | M.S. girders | | |

Inlet nozzle is provided on the top of the tank. Outlet is provided in one side of the bottom. One manhole is provided at the top of the tank for cleaning and maintenance. A vapour inlet is provided on the top.

In the bottom part of the tank two agitators are provided for agitation of the pulp. One KMW pump with size 250 mm x 200 mm is provided for recirculation of the pulp. Equipment is complete with six back liquor injection nozzle.

**4. Beater**

| | | |
|---|---|---|
| Capacity | : | 500 kg. B.D. pulp per batch |
| Consistency | : | 5-7% |
| Type | : | Hollander type breaker beater |
| Beating time | : | 2.5 – 3 hours |
| Inlet freeness | : | 20-22$^0$ SR |
| Outlet freeness | : | 40-45$^0$ SR |
| Power requirement | : | 80 hp |
| R.P.M. | : | 160 |
| Dia. of the roll | : | 1275 mm, face 1300 mm |
| Average weight of the roll | : | 6 tonnes |
| No. of knives in roll | : | 72 |
| No. of bed boxes | : | 3 |
| Trough volume | : | 10 cu.m. |

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**5.** **M.S. Washing Drum**

| | | |
|---|---|---|
| Dia. | : | 1200 mm |
| Face | : | 1500 mm |

Materials of construction

| | | |
|---|---|---|
| Pedestals | : | C.I. |
| Spiders | : | C.I. |
| 188 mm dia. shaft | : | EN8 |
| Roll knives | : | High carbon chromium steel |
| Bed plate knives | : | High carbon steel |
| Bearing housing | : | Grey cast iron |
| Bearing | : | Gun-metal |
| Beater shaft pulley | : | C.I. |
| Lubrication | : | One oil ring is provided for self lubrication. |

Beater is complete with lifting and lowering arrangement.

| | | |
|---|---|---|
| Beater shaft pulley | : | 5 groove, D-Section dia. 1500 mm |

Motor

| | | |
|---|---|---|
| HP/RPM | : | 80/960 |
| Motor pulley | : | 5 groove, D-Section dia. 250 mm |

**6.** **Disk Refiner**

| | | |
|---|---|---|
| Capacity | : | 15 tonnes per day |
| R.P.M. | : | 750 – 1000 |
| Peripheral speed | : | 30 – 42 m/second |
| Power requirement | : | 75 hp |
| Consistency | : | 4% |
| Output freeness | : | 25-30$^0$ SR |
| Inlet freeness | : | 22$^0$ SR |

Materials of construction

| | | |
|---|---|---|
| Body | : | Cast iron |
| Shaft | : | EN8 |
| Disc | : | Ni-Chrome hard steel |
| Base plate | : | Cast iron |
| Coupling | : | Cast iron |
| Bearing housing | : | Cast iron fitted with self aligned roller bearing, thrust bearing, balanced statically. |

Drive : 75 hp, 960 rpm, 440 V, 3 phase, 50 c/s

**7. Vibrating Screen**

| | | |
|---|---|---|
| Capacity | : | 22 tonnes per day |
| Perforation size | : | 3-4 mm dia. |
| Consistency | : | 0.5 – 0.8% |
| Power requirement | : | 5 hp |

Materials of construction

| | | |
|---|---|---|
| Frame | : | Mild steel |
| Screen | : | Stainless steel 304 quality |
| Pedestals | : | Cast iron |
| Chute | : | Mild steel |

Drive : 5 hp, 960 rpm motor

Construction

Screen basket slightly inclined is fixed on the frame with 4 springs and is eccentrically oscillated by an electric motor.

A shower pipe is provided on the top for residual control and washing of pulp.

**8. Decker Thickner**

| | | |
|---|---|---|
| Capacity | : | 10 tonnes per day |
| Inlet consistency | : | 1% |
| Outlet consistency | : | 4-5% |
| Horse power | : | 7.5 |
| Diameter of the drum | : | 1200 mm |
| Face of the drum | : | 3000 mm |
| Vat | : | R.C.C. |
| R.P.M. | : | 10 |

Materials of construction

| | | |
|---|---|---|
| Shaft | : | EN8 |
| Spider | : | C.I. |
| Longitudinal rods | : | 9 mm, 100 nos. brass |
| Backing wire | : | Phosphorous bronze |
| Bearing housing | : | Grey cast iron fitted with ball bearing, both ends sealed with rubber sealing, 5 mesh half round supporting wire. |
| Shower | : | A pressure shower is provided on the top of the thickner drum. Inlet and outlet flange connecting piece fabricated out of mild steel. |
| Coupling material | : | C.I. with rubber pads. |

Drive : 70 hp, 960 rpm motor

**9. Potcher Washer**

| | | |
|---|---|---|
| Dia. | : | 150 mm |

Materials of construction

| | | |
|---|---|---|
| Trough | : | R.C.C. |
| Shaft | : | EN8 |
| Bearing housing | : | G.M. |
| Washing drum | : | C.I. side plate |

CVSRTA

**10. High Density Cleaner**

| | | |
|---|---|---|
| Capacity | : | 15 tonnes per day |
| Operating consistency | : | 4 – 4.5% |
| Throughput | : | 550 litres per minute |
| Pressure drop | : | 2.0 mw |
| Rotary disc. Speed | : | 1440 rpm |
| Power required for the disc | : | 2.5 hp |
| Shaft dia. | : | 50 mm |
| Length of the tube | : | 2230 mm |
| Volume of dirt chamber | : | 10 cu.m. |

Materials of construction

| | | |
|---|---|---|
| Accept exit pipe | : | Stainless steel 304 quality |
| Disc. | : | Stainless steel 304 quality |
| Sleeve | : | Stainless steel 304 quality |
| Shaft | : | EN-8 |

A gland window has been provided in the dirt collecting chamber.

| | | |
|---|---|---|
| Inlet nozzle | : | Provided on the top |
| Bearing housing | : | C.I. |
| Collecting chamber | : | C.I. |
| Body | : | C.I. |
| Motor | : | Vertical, 25 hp, 1440 rpm |

**11. Agitator**

| | | |
|---|---|---|
| Type | : | CR3 KMW horizontal Agitator side entry at the bottom. |
| Chest capacity | : | 50 cu.m. |
| Pulp consistency | : | 6% |
| Shaft dia. | : | 75 mm |
| Impeller dia. | : | 660 mm |
| Shaft speed | : | 300 rpm |
| Shaft power requirement | : | 25 hp |

Materials of construction

| | | |
|---|---|---|
| Impeller | : | Stainless steel 304 quality |
| Sleeve | : | Stainless steel 304 quality |
| Bearing housing | : | Cast iron |
| Grouting rings | : | Cast iron |
| Shaft | : | EN8 |
| Bearing | : | Roller bearing (spherical) |

Drive : 'V' belt drive, groove 3, C Section

| | | |
|---|---|---|
| Pulley | : | C.I. size 500 mm dia. |
| Motor pulley size | : | 150 mm dia. |
| Electric motor | : | 25 hp, 960 rpm, 440 V |

## 12. <u>Conical Refiner</u>

| | | |
|---|---|---|
| Type | : | R1 |
| Capacity | : | 30 B.D. tones per day |
| Final freeness | : | $30^0$ SR ($25^0$ – $30^0$ SR) |
| Inlet freeness | : | 20 – $22^0$ SR |
| Rise in freeness | : | 5 – $8^0$ SR |
| Inlet consistency | : | 4% |
| Power requirement | : | 70 hp |

Materials of construction

| | | |
|---|---|---|
| Body | : | Grey cast iron |
| Shaft | : | EN-8 |
| Shell | : | Stainless steel 304 quality |
| Plug | : | Stainless steel 304 quality |
| Housing | : | Cast iron |
| Sole plate for refiner | : | Cast iron |

Paper making section

Paper machine complete with following specifications etc.

| | | |
|---|---|---|
| Type of paper to be manu-factured | : | Kraft variety of 34-80 gsm |
| Capacity | : | 13 – 15 tonnes per day |
| Operating speed | : | 30 – 120 metres per minute |
| Drive | : | Line shaft |
| Head box | : | Open type |
| Table rolls | : | 21 nos. |
| Suction box | : | 6 nos. |
| Wire length | : | 22 m |
| Suction couch | : | 1 no. |
| Suction press | : | 1 no. |
| M.G. cylinder | : | 3.6 m dia. |
| Pope reel | : | 1 no. |

## 40 TPD DUPLEX BOARD-CUM-PAPER MACHINE WITH M.G. CYLINDER

### Mould Section

| | | |
|---|---|---|
| Cylinder moulds | : | 2 nos. counter flow type<br>2 nos. Uniflow type<br>1 no. Extractor mould |
| Mould face | : | 2850 mm |
| Mould dia. | : | 1250 mm |
| Couch roll face | : | 2850 mm |
| Couch roll dia. | : | 400 mm |
| Cylinder mould vats | : | 4 nos. in S.S. 304 construction with manifold. |
| Showers | : | 5 nos. in S.S. 304 with fan jet nozzle |
| one for each mould. | | |
| Turning roll | : | 1 no. |
| Dia. | : | 390 mm |
| Face length | : | 2650 mm |

### Baby Press

| | | |
|---|---|---|
| Top roll | : | 2 nos. 450 mm OD x 2650 mm face bone hard rubber covered |
| Bottom roll | : | 2 nos. 450 mm OD x 2650 mm face rubber covered |
| Felt roll | : | 26 nos. 175 mm OD x 2650 mm face bone hard rubber covered |
| Felt stretchers | : | 2 sets manual |
| Felt guides | : | 2 sets manual |
| Suction tubes for holding sheets | : | 4 nos. in S.S. 304 construction with HDPE lips having 10 mm opening |
| Felt cleaning Uhle boxes | : | 2 nos. in S.S. 304 construction with HDPE lips having 10 mm opening in top felt circuit. |

| | | |
|---|---|---|
| Showers | : | 1 no. low pressure in S.S. 304 quality construction for felt cleaning. |
| Save all trays | : | 2 nos. in S.S. 304 quality construction under the bottom Baby Press Roll.<br>1 no. in S.S. 304 quality construction under the Uhle boxes. |
| Frames | : | Entire frames for mould and Baby Press section are made out of M.S. Loading of Presses and mould couch rolls are through pneumatic cylinders. The sheet is lowered before the dandy on the fourdrinier through the carrier felt. |

**<u>M.G. Section</u>**

| | | |
|---|---|---|
| M.G. cylinder | : | 1 no. C.I. MG 3650 mm dia. x 2650 mm face suitable for an operating steam pressure of 3.5 kg/cm$^2$ |
| Touch rolls | : | 1 no. 600 mm dia. x 2650 mm face rubber covered. |
| Nip loads | : | 1$^{st}$ nip - 50 kg<br>2$^{nd}$ nip - 70 kg |
| Felt rolls | : | 6 nos. steel rolls 175 mm dia. x 2750 mm face, identical to Dryer Felt rolls. |
| Lead rolls | : | 1 no. BHRC roll 230 mm dia. x 2750 mm face. |
| Doctors | : | 3 nos. standard Vickerys oscillating doctor blades. |
| Stretchers | : | 1 no. manual stretcher is provided for the glazing felt. |
| Guide | : | 1 no. manual guide for the glazing felt is provided. |

**Technical Data**

| | | |
|---|---|---|
| Grade | : | Speciality Papers |
| Substance range | : | 60 – 180 GSM |
| Wire width | : | 2850 mm |
| Web at reel | : | 2450 mm |
| Maximum production at reel based on at 60 GSM | : | 40 MTD gross surface sized paper reel. |
| Production speed | : | 60 – 200 m |
| Design and drive speed | : | 250 mpm |

**Open Type Headbox**

| | | |
|---|---|---|
| Wire width | : | 2850 mm |
| Type | : | Open with taper inlet header and manifold |
| Throughput | : | 3000 lpm minimum<br>8000 lpm maximum<br>with recirculation of 10% of flow rate. |
| Slice width | : | 2750 mm<br>Vertical movement 0 – 50 mm<br>Horizontal movement – Nil<br>Slice profile correction through micro adjusters. |
| Rectifier rolls | : | 2 nos.<br>Throat position - 160 mm dia.<br>Slice position - 160 mm dia.<br>Holes - 24 mm dia. |
| Cross pressure control | : | By Lucite tube. |

All the wetted parts are in S.S. 316 quality. All surfaces coming in contact with stock are lined with S.S. 316 quality.

**EXERCISE**

1. Draw the process flow diagram of Pulp section along with brief functions of machinery used.

2. Draw the process flow diagram of Paper machine section along with brief functions of machinery used.

3. Provide data to collected at the time of taking inventory of following machinery to get current prices :

   - Rotary spherical digester
   - Hydro pulper
   - Blow tank
   - Beater
   - Washing drum
   - Disk refiner
   - Vibration screen
   - Decker thickner
   - High density cleaner
   - Conical refiner

# UNIT – 7

## PRINTING, BINDING AND PUBLISHING

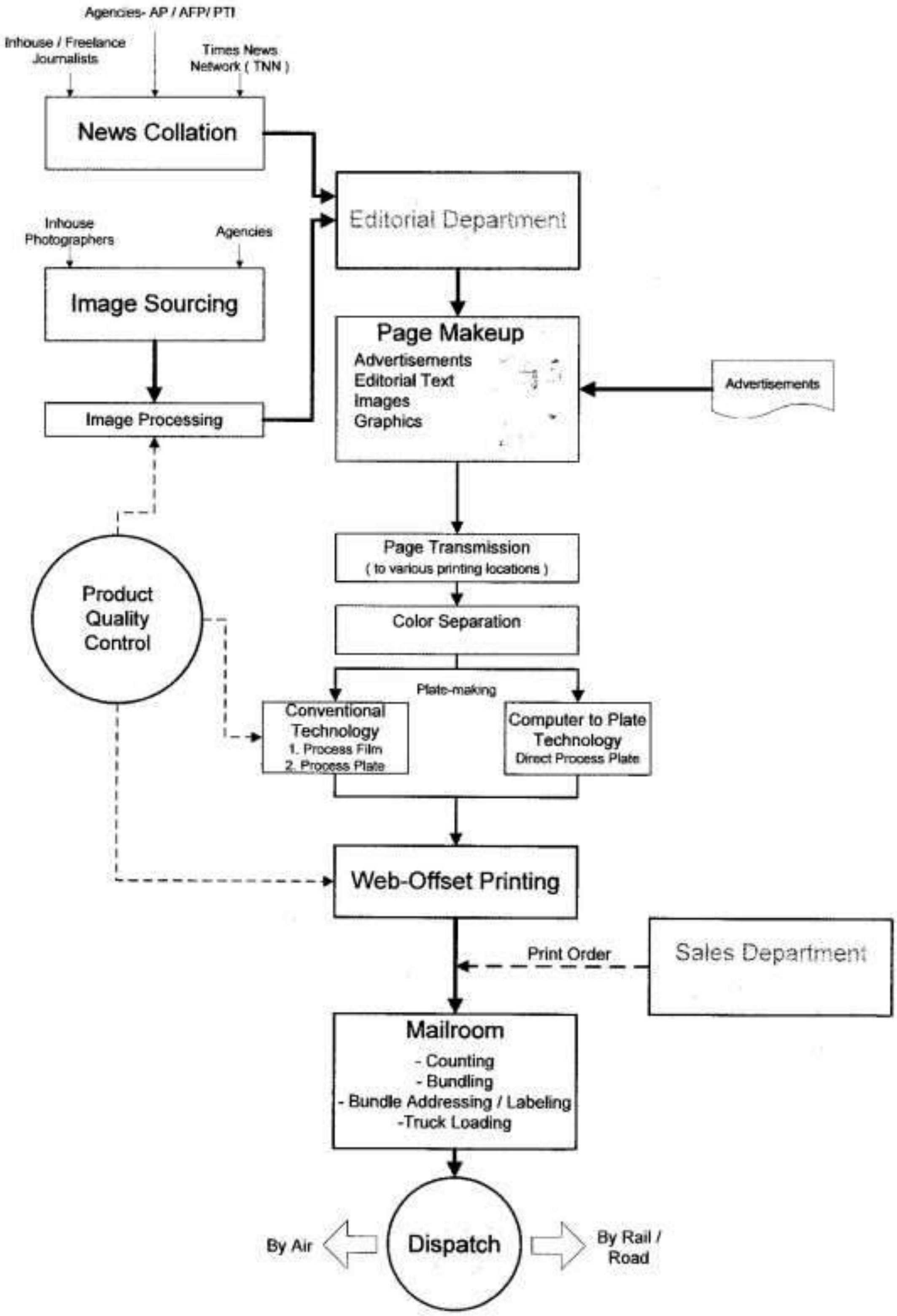
**OBJECTIVES :**

By the end of this chapter students will learn about :-

- Process flow diagram
- News and images sourcing
- Advertisement booking
- Image processing
- Editorial department
- Transmission to printing centres
- Colour separation
- Printing plate preparation
- Web offset printing
- Mailroom/dispatch
- Machines used

**FLOW DIAGRAM**

**Newspaper Publishing Workflow**



**Process Study**

1. **<u>News and Images sourcing :</u>**

   News and Images are sourced from professional agencies like AP, AFP, PTI etc and also from Times News Network, in-house journalists and photographers. The updates are made 24x7 to dedicated servers via V-SATs, leased lines and the internet.

2. **<u>Advertisement Booking :</u>**

   The Marketing team sells print space and the advertisements, mostly in the digital form are uploaded to designated servers. These advertisements are then placed on the final page before the page is released to the Editorial department for completion.

3. **<u>Image Processing :</u>**

   The images selected for print from the central basket by the Editorial department are specially processed and modified for the intended newsprint substrate viz Standard newsprint or Glazed newsprint.

4. **<u>Editorial Department :</u>**

   The Editorial department selects stories, articles and images from the central basket and completes the page with the advertisements already in place. The software used is a Page Makeup software like Quark, PageMaker etc.

5. **<u>Transmission to printing centres :</u>**

   The final pages in the Portable Document Format are transmitted to printing locations which may be local or anywhere across the world. The communication channels may be leased lines or satellites.

6. **<u>Color Separation:</u>**

The digital page files are separated into the process color separations viz, Cyan, Magenta, Yellow and Black.

7. **<u>Printing Plate Preparation :</u>**

The conventional method involved the transfer of the digital images to process films with the help of Image setters and then exposed on pre-sensitised printing plates. The advance in technology has made the process film nearly redundant and instead exposes the digital images directly onto the printing plate. This technology is better known as CtP or Computer to Plate imaging.

8. **<u>Web Offset Printing :</u>**

The printing plates are mounted on web offset machines where the newsprint is in the roll form and the paper feed is continuous. It uses the lithographic process, employing an emulsion of process inks and water to get the desired print on paper.

9. **<u>Mailroom / Dispatch :</u>**

The printed copies are counted and bundled along with labels indicating the number of copies and the dispatch destination.

The copies are dispatched to their respective destinations by Air / Rail or Road.

**Machines :**

1. **Information Technology Instruments**
   Telephone,
   E-mail
   Internet connection
   Fax
   Computer modem
   Scanners

2. **Laser printers**
   Speed,
   paper size,
   no. of colour

3. **Developer**
   Size of plate
   Ink ---▸Water ---▸Gum ---▸Heating ---▸Bending

4. **Metroliner printing set consisting of**
   - Monotone printing unit
   - Uniflow 2/1 folders
   - Three colour satellite printing unit

**General data :**

| | | |
|---|---|---|
| Electric supply | : | 400/440 V, 3 Ph, 50 Hz |
| Machine mechanically geared for cylinder revolutions per hour | : | 32500 copies |
| Maximum paper roll width | : | 1727 mm |
| Maximum paper roll diameter | : | 1065 mm |
| Core diameter | : | 76 mm |
| Reel sidelay | : | ± 19 mm |
| Nominal printing diameter | : | 356 mm |
| Nominal cut-off (printing size) | : | 560 mm |
| Plate thickness | : | 0.3 mm |
| Plate stagger | : | 90 deg. |
| Maximum blanket thickness (including packing) | : | 2.03 mm |
| Printing cylinder circumferential adjustment | : | ± 1.5 mm |
| Printing cylinder sidelay adjustment | : | ± 1.5 mm |

The equipment can produce broadcast or tabloid products in single (collect) or in double production.

Page Format (Broadsheet)

| | | |
|---|---|---|
| maximum | : | 432 mm x 560 mm |
| Print area maximum | : | 409 mm x 530 mm |

Operating speeds :

Operating speeds for optimum production vary depending on type and size of product.

Practical sustained operating speeds for various products (running 40/52 gsm newsprint) are :-

Broadsheet in Double Production

| | | |
|---|---|---|
| 8 - 12 pages | : | 45000 I.P.H. |
| 14 - 18 pages | : | 50000 I.P.H. |
| 20 - 22 pages | : | 55000 I.P.H. |
| 24 pages plus | : | 50000 I.P.H. |

Tabloid in Double Production

| | | |
|---|---|---|
| 8 - 12 pages | : | 30000 I.P.H. |
| 16 - 24 pages | : | 45000 I.P.H. |
| 28 - 36 pages | : | 50000 I.P.H. |
| 40 - 44 pages | : | 55000 I.P.H. |
| 48 pages plus | : | 65000 I.P.H. |

**5. Metroliner monotone printing unit**

This is a blanket-to-blanket perfecting unit printing recto and verso simultaneously.

Both blanket cylinders and both plate cylinders are fitted with bearers on both the drive and operating sides of the unit.

In production, the plate and blanket cylinders run bearer to bearer but there is no bearer to bearer contact between the two blanket cylinders. The cylinders are sized to create true rolling between the plate and blanket cylinders.

When the press stops, the blanket cylinders are separated pneumatically as also are the plate cylinders from the blanket cylinders.

In a similar manner, when the press stops, the ink for 'me' rollers, the ink feed rollers and (in the case of the colour deck only), the dampener for 'me' rollers, are thrown off pneumatically.

A sequential start up system supplied as part of the press package, controls these functions during start-up in a timed sequence.

**General construction :**

Arch type design with the inking as dampening system in each leg.

Heavy side frames firmly secured to one piece bed plate.

Unit completely enclosed.

Monotone units can be converted to three colour units by the addition of a half deck.

**Web lead tapes :**

Each unit is fitted with a motorized web lead tape assembly on the operating side of the press. The tapes terminate after the unit impression adjacent to the upper platform level.

**Web Infeed :**

Fixed speed driven infeed assembly with pneumatically operated rubber backing roller.

**Bearers :**

Both plate cylinders and both blanket cylinders are fitted with bearers on the drive and operating sides of the unit. The bearers are 50 mm wide in chrome-manganese steel, hardened and tempered. Their flatness in contact is a measurement of condition and is usually observed by using a piece of foil run between them.

**Plate cylinders :**

The plate cylinders are solid steel forgings, mounted on tapered roller bearings. They are given as electrolytic nickel plating as a final chrome covering.
The plate lock-up handle plates are one or two pages wide x one page deep. The plate lock-up springs and other components are made out in stainless steel 304 quality. These are staggered at 90 deg.

The plate cylinders are fitted with register pins.

**Blanket cylinders :**

The blanket cylinders are made of solid steel forgings, mounted on tapered roller bearings. They are given an electrolytic nickel plating and a final chrome covering.

The ‘T’ bar blanket lock-up system with 90 deg. stagger is used.

**Wash up devices :**

Each ink train has its own wash up device in the form of a steel container and a plastic scrapper blade which is manually operated to throw into contact with the auxiliary ink drum.

**Ink feed system :**

Each ink system has an undershot centre divided ink fountain which works as pivot for easy cleaning. The ink fountain roller is electrically driven proportional to press speed.

The system consist of :

Knurled gear driven steel ink transfer roller.

| | |
|---|---|
| Rubber transfer rollers | 120 mm diameter – 2 nos. |
| Rubber distribution roller | 120 mm diameter |
| Rubber for ‘me’ roller | 133 mm diameter |
| Rubber for ‘me’ roller | 140 mm diameter |

Copper plated ink drums with three step oscillation – 2 nos.

**Dampening system :**

Dampening system located in the unit aisle, adjacent to the upper ink drum where the dampener fluid is applied consists of :

Motor driven variable speed roller rotating within a S.S. 304 quality pan.
Motor driven fixed speed spiral brush.
Rubber transfer roller 127 mm diameter.
The system is supplied with four one-page-wide dampener supply stops.

In order to reduce waste at the initial start up, an automatic floor function introduces a surge in the supply of dampener solution, thus speeding plate clean up.

**Proportional dampener :**

The speed of the steel dampener roller is related to press speed. The relationship can be varied so that a non-linear proportional control results.

The curve of press speed/roller speed is electronically generated from straight lines, one device for folder. All units selectable to a folder follow this curve, but each roller speed is further variable via the unit control and the master dampener control at the folder desk.

**Ink feed adjustment for open fountain system :**

Ink feed control is an electro-mechanical function for each 32 zones across the printing unit. Engagement of each zone adjustment screw is by means of a solenoid device which connects to traverse shaft driven by a selsyn motor responding to signals entered by the operator at the unit facia.

The format for ink adjustments is :

'8' Ink zone selection/increase/decrease switches.
'8' zone ink increase/decrease switch.
4 page selection switches.
Adjustment indicator dial, graduated 0 – 25.

By operating the 'page selection switch' followed by selecting the relevant ink zone adjustment switch, the zone adjustment screw is engaged and its forward or reverse rotation increases or decreases the ink feed gap thus controlling the ink adjustment.

**Unit control facia :**

Each unit id fitted with a motorized web lead tape assembly on the

Panel of ink control switches - 2 nos.
Ink adjustment meters – 2 nos.
Oil flow warning light.
Controls for running circumferential and lateral adjustment (for register).
Ink feed switches with ON/OFF and MASTER locations – 2 nos.
Link for me switch with ON/OFF and MASTER locations.
Speed control for each of the two dampener fountain motors.
Speed control for each of the two ink fountain motors.
Indicator light for each of the two dampener fountain motors.
Indicator light for each of the two ink fountain motors.
Impression switch with ON/OFF and MASTER locations.

Infeed switch with ON/OFF and MASTER locations.
Key operated switch for engaging or cutting off the supply of power to the unit.

**Note :**
When any switch is in the 'MASTER' position, the operator at the press control desk has overall control of that function.

**6. Drive to standard metroliner unit**

All drive functions for the metroliner mono unit is confined to the drive side of the machine; there will be no gearing on the operating side.

The principle source of the drive transmission is the main gearbox located below the unit and under the press room floor. The gearbox houses horizontal shaft supported on two double row sealed bearings.

Keyed to the horizontal shaft is a spiral bevel pinion meshing with a spiral bevel gear for continuing the drive transmission to the press unit by means of a vertical shaft.

The vertical shaft is supported by double row tapered roller bearings at the bottom and by a single row ball bearing at the top. Near the top of the vertical drive shaft spiral bevel gears transmits the drive to the printing cylinders by means of a helical gear compounded with the spiral bevel.

The spiral bevel gear and its compound helical gear rotate on two ball bearings.

Where the mono unit is associated with a half deck immediately above, thus creating a three colour unit, the spiral bevel gears at the top of the vertical shaft are supplied as a triple set with clutch facilities enabling reversing when running in the three colour mode.

The main gearbox is fitted with a large oil sump and a mechanical oil pump. These serve a pressurized circulating system supplying oil to the plate and blanket cylinder bearings, blanket cylinder sleeves, the unit drive-gears, the vertical drive assembly, the oscillating drum drive, and oscillating drum eccentrics and bearings.

The horizontal shaft in the main gearbox connects to the main horizontal drive by means of a clutch on one side of the box and a coupling on the other. The drive system is designed for co-axially mounted electric drive motors.

The main drive gearbox fitted with a drain value.

The main drive gearbox is fitted with an oil flow warning switch.

**7. Metroliner three colour satellite printing unit**

The metroliner three colour unit can be used for printing spot colour or, alternatively, it can be set up for printing three colours and thus, in conjunction with an adjacent monotone printing unit, it is possible to print four colours on one side of the web.

Four colour printing using this method is standard metroliner printing procedure.

The metroliner three colour unit is reversible which gives the possibility of printing spot colour Recto or Verso on one web.

When printing in the spot colour mode, there is a lifting device for raising the chrome plated common impression cylinder thus increasing the clearances between that cylinder and the blanket cylinders of the mono unit below, thus minimising dangers of web warp up.

The chrome plated common impression cylinder has, as a standard fitting, a cleaning device which is operatable during the press run when it cleans the cylinder, thus minimising the effects of the ink set off.

All three plate cylinders within the three colour unit are fitted with motorized running sidelay and circumferential register adjustment.
The dampening system on the upper deck only has an aisle location adjacent to the plate cylinder where the dampening fluid is applied.

Motor driven variable speed roller rotating within a S.S. 304 quality pan.

Motor driven fixed speed spiral brush.

Stainless steel 304 quality oscillating drum.

Rubber for ‘me’ roller 127 mm diameter.

The system has four one-page-wide dampener supply stops.

In order to reduce waste at the initial start up, an automatic flood function introduces a surge in the supply of dampener solution, thus speeding plate clean-up.

The control facia is conveniently located and it generally follows the design for the monotone unit.

There is, however, a dampener for ‘me’ switch with ON/OFF and MASTER locations.

Apart from the foregoing, in other respects the design features of the Metroliner three colour printing unit is similar to those applying for the Metroliner monotone printing unit.

**8. Uniflow 2/1 folder**

**General :**

The maximum capacity of the folder is nine full width reels in double production (72 pages) or seven full width reels in single production (112 pages collect).

**Drive transmission :**

The main source of the folder drive transmission is a gearbox situated blow press room level, and continuing by means of various supplementary drive transmissions to the principal elements of the folder.

**RTF :**

The roller-top-of former is approximately 232 mm diameter, the main features are :

Constructed from knurled and ground pulleys, split where possible.
Three bearings mounting : operating side, drive side and at the press centerline.
Gear driven slitter assembly with pneumatic throw off.
Nylon propellers with pneumatic pressure control.

**Former :**

Chrome plated former is fitted with a press mounted air blower and capable of sideway movement (± ½ inch).

**Rollers-point-of-former :**

Two free running forming rollers are located at the base of the former. Running adjustment in the horizontal plane is provided.

**Draw rollers :**

Three sets of gear driven draw rollers located below the former. The rollers are with remote setting control.

**Folding couple :**

Folding device, delivering to the operating side of the machine and comprising :

Folding cylinder two copies in circumference with two pin mechanisms and one pin cam, two folding blades and two cutting rubbers.

Cutting cylinder one copy in circumference with one set of collect needles and one knife case of the latest design incorporating two hard wearing plastic cushions.
Folding and cutting cylinders both run on tapered roller bearings.

**Second fold rollers :**

The second fold rollers are untimed.

**Delivery fly:**

The folders have five pockets files, five blades wide.

**Delivery belts :**

A belt delivery conveys the copies from the delivery fly to a point on the edge of the lower folder frame. A connection is fitted for newspaper conveyor.

**Lubrication :**

A pumped oil circulation system lubricates the main drive gearbox and all the main geared drive transmissions.

In certain applications' sealed-for-life bearings are used.

**Safety features :**

Scanners at the second-fold-rollers and at the delivery belts.

Torque clutch on drive folding cylinder.

Both systems electrically interlocked with press stop circuits.

The folder is adequately protected by a system of guards.

**Counter :**

Counter at each folder.

**9. Reels and tensions**

The reels and tensions consists of the following :

**Cross shaft assembly :**

The cross shaft assembly is mounted on the press supporting structure. It comprises a central shaft to which are keyed to three arm spiders for supporting three paper rolls each 107 cm diameter. Rotation of the assembly is achieved via gear driven by 1.5 kw motor.

The spider keying is arranged to permit spider adjustment to accommodate quarter, half, three-quarter and full width reels. The fractional width reel can be located to suit pagination.

Paper reel chucking is achieved by quick action lock-up in conjunction with self expanding chucks suitable for cardboard reel cores.

Sidelay adjustments of the cross shaft assembly is achieved hydraulically providing 19 mm about a centre-line.

**Pneumatic tension control :**

Web tension is applied by static belts. The tension system is operated via a position sensitive counter-loaded governor roller.
A filter lubricator is provided to a compressed air supply of 6.3 kg/sq.cm minimum.

The tension is set by a control located o the folder desk.

**Controls :**

The reel-stand controls are housed in the operating side press support members which carries the cross shaft assembly :-

Tension 'ON/OFF' switch
Tension 'ON' lamp (white)
'Position' push-button
Press drive 'Slower' push-button
Press drive 'Stop' push-button'
'Safe' lamp
'Ready' lamp

Cross shaft assembly 'Forward/Reverse' push-buttons are provided on one side face of the operating side support column and are duplicated on the drive side spider. A switch for sidelay control 'Margin Right/Off/Margin Left' is provided on the other side of face of the operating side support column. This control function is duplicated at the folder desk.

**Dampener fluid supply system :**
The press is equipped with a proportioner and a circulator.

**10. The press drive and substructure**

The press is powered by drive motors co-axially mounted on the press drive shaft.

A feature of the main drive equipment is group inching in either the forward or reverse direction.

The press drive is geared to suit 65000 impressions per hour, at which speed the horizontal drive shaft will run at 2166 rpm.

The press is mounted on heavy cast iron columns complete with base plates, leveling pads and leveling screws.

The main horizontal shaft clutches are of the internal gear type and designed to give maximum efficiency combined with minimum wear and noise emission. The clutches can be operated from press room floor level and are electrically interlocked with the press drive controls.

The main horizontal shaft couplings is all metallic flexible power couplings and do not require lubrication or maintenance.

The main drive boxes are provided with a drain valve. In each drive box, an oil flow light is employed to prevent breakdown due to lack of oil.

The alarm system includes a flashing light on each unit and on the folder. This light is duplicated on the main press control console.

Each unit folder can be engaged and disengaged electrically and mechanically.

**11. Details of drive etc.**

**Main drive motor :**

2166 rpm, dc motors to BS 2613/70. Drip proof, force-ventilated with fan, filter and air pressure switch. Double shaft extension wall mounting.

| | | |
|---|---|---|
| Rating | : | Continuous with constant full load torque over 100:1 speed range. |
| Supply | : | D.C. variable voltage |
| Characteristic | : | Shunt wound |
| Terminal box | : | Undrilled gland plate |
| Shaft extension | : | Double shaft extension suitable for mounting co-axially with the press lineshaft. |
| Windings | : | Class ‘F’ insulation |

**Press control station :**

Control station supplied for mounting at the folder delivery.
Press drive push-buttons INCH/CRAWL/FASTER/SLOWER/STOP.
Press drive indicator lamps READY (red), SAFE (green).

**Tachogenerator :**

Tachometer per folder for press drive electronic speed control reference. Press mounted with drive from main dive lineshaft.

| | | |
|---|---|---|
| Type | : | BD2510 |
| Output | : | 100 V/1000 rpm |
| Mountings | : | Foot |
| Drive | : | Toothed belt |

**Audible alarm :**

The drive system incorporates a delay time on START/INCH functions such as that the alarm sounds for a predetermined period before the press starts.

The alarm re-activates if the INCH or START functions lapse for more than a predetermined time.

Audible alarm per folder.

**12. Press protection system :**

In order to protect the press from damage and to save time during make-ready, a co-ordinated system of detectors, severers and trolleys is employed. The system is interlocked to protect the press for every web lead. The components of the system are :

Cooksey finger-type web break detectors (including double detectors at unit).
Electro-pneumatic web severers at the reel position.
Cooksey web propulsion trolleys.

**13. Dust extraction system :**

A composite dust extraction system arranged to extract paper dust at each roller-front-of-turning bar, at the folder 'RTF' and at each rotary folding mechanism.

The system comprises :

Collector units incorporating filters, explosion relief panels and quick released dust collectors.

Motorised extraction fan with outlet silencer mounted on the clean air side of collector unit.

Extraction hoods at the roller-front-of-turning bars.

A set of extraction hoods at the folder 'RTF'.

A set of extraction hoods at the folding mechanism.

A set of press-mounted interconnecting ducting which will terminate adjacent to the folder.

CVSRTA

## 14. Autopaster

The autopaster is capable of splicing the web at any production speed. It is equipped with a pre-drive to accelerate the new reel to paste speed and this device also serves to control tension during the transition period as the new reel rotates into contact with the tension belts. A separate assembly, carrying the brushes and cut-off knife is lowered and retracted as part of the splicing sequence.

Control of the butt size is provided over the range 100 mm to 127 mm in 3 mm increments.

**Controls :**

The paster pilot electronics, power supplies and other 'RTP' control gear are housed in a sheet steel panel suitable for mounting in the reel room adjacent to the reel stand with which it is associated.

The paste cycle is automatic but push-button control is provided for standby/service purpose.

Additional reel stand controls.

'Paste Speed' lamp.

'Paste' push-button.

'Reset' push-button.

Digital Pilot 'ON/OFF' switch.

Digital 'ON' lamp.

One lamp per reel stand, which is illuminated during the paste cycle is mounted at the folder desk, together with one only 'Tail' light to alert the operator when a splicing has been completed.

## EXERCISE

1. Write short note on process of printing of newspaper.

# UNIT – 8

## BREAD MAKING

**OBJECTIVES :**

By the end of this chapter students will learn about :-

- Process flow
- Brief description and functions of various main process and ancillary equipment
- Technical specifications of machinery

**PROCESS WRITE-UP**

Bread making is an art which has been practiced from time immemorial. With the advancement of science and technology, bread making transitioned from the traditional domestic art to the status of baking technology.

The main raw-material wheat flour is fermented by the action of yeast and converted into a wholesome food. The basic ingredients for bread making are flour, water, yeast and salt. Various other raw-materials are added to the basic ingredients to add richness and flavour to the bread. A step by step description of the processes is given below:

1. <u>Sifting</u>

   Maida flour is sifted in a sifter. This process removes any foreign material present in it and provides aeration. The sieved flour goes directly into a mixer or is collected in a mixing bowl in required quantity.

2. <u>Mixing</u>

   Mixing is done in two steps. In the 1$^{st}$ step sifted flour yeast and water are blended together to form a light dough. In the 2$^{nd}$ step all other raw-materials are blended to the dough and mixed until the dough develops into a homogenous, pliable and extensible mass.

3. Bulk fermentation

After the 1st step of mixing the dough is kept aside in a specially designed fermentation room for 1 ½ to 3 hours under controlled conditions of temperature and humidity. Here yeast acts on the available sugars in flour producing carbon-dioxide gas. During the process the dough rises and becomes lighter acquiring the typical fermented flavour.

4. Dividing

The fermented and remixed dough is taken to a machine called Bowl Hoist where the bowl is locked safely with a liver and lifted automatically until it tilts enabling the dough mass to be dumped into a receiver called the 'Hopper'. The hopper is attached to the divider machine. The dough is then divided for each loaf of bread in a 'Divider'. The curling operation is done by a cutter and plunger. The weight of the divided dough is frequently checked on an ordinary balance, placed nearby the machine.

5. Rounding

The divided dough pieces are rounded and shaped like balls in the machine called Rounder.

6. Intermediate proof

The rounded dough balls pass through an intermediate prover, where the dough is given a rest period of 7 to 8 minutes. This allows the dough to relax and become pliable and extensible again.

7. Moulding

The dough pieces coming out of the inter prover are flattened into thin sheets, rolled into cylindrical shape by the action of rollers, a curling chain and a pressure board. This machine is called moulder.

8. Panning

The moulded dough then passes through an oiling machine and falls automatically in greased baking moulds/tins.

9. Final proof

The baking tins with the dough are placed in the traveling trays of the final prover chamber. Here the dough pieces are allowed to rise to the desired volume under controlled conditions of temperature and humidity. The proof time of the dough can be controlled by adjusting the traveling time of trays within this chamber. Careful handling of the moulds / tins is required at this stage, because a well risen dough is likely to collapse or fall if handled roughly. The developed dough is then fed into the baking oven.

10. Baking

The proved dough is then baked in a baking oven which works on light diesel oil. The baking temperature and time are electronically controlled. Here the yeast action which was initiated at the time of mixing stops as the yeast cells are inactivated due to high temperature prevalent in the oven. Here the bread is baked-starch is gelatinized excess moisture is evaporated and crust develops golden brown colour due to caramelization and other browning reactions. The oven has travelling trays which enable loading and unloading of oven from the same position. The unloaded bread is taken on a conveyor to a 'Depanner' where bread is depanned automatically using vacuum rubber cups. The empty moulds/tins travel back to the 'Panner' where they are again fed with moulded dough. Depanned bread are stacked on trolleys and placed in a cooling tunnel. Here a fan blows fresh air on to the bread and the heat emitted by the bread is removed by an exhaust fan. The bread is cooled and ready for slicing in 2 to 3 hours.

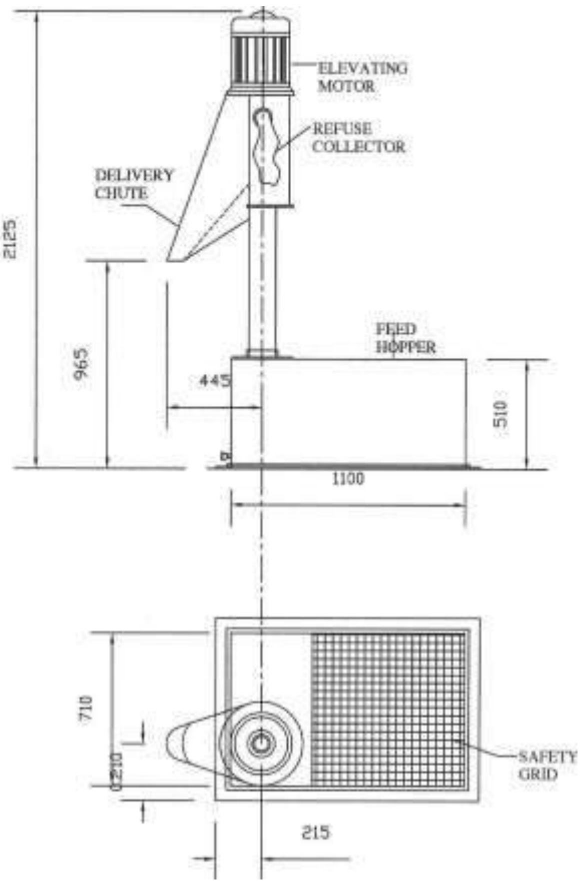
11. Slicing and packing

Cooled bread is fed on to the slicer-end of a slicing and bagging machine. The bread is sliced into the required number of slices using a band slicer. The sliced bread passes on to the bagging section. Here a pouch/bag fixed on wicket rods gets opened and a bread moves into it. The mouth of the bag is then tied securely using a twist the ribbon.

The sliced and bagged loaves of bread move out on conveyors and are collected in baskets. These baskets of bread are then transferred to the marketing section, ready for dispatch to various places.

BRIEF DESCRIPTION AND FUNCTIONS OF VARIOUS MAIN PROCESS AND ANCILLARY EQUIPMENT

1. **Flour Handling Equipment**

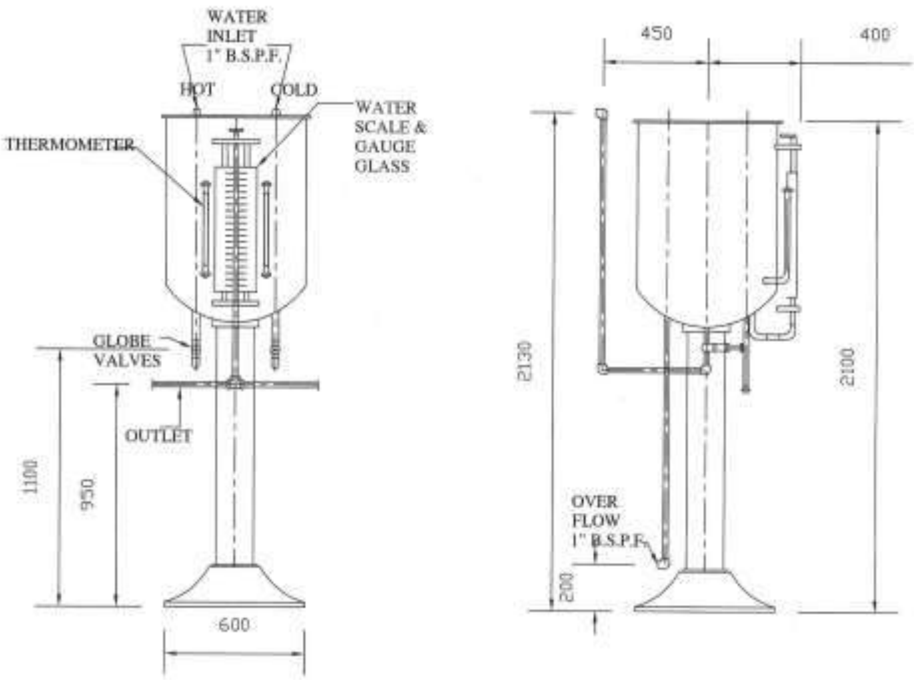



**Flour Sifter**

The function of flour handling equipment is to (1) sift the flour (2) to remove the foreign materials (3) to loosen and aerate the flour (4) to blend the flour.

The flour handling equipment is fabricated out of M.S. sheets and one number horizontal spiral conveyor and one number of vertical spiral conveyor are arranged in the manner to take the flour to the sifting head. The sifting head consists of screen made out of perforated M.S. sheet and contains 4 numbers nylon brushes. The flour is pressed by these brushes against the perforated sheet and is discharged through hopper chute. The foreign material is transferred to a collecting bag.

2. **Water Tempering Tank**

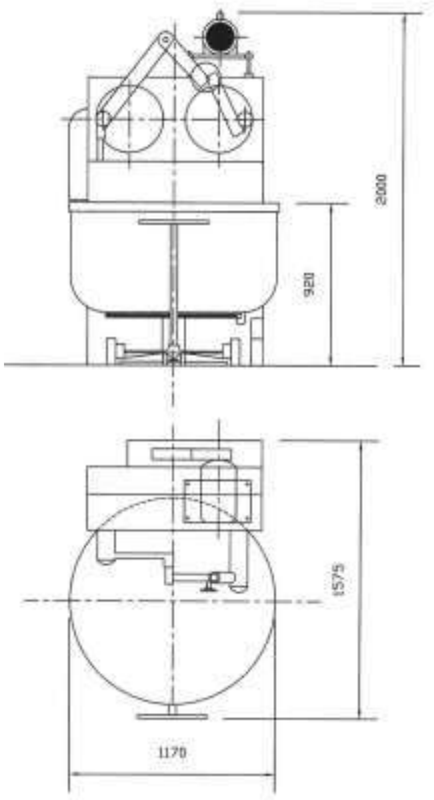



**Tempering and Measuring Tank**

The water-tempering tank is to supply the water at the required temperature and the measured quantity of the water to be mixed in the flour and also to regulate the desired temperature of the water. The water-measuring tank is fabricated out of stainless steel sheet with inlet and outlet connections for plain water, chilled water, hot water. It has a graduated scale in front and a dial thermometer to read out the level of the water and the temperature.

The water measuring tank is insulated and cladded with stainless steel sheet.

3. **AMF-Sterling Dough Mixing and Kneading Machines**




**Twin Arm Dough Kneader**

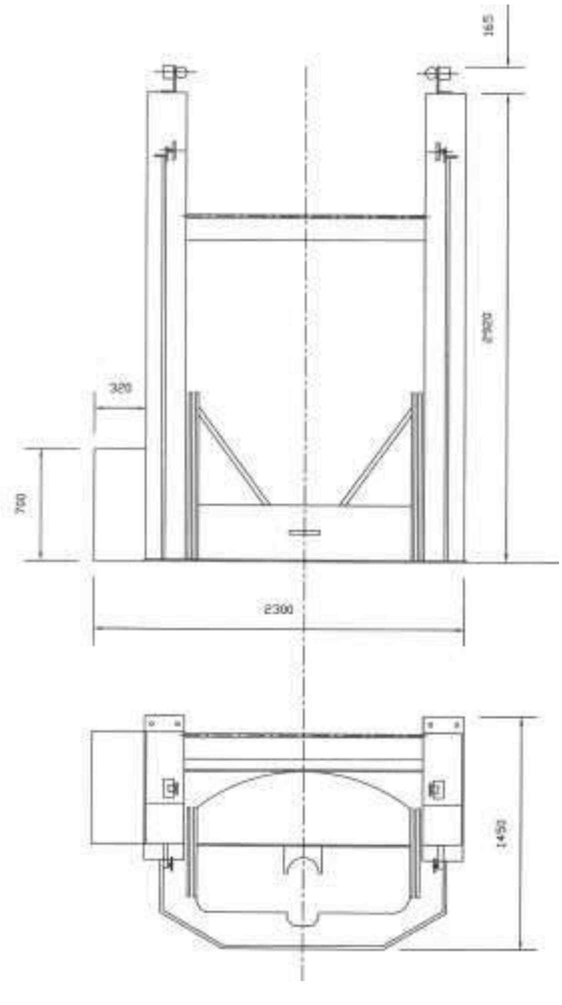
The basic principle of a dough kneader or mixing machines is to mix the ingredients properly and develop the dough suitable for bread processing.

The entire machine is fabricated out of M.S. plates with balance gears at the top head. The mixing and kneading arms are fitted with crank disc in the front of the machine. The dough bowls are fitted and are given rotation by bowl rotating arrangement provided at the base of the machines.

4. **Fermentation Room**

The function of the fermentation room is for fermenting the dough after mixing under controlled conditions. The condition of the fermentation rooms are maintained in such a manner that the temperature of the room is maintained in between $78^0$ to $82^0$ F and humidity of the room is maintained between 75% to 80% RH. The conditions are maintained by an air-conditioning unit, heating equipments and humidifier.

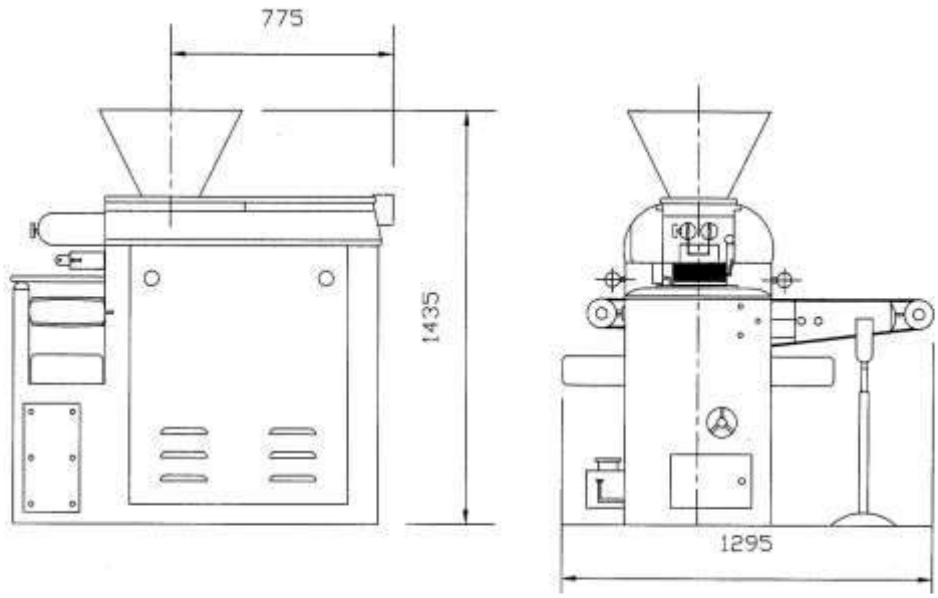
5. **Hoist**




**Dough Bowl Hoist**

The function of hoist is to lift the bowl loaded with fermented dough and to transfer this dough into the hopper of Divider Machine.

6. **Divider (Single Pocket or Two Pocket Type)**

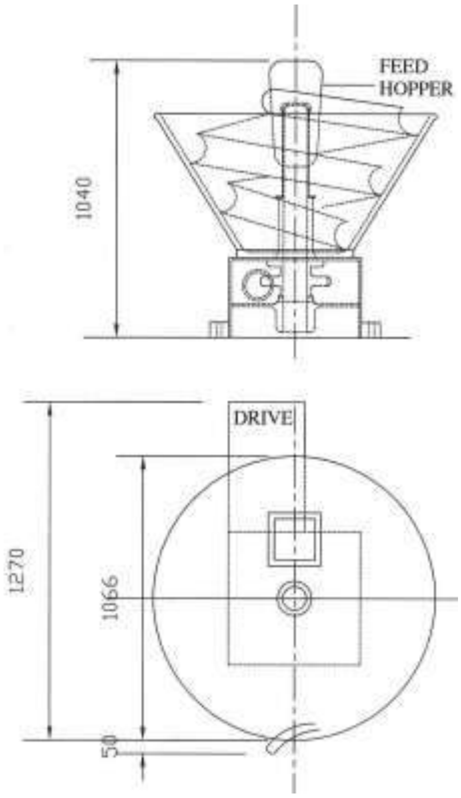



**Two Pocket Divider**

The purpose of this machine is to equally divide the dough into preset volume. The dough is of the constant pressure volumetric measuring type. It is, therefore, necessary that while using the divider one has to take care to ensure that the divider is adjusted frequently so that the dough is divided to the exact desired weight. The output range of a single or two pocket divider is 20 to 40 pieces per minute.

7. **Rounder**

The basic principle of this machine is to give round shape to the divided pieces of the dough so as to make it possible to mould properly. The rounder also makes slow stretching of the gluten continuously to improve the elastic property of the dough which will ensure good volume of the bread. Apart from the above function, it also forms the proper seal to the surface of the dough to ensure the distribution of gas throughout the dough and also to ensure that the gas will be retained in the dough during the intermediate proofing.



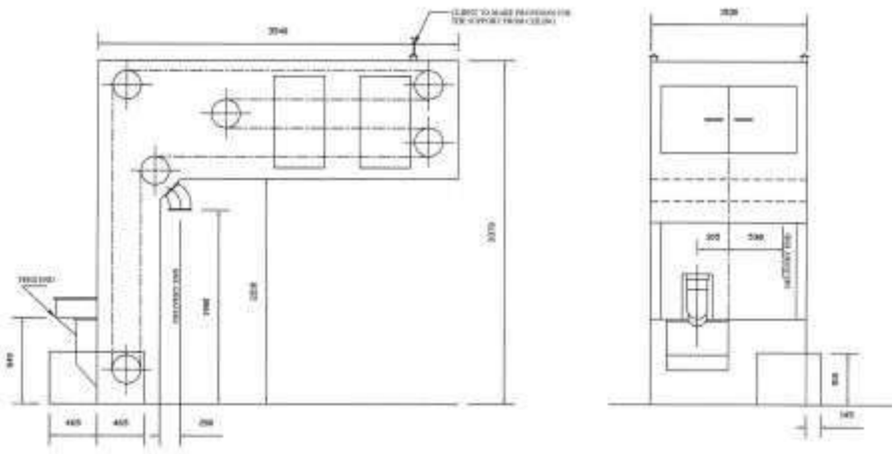

**Rounder**

Cone type rounders are used with rounder spiral at the centre. The cut dough pieces from divider falls into the centers of the cone which rotates along with the spiral which gives the round shape to the divided dough at the discharge stage.

8. **Intermediate Proover**

The basic function of the intermediate proover is to give rest and aerate the dough pieces. After the divider and the rounder if this rest is not given before moulding, the dough will be rubbing in the moulder and will not make up into satisfactory loaves.

The machine is fabricated out of M.S. sheets in the box form having the chain tracks. The hollow bush pin chain travels on the track throughout the length of inter proover. The chain carries IP trays having six pockets. The number of trays provided in the each intermediate proover is between 76 to 95 numbers. The trays are made out of plastic/fibre glass/stainless steel.

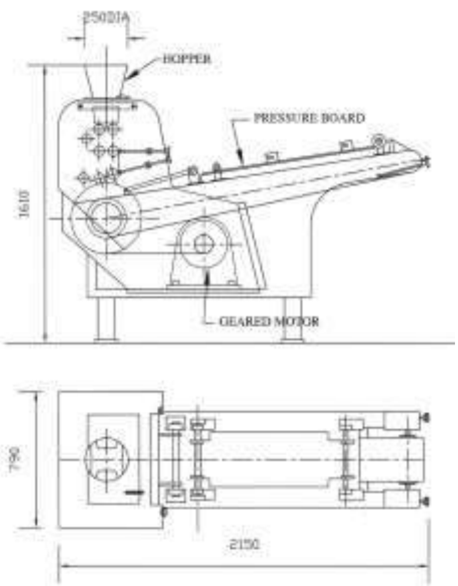


**Inter Proover**

The round dough pieces are allowed to travel between 6 to 10 minutes where dough pieces are transferred into tray pockets and where they remain until they are discharged on the dough conveyor, leading to moulder.

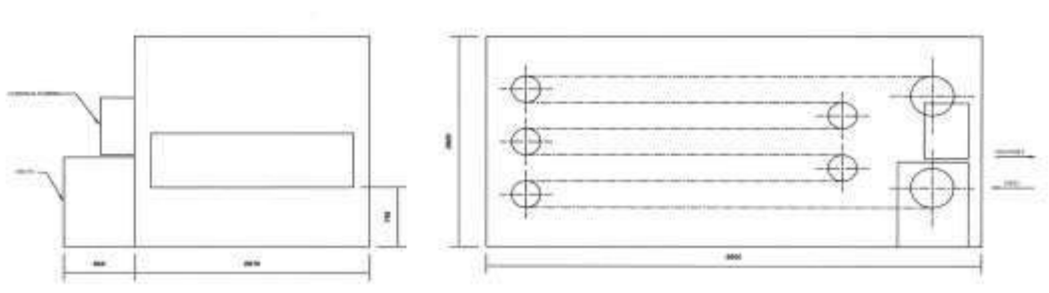
At the entry of the intermediate proover an arrangement of dusting the dough PCS with flour is also provided to avoid any sticking of the dough pieces of the pockets.

9. **<u>Moulder and Panner</u>**




The moulder and panner is a very important item of machinery and it plays an important role in finishing of the product and final make up stage of the dough. In the process of moulding, the dough is shaped into sheet by the teflon rollers and curled and passes through the pressure board and then deposits into the pan automatically by the panner. The purpose of moulding is to give uniform shape of the bread piece. The moulding head consists of three sets of rollers out of which two sets of rollers are Teflon sleeved and the gap between the rollers can be manually adjusted to the desired size.

10. **<u>Final Prover</u>**



**Final Prover**

The purpose of the final prover is that the action of the yeast is speeded up by higher temperature and the gluten also becomes more mellow.

The final prover is a mechanical swinging tray type in which the trays are carried on endless chains through a chamber maintained at the desired temperature and humidity. The prover is arranged for manual operation being loaded and unloaded at the same end.

The chains are carried on tracks for the horizontal runs and on sprockets at all turning points. All shafts are mounted in sealed grease-packed ball bearings. Lubricators are fitted to provide lubrication of chain rollers and pins. Automatic spring loaded chain tensioning is provided in addition to screw take-up for adjustment.

The prover is fitted with an intermittent drive. The drive unit consists of an electric motor with vee belt drive to a reduction worm gear. Proof time may be varied by means of an electronic timer mounted on the electrical control panel which controls the pause time of the trays.

The electrical control panel is mounted on the feed end of the prover. It is fitted with push buttons for the drive, proof time control and switches for the heating and humidity. The panel contains an isolating switch, electric motor starter, electronic timer, fuses and relays.

The air conditioning equipment consists of four galvanized steam heating coils and galvanized steam humidifier mounted in the lower section of the prover.

Control devices are fitted to provide adjustment of temperature and humidity within the prover and to automatically maintain the desired conditions during operation.

These proof boxes are manufactured out of insulated panels and are having the arrangement of maintaining the temperature and humidity in the proof chamber.

## Maintenance

The floor should be cleaned every week and the drainage outlet should be kept clean.

The insure of the prover casing should be thoroughly cleaned and where the slightest sign of rusting shows the sheets should be scraped clean and painted with corrosion-resistant paint.

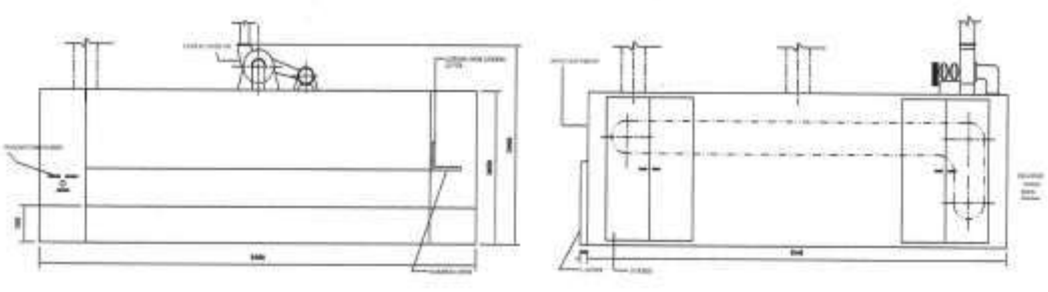
Every three months all trays should be removed and cleaned.  Any tray pins which are badly worn should be replaced.

Swing trays which have become bent or twisted should be immediately removed, straightened and examined for fracture.  When replaced the tray must swing freely on the tray pins.

The tension of the conveyor chains should be kept in adjustment so that the chain on the slack side of the sprocket can be moved slightly by hand.

Vee belts generally stretch during operation.  Careful attention should be given to all vee belt drives to ensure proper performance.  If the vee belts become hot or squeal when starting up the belts are too loose and should be tightened. They should be tightened sufficiently to transmit the drive and should not be over tightened.

## 11. Baking Ovens



**Swing Tray Oven**

The function of the baking oven is to bake the proofed dough to the desired level. The yeast present in the dough is killed, the carbon-di-oxide gas is fully released. The protein, starches are fully smelled and the maximum expansion of the loaf takes place. The uniform temperature of the oven forms the walls of the load and gives the final crust colour to the loaf.

The oven is a travelling bread baking oven fitted with swinging trays and is heated by oil. The oven trays are 8 feet, 1 in long and is supplied in 11” and 16 ½” width. A unique feature of the oven is that steam formed during baking is retained in the baking chamber to produce a highly glazed finish on upright varieties of bread and rolls.

It is a fabricated steel construction with completely separate inner and outer casings. The inner casing is fully welded to give a steam-tight baking chamber and is insulated with mineral wool. The outer casing provides a flush exterior and is fitted with access doors where required.

The fabricated steel trays are carried on two hollow bearing pin conveyor chains which are automatically tensioned by means of a spring loaded front shaft.

The front of the oven is designed so that two trays remain stationary at the oven mouth allowing trays being unloaded in the lower position and loaded in the upper position.

The oven drive shaft and the front tension shaft are carried in self-aligning bearings. Graphite bushes are fitted to the drive shaft. These require no lubrication or maintenance but require frequent checking for undue wear and tear.

The oven is fitted with an intermittent drive. The drive motor and worm reduction gear are mounted at the rear of the oven. A shear pin is provided in the drive to protect the oven from damage in the event of an overload. Provision has been made to allow the oven trays to be moved by hand in the event of a power failure and prevent burning/over baking of breads.

The oven is equipped with a fully automatic oil burner unit designed to burn light diesel oil. The burner is the pressure atomizing type with electric spark ignition and is equipped with photocell flame failure protection. Safety devices are also included to guard against circulating fan failure.

Thermostatic control of the burner operating on the “on-off” system is provided by a control pyrometer connected to a series of thermocouples mounted in the oven chamber.

The oven chamber is heated by tubular radiators through which hot gases are circulated by means of fan and then returned to the furnace for reheating. There is a radiator positioned between the upper and lower tray runs. A radiator is also positioned below the lower tray run. The distribution of hot circulating gases to each adjustable and provision is also made for setting the lateral distribution within each radiator. A fully insulated explosion relief door is incorporated in the duct work.

The whole of the furnace tunnel is lined with special refractory bricks to withstand combustion temperature and to ensure long life.

Incorporated in the design of the oven is a means by which steam formed during baking is retained in the chamber. This enables a highly glazed finish to be obtained on upright varieties of bread solely by utilizing the steam produced during baking. If at the commencement of baking, the oven is loaded with upright bread, it is necessary to supply steam initially to the oven chamber. A steam injector is fitted for this purpose. If a quantity of lidded bread is baked first, sufficient steam is retained in the chamber to give the desired glaze when the change is made to upright bread.

A steam relief damper is fitted to the oven to allow steam to be evacuated from the oven when required.

All motor starters, fuses and circuit isolating switches are mounted on a panel housed inside the outer casing near the front of the oven. Push buttons, burner indicating light and baking time indicator are mounted at the front of the oven.

A separate box is provided for mounting the control pyrometer adjacent to the oven away from high temperature and vibration.

**Operation of Mechanical Equipment**

Starting up

The oven should be lit up a sufficient time to allow the chamber temperature to reach that set on the pyrometer controller up to ½ hour before loading is commenced. Under normal conditions the oven will heat up at the rate of approximately $400^0$ F per hour.

Turn on the isolating switch in the electrical control panel.

Start up the oil firing equipment in accordance with the following sequence:

1. Start the circulating fan. This closes the suction switch.

2. Set the pyrometer controller to the desired oven temperature.

3. Check that the manual safety switch on the protect relay is in the reset position.

4. Open the oil cock in the oil line to the burner.

5. Turn on the burner switch which is mounted adjacent to the burner.

The ignition should start immediately, the burner should follow about 15 seconds later and a flame should be established. The red burner lamp also lights up.

Running

There should be no further attention required as the burner is now under the control of the pyrometer controller. This should be set at the baking temperature so that best use of the automatic on-off control is obtained.

At the time of lighting up, the main drive should be started. This ensures that all trays are heated evenly. During heating up the oven door if provided should be kept closed.

If it is desired to commence baking upright varieties of bread or rolls, the steam should be turned on 5 minutes before loading is commenced.

If lidded bread is baked first, the oven will have generated sufficient steam to glaze upright varieties after several trays have been loaded.

Naturally the point at which this stage is reached is dependent on the size of the oven and the dough weight in the oven. As a guide a 50 tray oven requires approximately 1400 lbs. of dough weight to have been loaded into a dry oven before self-steaming is achieved.

During baking excess steam may be evacuated from the chamber by means of the steam release damper which is controlled from the front of the oven.

When loading tins, care must be taken to place them centrally across the trays so that the tray hangs vertically. Failure to do this may result in tins falling off during baking causing a jam-up and consequent disruption to production.

<u>Closing down</u>

Close down the oil firing equipment in accordance with the sequence.

1. Turn off the burner switch. The burner shuts down and the red lamp goes out.

2. Close the stop cock in the oil line.

3. Stop the circulating fan.

Important note

Circulating fan must operate for 15 minutes after extinguishing burner.

Switch off the main drive and turn off the isolating switch in the electrical control panel.

Open has steam release damper fully for five minutes to purge the oven of steam. Close the damper. Clean out the floor inside the oven front and close the oven door.

**Lubrication of Oven Chains**

Regular lubrication of oven chains is most important to ensure long chain life.

The oven chain lubricant is a specially designed heat resistant lubricant with a wear base. The water is used to carry the lubricant to the moving parts of the chain.

The lubricant should be applied when the oven temperature is approximately $250^0$ F as the water will evaporate before the lubricant reaches the bearing surfaces if the oven is too hot. On the other hand rust may be formed before evaporation takes place if the oven is too cool.

Before applying the lubricant make sure that the chains are clean and if any rollers do not rotate freely they should be freed by means of Stillson grips.

The lubricant is prepared for use by thinning down with clean warm water to the consistency of paint. Apply with a paint brush getting the lubricant well down between inner and outer links and between the inner links and rollers.

The surface of the lubricant should be kept covered with water in its container when not in use.

The lubricant should be applied at least once a week and should be used just prior to heating up so that the rising oven temperature will insure evaporation of the water before rust can be formed.

**General Description of Oil Firing Equipment**

The oil firing equipment comprises oil burner and safety devices to provide protection against fan and flame failure.

The oil burner limit is driven by motor controller by a relay direct coupled to the fan and oil pump.

L.D.O. is pumped from the oil filter via a built-in pressure regulator to the nozzle at the required pressure of approximately 120 p.s.i. The pressure regulator does not admit oil to the nozzle until the required pressure is reached. If the oil pressure rises above the required figure, the pressure regulator by-passes the excess oil back to the pump intake. Primary air is supplied by the centrifugal type fan in the body of the burner. The supply is controlled by the setting of the air shutter on the micro screw adjuster. Ignition of the burner is by a spark across two electrodes. The ignition is continuous whilst the motor is running.

The burner is thermostatically on-off controlled by a pyrometer controller with thermocouples in the baking chamber. When the controller calls for heat, a relay is energized starting the burner and when the temperature has reached the controller setting, the relay is de-energized and the burner stops. Whilst the burner is operating the red indicator lamp is alight.

Safety protection is provided as follows:

In the event of flame failure, a photo-resistor mounted in the burner air tube operates a flame relay causing a safety switch heater to begin heating and after 30 seconds, unless the burner has re-ignited, the switch will warp out. This shuts down the burner, and the alarm bell will ring. The burner can only be restarted by the actuating of the manual reset lever on the Honeywell relay, and the alarm bell will stop ringing. It is necessary to wait about 70 seconds for the switch to cool down before this can be done.

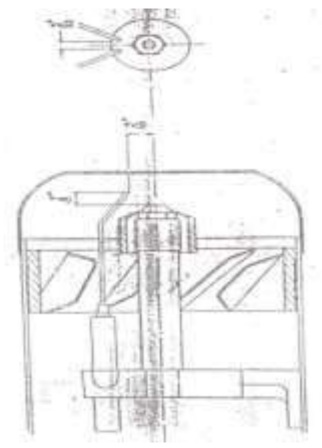
Secondly, if the circulating fan ceases to run the suction switch opens and this stops the burner, and the red indicator lamp will go out.

**Safety Shutdown**

(a) Failure to Ignite

If the burner fails to ignite the flame relay will operate, and the safety heater switch will warp out after 30 seconds, and the red indicator lamp will go out and the alarm bell will ring. Likely causes are listed below and each of these should be checked in turn.

(i) Oil line stop cock not open
(ii) Empty oil tank.
(iii) Blockage in oil line.
(iv) Electrodes are dirty.
(v) Electrodes not in proper position. The correct setting for this is shown on the following diagram.



(vi) Dirty photo-resistor glass.
(vii) Loose electrical connections.

(b) Flame Failure Shutdown

This will have the same effect as Failure to Ignite.

The same checks are also necessary.

(c) Circulating Fan Shutdown

When the circulating fan shuts off, the suction switch will open and the burner will stop. The red lamp will then go out. Check for the following possible causes:

(i) Overload on the motor which could be caused by seized fan bearings.
(ii) Failure of the electrical supply.
(iii) Overheating of the motor.
(iv) Broken vee belts.

**Weekly Operational Checks**

1. Thermostatic control

This is automatically checked daily if the starting sequence is followed.

2. Flame failure protection

Whilst burner is running shut off the oil stop cock. Then proceed as for the flame failure shut down waiting till the manual safety switch in the Relay has cooled before restarting.

3. Circulation

Switch off the circulating fan whilst the burner is running. The burner should stop.

**Maintenance of Burner Unit**

Burner

It is recommended that arrangements be made for regular servicing of the oil burner.

Once every week withdraw nozzle from the burner head. Check the electrode setting and make sure that the photo-resistor glass is clean.

The nozzle tube can be withdrawn from the assembly by slackening off the grub screw and the nozzle removed for cleaning. This should be done by soaking and washing in lacquer thinners, removing any particles of carbon with a sharpened match or tooth pick. On no account should any metal object be used on the nozzle parts. When re-assembling the nozzle, it should be held vertical with the orifice downward to assist in locating and seating the disc.

Furnace brickwork

Inspect the furnace brickwork every month for any displacement or other defects. Special high temperature refractories are to be used for the furnace linings and replacements to be made accordingly, if any.

**Auto Lidding of Simplex Oven**

Description

The mechanism in Simplex auto lidding provides for bread to be baked with the lids either lying on top of the tins, or alternatively, locked in the raised position, approximately 7.5/8" above the trays. Simplex auto lidding has no drive as such, it simply makes use of the movement of the trays to actuate toggle links to raise or lower the lids as required. Lidding is controlled by a spring loaded self locking lever which may be placed in two positions marked "Lidded" and "Non-Lidded". Lids on the trays in the loading and unloading positions are always raised regardless of the setting of the lidding control lever.

Two toggle links fitted to either end of the tray as shown in **Figures 1 and 2,** control the position of the lids by means of cams which act on the centre or control roller of the links. The cams consist of two welded steel frames attached to either side of the vertical run of the oven, and through these cams pass the link and stabilizers at the end of the trays.

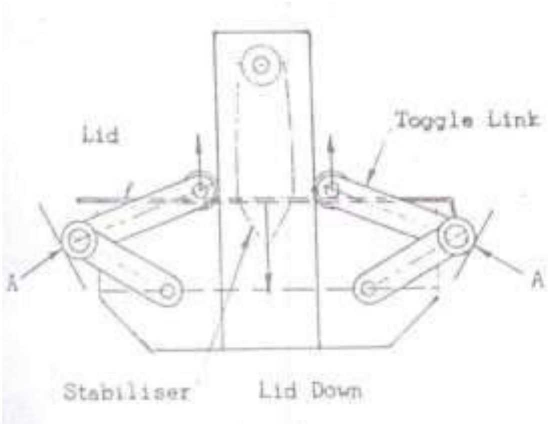



Fig. 1

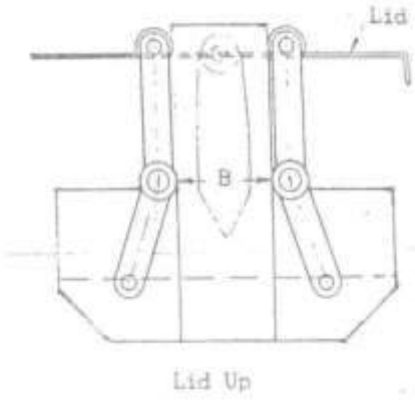



Fig. 2

The control rollers on trays passing through the cams first contact the elevating cams which push the rollers in the direction of arrow A. **Figure 1**, until the lids are fully raised and locked up, as shown in **Figure 2**. The elevating cams are placed in the vertical return run as shown in **Figure 3**, so that the lids are raised ready for unloading as soon as the trays emerge from the baking chamber.

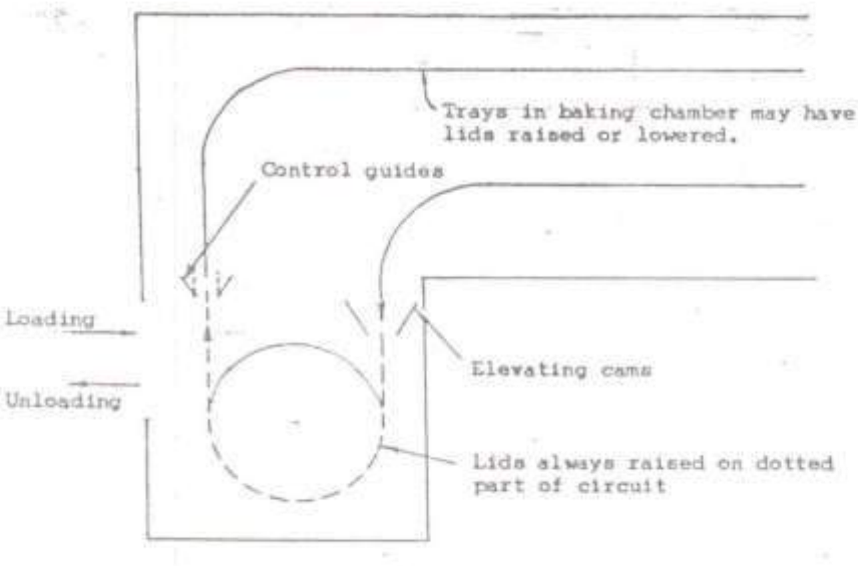



Fig. 3

Trays proceeding from the loading position, pass the control guides which may be set either to miss the control rollers or alternatively, to push them outward in direction of arrow B **Figure 2**, thus lowering the lid until it is resting on the tin.

Trays are fully stabilized for the whole of the time they are passing through the cams, this includes the time at loading and unloading positions. Raising and lowering of the lids is completely controlled at all times, resulting in an extremely gentle and practical noiseless action.

Operation

Set lidding control lever in desired position, either "Lidded" or "Non Lidded", when trays are stationary. Changing the setting when the trays are moving could result in improper lidding of the tray passing through the control guides and is therefore to be avoided.

When loading, ensure that tins are placed centrally across the trays to prevent undue tilting which could result in a jam up. Under no circumstances must anything be placed on top of the lids as this also could cause severe damage to the lids and trays.

**Maintenance and Lubrication**

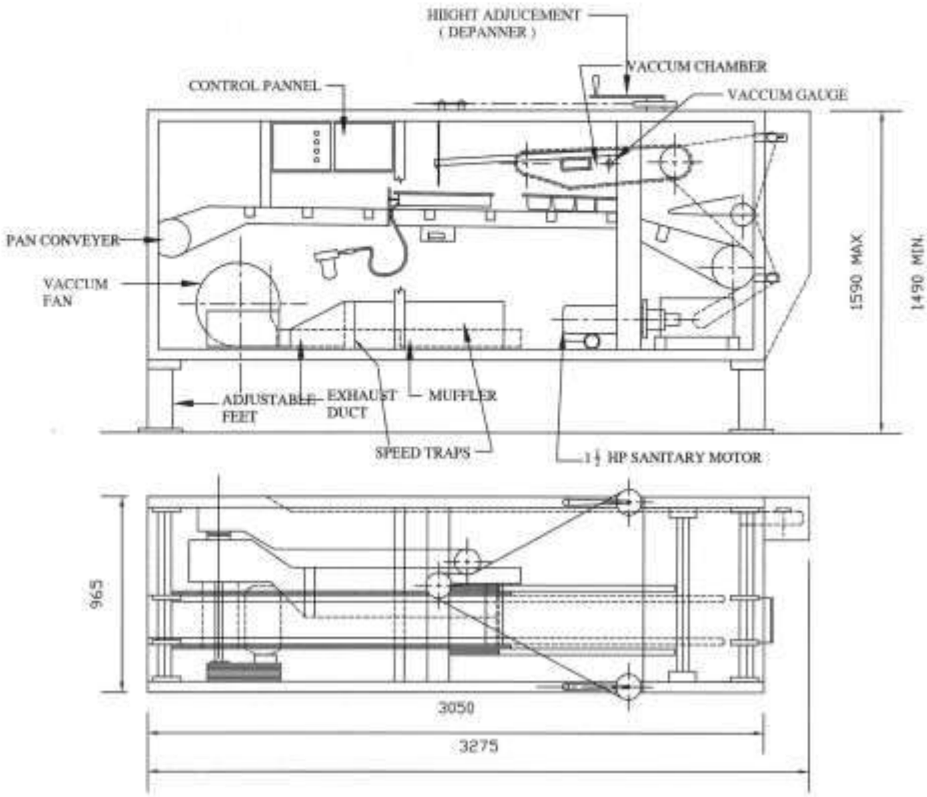
Trays

Once a week Lubricate joints and rollers of each toggle link with oven chain lubricant. Access to the front toggle links is obtained through loading door, and to the rear links, through rear oven doors. Regular and thorough lubrication of toggles links and pins is essential for the trouble free operation of the auto lidding. Apply with paint brush getting the lubricant well down between inner and outer links and between inner links and rollers. Check all rollers to ensure freedom of movement and free all tight ones by means of Stillson grips. The lubricant should be applied when the oven temperature is approximately $250^0$ F.

12. **De-Tinner / De-Pan-Ovac**

The basic function of this machine is to remove bread automatically from the bread baking tins at a very fast rate. The hot bread baking tins at a very fast rate. The hot bread tins are diverted to the tin cooling system and the hot bread is conveyed to the collecting table, from where the breads are lifted and stacked in trolleys for cooling purpose before these are sliced and packed.

The machine is fabricated structure consisting of slat band conveyor for conveying the bread baking tins with bread. A vacuum conveyor assembly placed over the slat conveyor with aluminium cup holders with rubber cups. An exhaust blower is attached to the vacuum cup conveyor assembly for creating vacuum which helps in removing the baked product from the tins. A common drive arrangement with reduction gear box is provided at the bottom of the machine to give drive to the slat chain and vacuum conveyor assembly.




**De-Panner**

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13. **Tin Cooling System**

Tin cooling system fixed on the conveyor with ducting and axial flow fans/blower fans for circulating the forced cool air over the tins to cool them sufficiently before the panning stage.

14. **Slat Band Conveyor System**

All the plans are provided with 7 ½ inches x 1.5” pitch slat band conveyor. The slat band conveyor system is provided all around the final prover and ovens for easy flow of loaded and empty tins. The slat band conveyors are made out of M.S. case hardened steel and blackodised.

The conveyor systems provided are working on the fabricated steel structure which supports the slat band chain running over the sprockets and the drive is given through reduction gear boxes. The same system is adopted for wire conveyors also for conveying breads.

15. **Cooling Tunnel**

Every unit is provided with cooling tunnel(s). The basic principle is to enable fast cooling of the baked products and to prevent excessive hardening of the baked product. This also helps in reducing the cooling loss.

The cooling tunnel is a static chamber fitted with inlet and exhaust fans made out of M.S. fabricated channels. The inlet and exhaust is provided through axial flow fans forcing the air over the product and exhausting the hot air. In most of the bakeries air washing system is also provided with a cooling fan for forcing the cooled air on to the product during the summers.

16. **Automatic Slicing and Wrapping Machines**

These are highly specialized machines consisting of 3 sections viz. slicing, synchronizing and wrapping sections. The slicing section slices the bread with the help of reciprocating knives through which the breads are passed and sliced.

The Synchroniser carried the sliced bread up to the wrapper feed point and feeds the sliced bread into the wrapping machine. The wrapping machines wraps the bread in the wax paper which is in the form of rolls. The wax paper covers sliced bread and seals the same with the help of heat sealers and is finally discharged on to the conveyor for collection and filling into the bread baskets.

**BRIEF DESCRIPTION AND FUNCTIONS OF ANCILLARY EQUIPMENTS**

1. **Air Compressor**

These compressors produce compressed air at 100 to 250 lbs per square inch. The compressed air is used for cleaning all the bakery equipments as well as in the air jet system of Depanovac machines.

2. **Boilers**

Package type of boiler are used for steam generation. These boilers are of non-I.B.R. category and are of coil type. These boilers are fitted with oil burners and are completely automatic with various controls and satches.

The basic use of the steam, generated by these boilers is used in heating and humidifying the final proves. A part of the steam is also used in the mixing section for preparation of GMS emulsion and in fermentation rooms for maintaining required temperature during the extreme winter season.

3. **Air Conditioning and Chilled Water Plants**

The essential equipment of the cold store are motor, compressor, air handling unit, controls and insulated storage space fitted with heavy insulated door. The temperature is maintained by providing evaporative coil with air handling arrangement. The refrigerant is circulated into evaporative coil with the help of the refrigeration compressors and refrigerant is cooled by the shell and tube type of water circulated or air cooled condensers. Each cold store is provided with one stand by compressor.

4. **Fermentation Room**

The fermentation room is also equipped with air conditioning and heating equipments. The temperature and humidity of the fermentation room is also maintained at the desired level. It consist of evaporative coil with air handling equipment along with the electrical heaters. The electrical heaters are used during the winter season where the temperature has to be raised to the desired level. The fermentation room equipment also consist of refrigeration compressors of suitable capacity with water circulated shell and tube type of condensers with standby compressor. The humidity is maintained by water spray nozzles / humidifiers.

5. **Chilled Water Plants**

The chilled water is used in the process for maintaining the dough temperature. The chilled water equipment consist of water chillers, tank coil systems, refrigeration compressors and refrigeration condensers.

In air conditioning equipment, Freon Gas is used as refrigerant. All the water cooled condensers are connected by the suitable pumping system to the cooling towers which brings down the temperature of the water after it is circulated through the condenser system of the refrigeration plants.

Apart from the above process and ancillary equipments the following important bakery equipments also for the purpose of carrying out production and dispatch:

1. <u>Bakery equipments</u>

(i) <u>Weighing scales</u>

Precise weighing scales of various capacities. The weighing scales are provided for weighing various ingredients to be added into the product very precisely as per the laid-down formulations and also to check the incoming quantity of the raw materials received in the stores along with the monitoring of finished product weights before dispatches.

(ii) <u>Bread baking tins</u>

Bread baking tins of various sizes as per requirements.

(iii) <u>Bread cooling trolleys</u>

Sufficient number of bread cooling trollies for cooling the baked product before the slicing and packing are required to handle full production capacity of one line.

(iv) <u>Morries trollies</u>

For material handling pallet trucks / Morries trollies are provided in various sections as per the need.

(v) <u>Bread baskets</u>

Bread baskets for handling the finished product which is sent to the market through the delivery vans.

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2. Other installations

(i) H.T. and L.T. Electrical Installations

The H.T. and L.T. electrical installation is provided in the bakery unit to give continuous un-interrupted power supply for running of the various equipment. The power supply is available at high voltage from the respective state undertakings. This H.T. supply through the H.T. equipments is fed to the step down transformer to convert the high voltage supply into the low voltage supply at 415 volts from operating the equipments. After the transformer installation, L.T. distribution board is provided and the supply is then further, distributed to various points in the bakery.

(ii) Water Supply Installation

Bakery requires its water supply installation to receive water from the municipal corporation or any other source. The tube well installation is provided for getting the water supply within the premises. The underground or overhead storage tanks distributes the water to various points in the bakery.

(iii) Oil Installation

Underground/overhead oil storage tanks along with its complete installation to the required equipments through service tanks.

(iv) Fuel Oil Installation

Fuel oil installations by providing bulk storage tanks either underground installation or overhead installation along with service tanks and pipe lines for supply of fuel oil to the ovens and boilers.

3. <u>Fire Fighting Equipments</u>

The installation of the fire fighting equipments at the various strategic locations for fire fighting is a statutory requirement. The various types of fire fighting equipments as per the class of fire and as per the recommendation of the local fire authority are required to be provided.

4. <u>Delivery Vans / Staff Cars</u>

Baking is requires one or two staff van / cars and sufficient numbers of the delivery vans.

## TECHNICAL SPECIFICATIONS

### 1. Flour Sifter

**Capacity :**

Designed for aerating and sifting flour at rate of 2.5 Tonne per hour.

**Electrical Characteristic :**

Elevating Conveyor Motor : 3 HP, 960 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. cage TEFC Induction motor.

Horizontal Conveyor Motor : 3/4 HP, 960 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. cage TEFC Induction motor.

**Simplicity of operation :**

Flour from bags is dumped into the Feed Hopper, where it is conveyed to the removable perforated steel sifting head and delivered to the bowl. The residual flour is diverted into the refuse collector.

**Net Weight** : 320 kg

**Gross Weight** : 410 kg

### 2. Water Tempering and Measuring Tank :

**Capacity :**

Overflow capacity : 190 Litre
Sliding Scale : 165 Litre

**Simplicity of operation :**

It is designed for supplying water at a constant ad pre-determined temperature to Dough Kneader bowl. A large instantaneous reading thermometer facilities quick adjustment of the mixing valves.

**Net Weight** : 320 kg

**Gross Weight** : 410 kg

3. **Twin Arm Dough Kneader :**

**Capacity :**

Designed to mix and knead maximum up to 220 kg of flour per batch or 300 kg of Dough per batch.

**Electrical Characteristic :**

5 HP, 1440 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. cage TEFC Induction motor.

**Simplicity of operation :**

All controls are positioned for easy operation. It is simple and quick to lock the bowl in position and engage the worm with the worm wheel. The Mixing Arm can be run idle by operating the hand wheel while the Kneading Arm can be tilted outwards using a special spanner supplied with the machine.

**Net Weight** : 1400 kg only mixer
1650 kg with Bowl

**Gross Weight** : 1600 kg only Mixer
1900 kg with Bowl.

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4. **Dough Bowl Hoist :**

**Capacity :**

Designed to lift the Dough Bowl used with Model 9543 Dough Kneader to deliver the dough into Divider Hopper.

**Electrical Characteristic :**

Drive Motor : 2 HP, 1440 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. cage TEFC Induction motor.

**Safety of operation :**

To ensure absolute safety of operation a limit switch is provided to automatically stop the machine when safety guard is opened.

**Net Weight** : 3200 kg

**Gross Weight** : 4000 kg

5. **Two Pocket Divider :**

**Capacity :**

Designed to scale dough into pieces having equal weights ranging from 225 gm to 1020 gm with variable output from 2000 to 3000 dough pieces per hour.

**Electrical Characteristic :**

2 HP, variable speed electric motor, 400/440 volts, 3 phase, 50 c/s.

**Simplicity of operation :**

All controls are positioned for quick and easy operation. Weight adjustment is simple and positive by means of a weight regulating hand wheel. The output of the Divider can be varied by means of speed regulating hand wheel.

**Net Weight** : 1100 kg

**Gross Weight** : 1250 kg

**6. Rounder :**

**Capacity :**

Design to mould 400 gm to 1000 gm dough pieces at the rate of 3600 pieces per hour into uniform smooth spherical shapes for subsequent first proof.

**Electrical Characteristic :**

3/4 HP, 940 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. cage TEFC Induction motor. Motor and Switchgear can be supplied to suit voltages etc.

**Simplicity of operation :**

The dough pieces from Divider are fed into the Hopper and discharged straight through from the outer edge of the Conical Table into the hopper of the Inter Prover.

It is simple and quick to remove the spiral trough for maintenance.

**Net Weight** : 530 kg

**Gross Weight** : 650 kg

**7. <u>Inter Prover :</u>**

**<u>Capacity :</u>**

<u>Proof Time in Minutes :</u>

| OUTPUT | DOUGH PIECES PER HOUR | | | |
|---|---|---|---|---|
| No. of Laps | 2400 | 2200 | 2000 | 1800 |
| 6 | 10.7 | 11.7 | 12.9 | 14.3 |
| 5 | 8.9 | 9.7 | 10.7 | 11.9 |
| 4 | 7.0 | 7.7 | 8.5 | 9.4 |

<u>No, of Trays :</u> 74 nos. Six pocket trays.

<u>Max. Capacity of pockets :</u> 1000 gms.

**<u>Electrical Characteristic :</u>**

Motor : 1 HP, 1440 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. cage TEFC Induction motor. Motor and Switchgear can be supplied to suit voltages etc.

**<u>Simplicity of operation :</u>**

All controls are positioned for quick and easy operations. It is simple and quick to set the loader flaps to make 4, 5 or 6 laps of tray circuit to give different proof time without changing the speed of the drive. The drive speed can be varied to give max. desired output by the hand wheel provided at drive unit.

**<u>Net Weight</u>** : 1000 kg

**<u>Gross Weight</u>** : 1200 kg

**8. Straight Moulder:**

**Capacity :**

Design to mould dough pieces weighing 400 gm to 1000 gm to produce length between 150 mm to 350 mm to give output up to 2300 dough pieces per hour..

**Electrical Characteristic :**

Motor : 2 HP, 400/440 volts, 3 phase, 50 c/s, 230 RPM Geared motor.

**Simplicity of operation :**

CONTROL : All controls are positioned for quick and easy operation. It is simple and quick to change over from 400 gm to 1000 gm settings.

Safety of operations : To ensure absolute safety of operation, both front and rear hinged vision doors are fitted with micro switches which automatically stop the moulder when either door is opened.

**Net Weight** : 700 kg

**Gross Weight** : 1000 kg

**9. Final Prover :**

**Capacity :**

1800 loaves of 800 gms size per hour based on 60 minute proof.

**Electrical Characteristic :**

Drive Motor : 1 HP, 1000 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. Cage TEFC Induction Motor.

**Important Features :**

Final Prover body consists of heavy steel sections and mounted on a rigid steel base. It is corrosion protected. Access doors are provided for normal maintenance.

Conveyor system consists of 101 Swing type galvanized trays carried on 6” Pitch Chain running on steel track on either side. Air conditioning system ensures to maintain desired temperature and humidity during the operation.

**Net Weight** : 12 Tonne

**Gross Weight** : 15 Tonne.

**10. Swing Tray Oven :**

**Capacity :**

1800 Breads of 800 gms suze per hour based on 30 minutes bake.

**Electrical Characteristic :**

Drive Motor : 1.5 HP, 1440 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. Cage TEFC Induction Motor.

Circulating Fan Motor : 10 HP, 1440 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. Cage TEFC Induction Motor.

Extraction Fan Motor : 1.5 HP, 1440 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. Cage TEFC Induction Motor.

**Important Features :**

Oven body consists of inner and outer walls, mounted on heavy steel base and thoroughly insulated. Suitable openings are provided for temperature measuring equipment, inspection windows, light boxes etc. with a walk in space for maintenance.

Oven Conveyor system has 50 Swing Type Trays supported on 4” Pitch Chain and carried on tracks at each side. Trays have automatic lidding/non-lidding arrangement.

Automatic oil Jet burner suitable for working on Light Diesel Oil is provided in the heating system. Controls are provided for oven conveyor system, burner operations, baking time, temperature etc.

**Net Weight** : 15 Tonne

**Gross Weight** : 17 Tonne.

**11. Depanner :**

**Capacity :**

Designed for De-panning breads from standard size Bread Straps at the rate of12 to 35 sets per minute.

**Electrical Characteristic :**

Vacuum Fan Motor : 10 HP, 3000 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. Cage TEFC Induction Motor.

Drive Motor : 1.5 HP, 1440 RPM, 400/440 volts, 3 phase, 50 c/s, Sq. Cage TEFC Induction Motor.

**Simplicity of operation :**

CONTROL : All controls are positioned for quick and easy operation. It is simple and quick to change the speed of the conveyors and to adjust the height of the Cup Conveyor for different size of bread straps.

Safety of operations : To ensure absolute safety of operation, limit switch is provided to alarm and stop the machine when the bread straps get jammed on the pan conveyor.

**Net Weight** : 2200 kg

**Gross Weight** : 2600 kg

**EXERCISE**

1. Draw process flow diagram of bread making.
2. Give brief description and functions of various process and ancillary equipment.
3. Provide data to be collected at the time of taking inventory of machinery used in bread making to get the current prices.

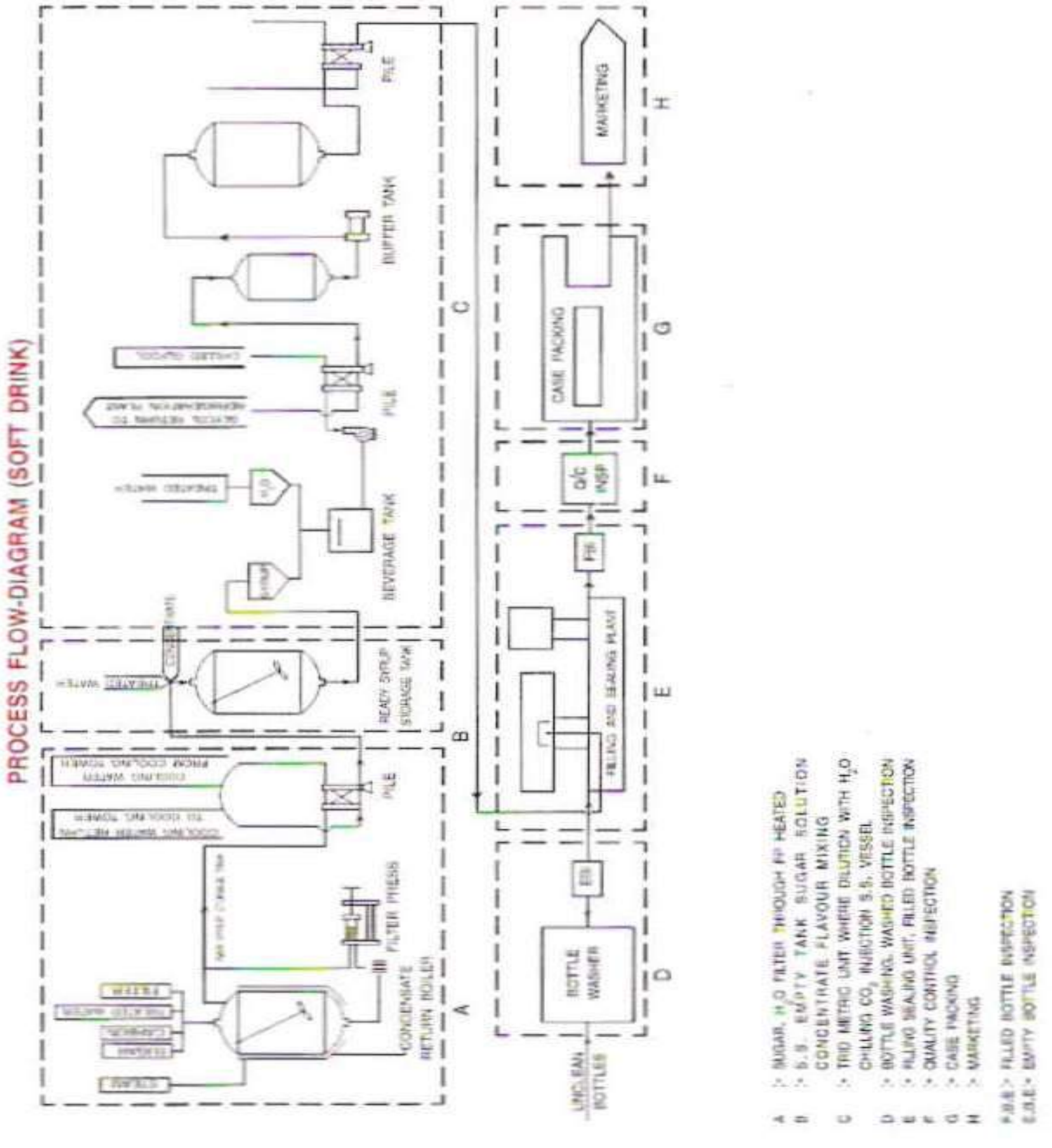
# UNIT - 9

## MANUFACTURING PROCESS OF SOFT DRINK

**OBJECTIVES :**

By the end of this chapter students will learn about :-

- Process flow
- Manufacturing process



**Manufacturing Process of Soft Drink**

The following steps are involved in the manufacturing process of beverage drinks:

* Water treatment - (i) Chemical treatment to raw water for process water.

  (ii) Softening treatment to borewell water for bottle and boiler cleaning.
* Sugar syrup preparation
* Concentrate syrup preparation
* Bottle washing and empty bottle inspection
* Proportionating unit – dilution – chilling and carbonation
* Filling, sealing and filled bottle inspection
* Case packing
* Marketing
* Quality control assurance laboratory

**Water treatment :**

(i) Chemical treatment to raw water for process water.

Raw water obtained from the municipal source is stored in a tank (generally of R.C.C. construction) and then transferred to a chemical treatment tank (mechanical agitators are provided in each of the tanks and tanks are generally of R.C.C. construction). Where lime-ferrous, sulphate-bleaching powder treatment is given to reduce the alkalinity, turbidity and micro-organisms. After treatment, required settling time is given for flock settlement at the bottom of the tank. After that chemically treated water containing 8 ppm (parts per million) – 10 ppm residual chlorine ($Cl_2$) is transferred to overhead storage tanks (generally these tanks are of R.C.C. construction).

From there it passes through –

* Sand filter (for removing suspended impurities)
* Carbon filter (for removing residual chlorine)
* Micron filter (for removing turbidity)
* Ultraviolet sterilizers (for killing micro-organisms)
* Sugar syrup preparation room
* Concentrate preparation room

(ii) Softening of bore well water

The raw water from bore well is collected in storage tanks (normally of R.C.C. construction) where automatic chlorination (8 ppm – 10 ppm) takes place. Sufficient contact time is given to kill micro-organisms; water is then passed through sand and carbon filters for removing suspended impurities and residual chlorine respectively. Ion exchangers (softners) reduces total hardness of the water up to less than 10 ppm. Softer water is then collected in overhead tanks and then subsequently passed through ultraviolet sterilizers (UV lamps). This water is used for bottle washing, boilers, cooling towers, generators and for plant cleaning purposes.

**Sugar syrup preparation :**

For preparing sugar syrup – white crystal sugar, carbon powder filter, citric acid and water in required quantities are heated to about $75^0$ C in a steam jacketed tank with a mechanical agitator. On achieving the required temperature, appropriate contact time is allowed for better inversion. Hot sugar syrup is then passed through the filter press for removing impurities and through a plate heat exchanger for reducing the temperature. This clear, odourless, colourless sugar syrup is kept in S.S. mixing tanks.

**Concentrate syrup preparation :**

For preparing concentrated syrup, sugar syrup is mixed with acid flavour, colour and other ingredients along with treated water. The mixing takes place in S.S. mixing tanks with mechanical agitators. The prepared concentrated syrup is kept for ageing as per the required standard for different flavours. In order to maintain standard mix with required volume, treated water is added.

**Bottle washing and empty bottle inspection :**

Empty bottles received from market are pre-inspected for chipped glass, straw removing, rustiness and washed with hot water on a washing machine, they are then thoroughly cleaned, washed, sterilized and finally rinsed with soft water.

**Proportionating unit :**

Concentrated ready syrup is mixed with treated filter water for dilution depending upon the flavours in the mixing tanks. The mix passes through chilling plate heat exchanger for carbonation with carbon dioxide gas. The carbonation is different for different flavours.

**Filling, sealing and filled bottle inspection :**

Bottles from the washing machine are filled with a carbonated beverage to a proper level and sealed on an automatic filling and sealing machine. Subsequently they are inspected for the proper level of liquid, crown crimping and dirt. Finally bottles are put in crates for marketing.

**EXERCISE**

1. Write short note on manufacturing process of soft drink.

# REPORT WRITING

Please refer the book- ***Valuation on Plant & Machinery (Theory & Practice) by Kirit P. Budhbhatti*** for the details on this subject.

# CASE STUDIES

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Mr. Kirit P. Budhbhatti

Chairman – CVSRTA

CVSRTA

**INDEX**

**CASE STUDIES**

This section covers the case studies of Valuation assignments handled in actual practice. These case studies are based on the situation/conditions prevalent as on date of valuation when the valuation was undertaken. However, they certainly throw light on issues to be taken into consideration for valuation under different facts and circumstances.

The format of presentation of various case studies is as under:

Facts of the case are given first and the report is presented in the form of executive summary.

While going through the case studies one finds that the following observation of Honorable David Laro of United States Tax Court, Washington, D.C. on valuation is very appropriate:

> "Anyone approaching the subject of valuation should be aware of certain truisms as a frame of reference. They are:
>
> Each valuation case is unique. Although guidance can be obtained from earlier cases, each case is unique. One case is rarely on point with another, and a significant differentiation of the facts can usually be made."

**Case Studies on Valuation Assignments handled in Actual Practice**

In this section, the following case studies are presented:

- Valuation of tangible assets of textile plant classified as Non-Performing Asset
- Valuation of an industrial plant for sale
- Valuation of an industrial plant for purchase
- Valuation for insurance
- Post demonitisation review of valuation

# A. Valuation of tangible assets of textile plant classified as Non-Performing Assets

## Facts of the Case

A textile unit engaged in manufacturing of grey fabrics was required to be valued for bank finance purpose as the account had become NPA (Non-Performing Asset).

While taking a loan from bank the borrower had offered land, buildings and plant & machinery as a security which are subject matter of valuation in this case.

Any security offered by the borrower is governed by Section 5(n) of Banking Regulation Act, 1949, which defines '**Secured loan or advance'** as:

"a loan or advance made on the security of the assets the **market value** of which is not at any time less than the amount of such loan or advance".

The next question then arises – What is the meaning of the term market value?

**"Market value"** is as defined under Chapter-2 Role and Function of a Plant & Machinery Valuer.

**Non-Performing Assets (NPA) means:**

A loan or lease that is not meeting its stated principal and interest payments. Banks usually classify as non-performing assets any commercial loans which are more than 90 days overdue and any consumer loans which are more than 180 days overdue. More generally, an asset which is not producing income to service the debt.

Thus, from the point of view of bankers the security offered by the borrower should be sufficient enough to recover loan advanced with accumulated interest if any. This is the reason why RBI policy stipulates that the assets offered as a security to be revalued once in two years.
The tangible assets offered as security play vital role in generating the income through which the payment is to be made.

In the event of sale of these assets any buyer will take into consideration what is the potential of deriving the income in future on purchase of machinery. In other words, he will certainly look into the aspects of future income earning capacity especially when an account has become NPA.

The account can become NPA due to any of the following reasons:

- management failure
  or
- assets have lost their capacity to perform and hence unable to generate the income
  or
- even if assets are in good condition but products manufactured by the machines do not have any demand for a foreseeable feature.

It is very essential to consider all the above aspects while valuing tangible assets of NPA account. This is so because generally there is a feeling that once the account becomes NPA their tangible assets are not valuable.

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# Report on Valuation of Fixed Assets
# Of
# The XYZ Ltd., Ahmedabad, Gujarat

## Part – I: Executive Summary

**1.0** The XYZ appointed us to estimate the market value of the assets mentioned in para 2.0 of this report.

**2.0** **Details of fixed assets under consideration located at Ahmedabad:**

- Land
- Buildings
- Plant & machinery
- Electrical installations

The above fixed assets contribute to more than 99% value of all the fixed assets appearing in the schedule of fixed assets of the balance sheet of the company.

The plant went into commercial production on 1st January 1995.

**3.0** **Date as on which valuation is made:** 31st January, 2005.

**4.0** **Purpose for which exercise carried out:** Sale of tangible assets as the account has become NPA.

**5.0** In order to carry out the exercise, team consisting of – valuers of real estate as well as plant & machinery and civil, electrical and mechanical engineers visited the plant.

**6.0** The assets are utilized for manufacturing of polyester grey fabrics.

**7.0** **Definition of market value used**

The definition used is as outlined earlier in Chapter-2 Role and Function of a Plant & Machinery Valuer.

**Basis of Valuation**
Valuation is based on market value in existing use in-situ.

**8.0 Assets under consideration fall under limited market, specialized, special purpose and specially designed.**

Such specialized assets are sold by way of sale of the business of which it is a part because of uniqueness arising from the specialized nature, design, size, location, etc. Hence, such assets suffer from limited marketability.

There are following three approaches to estimate value:

- Market
- Income
- Cost

- The assets under consideration are specialized assets and hence, there are no instances of sale of such plant and therefore it cannot be valued by sales comparison method by market approach except land.
- Neither rental/lease evidence of such plants is available nor it is possible to quantify contribution of assets under consideration to the total turnover of the company and therefore income approach is also not applicable.
- In view of above, valuation is carried out by cost approach.

It is noteworthy to mention here that as valuation is carried out by cost approach the value of tangible assets is subject to potential profitability.

**9.0 The report is based on following information furnished by the clients and inspection carried out by us:**

(a) Land

(i) Photocopy of deed of conveyance.

(b) Buildings

(i) Year wise additions
(ii) Year of construction of individual buildings

(c) Plant & machinery

(i) Year of installation of individual machines
(ii) Technical specifications of major equipment
(iii) List of machineries with brief description

(iv) Process /Machinery lay out

(d) Electrical installations

(i) Details of HT/LT distribution and sub-distribution system

(ii) Connected load

**10.0 For the purpose of the exercise the report is divided into following parts:**

| | |
|---|---|
| Part – I | Executive Summary |
| Part - II | Company profile, brief manufacturing process and process/ machinery lay out |
| Part – III | Land and buildings |
| Part – IV | Plant & machinery and electrical installations |

**11.0 The plant & machinery installed are supplied by reputed textile machinery manufacturers mainly from Japan.**

The major machinery installed are -

| Description of equipment | Name of manufacturer |
|---|---|
| Water jet looms | Tsudakoma, Japan |
| Two for one twisters | Murata, Japan |
| Preparatory machines | Todo, Japan |
| Pirn winders | Nakagoshi, Japan |

As per the information furnished by the clients they have initiated following steps after account was declared as NPA:

XYZ has been set up to produce the complete range of Polyester Synthetic Fabrics. Such fabrics are made in various ranges and from the most cost effective and popular fabric for clothing needs world-wide, particularly as dress materials for ladies and children. With the application of latest fabric designing and finished technology, polyester fabrics are today being used more and more as fashion fabrics. Such expensive varieties churned out are being appreciated even by the affluent for multiple applications and needs.

Some of the popular trade names and product categories being manufactured are Koshibo, Faille, Dobby Georgette, Single Georgette, Dark Wood, Laser, Soft Touch, Wool Crepe, Soft Skin, ITY Bliss, Wool Peach, Sysrasso.

In order to lend competitiveness to the existing products and to avail benefits of value addition for dyed and processed fabrics the company has entered into arrangements with established processors for dyeing and processing of grey fabrics whereby XYZ will be able to broad base the marketability of its products. However, grey fabrics will continue to be marketed as earlier both in export and domestic market.

XYZ has got the following strengths as on today:

(i) Good infrastructure,
(ii) Good production machinery,
(iii) Ability to produce quality grey fabrics,
(iv) Capability to cater international and domestic markets with premium quality.

XYZ has to address the following key issues:

(i) Increase in capacity utilization,
(ii) Widen product range, and
(iii) Reduce production costs.

It has already initiated steps to meet the challenges it faces today. The same are as under:

<u>Capacity Utilization</u>

- Generate more product demand.
- Overcome stagnancy in grey fabric markets.
- Increase market size by widening product range.
- Create new markets, enhance marketing infrastructure.
- Achieve production consistency of 0.65 Million meters/month and increase to 0.85 Million meters/month minimum in rapid time.
- Aim for 1 Million meters/month in next 3 to 4 years.

<u>Status</u>

- Average production during September 2004 - June 2005 achieved was 0.69 Million metre/month and during July-September 2005 was 0.8 Million metre per month.
- Current order book – 3 months on average.
- New dealers appointed in Europe as well as in domestic markets.

- Marketing office set up at Delhi to cater to northern India markets, major export house at Surat, being main Polyester fabric market in India.
- Marketing office being set up at Mumbai for western and southern markets.

Product range

- Achieve a wider product mix between grey / processed fabrics.
- Outsource processing from external process houses in the country.
- Maintain market share in grey fabrics. Hold existing customers.
- Revive earlier grey fabric customers with offer of processed fabrics.
- Derive additional margin/meter of ` 5-7 on processed fabrics.

Status

- Processing done through 2 reputed process houses in western India.
- Quality established and approved. Initial lots of processed fabrics already delivered.
- Grey-fabric markets maintained at earlier levels.

Production costs

- Reduce interest cost to achieve competitiveness.
- Reduce debts to manageable level over specific time period.
- Seek any possible periodic-specific relief from bankers.
- Procure industry specific reliefs/supports, etc. offered to textile industries, if any, like various other countries of the world from the Govt. or any of its empowered agencies.

Status

- Matter already taken up by way of discussion with bankers to explore the possibilities of restructuring of debts and reduction of interest cost in real terms.

## 12.0 Procedure adopted for valuation:

### 12.1 Land

The land in question is an industrial land.

Inquiries were made with local real estate agents to ascertain industrial land rates prevalent in the locality for freehold industrial land available for such a large size of land. The industrial land parcels of freehold land already transacted were inspected and also the parcels of industrial freehold land available for sale were also inspected and asking prices were obtained. The comparison of land in question with land recently sold and available for sale was made. From the office of sub-registrar of documents, details of industrial land sold in last three years for such a large size were obtained for the years 2002, 2003 and 2004 and it was found that demand was increasing at the rate of 25% per annum. This is indicative that industrial freehold land of such a large size is in demand.

### 12.2 Buildings

(i) Bill of quantity, copy of contract as well as sectional plans and elevations of buildings were not available.
(ii) The buildings were surveyed, measured and visible technical details were noted.
(iii) Inquiry about rates of building material and labour prevalent in the locality was made.

### 12.3 Plant & machinery

(i) Inventory of plant & machinery installed in the plant was taken. Items of plant & machinery included in inventory were identified in the list of machinery supplied by the company.
(ii) The technical specifications were collected from manuals of machinery maintained by the company.
(iii) Discussions were held with technical personnel of the company.

## 12.4 Electrical installations

(i) The electrical layout showing HT installations, transformers, main LT panel incoming/outgoing, distribution and sub-distribution was prepared by the technical personnel of the company during our visit and same is relied upon. The inspection of major equipment falling under this category was carried out by us.

# 13.0 Method of computing Replacement Cost New and Depreciation for wear and tear:

## 13.1 Buildings

Replacement Cost New of buildings under consideration have been estimated depending upon the type of construction, amenities provided and rates of building material, labour, transportation charges prevalent on the site on the date of valuation. The replacement cost includes following:

- Rates of building material and labour
- Contractor's profit
- Architect's fees
- Structural engineer's fees
- Municipal levies and charges
- Plan approval fees
- Applicable taxes

The depreciation is calculated on straight line basis. For this purpose, total economic life is estimated by considering the age and balance/future economic life.

The Replacement Cost New Less Depreciation leads us to Depreciated Replacement Cost (DRC).

Scrap Value is considered to be 5% of replacement cost new.

## 13.2 Plant & machinery

(i) Due to shortage of time it was not possible to get the offers from suppliers. However, discussions were held with the representatives of suppliers of machinery in India. The current cost of brand new similar machines orally furnished by the representatives for machines have been relied upon.

(ii) Replacement Cost New is estimated from market inquiries / estimated. Replacement cost includes all direct and indirect costs to bring machine to commercial production.

(iii) The depreciation is calculated by adopting balance economic life as under:

a. Preparatory machinery - 10 years
b. Looms and chilling plant - 05 years
c. TFO - 10 years

(iv) Scrap Value is considered to be 10% of replacement cost new.

**13.3 Electrical installations**

(i) Replacement Cost New, Depreciation and DRC is estimated on lump sum basis as a whole; as it is not possible to get item wise details like age etc. under this category.

**14.0 Sample calculation**

**(a) Building**

Let us consider a hypothetical case of a building having following data:

| | |
|---|---|
| Replacement Cost New (RCN) | 1,000,000/- |
| Age | 10 years |
| Total economic life | 50 years |
| Scrap value | 5% of RCN |
| Depreciation for wear and tear per annum | $\frac{100-5}{50}$ = 1.9% |
| Depreciation for 10 years | 19% = 190,000/- |
| Depreciated replacement cost | 1,000,000 - 190,000 <br> 810,000/- |

The buildings are not suffering from technological and functional obsolescence and same have not been considered.

Please refer to para 17.0 later for economic obsolescence.

**(b) Plant & machinery**

Let us consider a hypothetical case of a machine installed in Looms and Chilling Plant in the year 1995 having following details:

| | |
|---|---|
| Replacement cost | 1,000,000/- |
| Age as on date of valuation | 10 years |
| Estimated economic balance life | 5 years |
| Scrap value 10% of RCN | 100,000/- |

Total economic life = Age + Estimated economic working life

= 10 + 5 = 15 years

Depreciation per annum for wear and tear

$$= 0.9 \times \frac{100}{15}$$

= 0.9 x 6.66%

= 6%

$\therefore$ Depreciation for age = 10 x 6

= 60%

Depreciation amount in = 600,000/-

Depreciated replacement cost = 1,000,000 – 600,000

= 400,000/-

Plant & machinery are not suffering from technological and functional obsolescence and hence the same have not been considered.

Please refer to para 17.0 later for economic obsolescence.

### 15.0 General remarks:

#### 15.1 Year wise additions to assets under consideration:

(` in 000s)

| Year | Land | Building | Plant & machinery (including electrical installations) |
|---|---|---|---|
| 1995-1996 | 5,500 | 55,000 | 300,000 |
| 1996-1997 | - | 25,000 | 250,000 |
| 1997-1998 | - | 2,500 | 13,000 |
| 1998-1999 | - | 3,500 | 30,000 |
| 1999-2000 | - | - | 22,500 |
| 2000-2001 | - | - | 15,000 |
| 2001-2002 | - | - | 500 |
| 2002-2003 | - | - | 10,000 |
| 2003-2004 | - | - | 100,000 |
| **Total** | **5,500** | **86,000** | **741,000** |

**15.2** Furnished below is the statement showing Gross Book Value (GBV / Original cost / Purchase price without depreciation, depreciation and Net Book Value (NBV) as per the balance as at 31st March 2004 for assets under consideration:

(` in 000s)

| Particulars | GBV | Depreciation | NBV |
|---|---|---|---|
| Land | 5,500 | - | 5,500 |
| Buildings | 86,000 | 18,000 | 68,000 |
| Plant & machinery (including electrical installations) | 741,000 | 300,000 | 441,000 |
| **Total** | **832,500** | **318,000** | **514,500** |

**15.3** The statement showing installed capacity, capacity utilization and amount spent for repairs to plant & machinery furnished by the company is as under:

| Year | Installed capacity (in 000 mtrs) | Capacity utilization (in 000 mtrs) | Repairs to plant & machinery (` in 000s) |
|---|---|---|---|
| 1999-2000 | 15,000 | 10,000 | 10,000 |

| | | | |
|---|---|---|---|
| 2000-2001 | 15,000 | 7,000 | 16,000 |
| 2001-2002 | 15,000 | 6,000 | 20,000 |
| 2002-2003 | 15,000 | 7,500 | 10,000 |
| 2003-2004 | 15,000 | 8,000 | 20,000 |

**The discussions with the technical personnel revealed that the plant & machinery are running in good condition and the production efficiency is maintained and the machines are capable of giving the production. The Capacity utilization is less on account of inefficiency of marketing department.**

**The marketing personnel also admitted that their department was not aggressive as they ought to be due to internal problems.**

**15.4** The production building is specially designed and having the facilities like rcc ducting with closed circuit arrangement to maintain temperature and humidity inside the plant.

**15.5** Prospects and opportunities for manmade fiber in India.

- *"India is said to be second after China in terms of post quota prospects. It is the only country in Asia with self-sufficiency in multi-fiber raw material supply and presence across entire value chain. Besides, low cost of production, Indian competency is built around its skilled manpower, garment expertise, product and technical knowledge and information technology strength."*

Ref. Textile Times (Monthly Magazine of the Indian Cotton Mills Federation), November 2004, page no.27

- Increasing importance of Synthetics in India is evident from the table given below:

***($ in billions)***

| | 2004 | | | 2010 | | |
|---|---|---|---|---|---|---|
| | Total | Cotton | Synthetics | Total | Cotton | Synthetics |
| Domestic | 22 | 11 | 11 | 40 | 15 | 25 |
| Export | 14 | 11 | 3 | 50 | 25 | 25 |
| **Total** | **36** | **22** | **14** | **90** | **40** | **50** |

Ref. Textile Times (Monthly Magazine of the Indian Cotton Mills Federation), November 2004, page no.27

- The Govt. of India is going to offer incentives to man made fiber industry in the next budget to be presented by Finance Minister in 2005. Extracts of HT Business, Hindustan Times, New Delhi, dated 24th December 2004 is reproduced below:

  *“In a bid to make the textile industry competitive in the post-quota regime, the Centre has decided to provide capital subsidy to processing units.”*

- “The fact that overseas buyers are not looking at placing their orders only with the Chinese augurs well for the Indian Textile Industry, Mr. Sarode said India is also a safer bet for buyers as compared to Pakistan or Bangladesh.

  A vast base of deft, inexpensive workers and raw materials could soon see India turning into a textile outsourcing paradise with buyers in the US, Europe and Africa. The Government has said the country’s textile exports could double to US $ 25 billion in the next two years and touch US $ 50 billion by 2010.”

  *(Ref: The Asian Age, Mumbai Edition 28th December 2004)*

- “The Indian textile sector has the potential to reach a size of $ 85 billion by 2010, from the current size of $ 36 billion (an annual average growth rate of 11 per cent),” a Crisil study surmises, adding, “This growth can be fuelled by exports as well as by a rise in domestic consumption.” It reckons that textile exports could well touch $ 40 billion by 2010 from the $ 11 billion in 2002 – an average annual growth rate of 18 per cent – raising India’s share in the global textile and clothing trade from present six per cent. On the domestic front, it seems that fast growing middle class with higher disposable incomes driving per capita consumption levels and stimulating an 8 per cent volume growth and 9 per cent value growth.

  Indicating that despite its technology advances, India’s textile sector is the largest employer after the agricultural sector, the agency believes that achieving the Vision will help generate over 12 million new jobs, mainly semi and unskilled workers. “Direct employment opportunities of five million jobs are envisaged, of which over four million would be in the apparel segment," it notes. "Another seven million jobs are expected to be generated in the allied sectors, primarily in cotton and jute agriculture."

GTN advisor M.P. Gajaria observes, "The weaving and processing sectors are modernizing fast and are capable of meeting the requirements of international buyers." Maintaining that India is one of the few countries with a presence in the entire value chain of textiles, he mentions that the country can yet boast of a comparatively cheaper pool of professionals, technical and marketing experts and skilled workers."

"India is by far superior to others in terms of top-end specialized products like embroideries, trims and embellishments as in high value made-ups. According to him, a significant feature of the textile export profile is the increased share of made-ups from 28 per cent in 1999-2000 to 35 per cent in 2002-2003. "While the shift in the export base from raw material to value added products like made-ups is positive development, the overall growth in terms of gains in market share will be driven by the efficiency and speed with which the sector overcomes the challenges of tomorrow."

And as on 1 January deadline draws high, the industry, as the arbiter, and the government, as the facilitator, need to join forces to chart India's standing as a textile superpower. As Vanavarayar points out, "the future of the Indian economy and the future of the Indian textile industry are synonymous with each other."

(Ref: *Ref: Business India, January 2, 2005, page no. 114 and 115)*

- With the elimination of the multi-fiber agreement a few days ago, there is enormous opportunity for the textile industry in the country to tap the global market.

  China demonstrated the scale of the market that exists globally, and it is for the Indian industry to use this opportunity, according to Dr. Montek Singh Ahluwalia, Deputy Chairman, Union Planning Commission.

CVSRTA

The country's textile industry is talking about the possibility of reaching $ 50 billion in a few years. This can be achieved only if the Government provides a supportive environment, he said, delivering the 30th Frank Moraes Memorial Lecture organized by the United Writers' Association.

Doing a SWOT (strengths, weaknesses, opportunities and threats) analysis for India, Dr. Ahluwalia said, the country's greatest strength has been its economic growth in the last few years. Globally, the country is respected for its growth. The private sector has also contributed to a large extent in this regard. "We have done well in terms of economic growth but could achieve only 6 per cent against the targeted 8 per cent," he said.

(Ref: The Hindu Business Line, Mumbai edition Monday, 10th January 05- page no.5)

**One can conclude that there is a good future for textile industry and has a potential to earn.**

**15.6** Our quick survey reveals that due to non-availability of spares-parts, the parts of the idle machines are used for other similar machines in operation.

There is an immediate need for replacement as outlined below:

(i) Electronics cards on looms
(ii) Belts and bearing of TFO

**15.7** There is a water leakage in TFO and loom area indicating requiring replacement of false ceiling.

Buildings and machinery require general maintenance and replacement of spares.

**15.8** We are informed by the clients that there is no notice issued by government agencies for violation of any of the regulatory measures.

**16.0** The technical personnel were requested to furnish following information for major equipment.

- When did the machinery undergo capability test?
- What is the present condition in terms of production rate and accuracy viz a viz the original at the time of purchase?

Their reply:

- They underwent the test only last year. The present condition in terms of production rate and accuracy viz a viz at the time of purchase is almost same.

**17.0** In order to ascertain potential profitability a following question was referred to business valuers.

Is BE-NWC > FA + IA in case of business under consideration? In other words, does the market value of land/DRC of buildings, machinery and electrical installations worked out support the earnings?

Where,

| | | |
|---|---|---|
| BE | = | Business Enterprise Value |
| NWC | = | Net Working Capital |
| FA | = | Value of Fixed Assets estimated |
| IA | = | Value of Intangible Assets |

Business valuers opined that:

- Value of Business works out to 150 Crore and
- NWC = 30 Crore

which gives BE - NWC = 120 Crore

Whereas market value of land and DRC of buildings and plant, machinery and electrical installations is estimated at ` 73.5 crores which suggests that these fixed assets are capable of generating excellent income stream and do not suffer from economic obsolescence.

Estimated value/DRC of fixed assets supports the earnings.

**This is indicative that in spite of good assets the account has become NPA.**

**18.0** Assumptions and limiting conditions

(a) Bill of quantity for buildings under consideration was not available.

(b) Role of unaccounted money in property transaction.

(c) The fixed asset records maintained by the clients need to be thoroughly updated. The information contained is not sufficient which makes identification of items taken during physical inventory from fixed asset records submitted by clients very difficult.

(d) The property is free from rot infestation or defect of any other nature including inherent weakness due to use of deleterious material etc. in construction.

**19.0 Caveat**

The information presented in this report is based primarily on information received from the plant personnel and from a site visit, unless stated otherwise.

Valuation is based upon conditions and operations at the time of the site visit. A change in any of these factors may influence the findings and conclusions.

It is agreed between the XYZ and valuer that appearing in Court/Judicial proceedings by valuer is out of scope of the assignment.

The report is for the exclusive use of our clients XYZ for the purpose mentioned herein. Use of this report in whole or any part of its contents by any third party is expressly prohibited - Valuer shall not be liable to the third parties.

It is agreed between clients and valuer that neither the whole nor any part of this report or any reference to it may be included in any published documents, circular or statement, nor published in any form without the valuer's prior written approval of the form and context in which it may appear.

The report is confidential to the clients. The valuer disclaims all responsibility and will not accept any liability to the third party.

## 20.0 Summary of valuation:

(` in 000s)

| Sr. No. | Particulars | Original Cost as at 31-03-2004 | Replacement Cost | Depreciation | Depreciated Replacement Cost |
|---|---|---|---|---|---|
| | | | (a) | (b) | (a) – (b) |
| 1 | Land | 5,500 | 15,000 | - | @ 15,000 |
| 2 | Buildings | 86,000 | 150,000 | 30,000 | 120,000 |
| 3 | Plant& machinery including electrical installations | 741,000 | 1,000,000 | 400,000 | 600,000 |
| | **Total** | **832,500** | **1,165,000** | **430,000** | **735,000** |

@ indicates market value

## 21.0 Opportunity Cost

This is an established running concern. It will take at least 2 years from formation of the company to start commercial production if identical plant is to be established. The acquirer of the plant can continue the production on acquisition. That shows that the acquirer can generate revenue 2 years in advance if the acquires were to set up Greenfield plant. In view of this, any acquirer who can run the plant efficiently will be prepared to pay for opportunity cost and buy the plant at an additional cost rather than going for Greenfield plant which will take 2 years. However, the amount of opportunity cost will differ from buyer to buyer due to different perceptions of the individuals. The opportunity cost has not been considered in this exercise.

## 22.0 Recommendation

Since the XYZ Ltd., is an established undertaking in the industry, it has created intangible assets in the form of intellectual property. It is recommended that an exercise of quantifying value of intangibles be undertaken.

## B. Case Studies on Valuation for Sale and Purchase

The Valuer must be able to value asset on behalf of vendors and he can also be retained to act for purchasers. In the former case, he will explore the potential, seeking the highest possible valuation for his client, whilst in the later there is a natural tendency to be more conservative. However, judicious balance is necessary in each case.

If the vendor client purchased the asset in recent years and its value is not declined after the purchase due to any reasons, then market value can be worked out by modifying the purchase price. In addition, the valuer will advise the vendor as to the right price for negotiations.

### B1. <u>Valuation of an industrial plant for sale</u>

**Facts of the Case (Illustration)**

The company engaged in the manufacturing of PVC packaging products appointed a valuer in 2002 to estimate the value of land, buildings, plant & machinery of their unit located in Maharashtra.

The valuation was required for sale as the mortgagor could not repay the loan advanced by the mortgagee. The mortgagee a private finance company wanted to liquidate the above assets pledged as a security. According to mortgagee the assets were not valuable and wanted to sell at throw away price.

The mortgagor appointed a valuer to estimate value of the assets mortgaged.

The company was established as a partnership company in the year 1989-90. It became a public limited company in the year 1995. In 1996 – 1997, the company embarked on a project for manufacturing Plastic Laminated Tubes (PLT) with a project cost of ` 1,000 million.

A study was undertaken to find out the reasons for the default by the mortgagor. The following facts were noticed:

(a) The most of the key personnel left the company during 1996-97 to 1998-99.
(b) The key personnel left the company were not replaced by equally talented

people.

(c) The capital expenditure of about ` 600 million in each of the 3 years during 1997-98, 1998-99 and 1999-2000 totaling to ` 1.8 billion did not create value to the business.

(d) The interest and depreciation charges accumulated.

(e) There was a syphoning of the funds by the management.

(f) The actual production was much less than the installed capacity in spite of good tangible assets and good demand for the product.

The market value of land was estimated and the depreciated replacement cost (DRC) for buildings and machinery was worked out. These are subject to potential profitability.

The study of future demand of the products manufactured revealed that there will be a good demand for the products. Buildings, plant & machinery were in good working condition.

Thus, it was concluded that the mortgagor became the defaulter in spite of valuable tangible assets.

**REPORT ON VALUATION OF FIXED ASSETS**
**OF**
**ABC LTD., MUMBAI - 400 001**

## PART – I : EXECUTIVE SUMMARY

**1.0** The ABC Ltd. appointed us to estimate the market value of the assets mentioned in para 2.0 of this report.

**2.0 Details of fixed assets under consideration located at Ahmedabad:**

- Land
- Buildings
- Plant & machinery
- Electrical installations

The above fixed assets contribute to more than 99% value of all the fixed assets appearing in the schedule of fixed assets of the balance sheet of the company.

**3.0 Date as on which valuation is made:** 31st March, 2003.

**4.0 Purpose for which exercise carried out:** To estimate market value of fixed assets offered as a security for mortgage finance.

**5.0 In order to carry out the exercise, team consisting of –** valuers of real estate as well as plant & machinery and civil, electrical and mechanical engineers visited the plant.

**6.0** The assets are utilized for manufacturing of polyester grey fabrics.

**7.0 Definition of market value used**

The definition used is as outlined earlier in Chapter-2 Role and Function of a Plant & Machinery Valuer.

**Basis of Valuation**

Valuation is based on market value in existing use in-situ.

**8.0 Assets under consideration fall under limited market, specialized, special purpose and specially designed.**

Such specialized assets are sold by way of sale of the business of which it is a part because of uniqueness arising from the specialized nature, design, size, location, etc. Hence, such assets suffer from limited marketability.

There are following three approaches to estimate value:

- Market
- Income
- Cost

▪ The assets under consideration are specialized assets and hence, there are no instances of sale of such plant and therefore it cannot be valued by sales comparison method by market approach except land.

▪ Neither rental/lease evidence of such plants is available nor it is possible to quantify contribution of assets under consideration to the total turnover of the company and therefore income approach is also not applicable.

▪ In view of above, valuation is carried out by cost approach.

It is noteworthy to mention here that as valuation is carried out by cost approach the value of tangible assets is subject to potential profitability.

**9.0 The report is based on following information furnished by the clients and inspection carried out by us:**

(a) Land

(i) Photocopy of deed of conveyance.

(b) Buildings

(i) Year wise additions

(ii) Year of construction of individual buildings

(c) Plant & machinery

(i) Year of installation of individual machines

(ii) Technical specifications of major equipment
(iii) List of machineries with brief description
(iv) Process/Machinery lay out

(d) Electrical installations

(i) Details of HT/LT distribution and sub-distribution system
(ii) Connected load

**10.0** For the purpose of the exercise the report is divided into following parts:

Part – I Executive Summary
Part - II Company profile, brief manufacturing process and process/ machinery lay out
Part – III Land and buildings
Part – IV Plant & machinery and electrical installations

**11.0 Main objects of the company:**

The main objects of the Company to be pursued by it on its incorporation as set out in the Memorandum are as under:

(a) To manufacture, process, purchase, sell, import, export and otherwise deal in laminated web material, laminated tubes (collapsible or non-collapsible), flexible tubes and all types of films, multi-layer films, sheets, containers, bags, pouches and articles made by using such web material, films or sheets and / or by using PVC, HDPE, LDPE, LLDPE, Polypropylene, Nylon, Polyester, BOPP and other Polymers, Papers, Board and such other materials and all types of foils and also to carry out polymer processing and printing work.

(b) To carry on the business of manufacture, importer, exporter, or otherwise as dealers in all kinds of packing materials and all kinds of packing items made out of different qualities of plastics and polymers or out of man-made or natural fibrous materials or out of any other materials.

**12.0 Company profile:**

**1989 – 1990** **-** The company started as manufacturer of poly coated webs and Geo fabrics as a partnership firm.

| | | |
|---|---|---|
| **1994 – 1995** | - | The partnership company was converted into a public limited company. |
| **1996 – 1997** | - | Embarked on a project for manufacturing of Plastic Laminated Tubes (PLT) with project cost of ` 1,000 million. |
| | - | Installed Capacity of PLT envisaged at 300 million. |
| **1998 – 1999** | - | Expansion Phase-I was undertaken at a cost of 900 million for PLT and other packaging products. |
| | - | Installed capacity of PLT increased from 300 million to 500 million. |
| **1999 – 2000** | - | Installed capacity of PLT and Plastic Tubes increased to 900 million. |

## 13.0 Products manufactured and their utility

| **Products** | **Utility** |
|---|---|
| Multi-layer laminated tubes | Dental paste, cosmetics, food, pharmaceuticals etc. |
| Multi-colour self-adhesive stickers/labels | Labels on packing boxes, bottles. |
| Speciality packaging and plastic products | Packaging of soaps, consumer products, industrial products, packaging of edible oils and processed foods. |

## 14.0 Technical alliances

| **Products** | **Alliances with reputed companies in following countries** |
|---|---|
| Laminated tubes | Switzerland |
| Laminated web | Japan |
| Printing | Japan |
| Multi-layer film | U.S.A. |
| Extrusion coating | Germany |

## 15.0 Key customers

| Products | Customers |
|---|---|
| Plastic laminated tubes | Globally reputed multinational and indigenous FMCG companies. |
| Labels and stickers | - do - |
| Speciality packaging & plastic products | - do - |

**16.0 Existing installed capacity and actual production** of various products manufactured by the company as provided by the company are furnished below:

| Product | Quantity | Installed Capacity | Actual Production |
|---|---|---|---|
| Multi-layer tubes | Mn Tubes | 1000.0 | 500.0 |
| Seam less tubes | Mn Tubes | 50.0 | 30.0 |
| Printing capacity | Mn SQM | 40.0 | 25.0 |
| Multi-layer film capacity | Mn Kgs | 3.0 | 1.5 |
| Extrusion coating facility | Mn SQM | 300.0 | 150.0 |
| Plastic laminated cup | Mn Cups | 350.0 | 240.0 |

## 17.0 Definition of market value used

The definition used is as outlined earlier in Chapter-2 Role and Function of a Plant & Machinery Valuer.

**Basis of Valuation**

Valuation is based on market value in existing use in situ.

## 18.0 The procedure adopted for valuation

### 18.1 Land

In order to ascertain the land rate prevailing in the locality, enquiries were made with the following agencies:

(a) Stamp duty department of state government
(b) Gram panchayat
(c) Local estate brokers
(d) State Industrial corporations allotting the land for establishing industries in the region
(e) The recently sold land with similar size and shape were inspected
(f) The lands available for sale were inspected and asking prices were noted.

**18.2 Buildings**

Buildings were measured, visual inspection carried out and technical details were noted.

**18.3 Plant & machinery**

(i) The clients have furnished the list of machineries purchased by them up to 30th September 2002 having a gross book value (purchase price inclusive of taxes, duties, erection, installations, pre-operative expenses etc.) amounting ` 4.50 billion (containing 200 items. Out of these 200 items, the machinery having purchase price exceeding ` 1 crore amounts to about ` 4.25 billion. There are 50 items of plant & machinery contributing to purchase price of ` 4.25 billion indicating about 25% of total items are contributing to more than 95% of purchase price of ` 4.50 billion.)

In view of this, the emphasis was given on these major items.

(ii) The inventory of plant & machinery was taken. Items having purchase price exceeding 10 million were identified.

**19.0 METHOD OF VALUATION**

**19.1 Land**

Due regard is given to following factors while deciding value of land:

(i) Size, location and topography.

(ii) Tenure of land – freehold/lease-hold.
(iii) User of land – residential / commercial / industrial.
(iv) Inquiries made with agencies mentioned under para 9.1 earlier.
(v) Whether there is any liability on account of non-compliance of land laws applicable to land.

**19.2 Buildings**

(i) Replacement cost of each building is estimated by taking into consideration type of construction, facilities provided, rate of building material, labour, architect's fees, structural engineers fees, municipal levies and fees, transportation charges etc. prevailing on the date of valuation.

(ii) The depreciation is calculated as per age of each building by Straight Line method.

Scrap value is considered to be 5% of Replacement cost.

(iii) The difference of Replacement cost and Depreciation will be Depreciated replacement cost.

(iv) Some of the items falling under this category like compound wall, roads etc. have been valued on lump sum basis.

(v) The buildings are not suffering from technological as well as functional obsolescence.

**19.3 Plant & machinery**

Replacement Cost method of valuation is adopted. Replacement cost of brand new machinery is estimated by applying price index number to the purchase price as current cost of brand new machinery could not be furnished by the suppliers in a short period. Replacement cost includes all direct and indirect costs.

Life of machinery is considered to be 20 years.

Life of dies and moulds is considered to be 5 years.

Depreciation is considered on Straight line basis and scrap value is considered to be 10% of Replacement cost.

The technology used is current/latest. Plant & machinery are not suffering from technological and functional obsolescence.

**20.0 Future prospects of the industry**

Global usage of packing tubes is estimated to be closed to 30 billion tubes per annum and these tubes find application in three major segments as under:

- Toothpaste
- Pharmaceuticals
- Cosmetics

Of these about 43% contribute to aluminum tubes and balance being laminated or plastic tubes. As compared to aluminum tubes, laminated tubes offer two superior features:

- Convenience of use
- High aesthetic value

In view of the rising importance of aesthetics in most consumer products, there exists enormous potential for replacement led growth for laminated tubes. This is evident from the fact that the toothpaste segment has witnessed the highest-level replacement as compared to the pharmaceutical segment. On the other hand, the cosmetic segment has witnessed a significant shift to the higher value plastic tubes.

The toothpaste segment is currently the largest user of packaging tubes followed by pharmaceuticals.

Global toothpaste tube demand is estimated at 14 billion tubes per annum. Of this, an estimated 10 billion or 70% are currently in the form of laminated tubes, which translates into a conversion potential for 4 billion tubes, without factoring in any demand growth in India, the consumption of packing tubes is estimated to be close to 3 billion packaging tubes per annum. Of this, an estimated 1.9 billion of 60% are currently in the form of laminated tubes, thereby offering a conversion potential of 1.1 billion tubes.

It is important to note that the conversion of laminated tubes in the country has largely been in the toothpaste segment, which is evident from the fact that one of the largest manufacturer of toothpaste successfully completed the conversion of 50 gms. tubes in the year 1999.

The prospects for laminated tubes in the country are now dependent mainly on the growth in the toothpaste segment. The toothpaste consumption has grown 8 – 10% for the past 5 years, mainly due to penetration into rural markets.

In India, an estimated one out of five people use non-traditional dentifrice products, therefore there is an enormous potential of toothpaste demand. This is indicative of good future for the products for which the assets are utilized and industry has a bright future.

## 21.0 General remarks

### 21.1 Land

There is no liability on account of non-compliance of land laws applicable to land.

### 21.2 Buildings

(i) Bill of quantity for buildings standing on the land was not available.
(ii) Fixed asset register maintained for buildings was not complete.
(iii) Buildings are in very good condition, well maintained and suitable for the purpose for which they are utilized.

### 21.3 Plant & machinery

(i) Plant & machinery are in very good condition.
(ii) Maintenance of the plant & machinery is under the control of qualified personnel.
(iii) The buildings have the facilities for installing additional machinery for future expansion.
(iv) Amount spent on repairs to machinery:

| Year | Amount ( ` in lakhs) |
|---|---|
| 1996 – 1997 | 10.00 |
| 1997 – 1998 | 12.00 |
| 1998 – 1999 | 80.00 |
| 1999 – 2000 | 250.00 |
| 2000 – 2001 | 375.00 |
| 2001 – 2002 | 400.00 |

(v) Most of the plant & machinery are running in 3 shifts for about 300 days in a year.

(vi) The technical specifications of major plant & machinery are taken from respective purchase orders, technical manual and plant personnel.

(vii) The technical personnel were requested to furnish following information for major equipment.

- When did these equipment undergo capability test?
- What is the present condition in terms of production rate and accuracy viz a viz the original at the time of purchase?
- Are there any imbalances in different production sections?
- Is there any violation of regulatory measures?
- Do equipment suffer from any obsolescence?

Their reply:

- They underwent the test only last year. The present condition in terms of production rate and accuracy viz a viz at the time of purchase is almost same.
- There is no imbalances in the different production sections.
- There is no violation of any regulatory measures.
- The equipment do not suffer from technological and functional obsolescence.

(viii) We are informed by the clients that there is no notice issued by government agencies for violation of any of the regulatory measures.

(ix) In order to ascertain potential profitability a following question was referred to business valuers.

Is BE-NWC > FA + IA in case of business under consideration? In other words, market value of land/DRC of buildings, machinery and electrical installations worked out supports the earning?

Where,

| | | |
|---|---|---|
| BE | = | Business Enterprise Value |
| NWC | = | Net Working Capital |
| FA | = | Value of Fixed Assets |
| IA | = | Value of Intangible Assets |

Business valuers opined that:

- Value of Business works out to 6.00 billion and
- NWC = 500 million

which gives BE - NWC = 5.50 billion

whereas market value of land and DRC of buildings and plant, machinery and electrical installations is estimated at ` 4.50 billion which suggests that these fixed assets are capable of generating excellent income stream and do not suffer from economic obsolescence.

Estimated value/DRC of fixed assets supports the earnings.

**This proves that in spite of good assets the mortgagor became defaulter.**

**22.0 Assumptions and limiting conditions**

(a) The assets under consideration are free from any encumbrances.

(b) Bill of quantity for buildings under consideration was not available.

(c) Role of unaccounted money in property transaction.

(d) The fixed asset records maintained by the clients need to be thoroughly updated. The information contained is not sufficient which makes identification of items taken during physical inventory from fixed asset records submitted by clients very difficult.

(e) The property is free from rot infestation or defect of any other nature including inherent weakness due to use of deleterious material etc. in construction.

## 23.0 Caveat

The information presented in this report is based primarily on information received from the plant personnel and from a site visit, unless stated otherwise.

Valuation is based upon conditions and operations at the time of the site visit. A change in any of these factors may influence the findings and conclusions.

It is agreed between the ABC and valuer that appearing in Court/Judicial proceedings by valuer is out of scope of the assignment.

The report is for the exclusive use of our clients ABC for the purpose mentioned herein. Use of this report in whole or any part of its contents by any third party is expressly prohibited - Valuer shall not be liable to the third parties.

It is agreed between clients and valuer that neither the whole nor any part of this report or any reference to it may be included in any published documents, circular or statement, nor published in any form without the valuer’s prior written approval of the form and context in which it may appear.

The report is confidential to the clients. The valuer disclaims all responsibility and will not accept any liability to the third party.

**24.0 Summary of valuation**

(` in million)

| Sr. No. | Particulars | Replacement cost in ` | Depreciation in ` | Depreciated Replacement cost in ` | |
|---|---|---|---|---|---|
| | | (a) | (b) | (a) – (b) | |
| A | Land | 20* | - | 20* | |
| B | Buildings | 480 | 50 | 430 | |
| C | Plant & machinery | 5,500 | 1,450 | 4,050 | |
| | | | * Indicates market value. | | |
| **Grand total of (A + B + C)** | | **6,000** | **1,500** | **4,500** | **(I)** |
| **As per books** | | **4,000 (Gross block)** | **1000 (Depreciation)** | **3,000 (Net book value)** | **(II)** |
| **Increase (I) - (II)** | | **2,000** | **5,00** | **1,500** | |

**25.0 Opportunity cost**

This is an established running concern. It will take at least 2 years from formation of the company to start commercial production if identical plant is to be established. The acquirer of the plant can continue the production on acquisition. That shows that the acquirer can generate revenue 2 years in advance if the acquires were to set up Greenfield plant. In view of this, any acquirer who can run the plant efficiently will be prepared to pay for opportunity cost and buy the plant at an additional cost rather than going for Greenfield plant which will take 2 years. However, the amount of opportunity cost will differ from buyer to buyer due to different perceptions of the individuals. The opportunity cost has not been considered in this exercise.

**26.0 Recommendation**

Since the ABC Ltd., is an established undertaking in the industry, it has created intangible assets in the form of intellectual property. It is recommended that an exercise of quantifying value of intangibles be undertaken.

## B2. Valuation of an industrial plant for purchase

**Facts of the Case (Illustration)**

The clients (a purchaser company) appointed a valuer to estimate value of a PVC film manufacturing unit in the state of West Bengal.

The draft report was required on top most urgency basis.

On inspection of the plant the valuer observed the following:

(a) The company had never made any profit since its inception.
(b) There were two calendar lines. They were about 40 years old on the date of valuation.
(c) The present owner had purchased both the lines sometime in nineties as second-hand.
(d) Both the lines were obsolete. These two lines can be replaced by one latest line with 30% higher production, reduced wages, less consumption of stores, energy, saving in space and less down time.
(e) Capital expenditure for additions to plant & machinery over the years 1992 to 2000 by the management did not help in creating the value.
(f) The cost of production was high.

The draft report was submitted to the clients with following observations:

**The issues to be addressed** for this exercise are:

- Present worth of future benefits
- Obsolescence
- Market Value in existing use satisfying willing buyer and willing seller concept.

In order to carry out detailed exercise for reporting proper value more time was necessary and therefore it was suggested to the client that if there is an urgency then in that case range of values will be reported as under:

| | | |
|---|---|---|
| Minimum Value | = | Scrap Value |
| Maximum Value | = | Depreciated replacement cost (DRC) |

The clients accepted the suggestion.

The asking price of seller was about thrice the DRC i.e. maximum value reported by the valuer.

The detailed report of the valuer was very helpful in negotiation and clients took the full advantage of the same.

This case study throws light on following points:

- Value to the buyer and value to the seller are different.
- Value to the seller is the deprival value.
- Value to the buyer is the capitalized value of future income generated due to acquisition of facilities.

**REPORT ON VALUATION OF PLANT AND MACHINERY**
**OF**
**ABC LTD (PVC FILM DIVISION), WEST BENGAL**

**1.0** Under the instructions from **DEF**, inspection of plant & machinery of PVC Film Division of **ABC Ltd.** located at Industrial Estate in West Bengal was carried out for estimating 'Market Value'.

**2.0** **Purpose for which valuation is made** : **For the purpose of purchase in existing use in-situ.**

**3.0** **Date as on which valuation is made** : 25th December, 2006.

**4.0** Plant & machinery were inspected by a team consisting of valuers of plant & machinery, mechanical and electrical engineers during 15th – 20th December 2006.

**5.0** **Brief history**

**(i)** The plant consists of following two Calendar Lines for manufacture of PVC films.

**<u>Calendar line No.1</u>**

This was a second-hand purchase and went into commercial production sometime during 1992-93. It was about 30 years old (1962 make) in 1992-93. The age of plant as on date of valuation is about 45 years.

**<u>Calendar line No.2</u>**

Calendar line No.2 was also a second-hand purchase and went into commercial production in the year 1988-89. It was about 25 years old (1965 make) in 1988-89. The age of plant as on valuation date is about 40 years

**(ii)** Utility equipment like – boilers, electrical installations, chilling plants, air compressors, etc. are of current technology and brand new at the time of installation and also were maintained from time to time as per requirement.

**(iii)** Furnished below is the details about major capital expenditure made for additions to plant & machinery, amount spent on consumption of spares, repairs to plant & machinery, range of actual production and highest production achieved.

(a) Major capital expenditure in additions to machinery:

| Financial Year | Capital expenditure (` 000's) |
|---|---|
| 1988-89 | 200,000 |
| 1992-93 | 150,000 |
| 1999-2000 | 60,000 |

(b) The amount spent on consumption of spares and repairs:

| Financial Year | Spares (` 000's) | Repairs (` 000's) |
|---|---|---|
| 1992-93 | 600 | 80 |
| 1997-98 | 4,800 | 560 |
| 2002-03 | 9,600 | 2,800 |
| 2005-06 | 14,400 | 4,200 |

It will be observed that there is an increase to consumption of spares as under:

1992-93 to 1997-98 is 800%
1997-98 to 2002-03 is 200%
2002-03 to 2005-06 is 150%

Overall increase to consumption of spares, from 1992-93 to 2005-06, is 2400%

Similarly, increase to amount spent on repairs is as under:

1992-93 to 1997-98 is 700%
1997-98 to 2002-03 is 500%
2002-03 to 2005-06 is 150%

Overall increase to amount spent on repairs, from 1992-93 to 2005-06, is about 5250%

(c) Actual production in the years 2003-04 to 2006-07 has been in the range of 60% to 70% whereas during the years 1996-97 to 1999-2000, it has been in the range of 15% to 40%

Highest production achieved was 70% in the year 2003-04.

(d) The company has never made a profit since inception.

It is noteworthy to mention that both the calendar lines have spent their total economic lives as they are about 40 years old. Their physical lives are increased by periodical repairs and maintenance.

The utility equipment are in good condition and almost brand new.

**6.0 Management of capital expenditure**

It is a well-known fact that the management of capital expenditure must create value to the business.

The above capital expenditure on plant & machinery mentioned has not been able to create value to the business which is evident from the fact that the plant has never made profit and there is a huge accumulated loss.

**7.0 Details of plant under consideration**

| **Sr. No.** | **Description of Machine** | **Make/ Supplier** | **Year of Manufac ture** |
|---|---|---|---|
| **(1)** | **(2)** | **(3)** | **(4)** |
| | **<u>PLANT AND MACHINERY</u>** | | |
| **1.** | **Calendar Line No.1 with following specifications**<br>No of Rolls: 4<br>Type: ‘I’<br>Width:700 mm<br>Thickness:100-700 micron<br>Capacity: 500 kgs/hr<br>Speed: 40 mts/min<br><br>Along with following equipment | Berstoff Germany | 1962 |

| | | | |
|---|---|---|---|
| | (a) Weighing and Dosing Equipment<br>Capacity: 600 – 700 kgs/hr | Steimd, Germany | |
| | (b) Kneader<br>Capacity: 500 kgs/hr<br>Screw dia.: 140 mm<br>L/D: 11 | Buss, Switzerland | |
| | (c) Control Panel | Obdenoff | |
| | (d) Mixer driven by 30 hp motor | Mixaco | |
| **2.** | **Calendar Line No.2**<br>No of Rolls: 5<br>Type: 'L'<br>Width:900 mm<br>Thickness:100-400 micron<br>Capacity: 1000 kgs/hr<br>Speed: 40 mts/min<br><br>Along with following equipment | Berstoff Germany | 1965 |
| | (a) Weighing and Dosing Equipment<br>Capacity: 2000 kgs./hr | Schenik & Jension | |
| | (b) Mixer driven by 60 hp motor | Neoplast Engineering, Ahmedabad | |
| | (c) Kneader<br>Capacity: 1000 kgs./hr<br>Screw dia.: 140 mm<br>L/D: 11 | Buss, Switzerland | |
| | (d) Control Panel | Obdenoff | |
| **3.** | **Utility equipment** like –<br>Boilers, Electrical Installations, Chilling Plants, Air Compressor etc. | | 2004 and 2005 |

**4. The specifications of latest Calendar Line available as on date of valuation**

| | |
|---|---|
| Capacity: 1500 kgs/hr<br>Speed: 90 mts/min<br>Width: 2100 mm | Berstoff / New Klockner Pentaplast, Germany |

Along with following equipment

| | |
|---|---|
| (a) Weighing and Dosing Equipment<br>Capacity: 3000 kgs/hr | Steimd, Germany |
| (b) Kneader<br>Capacity: 1500 kgs/hr | Buss, Switzerland |
| (c) Control Panel | Obdenoff |
| (d) Mixer driven by 60 hp motor | Mixaco |

**8.0 The issues to be addressed for this exercise are:**

(1) Present worth of future benefits

(2) Obsolescence

(3) Market Value in existing use satisfying willing buyer and willing seller concept.

The quick study revealed following:

(a) The selling price is in the range of ` 75/- to ` 78/- per kg. of finished product.

(b) The variable cost viz. raw material, fuel and power, salary and wages, water, electricity, marketing expenses, packing and forwarding is around ` 66/- per kg. of finished goods.

(c) The net book value as per the balance sheet of the year 2005-2006 is ` 360 million, even if we take the depreciation at 10% it will work out to ` 36 million per annum i.e. about ` 6/- per kg. for a production of 6000 tons per annum.

It is important to mention that the above working does not include insurance, interest, taxes, and other fixed cost.

Thus, prima facie it appears that the plant is not viable.

**8.1 Present worth of** future benefits

Film section is the heart of the plant and the plant in the present condition is not capable of generating sufficient cash flow to make the plant viable.

**8.2 Obsolescence**

Plants with 2100 mm width, i.e. more than double the width of the plants under consideration with higher capacities were available around date of valuation. Both the existing plants could have been replaced by one latest plant and that too with following additional advantages:

(i) 30% higher production
(ii) 50% reduced direct wages
(iii) 70% less consumption of stores
(iv) 40% less consumption of energy
(v) 25% saving in space
(vi) 70% less down time

Summarized statement of overall comparison:

| Sr. No. | Description | Old (%) Calendar Line No. 1 & 2 | New (%) |
|---|---|---|---|
| 1 | Production | 100 | 130 |
| 2 | Direct Wages | 100 | 50 |
| 3 | Store | 100 | 30 |
| 4 | Energy | 100 | 60 |
| 5 | Space | 100 | 75 |
| 6 | Down Time | 100 | 30 |
| | **Weighted Average** | **100** | **62.5** |

The old calendar lines no. 1 & 2 suffer from obsolescence of about 40%

Price for the new machine is US $ 17.5 million inclusive of all direct and indirect costs.

| | | | |
|---|---|---|---|
| Replacement Cost New for Calendar 1 & 2 | = | US $ 17.5 million X 0.6 | |
| | = | US $ 10.50 million | |
| | = | ` 420 Million | (Exchange Rate - 1 US $ = ` 40/-) |

RCN for Calendar Line No. 1 & 2 works out to ` 420 Million.

These two Calendar Lines were purchased as second hand as under

| Calendar Line | Year | Purchase Price in ` in Million | Approximate Exchange Rate ` to US $ in the year of purchase | Purchase Price in US $ Million |
|---|---|---|---|---|
| 1 | 1992-93 | 150 | 20 | 7.5 |
| 2 | 1988-89 | 200 | 13 | 15.38 |
| | | | **Total** | **22.88** |

The latest brand new Calendar Line with superior features was available for US $ 17.5 million in December 2006. Therefore, price of brand new latest Calendar Line in 1998-89 and 1992-93 must be less as per the opinion given by the people in industry. Hence, it is quite obvious that the price for second-hand machines more than 20 years old is bound to be lesser.

Therefore, this is clearly indicative that the book values are inflated and not reliable.

Hence, the capital expenditure in the year 1988-89 and 1992-93 seems to be incorrect, and can be considered as a management failure.

The clients are advised to look into this.

## 9.0 Valuation

The clients have requested to report maximum and minimum values as under:

Maximum Value = DRC
Minimum Value = Scrap Value

The machinery under consideration are falling under two categories:

1) Calendar Lines
2) Utility equipment

The Calendar Lines were more than 40 years old on date of valuation. Therefore, they have spent their economic life and their minimum and maximum value will be equal to scrap value considered at 10% of RCN, i.e. ` 42 million. … (a)

**Utility Equipment**

They are in very good condition and their maximum value is estimated at ` 10 million … (b)
and
minimum value is estimated at ` 2 million … (c)

**Maximum Value = (a) + (b) = ` 52 million**
**Minimum Value = (a) + (c) = ` 44 million**

## 10.0 General remarks

**10.1** As explained earlier the management of capital expenditure brings value to the business. Any prudent and willing buyer will carry out an exercise to ascertain capital expenditure required to be made so that it brings value. But looking to the present scenario prima facie, it appears that the capital expenditure is unlikely to bring the value.

It is worthwhile to mention here that the plant has never made any profit since its inception. There is a huge accumulated loss of about ` 300 million.

**10.2** The above discussion leads us to following conclusion:

Both the film plant on 'as is where is' basis is not capable of generating cash flow which can bring value to the business and suffers from technological, economic and operating obsolescence.

## 11.0 Assumptions and limiting conditions

(a) The assets under consideration are free from any encumbrances.

(b) The fixed asset records maintained by the clients need to be thoroughly updated. The information contained is not sufficient which makes identification of items taken during physical inventory from fixed asset records submitted by clients very difficult.

## 12.0 Caveat

The information presented in this report is based primarily on information received from the plant personnel and from a site visit, unless stated otherwise.

Valuation is based upon conditions and operations at the time of the site visit. A change in any of these factors may influence the findings and conclusions.

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## C. Case Study on Valuation for Insurance

There are two case studies,

**Case Study – I**

**Facts of the Case Study**

This case study pertains to valuation of same property carried out in the year 1987-88 and 2002-03 for taking insurance on reinstatement value basis.

Though the instruction was same to report insurable value on Reinstatement Value basis both the time; but it was essential to take different approach both the time as explained below:

Let us examine the terms **'Replacement Cost New'**, **'Reproduction Cost New'** and **'Reinstatement Value'.**

**Replacement Cost New** means – the cost of acquiring an asset at current price having utility equivalent to asset under consideration but having materials, standards, design according to prevalent market.

**Reinstatement Value** means – the amount payable under the policy to be calculated shall be cost of replacing or reinstating on the same site or any other site with property of the same kind or type but not superior to or more extensive than the insured property when new as on date of the loss.

**Reproduction Cost New** means – the cost of acquiring an identical asset / replica using same material, design, standards, quality, workmanship of the asset under consideration. It carries with it the good and bad attributes of the original.

The property under consideration was a Heritage Building Grade-I in Mumbai. The cost of construction of replica in 1987-88 was say X. This means reproduction cost new was X in 1987-88 and replacement cost new was 0.7X. The insurable value of the building under consideration on reinstatement value basis was 0.7X in 1987-88. In the event of any catastrophe if entire building is destroyed then the insurance company will reinstate the building having same cubical content as per building material available at the time of reinstatement which in this case works out to 0.7X .

But situation was different in the year 2002-03 as explained below:

> Government of Maharashtra introduced Heritage Regulation. Heritage Grade-I comprises of buildings, and precincts of national or historical importance embodying excellence in architectural style, design, technology and material usage; they may be associated with a great historical event, personality, movement or institution. They have been and are the prime landmarks of the city.

**Objective:**

Heritage Grade-I richly deserves careful preservation.

**Scope for changes:**

No interventions would be permitted either on the exterior or interior unless it is necessary in the interest of strengthening, and prolonging, the life of the buildings or precincts or any part or features thereof. For this purpose, absolutely essential and minimal changes would be allowed and they must be in accordance with the original building.

**Procedure:**

Development permission for the changes would be given by the Planning Authority on the advice of the Heritage Conservation Committee appointed by the State Government.

**Vistas / Surrounding Development:**

All development in areas surrounding Heritage Grade-I buildings shall be regulated and controlled, ensuring that it does not mar the grandeur of or views from, Heritage Grade-I buildings.

**Restrictions on Development / Redevelopment / Repairs of Heritage building:**

No development or redevelopment or engineering operation or additions, alterations, repairs, renovation including the painting of buildings, replacement of special features or demolition of the whole or any part thereof or plastering of said listed / heritage buildings or listed / heritage precincts shall be allowed only with the prior written permission of the Commissioner. The Municipal Commissioner shall act on the advice of/in consultation with the Heritage Conservation Committee.

Valuer had a meeting with a member of Heritage Conservation Society to discuss various issues related to applicability of Heritage Regulation for buildings owned by the clients. It was informed by him that in the event of destruction / damage of any of the building falling in the clients' precinct need to be reinstated replica.

In view of facts mentioned above, reinstatement values of heritage building had been worked out accordingly. In the year 2002-03 **reinstatement value** was **reproduction cost new** due to legislation on heritage building in force and not replacement cost new as adopted in 1986-87.

This shows legislation has direct bearing on value.

CVSRTA

**Case Study - II**

## Illustration on computation of Insurable Value of a machine

Insurable value is based on market value or reinstatement value. Both these values are discussed earlier in Chapter 12 Fire Insurance of Plant & Machinery and out of two, reinstatement value is desirable though premium payable is high but the benefits derived are more in the event of loss.

**Computation of reinstatement value**

First step is to inspect the machine and collect the data so that the current cost of brand new machine can be estimated and supplier of machine can quote current price without any further query.

The details collected for machine under consideration are as under:

**Plant, machinery and equipment to be valued: IQF Hardening – Tunnel**

Single Belt Tunnel for individual quick freezing (hardening) of sea food products.

On a plastic modular belt, the product is led past the high velocity airflow called Arctic Flow®, which blows the air across the belt and past the product and then continuously blows through the evaporator.

The rapid horizontal Arctic Flow® and the ultra-low temperature ensure a quick and homogenous freezing within a minimum of time. Thus, ensuring a good quality finished product, with an equalized core temperature of minimum –180 C within a minimum of time.

**Features**

- Plastic modular belt, suitable for small and large products.
- Belt frame and support, in-feed/outlet and guiding plates are in stainless steel in an open design, to ensure easy cleaning and a long life without corrosion.
- In-and-Out-feed openings are fully covered by 2 x double layer Silicon strip curtains to minimize air/moisture entering the cabinet, which prevents frosting built-up on the evaporator and prolongs the time in between defrosting periods.

- Self-adjusting mechanically operated belt tension system to slacken or tighten belt.

- Long durable UHMW polyethylene wears rails on frame and belt support, to ensure long belt life.

- Electrically operated ventilators to ensure optimal air circulation from evaporator to product for quick and uniform freezing.
- Evaporator.

- Fully insulated cabinet made of 125 mm sandwich panels, insulated with polyurethane and plated with 0.6 mm galvanized steel plate, coated with 150 µm white PVC.

- Fully welded stainless steel floor with center mounted gully and hatch for water outlet when defrosting and cleaning.

- The cabinet is equipped with access door mounted with electrical door heater to prevent ice bounding of panel.

- Transmission (SEW)

- Additional emergency breakers mounted next to in-feed conveyor and inside cabinet for full personnel security.

- Internal electrical neon lights mounted in ceiling for clear view when freezing, cleaning or maintenance.

- Control Panel and digital touch screen monitor

**Technical data**

| | | |
|---|---|---|
| Cabinet dimension (L x W x H) (external) | : | 3,900 x 2,300 x 2,700 mm |
| Belt type | : | Plastic modular |
| Belt width effective/overall | : | 850 mm, 900 mm |
| Conveyor length | : | 3,600 mm |
| Belt speed | : | Adjustable from 2 to 10min per cycle |
| No. of belt | : | 1 |

| | | |
|---|---|---|
| Maximum product height | : | 75 mm |
| Product in-feed height | : | 1,100 mm |
| Product outlet height | : | 750 mm |
| Refrigeration duty to product | : | 10 kW |
| Coolant supply to evaporator | : | 15 kW |
| Suction temperature | : | Minus $40^0$ C, at evaporator |
| Air temperature | : | Minus $35^0$ C |
| Cooling medium | : | R-717 or R-22 pump |
| Cooling pump flow rate | : | 4-5 times evaporated liquid |
| Installed fan power | : | 3.3 kW |
| Power supply | : | 6 kW |
| Voltage | : | 380 V x 3ph x 50 Hz |
| Year of installation | : | January 2009 |
| Date as on which valuation is made | : | $31^{st}$ December 2010 |
| Gross Book Value | = | 12,500,000/- |
| Depreciation | = | 1,425,000/- |
| Net Book Value | = | 11,075,000/- |

The identical machine is available from the same supplier.

The quotation received is as under:

**Illustration on computation of Insurable Value**

Insurable value is based on market value or reinstatement value. Both these values are discussed earlier in Chapter 12 and out of two, reinstatement value is desirable though premium payable is high but the benefits derived are more in the event of loss.

| Particulars | Amount in ` | |
|---|---|---|
| C.I.F. (Cost, Insurance and Freight) | 10,500,000 | (a) |
| Custom Duty | 3,500,000 | (b) |
| Landed cost at Indian Port | 14,000,000 | (a) + (b) = (c) |

| | | |
|---|---|---|
| Clearing, Forwarding and Transit Insurance From Port to the Plant | 300,000 | (d) |
| Handling charges at Plant | 50,000 | (e) |
| Costs of foundation, erection and installation | 650,000 | (f) |
| **Total** | **15,000,000** | (c) + (d) + (e) + (f) |

(a) The insurance policy is for the period of one year.

(b) 15,000,000/- is value on first day of policy.

(c) Generally, cost of machines increases with time. Suppose if a mishap happens on the last day of the policy, the insured will not have sufficient funds to reinstall the machine, as the cost of machine would have increased. Hence it is prudent to consider an increase in price to account for price escalation from day one to last day of the policy period. To take care of this, it is advisable to take insurance policy with escalation clause. For the above machine, it is assumed that price is likely to increase by 10%.

Therefore, insurable value after considering escalation will work out to 16,500,000/-

Note: (i) The question of computation of depreciation does not arise as policy recommended is not market value policy but reinstatement value policy (RIV).

(ii) Even if the policy is taken at 16,500,000/- based on scientific valuation carried out by the valuer the insurance company will issue RIV policy and collect premium on the basis of 16,500,000/- but shall not commit to pay 16,500,000/- in the event of total loss because the question of adequacy of insurable value shall be considered at the time of reinstatement.

CVSRTA

## D. Case study of the post demonetization review of valuation carried out immediately prior to demonetization

**Facts of the Case**

The clients appointed to carry out valuation of an industrial plant located in Maharashtra for the purpose of surrendering their share in a company. The clients were privately negotiating for a price but the price could not be settled. Hence both the parties appointed the valuers.

The excellent report was submitted by a valuer on 7th November,2016 and on the next day Govt. of India withdrew currency notes for ` 500/- and ` 1,000/- which affected the property market.

After demonetization, the clients tried to get the bids for sale of assets valued and the offers received were very low compared to the valuation report and therefore Valuer's views were invited.

The Valuer's reply is given below.

**1.0 Introduction**

Valuation report submitted on 7th November, 2016 indicates market value. This was also prepared as a useful guide while making negotiations to sale the share of clients taking place between the parties acting as reasonable and willing buyers and sellers.

The current situation is entirely different than the situation prior to 8th November, 2016 mainly due to demonetization.

**2.0 Market Value is defined as under:**

"the price, which a **willing vendor** might reasonably expect to obtain from a **willing purchaser**. The disinclination of the vendor to part with his land and the urgent necessity of the purchaser to buy must alike be disregarded and both must be treated as persons dealing in the matter at **arm's length** and **without compulsion**."

## 3.0 Market study

Local inquiry revealed that post demonetization (November-December 2016 and January 2017), there are hardly any transactions of industrial land in the village in which the land under consideration is located. Whereas 150 transactions had taken place during November 15 to October 16. This is indicative of stagnancy in the property market and same leads us to conclude that the marketability is severely impacted due to demonetization. The marketability has a direct bearing on the value.

It is not possible to carry out analysis of market as transactions are not happening in the current market.

By and large, the assets are falling under the category of special purpose assets and being special purpose and they are suffering from limited marketability.

## 4.0 Utility of assets vs. price paid

The utility of assets to each buyer is different and therefore the price to be fetched will depend on subjective consideration of the buyers.

**4.1** **Replacement Cost New (RCN)** means cost of brand new similar asset including taxes, duties, erection, installation charges. Generally, this is the highest achievable price for brand new plant.

**4.2** **Maximum Value –** The plant under consideration is not the brand-new plant. The buyer, who is in the manufacture of same product and has very huge order on hands which cannot be executed with the plant currently held by him, will be interested in buying the plant under valuation at the price slightly lower than the Replacement Cost New. Say, he may be prepared to buy at 80% of replacement cost.

Thus, this is the price that can be realized from the buyer with maximum utility.

The buyer with extraneous circumstances may even buy at a price higher than the maximum value indicated above, that depends on the negotiation skill of seller and urgency of buyer.

**4.3** Minimum Value means the price that will be realized under liquidation condition in-situ. This means the buyer will be able to use the assets at the place where they are located / installed.

The buyer with hard bargaining capacity and seller in urgency to sell may transact at a price even lower than the minimum value.

**4.4 Scrap Value**

It is desirable not to sale at the price below scrap value.
Note: For land scrap value is not applicable and land cannot be replaced.

**4.5 Liquidation Scenario**

It is noteworthy to mention here that under liquidation scenario there are two situations:

(a) Price realized under orderly liquidation

(b) Price realized under forced sale liquidation

**Price realized under orderly liquidation condition –** The term 'orderly' implies that the liquidation would allow for a reasonable time to identify buyers, and the seller would have control of the sale process. The marketing time is sufficient for a sale and more than required under forced sale condition; but lesser than required under market value definition.

**Price realized under forced sale condition –** when the seller is forced to sell the assets compulsorily without proper marketing time/exposure time then in that case there is urgency to sell.

**Note:** So far as price obtainable in the forced sale condition is concerned, it is very difficult to predict because one is attempting to define a moving target. Is forced sale the one which is expected to take place within 3 months, 2 months, 1 month, 1 week or 1 day?

**5.0 Review of Replacement Cost New**

The replacement cost new of assets under consideration are as under and that remains almost same prior and after demonetization:

Building 50.0 Million
PM 250.0 Million

It is noteworthy to mention here that there are about 100 machines installed in the plant and out of that 10 machines purchased in last three years, which are in very good condition and they contribute to about 60% of total value.

## 6.0 Review of Scrap Value of above assets

### (a) Buildings

In order to work out the scrap value of assets accurately, bills of quantity of each building must be available. These were not available during our visit.

Therefore, very rough estimate of scrap value of major buildings is carried out based on information collected during site visit and the same is as under:

| Sr. No. | Particulars | Weight of M.S. Metal in Kg. |
|---|---|---|
| 1 | Production building | 62,938 |
| 2 | Bakery plant | 4,721 |
| 3 | Vat house | 27,386 |
| 4 | Godown (behind Vat house) | 27,173 |
| 5 | Cell room | 17,343 |
| 6 | Boiler house | 1,18,126 |
| 7 | 1 MW Power plant building | 30,904 |
| 8 | Oil unloading shed | 4,184 |
| 9 | Oil receiving shed | 5,510 |
| 10 | Jetty structure | 36,111 |
| | **Total** | **3,34,396** |

The current rate of MS scrap is ` 18/-per kg. which gives total scrap value = ` 6.01 million.

The replacement cost new worked out for above buildings is about ` 50.0 million. Therefore, scrap value works out to about 12% of replacement cost.

Let us consider average scrap value of buildings at 10% of RCN.

**(b) Plant & Machinery**

In order to work out the scrap value of assets accurately, the drawings of equipment, thickness of plates used, type of plates used are required but same were not available

Therefore, very rough estimate of scrap value of major machinery is now carried out based on information collected during site visit and the same is as under:

| **Sr. No.** | **Particulars** | **Weight of M.S. Metal in Kg.** |
|---|---|---|
| 1 | Production building | 3,22,855 |
| 2 | Refrigeration plant | 2,302 |
| 3 | Vat house | 55,544 |
| 4 | Cell room | 80,345 |
| 5 | Tank farm near production building | 1,41,140 |
| 6 | Tank farm near boiler house | 3,16,141 |
| 7 | Boiler house | 2,62,369 |
| | **Total** | **11,80,696** |

Current value of MS scrap weighing 11,80,696 kg. works out to ` 21.2 million.

The replacement cost new of above machinery works out to ` 250.0 million and therefore let us consider average scrap value of plant & machinery, on the conservative side, at 10% of RCN.

Summary of scrap value:

| | |
|---|---|
| Buildings | 6.01 million |
| Plant and machinery | 21.20 million |
| | 27.21 million |

**The company received a bid for purchase of land, building and plant & machinery for ` 10.00 million. Whereas the scrap value of buildings and machinery only is almost three times the price offered by the bidders.**

In order to calculate the scrap value accurately it is essential to have following information:

| | | |
|---|---|---|
| Buildings | – | Bill of quantity of each building showing details of material consumed in the Building.<br><br>(**Note:** The above information was not available) |
| Plant & Machinery | – | Detailed drawings from which weights of equipment can be precisely worked out.<br><br>(**Note:** The above information was not available)<br><br>No drawings are available for piping installations, steel used in platforms, erection, installations and foundations for equipment throughout the plant.<br><br>In chemical plant, it cannot be ignored. |

If above information is not available, then it becomes essential to take the measurements of each item involved in construction of buildings. It will also be necessary to take measurements of the equipment and also to measure thickness of plates of vessels, etc.

## 7.0 Review of Limited Marketability for Assets

Let's review the limited marketability for assets under consideration in the current scenario.

It is very difficult to measure limited marketability of assets accurately in absence of transactions in the market. However, the fact remains that there is a limited marketability for assets and it is significant for industrial property after demonetization.

With all constrains and in the circumstances, guesstimated limited marketability (LM) of assets is as under:

| | | |
|---|---|---|
| Land | – | 40% |
| Buildings | – | 50% |
| Plant & Machinery | – | 50% |

Then value will be as under:

| **Asset** | **Value as per report submitted on 7th November 2016 (` in Million)** | **LM (%)** | **Current Value (` in Million )** |
|---|---|---|---|
| Land | 150.0 | 40 | 90.0 |
| Buildings | 30.0 | 50 | 15.0 |
| Plant & Machinery | 200.0 | 50 | 100.0 |
| | | **Total** | **205.0** |

**8.0 Summary of Values**

Now let us summarize the Replacement Cost New, Maximum Value, Minimum Value and Scrap Value of buildings and machinery.

(` in Million)

| **Assets** | **RCN** | **Maximum Value (80% of RCN)** | **Minimum Value** | **Scrap Value (S.V.)** |
|---|---|---|---|---|
| Buildings | 50.00 | 40.0 | 15.0 | 6.01 |
| Plant & Machinery | 250.00 | 200.0 | 100.0 | 21.20 |
| | -------- | -------- | ------- | ------- |
| **Sub Total:** | **300.00** | **240.0** | **115.0** | **27.21** |
| **Add value of land:** | | 90.0 | 90.0 | 90.0 |
| | | -------- | -------- | -------- |
| **Total Value:** | | **330.0** | **205.0** | **117.21** |
| | | -------- | -------- | -------- |

The transaction must reasonably take place anywhere between ` 117.0 million to ` 205.0 million

If it becomes essential to demolish buildings and dismantle the plant & machinery and sale land with scrap, then in that case value works out to value of land + scrap value of buildings and machinery = 90.0 + 27.21 = ` 117.21 million

The value of scrap worked out is about ` 27.21 million. Scrap consists of mainly MS scrap (it could be more than 90%) and S.S. and other items could be 10% or less.

Therefore, MS scrap is worth 0.9 x 27.21 = 24.50 million Say ` 25.0 million. Weight of MS scrap works out to 1388 tonnes, on the basis, of scrap rate of ` 18/- kg. and SS and others 0.1 x 27.21 = ` 2.721 million at ` 90/- kg. it works out to 30.00 tonnes.

**The rate of scrap adopted is after considering the cost of demolition i.e. net scrap value.**

## 9.0 General remarks

It is pertinent to point out that unaccounted money has played a major role in property transactions in India. Moreover, in increasing property prices also unaccounted money has always played an important role. As per current situation due to demonetization there is hardly any unaccounted money which is evident from the fact that upper limit of cash transaction is ` 300,000; such provisions may have impact on mode of payment as well as velocity of completion of transaction and ultimately on price paid.

It is very difficult to predict at this stage whether the unaccounted money will be generated or not? If generated, then when and what will be the quantum. All these will depend on future action of the Government.

## 10.0 Conclusion

The above discussions lead us to conclude that it is essential for clients to accurately estimate the weight of material content of buildings and machinery before selling them as scrap.

To decide, whether the assets are to be sold on orderly liquidation basis or forced liquidation basis. If it is decided to sell on forced liquidation basis then what is the time frame one week, two weeks, one or two months, etc.

Moreover, current market conditions are such that this is not the right time to sale and at the same time, it is also difficult to predict whether the situation will improve or deteriorate and to what extent and when.

The fact remains that this is not the right time to sell.

**This case study throws light on following facts:**

At times, there are situations in practice where valuer has to give an opinion when market does not exist. Can there be any worse limited conditions then this? The job has to be performed in a best professional manner at times with intuition and guesstimate which can be appreciated by the client.