UNIT - I SCOPE OF MECHANICAL ENGINEERING

Mechanical Engineering Contributions to the welfare of Society

Mechanical Engineering Create and develop mechanical systems for all of human kind Concern with principles of force, Energy and motion.

Contribution to the Society

* Eliminate excessive usage of resources by optimizing and improving efficiency.
* To build things that make the world a better Living place.
* Reduce human effort and makes work easy.

It plays a crucial role in all ways of Living

* Transportation
* Medical
* Agricultural
* Defense
* Power generation

Specialized sub disciplines in mechanical Engineering

* Production Engineering
* Automobile Engineering
* Energy Engineering

Production Engineering

Production Engineering is a combination of manufacturing Technology, engineering sciences with management science. A production engineer typically has a wide knowledge of Engineering practices and is aware of the management challenges related to production.

The goal is to accomplish the production process in the smoothest, most-judicious and most-economic way.

Production engineering encompasses the application of castings, machining processing, Joining processes, metal cutting & tool design, metrology, machine tools, machining systems, automation, jigs and fixture, die and mould design material science, design of automobile parts and machine designing and manufacturing.

In industry, once the design is realized, production Engineering concepts regarding work study, ergonomics, operation research, Manufacturing management material management, production planning etc. play important roles in efficient production processes.

These deal with integrated design and efficient planning of the entire manufacturing system, which is becoming increasingly complex with the emergence of sophisticated production methods and control systems.

Automobile Engineering

Automobile is a "self Propelled Vehicle" generally driven by IC Engine and it is used for transportation of passengers & goods on ground.

Example: Car, Bus, Truck, Scooter etc.

Automobile Engineering includes modification of vechicles. Manufacturing domain deals with the creation and assembling the whole parts of automobiles is also included in it.

The automotive Engineering field is research - intensive and involves direct application of mathematical models and formulas.

The study of automotive Engineering is to design, develop, fabricate and test vechicles from concept stage to production stage.

Production, development, and manufacturing are three major functions in this field.

Energy Engineering

Energy engineering is a broad field of Engineering dealing with energy efficiency, energy services power plant engineering, sustainable energy and renewable energy technologies.

Energy Engineering is one of the more recent Engineering disciplines to emerge.

Energy engineers apply their skills to increase efficiency and further develop renewable sources of energy. The main job of energy engineers is to find the most efficient and sustainable ways to operate buildings and manufacturing Processes.

Energy engineers audit the use of energy in those processes and suggest ways to improve the systems. This means suggesting advanced lighting, better insulation more efficient heating and cooling properties of buildings.

Interdisciplinary Concepts in civil and Mechanical Engineering.

The main function of the civil engineering is the construction of buildings. Mechanical engineering is to Concentrate in mainly involved in production work in industries, for which they need a large number of buildings Which can be constructed by the civil engineers.

For construction in the work, we need a large amount of Cement. Through civil engineers we can buy the Cement from the market, it is manufactured by the mechanical engineers in the Cement-factory.

Now a days multistoried buildings are very common in all the countries. In olden days multi-storied buildings are very less in the amount but in the modern age, there are many and many more multi-stored buildings are presented.

One of the main functions of civil engineers are is to construct the buildings and the function of mechanical engineers is to work in the production department.

Ventilation facilities are especially in the multi-stored buildings, fire safety in the buildings and industries where civil engineers, mechanical engineers and fire safety engineers have to work together for the construction.

In the health sector, doctors, health care officers, educationlists, municipal officers, taluk and district administrators have to interact with the civil and mechanical engineers for the construction of specialized hospitals and educational institutions.

Construction of dust and micro-organism free operation theatres, tissue banks, words for patients of cancer and burns in the hospitals demand in the great- coadination.

Few of the tough and large scale activities are constructed of the steel industry, paper industry dams, bridges, tunnels, metal ores like iron, gold, silver other valuable products etc.

In the transpot sector, civil and mechanical engineers work together in executing facilities like roadways and railways etc.

For the construction of the automobile industry, we need civil engineers to construct it and the mechanical engineers to work in it.

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS.

Classification of Power plants

Powers Plants using Conventional (non renewable) Sources of Energy	Power Plants using Non-Conventional (renewable) Sources of energy.
* Steam Power Plant	Sobar thermal Power Plant
* Nuclear Power Plant	Wind powered generation
* Diesel Power Plant	wave power plant
* Gas Power Plant	Tidal Power plant
* Hydro electric (Hydel) Power Plant.	Bio-mass power plant

Internal combustion engines as automobile power plant

Yes! The development of I.C engines has made a great contribution to human comforts. It is indeed surprising - rather unbelievable - that about 100 years ago, there was no I.C Engine at all in any part of the world. Obviously, the present generation really enjoys very many comforts than our ancestors.

Four Stroke cycle Engines

Cycle of operation: There are distinctly four strokes Suction Stroke, Compression Stroke, Expansion Stroke and Exhaust Stroke for different operations in a cycle. Each ... identified as per the function.

Classification of I.C Engines.

Four Stroke Engines

Two Stroke Engines

Four Stroke Petrol engine

Petrol engine is also known as spark Ignition(S.I) Engine. Four stroke petrol engine requires four strokes of the piston to complete one cycle of operation in the engine cylinder.

It consists of a cylinder. Its one end is fitted with a cover and the other end left open. The cover is provided with inlet and exhaust apertures. These apertures are opened and closed by inlet and Exhaust Valves. A Spark Plug initiates the ignition of the fuel. The piston reciprocates inside the cylinder. The connecting rod and crank converts the reciprocating motion of the piston into rotary motion.

Power cycle of Petrol Engine – Otto cycle

The petrol engine works on the principle of otto cycle also known as constant Volume cycle.

1. Suction Stroke

During Suction Stroke, the Inlet Valve(I) opens and air fuel (petrol) mixture is sucked into the cylinder. The piston moves downward from Top Dead Centes (TDC) Till it reaches Bottom Dead Centes (BDC). During Suction Stroke the Exhaust Valve (E) is closed.

2. Compression Stroke

During this stroke, both the inlet and exhaust Valves are closed. The air-fuel mixture is compressed as the piston moves upwards from BDC to TDC. The Compression ratio in petrol engines Varies from 7 to 10. As a result of compression, pressure and temperature of the charge are increased to 15-20 bar and 400°C respectively.

Shortly before the piston reaches TDC, the charge is ignited by means of a spark plug. It suddenly increases the pressure and temperature of the products of Combustion, but the Volume remains Constant.

During the burning process, the chemical eragy of the fuel is converted into heat eragy, producing a temperature rise of about 2000°C.

3. Expansion or Powes or Working Stroke

During this stroke, both the Valves remain closed. Due to the rise in pressure, piston is pushed down with a great force. The hot burnt gases expand pushing the piston from TDC to BDC. It is also called working stroke as work is done by the expansion of hot gases.

At or near end of the expansion stroke, the exhaust Valve opens to release the burnt gases to the atmosphere. This Studenly brings down the cylinder to atmospheric pressure.

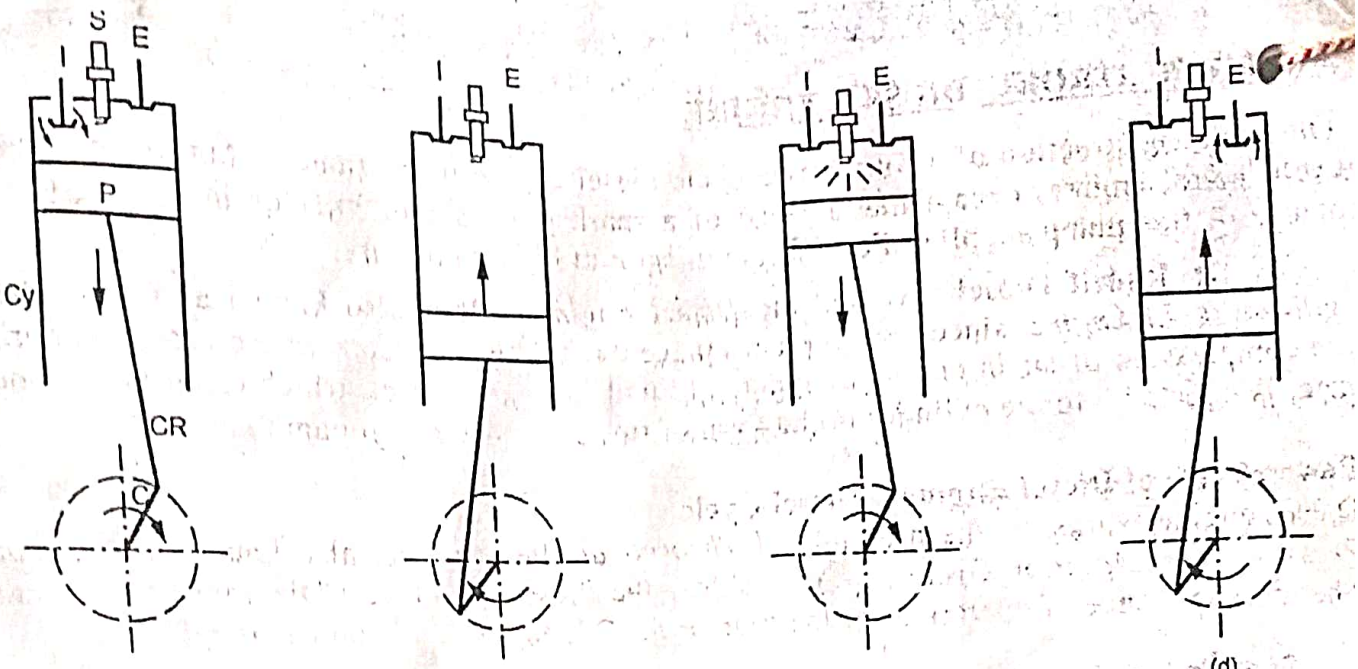


FIG. 2 FOUR STROKE CYCLE PETROL ENGINE

Exhaust Stroke

During this stroke, the exhaust valve opens, as piston moves from BDC to TDC. This movement of the piston pushes out the exhaust gases from the cylinder. The exhaust gases are exhausted through the exhaust valve into the atmosphere.

Uses:

Four stroke petrol engines have higher load Carrying Capacities than two stroke petrol engines. Hence they are used in high power - high speed motor cycles and passenger cars.

Four Stroke Diesel Engine

The basic construction of a four stroke cycle diesel engine is the same as that of four stroke cycle petrol engine, except that instead of a spark plug, a fuel injector in mounted in its place. A fuel pump supplies diesel to the injector at higher pressure.

Power cycle of Diesel Engine – Diesel cycle

Diesel cycle – Constant Pressure Heat addition cycle.

1. Suction Stroke

During Suction stroke, inlet valve (I) opens and Exhaust Valve (E) remains closed. The piston travels downwards from TDC. Air is drawn in, from outside to fill the cylinder through the inlet valve till the piston reaches BDC. The air taken in is at atmospheric pressure.

2. Compression Stroke

At the end of the suction stroke, both the inlet and exhaust valves remains closed. The piston moves upwards from BDC to TDC. The air sucked in during suction stroke is compressed to a high pressure (35-40 bar) and temperature with a decrease in Volume. These strokes Suction stroke and Compression stroke complete one revolution of the crankshaft.

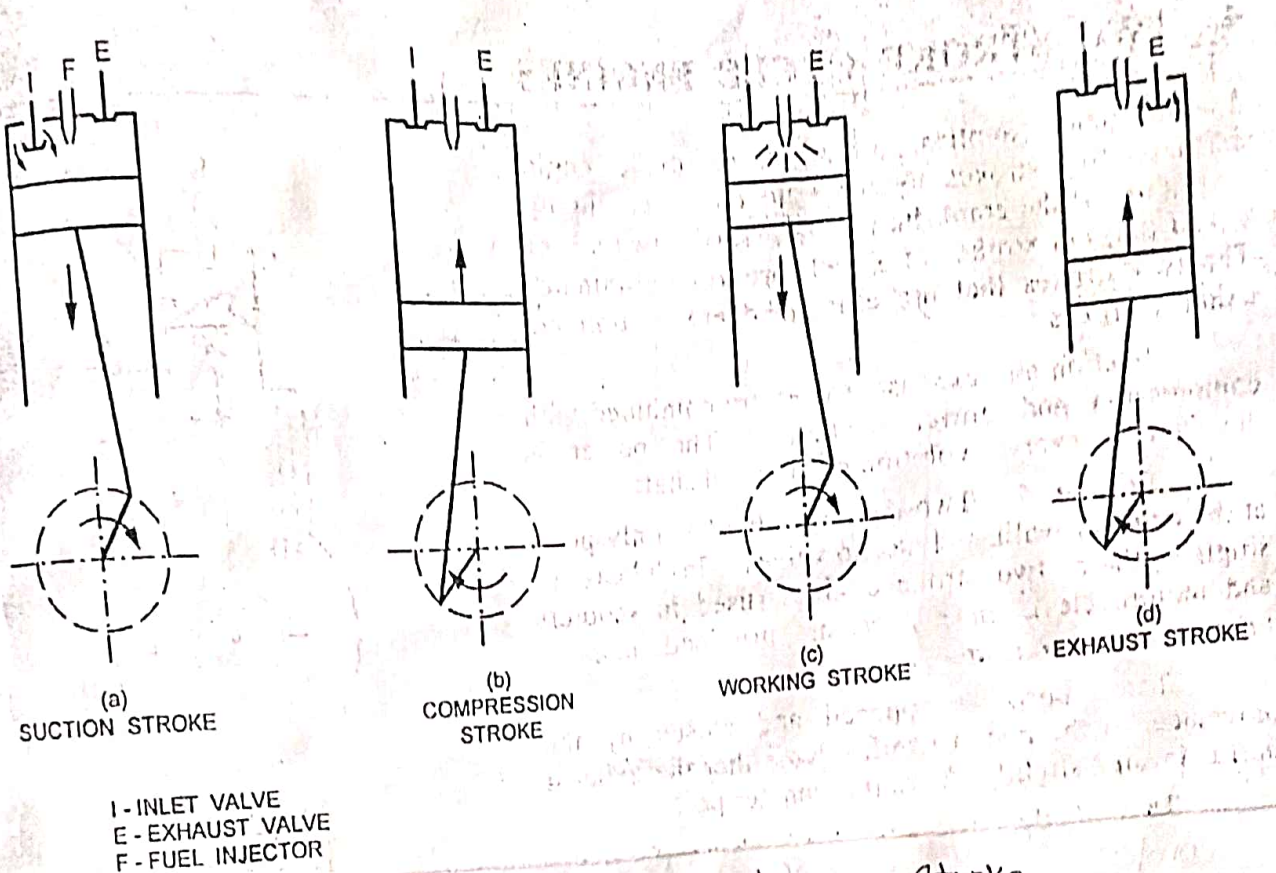
3. Expansion or power or Working Stroke

Just before the begining of this stroke, fuel (diesel) is injected in the form of fine spray into the cylinder through the fuel injector. At this moment, the fuel is ignited by the temperature of the hot

Compressed air and it starts burning at Constant Pressure.

Due to the high Compression ratio of 16 to 20, the temperature at the end of Compression stroke is more than 550°C. The temperature is sufficient to ignite the fuel, injected into the Combustion Chamber. The fuel is continuously injected for 20% of the expansion Stroke.

The ignited air-fuel mixture expands and forces the piston downwards from TDC to BDC. During this Contant Pressure expansion stroke, both the Valves remain



3. Expansion or powes or Working Stroke

Just before the begining of this stroke, fuel is injected in the form of fine spray into the cylinder through the fuel injector. At this moment, the fuel is ignited by the temperature of the hot Compressed air and it starts burning at constant pressure.

Due to the high compression ratio of 16 to 20, the temperature at the end of compression stroke is more than 550°c. This temperature is sufficient to ignite the fuel, injected into the combustion chamber. The fuel is continuously injected for 20% of the expansion stroke.

The ignited air-fuel mixture expands and forces the piston downwards from TDC to BDC. During this constant pressure expansion stroke, both the valves remain closed.

The piston is forced further during the remaining part of the expansion stroke due to the expansion of the burnt gases

4. Exhaust Stroke

During the exhaust stroke, the inlet valve is closed and the exhaust valve is opened. The piston is on its upstroke from BDC to TDC forcing the burnt gases out of the cylinder through the exhaust valve.

Uses: They are used in heavy-duty transport vechicles such as trucks, tractors, bulldozers etc powers generation, industrial and marine applications.

Two Stroke Cycle Engines

A two-stroke cycle engine performs two strokes to complete one cycle in one revolution of the crankshaft.

Suction and exhaust strokes are combined with compression and power strokes. The power is developed in every revolution of the crankshaft.

Two stroke engine has only ports at the cylinder walls and has no valves. In case of single cylinder two stroke engines three ports are provided, namely inlet, transfer and exhaust.

Two Stroke Petrol Engine

Scavenging

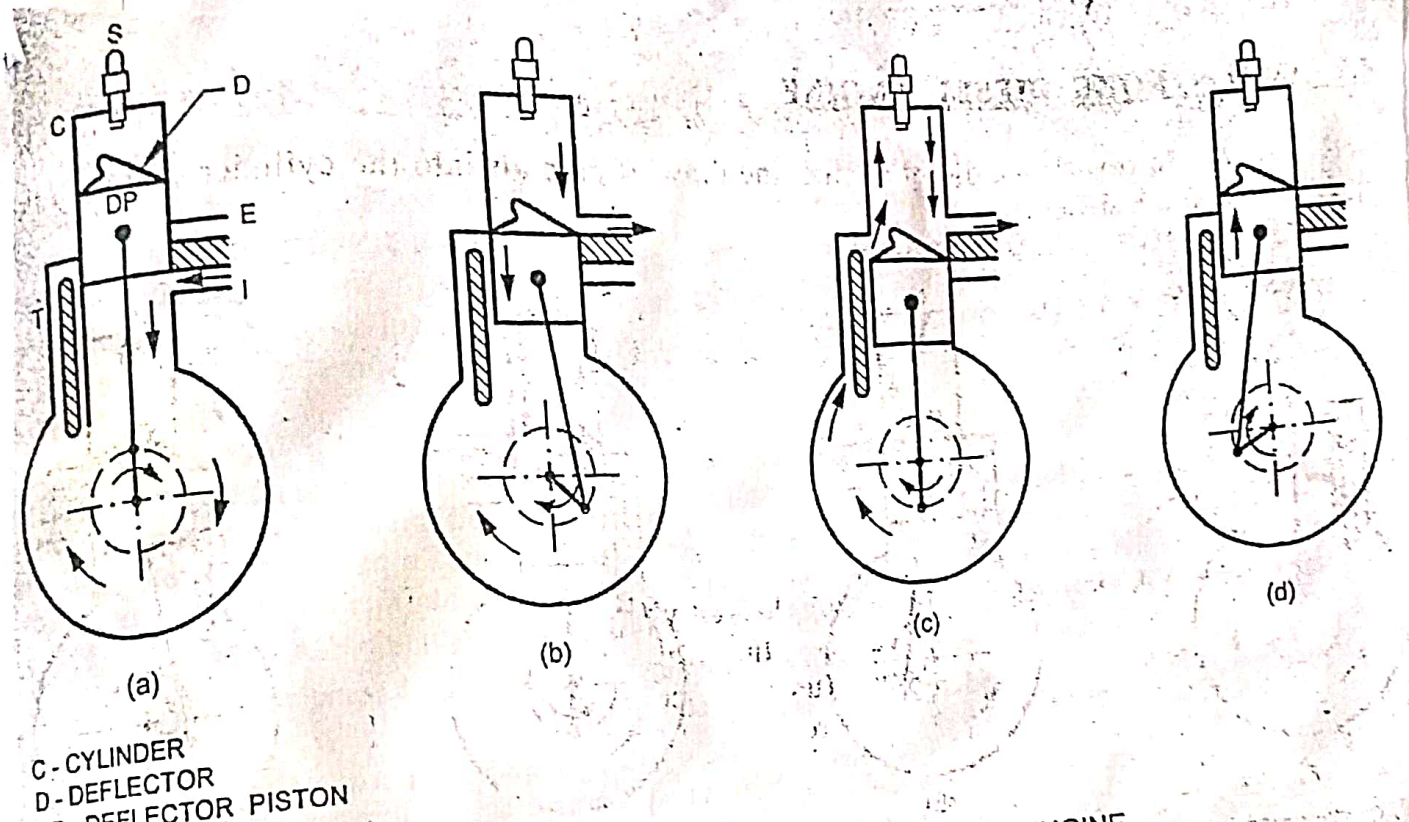
In the two-stroke petrol engine, the exhaust gases are removed from the cylinder with the help of fresh compressed charge. This process of removing exhaust gases is called scavenging. A specific shape is given to the piston called deflector. The deflector helps to prevent

First Stroke

At the end of compression, the spark is produced by the spark plug as the piston reaches TDC. The pressure and temperature of the gases are increased and hence the gases push the piston downwards producing the power stroke.

When the piston opens the exhaust port during the downward stroke, burnt gases leave the cylinder through the exhaust port.

A little later, the piston uncovers the transfer port and the crank case is directly connected to the cylinder through the transfer port. The downward stroke of the piston compresses the charge in the crank case by the underside of the piston.



C - CYLINDER
D - DEFLECTOR
DP - DEFLECTOR PISTON
E - EXHAUST PORT
I - INLET PORT
T - TRANSFER PORT
S - SPARK PLUG

FIG. 7 TWO STROKE CYCLE PETROL ENGINE

Second Stroke

As the piston moves upwards, it covers the transfer port. Hence, flow of charge into the cylinder is stopped. The upward motion of the piston lowers the pressure in the crank case below atmosphere and fresh air is induced in the crank case through the inlet port as it is uncovered. A little later, the piston covers the exhaust port and actual compression of the charge starts.

The compression is continued untill the piston reaches TDC. The ratio of compression ranges from 1:7 to 1:10. The cycle is thus completed within two strokes.

Uses:

Two stroke petrol engines are used in mopeds, Scooters, motorcycles because they run at high speeds with moderate power outputs.

Two Stroke Diesel Engine

First Stroke:

Diesel is injected using fuel injector just before completing the compression. It starts burning The high pressure, high temperature gases push the piston downwards, producing the power stroke. As the piston moves Little down, the supply of diesel stops.

In this piston uncovers the exhaust port during the downward stroke. Hence the burnt gases Leave the cylinder through the exhaust port.

Now the crank case is directly connected to the cylinder through the transfer port. Air in the crank case is compressed by underside of the piston and the compressed air is transferred to the cylinder through transfer port. The exhaust gases are pushed out

With the help of fresh air until the piston reaches BDC

Second stroke

The piston moves upwards. It first covers the transfer port and stops the flow of air into the cylinder. A little later, the piston covers the exhaust port, and actual compression of air starts.

The upward motion of the piston lowers the pressure in the crank case below atmosphere and fresh air is induced in the crank case through the inlet port as it is uncovered. The compression of air is continued until the piston reaches TDC.

The fuel supply starts just before the piston reaches TDC and the cycle is completed.

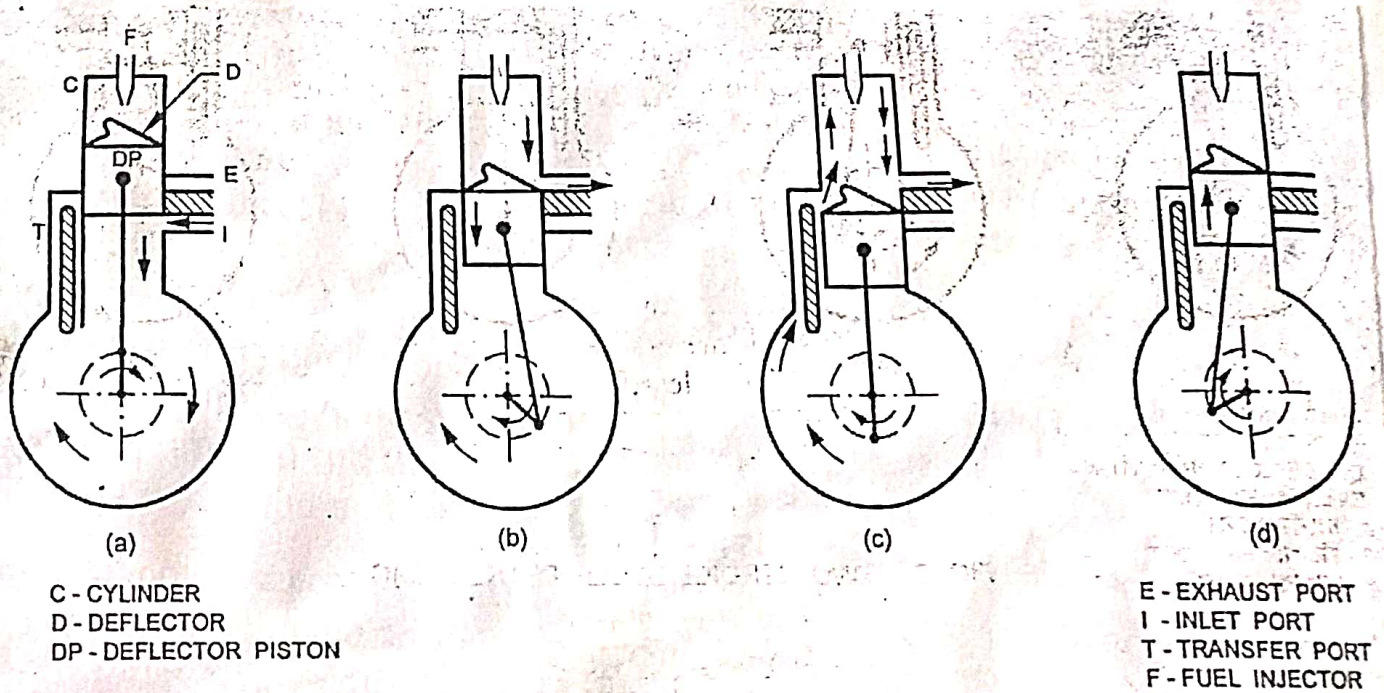


FIG. 8 TWO STROKE CYCLE DIESEL ENGINE

4. COMPARISON OF PETROL ENGINE AND DIESEL ENGINE

Sl.No.	Details	Petrol (S.I.) Engine	Diesel (C.I.) Engine
1.	*Fuel*	Petrol	Diesel oil
2.	*Charge drawn in suction stroke*	Air-fuel mixture is admitted.	Air alone is admitted.
3.	*Fuel admission*	Through carburettor.	Through fuel pump and fuel injector.
4.	*Mixing of air and fuel*	Air and fuel mixed *externally* in the carburettor.	Mixing of air and fuel takes place *inside* the cylinder.
5.	*Fuel Ignition*	Requires an Ignition System with spark plug (Spark-Ignition).	Self-Ignition due to high temperature caused by high compression of air (Compression-Ignition).
6.	*Compression ratio*	Low (7 to 10)	High (16 to 20)
7.	*Power Output*	Less due to low compression ratio.	More due to high compression ratio.
8.	*Cycle of operation*	Otto Cycle (Constant Volume Cycle)	Diesel Cycle (Constant Pressure Cycle)
9.	*Engine speed*	High speed (3000 rpm)	Low speed (400 – 1500 rpm)
10.	*Engine starting in cold weather*	Easy	Difficult due to high compression ratio.
11.	*Engine cost*	Less	More
12.	*Fuel consumption*	More	Less
13.	*Fuel cost*	More	Less
14.	*Maintenance Cost*	Less	Slightly higher
15.	*Thermal Efficiency*	Less (about 20%) due to low compression ratio.	More (about 30%) due to high compression ratio.
16.	*Weight*	Light	Heavy
17.	*Uses*	Automobiles & aero-planes.	Buses, tractors, trucks, etc.
18.	*Vibration and Noise*	Almost nil	More due to high operating pressure.

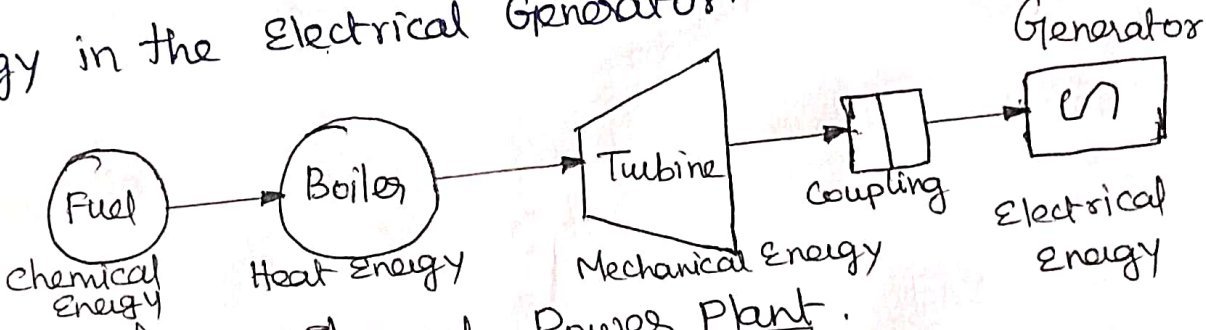
Comparison of Four Stroke Engine and Two Stroke Engine

Sl. No.	DETAILS	FOUR STROKE ENGINE	TWO STROKE ENGINE
1.	*No. of Strokes / Cycle*	Four strokes per cycle	Two strokes per cycle
2.	*No. of Revolutions / Cycle*	Two	One
3.	*Power Stroke and Power Output*	One power stroke for two revolutions. Hence, power output for the same size of the engine is less.	One power stroke per revolution. Hence, power output for the same size of the engine is more.
4.	*Torque*	Not uniform	Uniform
5.	*Weight of the Engine*	Weight of engine is more for the same power output.	Weight of the engine is less for the same power output.
6.	*Operating Temperature*	Less	More
7.	*Lubrication and Cooling Requirement*	Consumption of lubricating oil is less. Cooling requirement is less.	Lubricating oil consumption is more. Special piston cooling is necessary.
8.	*Fuel Consumption*	Less	More
9.	*Thermal Efficiency*	High thermal efficiency. Part load efficiency better than two-stroke engine.	Low thermal efficiency. Part load efficiency less than four-stroke engine.
10.	*Valves / Ports*	Contains valves	Contains ports
11.	*Initial Cost*	High, due to heavy weight and complication of valve mechanism.	Low, due to lightweight and due to the absence of valve mechanism.
12.	*Wear and Tear*	Less	More
13.	*Noise*	Less	More
14.	*Uses*	Used for slow speed high power applications, *i.e.*, in cars, buses, tractors, aeroplanes, power generation, etc.	Used for high speed low power applications, *i.e.*, scooters, motorcycles, lawn mowers, etc.

Thermal Powes Plant

A Thermal power plant is also known as Steam power Plant. It is using steam as working fluid. Superheated high pressure steam is generated in a Boiler using Coal as fuel. That is chemical Energy of coal is converted into heat Energy of steam by burning coal.

Heat energy of steam is converted into Mechanical Energy by expanding the steam in a steam Turbine. This mechanical energy is converted into electrical Energy in the Electrical Generator.



Layout of a Thermal Powes Plant.

It Consists of Four circuits. These are

1. Coal and ash circuit
2. Air and Flue gas circuit
3. Feed water and steam circuit
4. Cooling water circuit.

1. Coal and ash circuit.

Coal from the mines is stored in the Coal storage yard. It is transferred to the Boiler Furnace by means of coal handling equipment

like belt conveyor, bucket elevator etc. coal is burnt in the boiler furnace. Hot ash formed due to the combustion of coal in the furnace is removed to the Ash Storage Yard by means of ash handling equipment.

Air And Flue Gas Circuit

Air is taken in from the atmosphere to Air Pre-heater. Air is heated in the air-preheater by the flue gases from the economizer. Then the hot air from the air pre-heater is supplied to the furnace of the Boiler for combustion of coal.

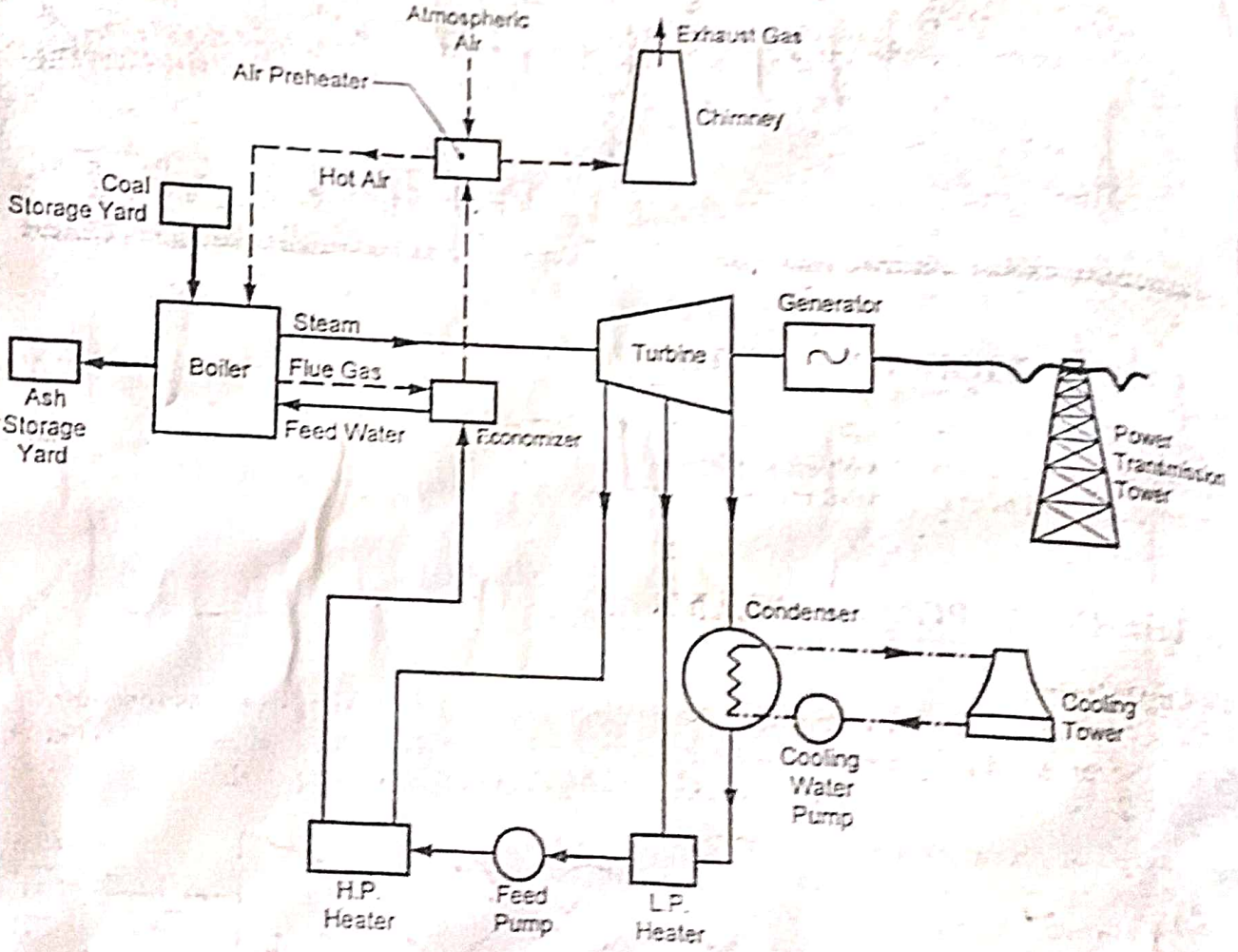


FIG. 2
LAYOUT OF A MODERN THERMAL POWER PLANT

The flue gases after combustion in the furnace, pass around the boiler tubes to generate superheated steam. The flue gases then flow through an Economizer and the Air pre-heater.

Economizer: The function of an Economizer is to absorb the heat of the outgoing flue gases, to raise the temperature of the feed water before it enters the boiler.

3. Feed water and steam Circuit

Steam Turbine

The high pressure steam generated in the boiler is supplied to the steam Turbine. Work is done by the expansion of steam in the turbine.

The function of the steam Turbine is to convert the heat energy in the steam into rotational power of the shaft on which the turbine is supported. The rotational speed of the turbine shaft is set by frequency of the electricity supply and is 3000 revolutions per minute corresponding to an alternating electric supply at 50 hertz.

Electrical Generator

The electric generator is directly coupled to the turbine shaft. It converts the mechanical energy of turbine shaft into electrical energy. Generator Generates the electricity at 11,000 volts.

Condenser

The expanded low pressure steam from the turbine passes to a condenser, where it is condensed to water by cooling. The condenser is a large vessel containing a numbers of brass tubes. Cold water is circulated through these tubes continously by condensing the steam flowing outside the surface of the tubes.

4. Cooling Water Circuit.

The condenser condenses the exhaust steam from the turbine to water by cooling. The volume occupied by the condensate is very muc Less than that of the low pressure steam. Thus, the pressure of the condensate reduces to vaccum When the exhaust steam is passed to the condense its pressure automatically drops to vaccum that is existing in the condenser.

Advantages

1. Water is a natural resource, It is a renewable energy source. It is the cheapest source of energy. It is a free gift by nature.
2. Initial cost is low compared with hydel power plant
3. The generation of power is not dependent on the nature's mercy like hydel plant.

HYDRO - ELECTRIC POWER PLANT

Working Principle

Hydro means water. Hydro - Electric power plant utilizes the potential Energy of water stored in a dam built across the river.

Potential Energy is the Energy which a Substance as due to its position or State. The potencial energy of the stored water is converted into kinetic energy by first passing it through the penstock pipe. The kinetic energy of water is then converted into mechanical energy in a water turbine. That is, the kinetic energy of water is used to drive the turbine.

The turbine is coupled to the Electric generator. The mechanical energy avilable at the shaft of the turbine is converted into electrical energy by means of the generator.

Components of Hydro-Electric Power Plant

Water Reservoir

It is the area near the dam, where large quantity of water is collected during rainy Seasons.

Dam

A Dam is a structure of masonry built at a Suitable location across the river. The function of a Dam is to increase the height of water level behind it which ultimately increaseas the reservoir capacity

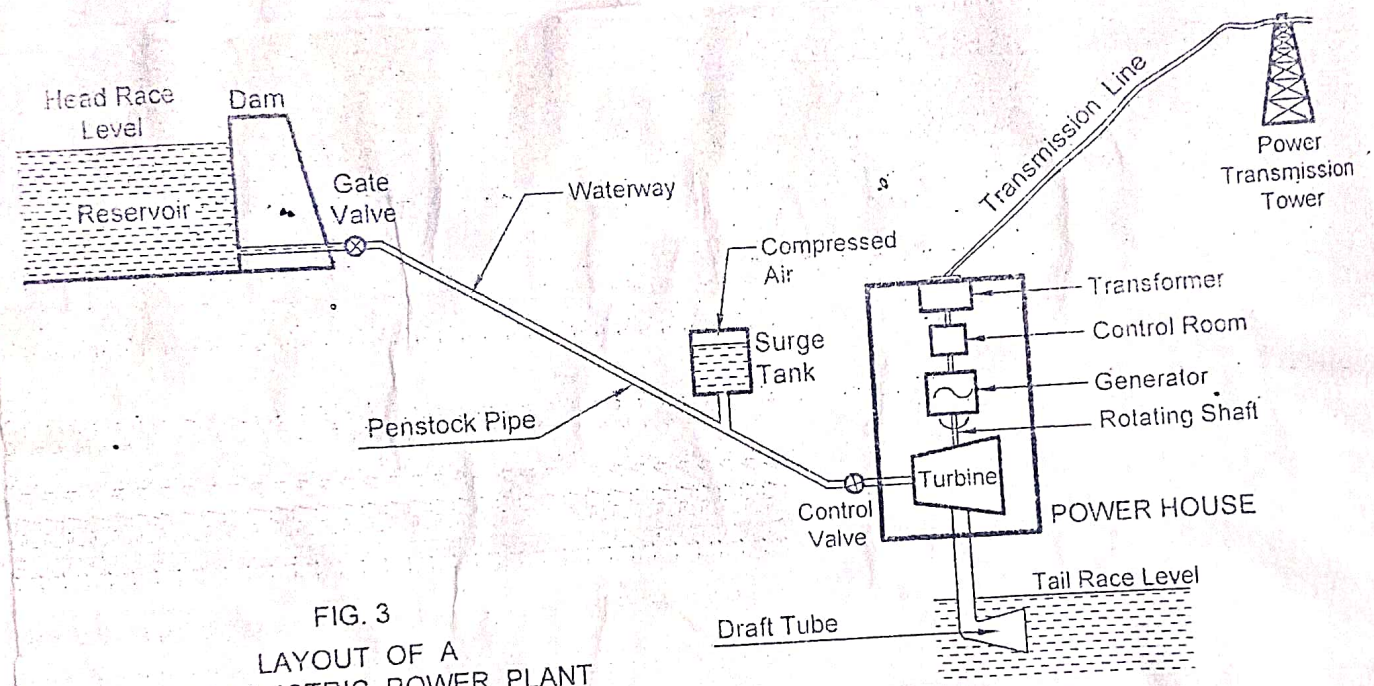


FIG. 3
LAYOUT OF A
HYDRO-ELECTRIC POWER PLANT

Spillway

When the level of water in the dam is much higher than the storage capacity, spillway is used to discharge excess water to other area. Spillway prevents damage to the dam.

Gate

It controls and regulates flow of water to the penstock. It is the portion of pipe that carries water from reservoir to surge tank.

Penstock

It is the long pipe carrying water from the dam to the turbine. The pipes are made up of steel or reinforced concrete.

Surge tank

It is a pressure compensator. When the load in the turbine is decreased, the water rushes backwards in the penstock with turbulence increasing the pressure which is called water hammer. Now the level of water in the surge tank rises and the water pressure in the penstock becomes normal. Thus the damage to the penstock is avoided by surge tank.

Inlet Valve

It controls the quantity of water that flows to the turbine. The valve may be opened widely to permit more water to the turbine during peak load periods.

The Valve may be closed enough to permit less water to the turbine during reduced load periods.

Water turbine

It is a disc mounted on a shaft, with a number of blades fitted on its periphery. Water from penstock (kinetic energy of water) strikes the turbine blades and momentum of water is transferred to the turbine shaft (Mechanical Energy).

Generator

The generator is directly coupled to the shaft of the turbine to produce electricity.

Draft Tube

It is connected to the exist of the turbine. It has the diverging portion which converts the kinetic energy of water after expansion in turbine into pressure energy. Thus it maintains water to flow into tail race which is used for irrigation purposes.

Tail Race

The level of water in the tail race is known as the tail race level. The discharged water is sent to the river.

Nuclear Power Plant

A nuclear power plant differs from a thermal power plant only in the steam generating part. There is no change in the turbine - generator and the condensing systems. The nuclear fuel which is at present in commercial use is Uranium. Scientists say that 1kg of U^{235} can produce as much energy as can be produced by burning 4500 tonnes of high grade coal.

Nuclear Fission

Uranium exists in the isotopic form of U^{235}, which is unstable. When a neutron enters the nucleus of U^{235} the nucleus splits into two equal fragments and also releases 2-5 fast moving neutrons with a velocity of 1.5×10^7 m/s producing a large amount of energy, nearly 200 million electron-volts. This is called as nuclear fission.

Chain Reaction

The neutrons released during the fission can be made to fission other nuclei of U^{235} causing a chain reaction. A chain reaction produces enormous amount of heat and under uncontrolled conditions it can release extremely large amount of energy causing Atomic Explosion.

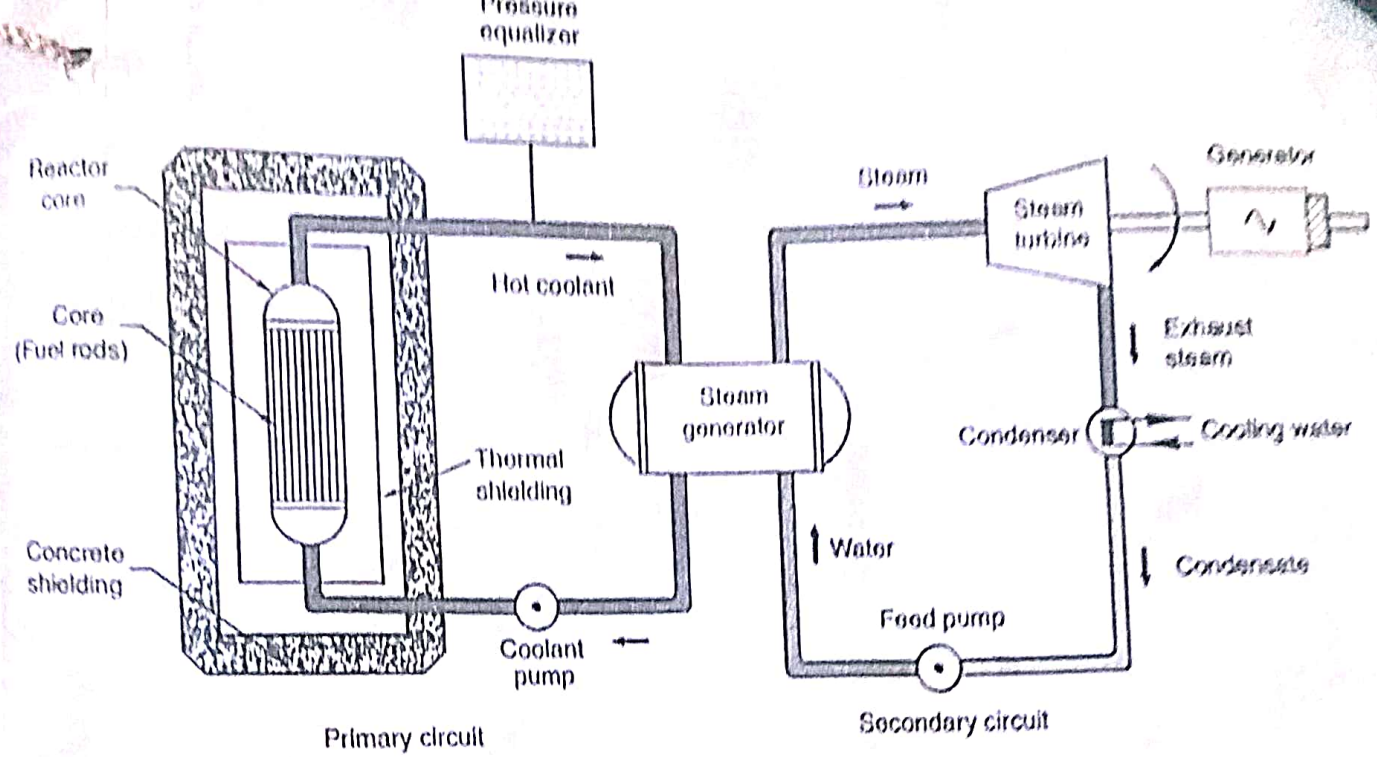


Fig.5.13 Pressurised Water Reactor Plant

Components Of Nuclear Power Plant.

1. Nuclear Reactor

A nuclear reactor is an apparatus in which heat is produced due to nuclear fission chain reaction. The reactor may be regarded as a substitute for the boiler fire box of steam power plant or combustion chamber of a gas turbine power plant.

2. Moderator

In the chain reaction, the neutrons produced are fast moving neutrons. They are less effective in causing fission of U^{235} and try to escape from the reactor. To improve the utilization of these fast neutrons, their speed is reduced in the moderator. The commonly used moderators are ordinary water, Heavy water Graphite and Beryllium.

3. Control rod

The energy produced in the reactor during chain reaction is enormous. If this is not controlled properly entire core and structure may melt and radioactive rays may come out of the reactor. The commonly used control rod materials are cadmium, Boron and Hafnium.

4 Reflector

The neutrons produced during the fission process will be partly absorbed in the reactor and balance neutrons will try to escape. Such escape of neutrons (losses) is prevented by the reflector, which will send the neutrons back into the core. The returned neutrons can cause more fission.

5 Biological Shielding

During fission reaction alpha particles, beta particles, gamma rays and neutrons are produced These radioactive ray are harmful to human lives. To protect from such harmful effects, thick concrete shilding is provided all round the reactor.

6. Coolant

Coolant flows through and around the reactor core. It is used to absorb large amount of heat produced in the reactor. If the coolant used is water, it absorbs the heat and gets converted into steam in the reactor, which is directly sent to turbine

for to produce electricity. The commonly used coolant materials are ordinary wates, heavy wates, Caubon dioxide, helium, hydrogen and liquid metals like Sodium & Potassium.

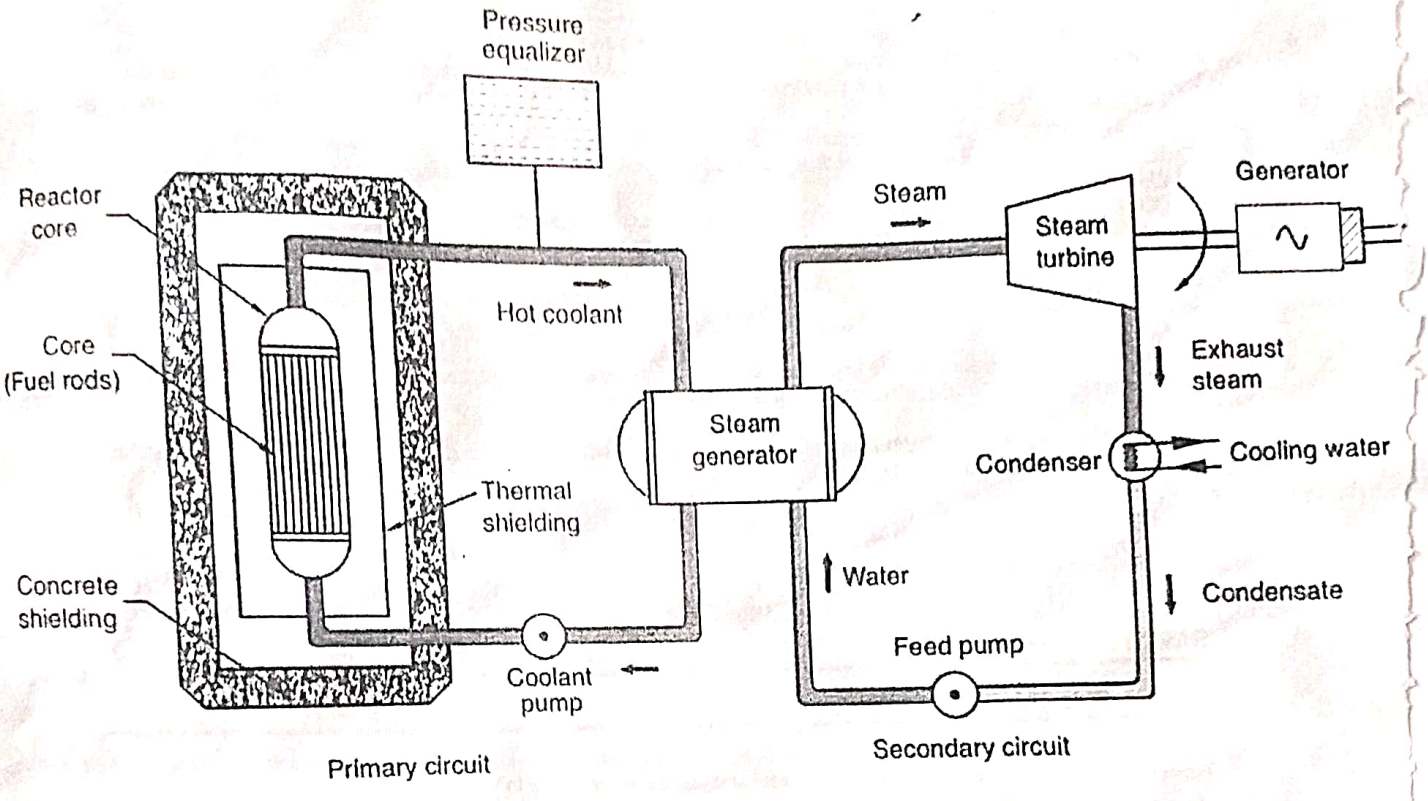


Fig.5.13 Pressurised Water Reactor Plant

Working Principle

1. large amount of heat is liberated inside the nuclear reactor from the nuclear fission process.
2. The heat is transferred to the coolant at high pressure and high temperature.
3. Coolant transfers its heat to the hot wates to convert it to steam in the steam generator.
4. steam at high pressure runs the turbine.
5. Turbines are coupled to generator to produce electricity.

Advantages.

1. Nuclear power plant can be easily adopted where water and coal resources are not avilable.
2. It requires very small quantity of fuel. Hence fuel transportation cost is less.
3. Space requirement is less compared to other power plants of equal capacity.
4. It is not affected by adverse weather conditions.
5. Fuel storage facilities are not needed as in the case of thermal power plant.
6. No of workmen required at nuclear plant is far less than thermal plant.
8. It does not require large quantity of water.

Disadvantages.

1. Radio-active wastes, when not disposed very carefully have adverse effect on the health of workmen and population surrounding the plant.
2. Nuclear plant is not suited for varying load conditions.
3. It requires well-trained personnel.
4. It requires high initial cost compared to hydro or thermal power plants.

DIESEL POWER PLANT

A power plant, which uses diesel engine as a prime mover to generate electric power is called a diesel power plant. Diesel engine is an internal combustion engine, which uses diesel as fuel. In a diesel engine the chemical energy of the liquid fuel is converted into mechanical energy.

Components of Diesel Power Plant

1. Diesel Engine

It is the Central, power producing elements in the power plant. It is a compression ignition engine The engine may be of two or four stroke, but the two stroke engine is more favored. Usually multi-cylinder engines are used.

Atmospheric air enters the cylinders of the diesel engine and is then compressed. At the end of compression, the temperature and pressure of air reach high values. The fuel (Diesel) is now injected into the cylinder through the fuel injectors and ignited. The fuel burns and the products of combustion expand and exert force on the piston, which reciprocates inside the cylinder. The motion is converted into rotary motion of the crankshaft and flywheel. The engine is directly coupled into the alternator. The torque available at the engine shaft rotates the alternator thereby generating electricity. The gases after expansion are expelled from the cylinder by the piston to the atmosphere.

2. Starting System

Diesel engine used in diesel power plants is not self starting. The engine is started from cold condition with the help of an air compressor

3. Fuel Supply System

The amount of fuel to be stored deperds on the service hours and is different for differer installations. The fuel delivered to the power plant is received in storage tanks.

Pumps draw the oil from the storage tanks and supply it to Day tanks which supply the day to day oil requirements of the Engine. The day tank is placed at greater elevation than the engi so that fuel flows by gravity.

4. Air Intake System

The air required for combustion of fuel inside the engine cylinder is drawn from the atmosphere through the air filter. The pupose of the air filter is to remove the dust from the incoming air.

5. Exhaust System.

The Exhaust gases coming out of the engine is very noisy. In order to reduce the noise a silencer is used.

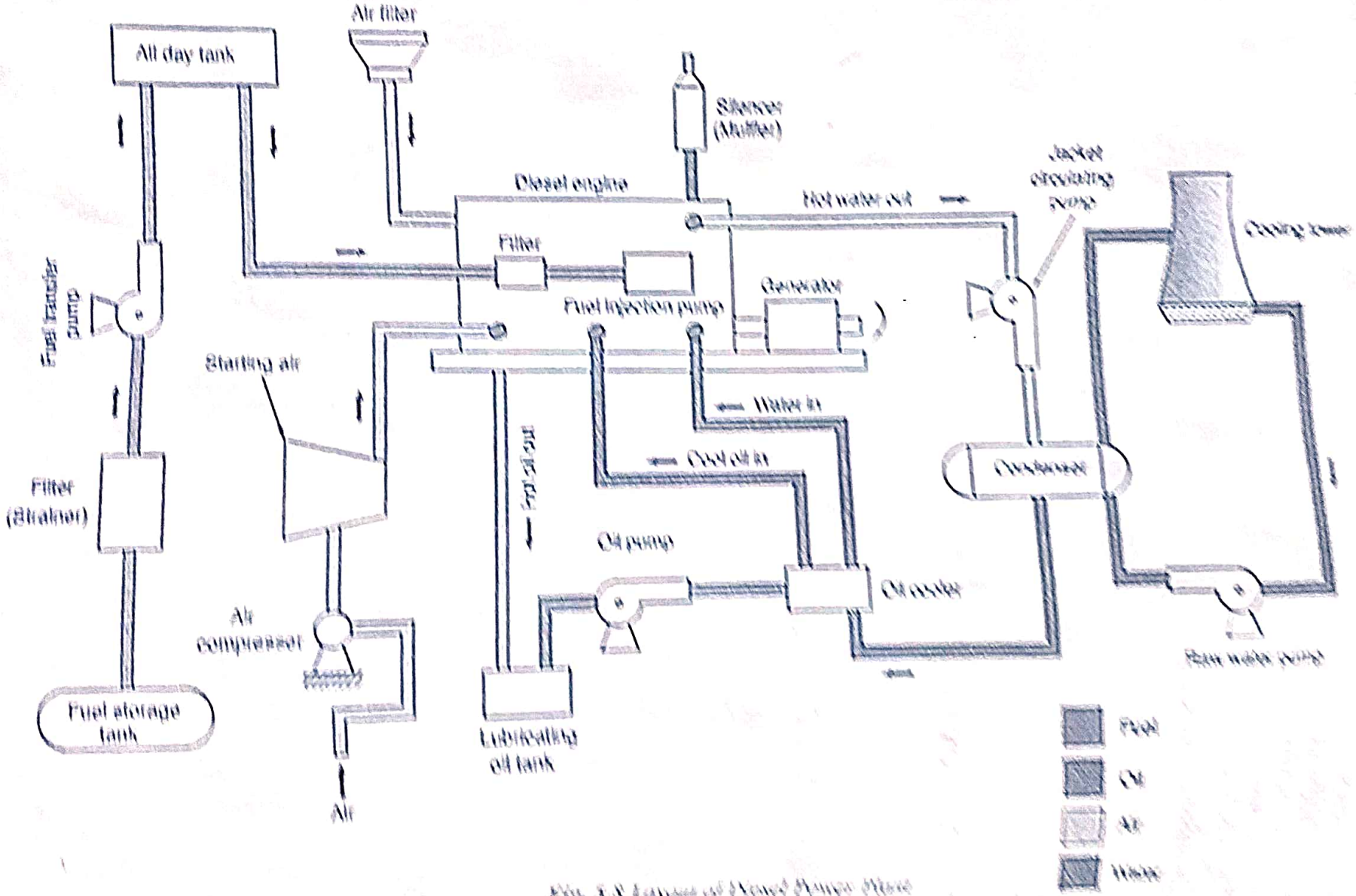


Fig. 3.8 Layout of Diesel Power Plant

6. Cooling System

The temperatures existing in the engine cylinder due to the burning of the fuel are in the order of 1500°c – 2000°c. These temperatures may cause uneven expansion of the engine parts such as cylinder head, walls piston and exhaust valves. In the extreme, it may even cause break down of the lubricating oil. Cooling water is kept in circulation around the cylinders by the Jacket circulating Pump.

The water, on absorbing the heat from the cylinder passes on to a heat exchanger where it gives up its heat to the raw water and this raw water is subsequently cooled in a cooling tower before being once again sent back to the engine cylinders.

7. Lubricating System.

This is essential to reduce the wear & tear of the moving parts. Lubricating system is also used to cool the engine to a certain extent. In a lubricating system, the oil which is hot after lubricating the various parts of the engine returns to the lubricating tank.

Advantages.

1. Handling of fuel is easy and only small space for fuel storage is required
2. It can be loaded near the load centre.
3. It can start quickly.
4. The plant is smaller in size than a steam power plant of the same capacity.
5. It requires less amount of water for cooling.

Gas Turbine Power Plant

Gas turbine power plants are generally used for low capacity electricity generation ranges from 5MW to 60MW. These are popularly used as peak load and standby units for steam and hydel power plants.

Working Principle

The simple gas turbine power plant consists of compressor, combustion chamber, and turbine. The atmospheric air is drawn in to the compressor and compressed to high pressure. Then it is passed through the combustion chamber where the fuel is injected and combustion takes place. It produces high pressure and high temperature gas, expanded in gas turbine develops mechanical work. Finally turbine coupled with generator produces electrical energy.

Components of Gas turbine Power Plants.

1. Starting Motor : For starting a Gas turbine powes plant, it requires a starting motor. It brings the turbine to rotate at minimum speed.

2. low Pressure Compressor

The major function of the Compressor is to Compress the air. The atmospheric air is drawn into compressor and is compressed.

3. Inter Cooler :

The air at the exist of L.P Compressor is hot on account of its pressure rise. Inter cooling is the removal of heat from Compressed air between stages. This reduces the work of compression because work of compression is proportional to inlet temperature. This is achieved by using Water Cooled Suface coolers called intes cooler.

4. High Pressure Compressor

The air from the inter cooler enters the high pressure Compressor where it is compressed to the requisite, final pressure. The reason for staging the Compression in H.P and L.P Stages is that high overall pressure ratios Can be achieved.

5. Regenerator

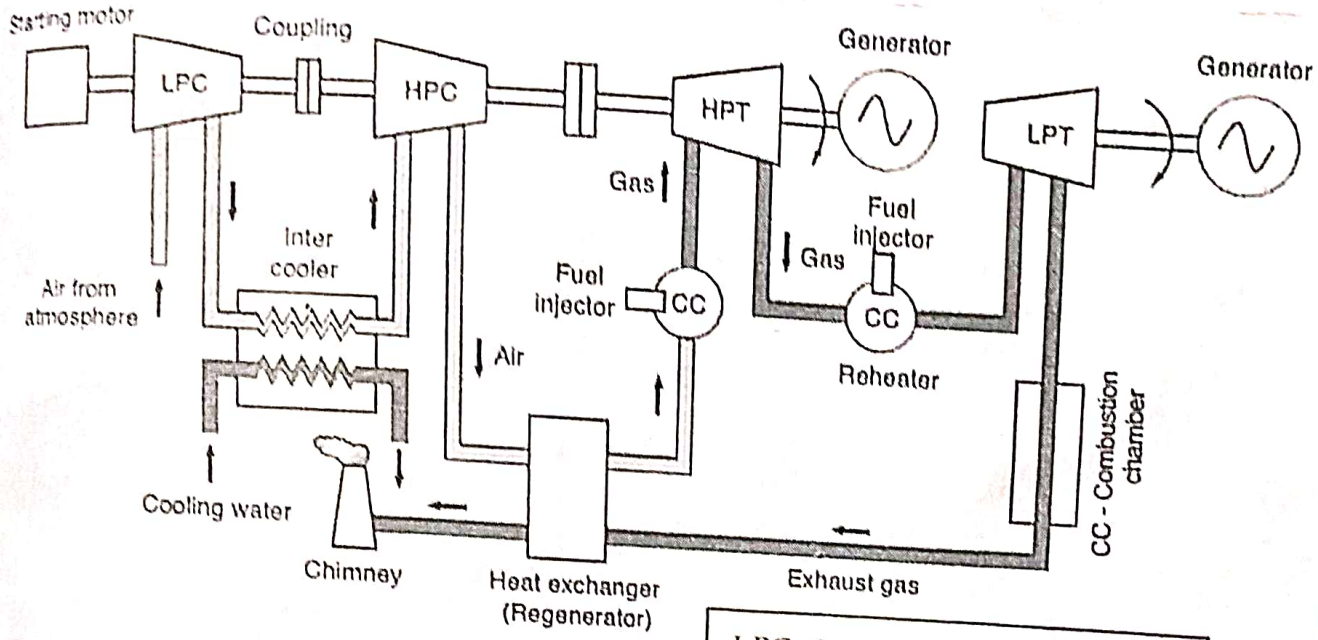
The air from the H.P compressor enters a regenerator which is a type of heat exchanger. Here the air is preheated by the exhaust gases from the L.P tubine before it enters the Combustion chamber.

6. Combustion Chamber

High pressure and hot air from regenerator flow to the combustion chamber. Any one of fuels such as natural gas, coal gas or gasoline is injected into the combustion chamber and burns in the steam of hot air. The products of combustion comprising a mixture of gases at high temperature and pressure are passed to the turbine.

7. High Pressure Turbine

The turbine is called H·P Turbine because the products of combustion which are at high pressure and temperature directly impinge on its blades. Only a part of the total expansion is carried out in the H·P Turbine.



LPC - Low pressure compressor
HPL - High pressure compressor
CC - Combustion chamber
HPT - High pressure turbine
LPT - Low pressure turbine
RH - Reheater

8. Reheater or Combustion Chamber

The products of Combustion, after expansion in the H.P Turbine enter the reheater or Combustion chamber, where heat is once again added to the products of combustion by adding required quantities of fuel.

Boilers

Boiler is also known as Steam Generator. It is a closed metallic vessel. In the boiler, water is converted into steam above atmospheric pressure by the application of heat. Fossil fuels are the source of heat energy.

Requirements of a boiler

1. Steam must be delivered at the required temperature pressure and at the required rate.
2. Maximum heat produced by the fuel in the furnace should be utilized for economy.
3. The boiler should be easily accessible for maintenance and inspection
4. It should rapidly meet the changes in load.

Cochran Boiler

Cochran boiler is a vertical boiler, multi tubular, internally fired, fire tube boiler having a number of horizontal fire tubes.

Max evaporative capacity is 4000 kg of steam per hour. Maximum pressure of steam is 10 bar.

1. Cylindrical shell
2. Gate and ashpit
3. Fire box
4. Flue pipe
5. Fire tubes or Flue Tubes
6. Combustion chamber
7. chimney
8. Manhole
9. Damper.

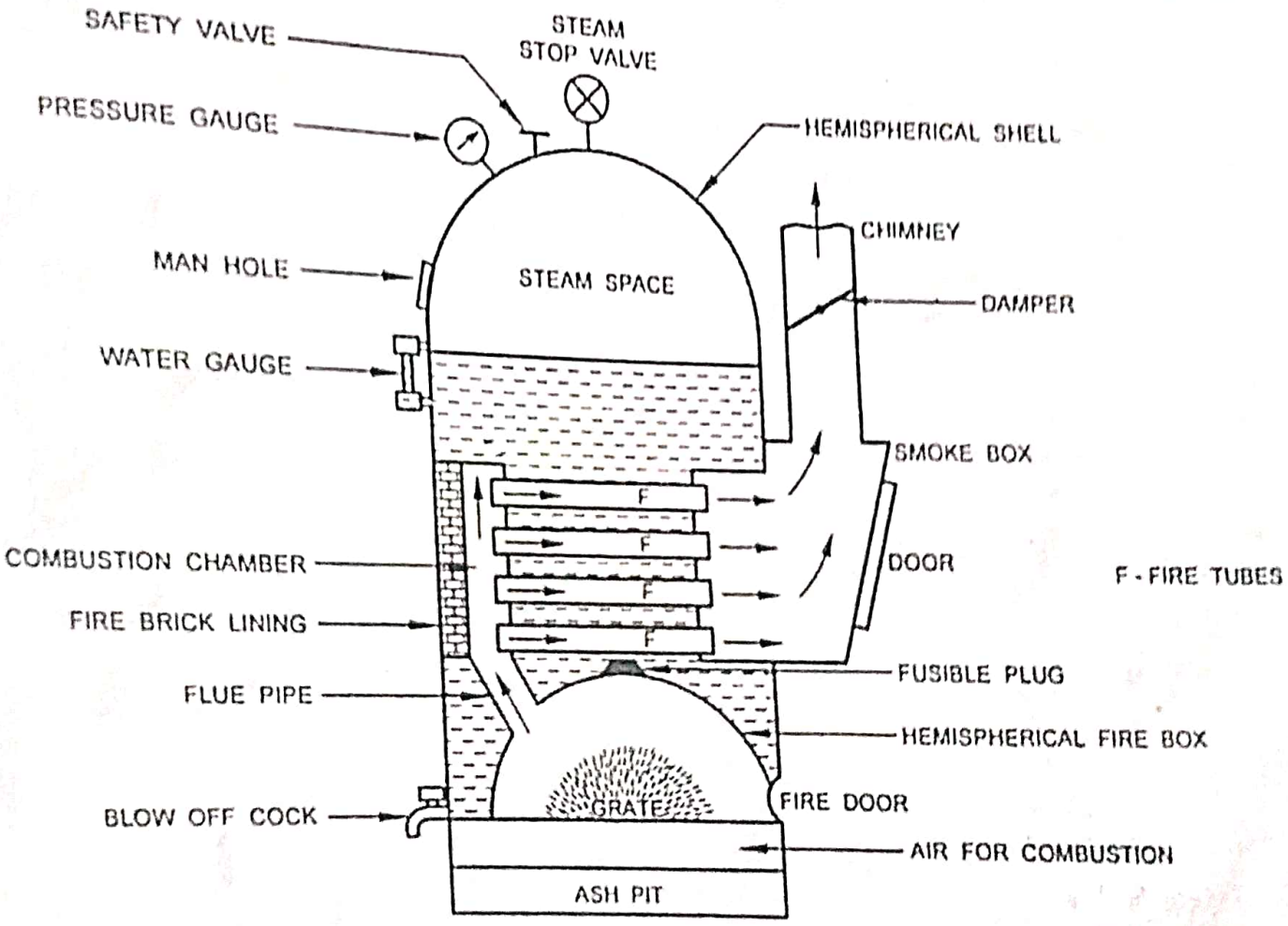


FIG. 1 COCHRAN BOILER

Coal is fed into the Grate through the Fire hole and burnt. Ash formed during burning is collected in the ashpit, provided just below the grate. The ash is then removed manually.

The hot gases from the grate pass through the Flue pipe to the combustion chamber. The hot gases from the combustion chamber flow through the horizontal fire-Tubes and transfers the heat to the water by convection.

The flue gases coming out of the fire tubes pass through the smoke box. From the smoke box, the gases are exhausted to the atmosphere through the chimney. Smoke box is provided with a door for cleaning the fire tubes and smoke box.

Damper controls the waste flue gases leaving the chimney. When damper is partialy closed manually, the quantity of waste gases flowing out is reduced. Hence the quantity of air entering the grate will also be reduced. This results in reduction of the fuel burnt and consequent reduction in the steam generation. Thus the damper controls rate of steam generation.

Turbines.

Prime movers are devices which convert the energy from natural source into mechanical work.

Impulse Turbine

In an Impulse Turbine, the high pressure high temperature steam from the boiler expands through a Fixed nozzle.

The high velocity jet of steam leaves the nozzle and is made to impact upon the blades. The blades are fitted on the periphery of a Rotor. The rotor is mounted on a shaft. The shaft rotates due to the impulsive force exerted by the steam jet on the blades.

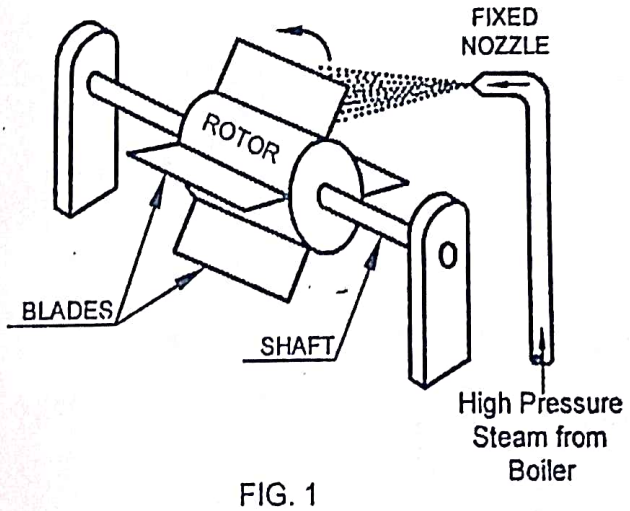


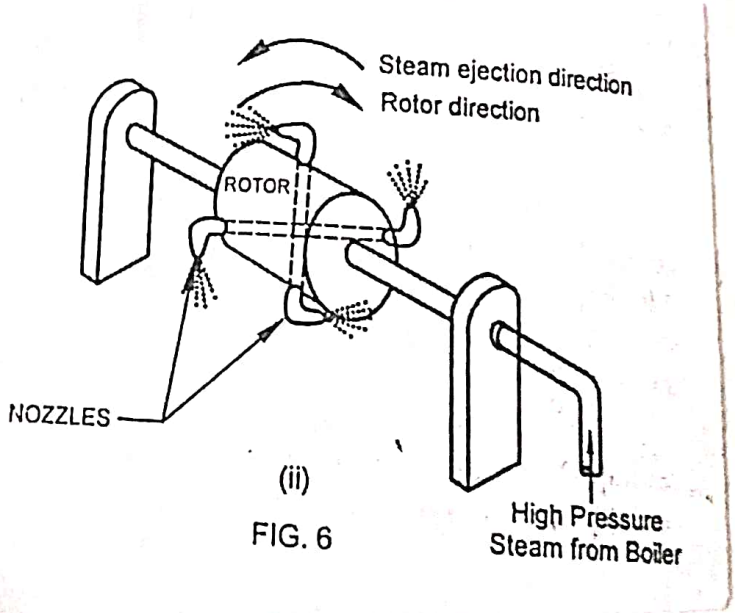
FIG. 1

Reaction Turbine

High pressure high temperature steam from the boiler is sent to a hollow cylindrical rotor.

The rotor has a few openings arranged radially through tubes. The ends of the tubes are shaped as Nozzles. Steam expands as it passes through the nozzles.

This expansion of steam causes a backward thrust on the nozzles. This backward thrust is known as reaction. Due to this reaction the rotor will rotate in a direction opposite to the direction of steam flow.



(ii)

FIG. 6

Reciprocating Pumps

A reciprocating pump converts the mechanical energy into pressure energy by sucking the liquid into a cylinder, in which a piston is reciprocating. It uses piston to positively displace the liquid during each stroke of the piston. The piston is moving backwards and forwards, exerting a thrust on the liquid thereby increasing its pressure energy.

Single acting reciprocating Pump

If a reciprocating pump uses one side of the piston for pumping liquid, then it is known as a single acting reciprocating pump.

Parts

1. Cylinder, Piston, Connecting rod, Crank
2. Suction pipe and suction valve
3. Delivery pipe and Delivery valve.

Suction Stroke

As the crank rotates from A to C, the piston moves towards right in the cylinder. This is called Suction Stroke.

Now, the Volume covered by the piston within the cylinder increases while the pressure decreases below the atomspheric pressure. During this stroke, the non-return valve at the delivery side will be closed by the atmospheric pressure existing in the delivery pipe. At the end of this stroke, the cylinder will be full of water.

Return Stroke

The movement of piston towards left increases the pressure of the liquid inside the cylinder to a pressure more than atmospheric pressure. Therefore the suction valve closes and delivery valve opens. Now the liquid inside the cylinder is forced into the delivery pipe through the delivery valve. Consequently the liquid is raised to the required height. Note that the liquid is discharged at every alternate stroke.

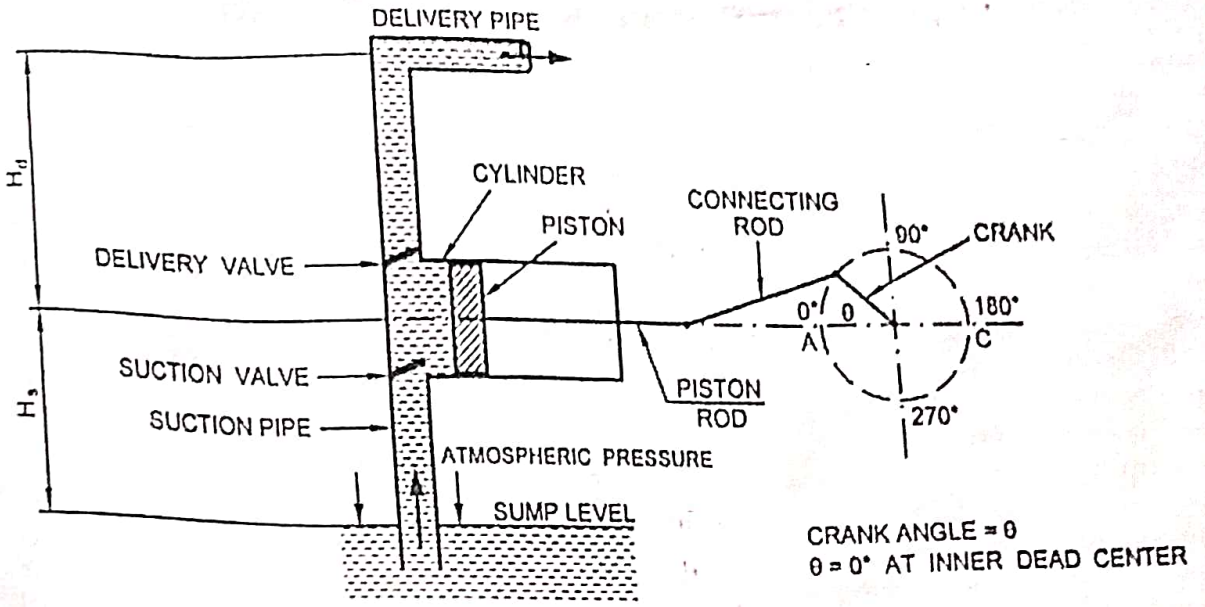


FIG. 1 SINGLE ACTING RECIPROCATING PUMP

Double acting Reciprocating Pump

If the liquid is in contact with both the sides of the piston it is known as double acting reciprocating pump. A double acting reciprocating pump has two suction and two delivery pipes. The corresponding two suction valves and two delivery valves are as shown.

During each stroke, when suction takes place on one side of the piston, the other side delivers the liquid. In this way, in the case of a double acting pump, in one complete revolution of the crank, there are two suction strokes and two delivery strokes. Therefore the liquid is delivered by the pump during these two delivery stroke.

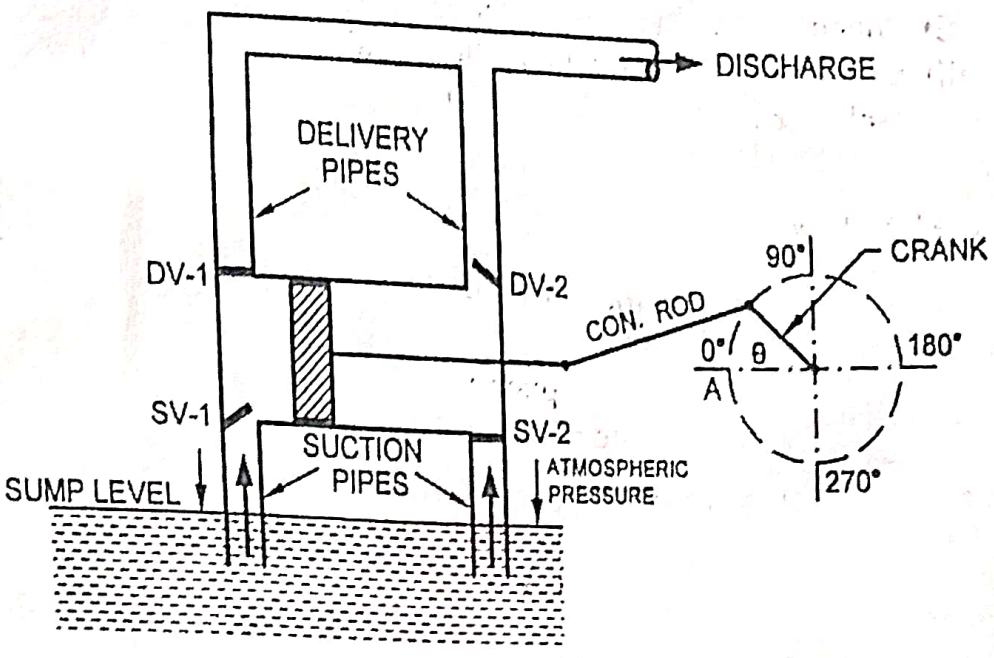
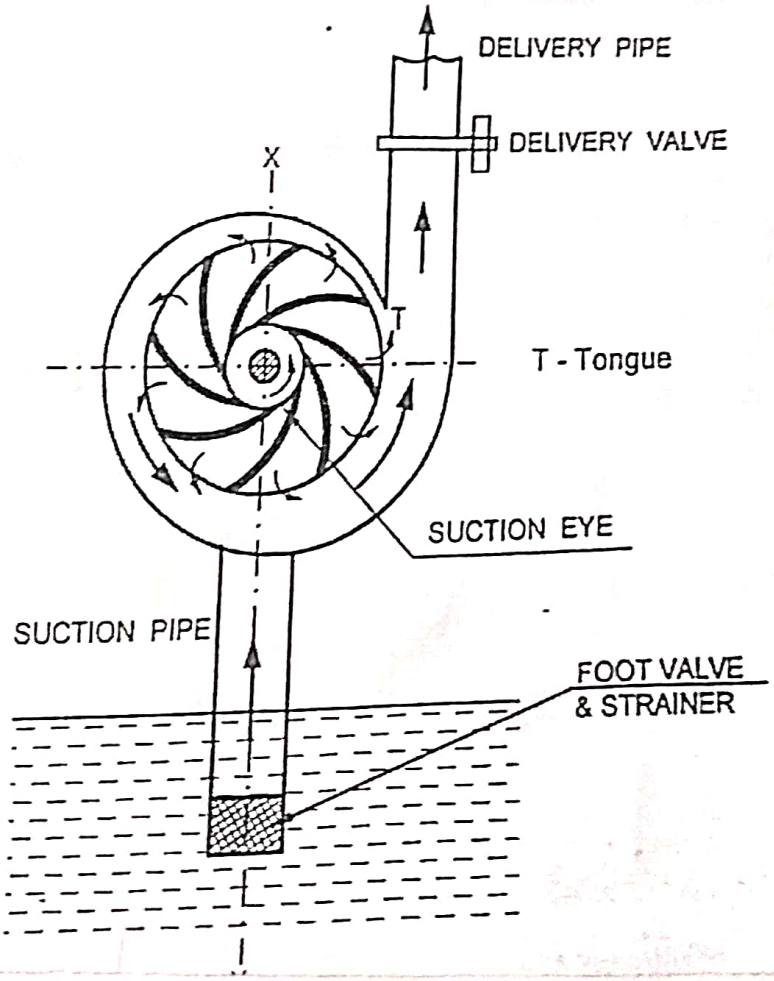


FIG. 2 DOUBLE ACTING RECIPROCATING PUMP

Centrifugal Pump

Centrifugal pump is a hydraulic machine with a rotating part called Impeller. In this pump, mechanical energy is converted into pressure energy by means of centrifugal force acting on the liquid. The liquid enters the pump at the peripheral hub and leaves the casing radially.

1. Volute Casing
2. Impeller
3. Suction pipe with strainer
4. Delivery pipe and delivery valve
5. Shaft
6. Stuffing Box.



UNIT V REFRIGERATION & AIR CONDITIONING SYSTEM

Terminology of Refrigeration

Second Law of Thermodynamics

It states that, "Heat flows from a system at a lower temperature to a system at a higher temperature with the aid of external work".

Refrigeration: Refrigeration is defined as an art of producing and maintaining the temperature in a closed space below atmospheric temperature.

Refrigerator: Refrigerator is an equipment used for producing and maintaining the temperature in a closed space below the surrounding atmospheric temperature.

Refrigerant: Refrigerant is the working fluid in a refrigerator. It absorbs heat at a lower temperature and rejects the heat at a higher temperature in the form of latent heat.

Application of Refrigeration

* Refrigeration is used to preserve Fruits, Milk, Drinks, Food etc for a long period.
* It is used in Water Coolers
* It is used to preserve medicines, Blood etc in hospitals
* Refrigerating machines are used to produce ice in Ice plants.

List of Commonly used Refrigerants

1. Ammonia (NH_3)
2. Freon-12
3. Freon-22
4. Carbon Di-oxide (CO_2)
5. Air

Refrigerating Effect

Refrigerating effect is defined as the rate at which heat is removed from the space to be cooled in a cycle. It is expressed in KJ/second or KW.

Ton of Refrigeration (TR)

Capacity of Refrigerator is defined as the rate at which heat can be absorbed from the cold body. It is expressed in Ton of Refrigeration (TR).

Unit of Refrigeration

A Ton of Refrigeration is the amount of heat absorbed to produce 1 Tonne of ice at 0°C within 24 hours when the initial condition of water is also at 0°C. The value of 1 Tonne of refrigeration is 3.5 KW in S.I units.

Coefficient of Performance (C.O.P)

It is defined as the ratio of amount of heat removed in a system to the external work done upon the working medium for the heat removal.

$$C.O.P = \frac{Q}{W} = \frac{\text{Heat removed from a refrigerator in KW}}{\text{Work done upon the working medium in KW}}$$

COP is always more than 1. Higher the value of cop performance of the refrigerator is better.

Types of Refrigerating Systems

1. Vapour Compression Refrigeration System
2. Vapour Absorption Refrigeration System

Vapour Compression Refrigeration System

Principle

In the Vapour Compression Refrigeration system, Freon-12 or Freon-22 is used as the refrigerant. A Compressor does work on the refrigerant vapour to increase its pressure and temperature.

The refrigerant is circulated through the system It alternately undergoes a change of phase from vapour to liquid and again liquid to vapour during the cycle. The latent heat of vaporization is used for absorbing the heat at low temperature from the refrigerated space. A constant temperature can be maintained in this space.

DESCRIPTION

Vapour compression Refrigeration system consists of the following parts

1. Condenser
2. Receiver
3. Expansion Valve (Capillary tube).
4. Evaporator
5. Compressor

Condenser

The delivery side of the compressor is connected to a condenser. Air or water is used as the cooling medium in the condenser. Air is used for refrigerators and window air conditioners. Water is used for large Centralized air Conditioning systems.

Receiver

Receiver is a vessel used to store the condensed liquid refrigerant coming from the Condenser.

Expansion Valve

The Receiver is connected to an Expansion Valve. The pressure of the liquid passing through the Expansion Valve drops for reuse in the Evaporator. low capacity systems like Refrigerators, window air conditioners etc.

Evaporator

An Evaporator Consists of coiled tubes. The substance to be cooled is placed in the Evaporator. It is the coldest region or space in the refrigerator and serves as the refrigerated space or Freezer Compartment.

Compressor

The Evaporator tube is connected to the suction side of the compressor. The compressor is driven by an electric motor.

Working

The refrigeration effect is produced at the Evaporator. The refrigerant enters the Evaporator at low pressure Low temperature (LPLT).

The LPLT Liquid Refrigerant is evaporated and changed into Vapour refrigerant at the Evaporator. Here the refrigerant absorbs its latent heat of vapourization from the substances kept around the Evaporator, thus cooling them at the Refrigerated space.

The LPLT Vapour Refrigerant from the Evaporator is drawn by the Suction side of the compressor. It is compressed to HPHT and discharged to the condenser, through the delivery side of the compressor.

In the condenser, the latent heat of the refrigerant is removed by either atmospheric air or water. Thus the HPHT Vapour Refrigerant is cooled and condensed into Liquid form.

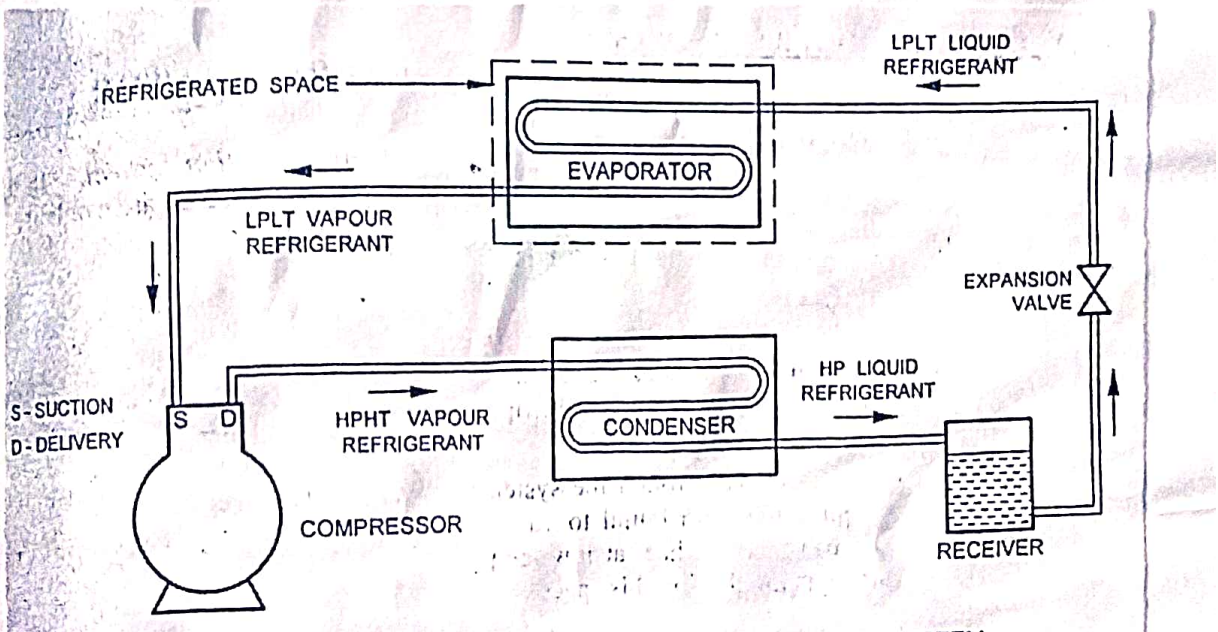
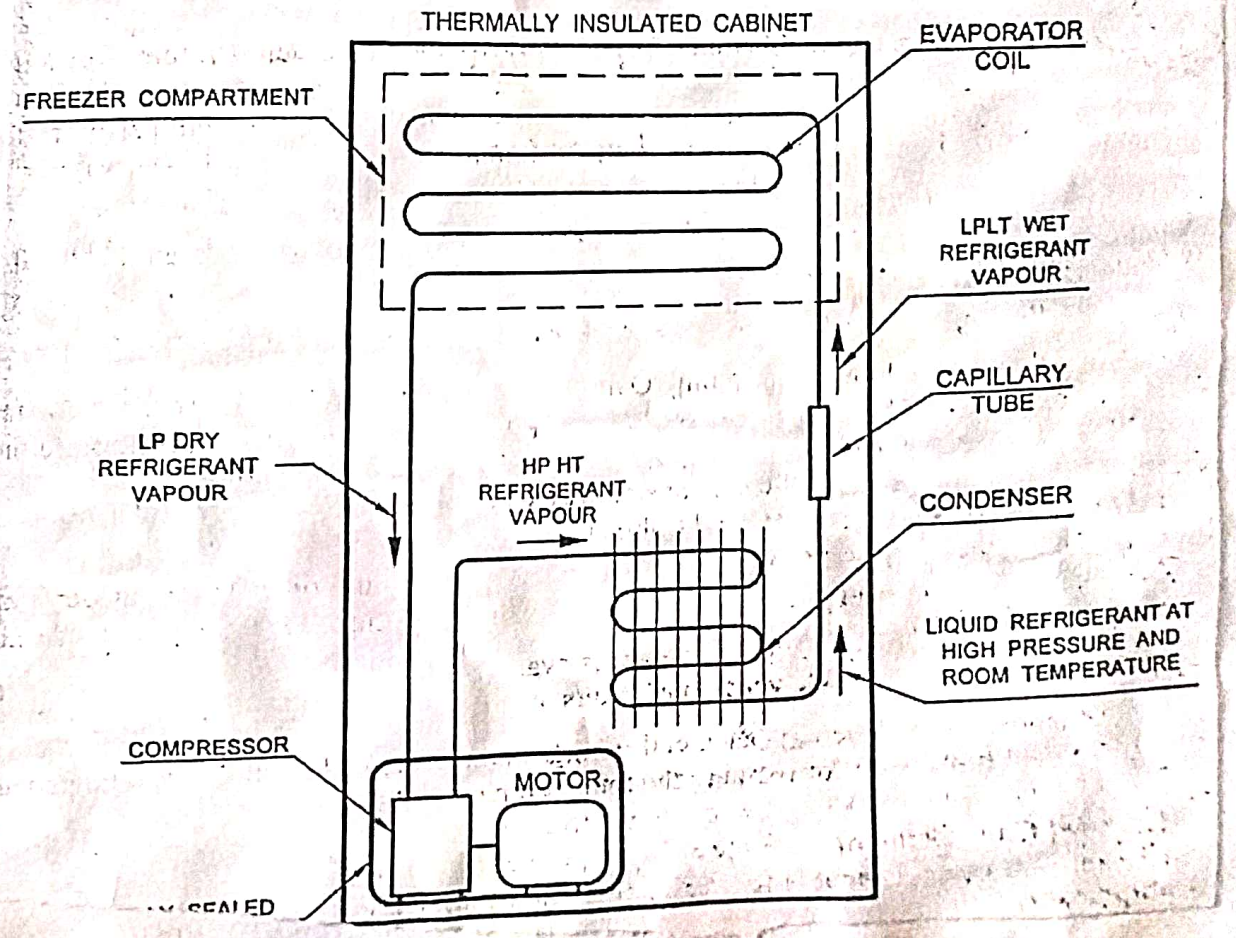


FIG. 1 VAPOUR COMPRESSION REFRIGERATION SYSTEM

The High pressure (HP) Liquid Refrigerant from the Condenser is collected in the Receiver. The high pressure Refrigerant passes through an Expansion valve and expands to low pressure. The Expansion Valve is a Capillary tube in small (domestic) refrigerators. The function of the Capillary tube is to throttle the refrigerant to low pressure low temperature. This LPLT Vapour Refrigerant enters the Evaporator. The cycle is repeated



Vapour Absorption Refrigeration

Principle

The Vapour absorption system, there is no compressor The compressor is replaced by the combined effects provided by an absorber, pump and Generator. The compressor work is replaced by the heat supplied in the generator and pump work. The pump consumes comparatively lesser amount of electric power. The generator is operated by heat energy obtained by burning low cost fuel or any other heat source such as solar energy.

Absorbent:

Absorbent absorbs refrigerant Vapour and converts it into liquid. When heated subsequently, it produces Vapour. Water has this property and is used as the absorbent.

Refrigerant

Ammonia (NH_3) is used as the refrigerant, as it easily dissolves in wates and Vapourizes when heated subsequently.

Aqua-Ammonia System

The homogenous mixture of Ammonia and wates is called Aqua-Ammonia. So the Vapour absorption System is also called Aqua-Ammonia Refrigeration system.

The Vapour Absorption Refrigeration system consists of the following parts.

1. Evaporator
2. Absorber
3. Circulation pump
2. Generator
3. Condenser
6. Expansion Valve

1. Evaporator: It is placed in the Refrigerated space. An Evaporator consists of coiled tubes. The substance to be cooled is placed in the Evaporator. It is the coldest region or space in the refrigerator and serves as the Refrigerated space.

2. Absorber Tank: Absorber Tank contains Absorbent (water) The absorbent should have high affinity for the refrigerant, remain in the liquid phase under operating conditions. It should have a high boiling point and low specific heat. It attracts the refrigerant vapour from the Evaporator.

3. Circulation Pump

The pump circulates the refrigerant to flow into the Generator.

4. Generator

Heat is added to the Generator from an External source. It may be a gas burner or solar heat

Window Air conditioner or Room air conditioner

All the components of an air conditioner are assembled inside a casing installed in the window of a room at the window sill level. Hence it is called window air conditioner.

Description

1. Evaporator
2. Compressor
3. Condenser
4. Expansion valve in the form of a capillary tube

The Evaporator part is facing the room (INDOOR) The condenser part projects outside the room (OUTDOOR) The evaporator part is insulated from the condenser part. That is, the evaporator and condenser coils are separated by an Insulated partition to avoid the air movement between the room and atmosphere.

A common double shaft motor drives a Fan at one end and a blower at the other end. Adjustable louvers continuously change the direction of air flow to ensure uniform distribution of conditioned air inside the room.

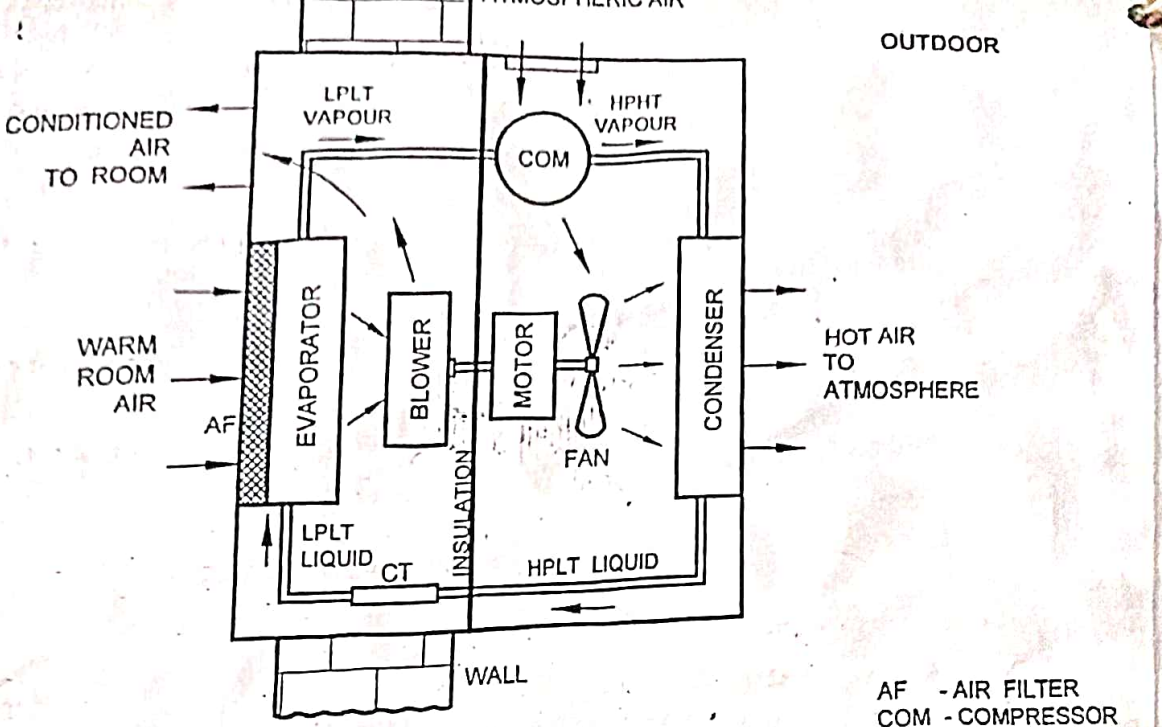


FIG. 2 WINDOW AIR CONDITIONER

Working Principle

Commonly used refrigerants are Freon-12 & Freon22

Evaporator

Evaporator is a cooling coil made of copper. The Centrifugal Blower is installed behind the evaporator. The Blower sucks warm air from the room and sends it to the evaporator through the Air filter. The LPLT refrigerant inside the evaporator coil absorbs the heat from the room air and evoporates. Therefore, the room air is cooled as well as dehumidified by continous heat removal. The dehumidified Cooled air is blown back into the room.

The desired temperature of 20°c to 25°c in the room for human body comfort is maintained using the control panel.

Compressor

The LPLT evaporated refrigerant is drawn by the suction of the compressor. The compressor compresses it to HPHT Vapour. Vapour flows into the condenser coil.

Condenser

The Fan draws the atmospheric air, which is circulated over the condenser coil. The HPHT refrigerant Vapour inside the condenser condenses by giving-off the heat to the air, which absorbs the heat.

This hot air is discharged to the atmosphere. The HPHT Vapour is condensed to high pressure low temperature (HPLT) Liquid refrigerant in the condenser.

Capillary Tube

Then the HPLT Liquid expands to LPLT Liquid in the Capillary Tube. This liquid refrigerant is re-circulated through the evaporator. The cycle is repeated.

The evaporator outer surface is cold, as it contains low temperature Liquid refrigerant. So water Vapour in the warm humid air condenses to form water

droplets on the outer surface of the evaporator.

Window air conditioners operate on 230V, Single phase AC supply.

Capacity of Air conditioner

A Ton of Refrigeration is the amount of heat absorbed to produce 1 ton of ice at 0°C within 24 hours when the initial condition of water is also at 0°C. The Value of 1 ton of Refrigeration is 3.5 KJ/sec or 3.5 KW in S.I units.

Air conditioners are also specified by the same Unit TR

Advantages.

1. Window air conditioner is a self-contained single package unit.
2. For more than one room in a residential building, several window units can be used. A separate temperature control is provided in each room in which the unit is installed
3. No Ducks: Ducks are not required for air distribution This advantage is especially noticeable in residence in mild climates where central heating systems are not required
4. Installation is simple and Plumbing is not required.

Disadvantages.

1. Not Suitable for large halls and applications where heat and moisture loads are high.
2. Air circulation: The unit has circulation of a fixed air quantity.
3. The installation must be made only on an External wall of the room.

SPLIT Type Room Air Conditioner

The present trend in the Indian Market is to go for the split type of the air conditioning system. It is built in two parts:

1. Cooling unit
2. Condensing unit

Cooling Unit (Indoor Unit).

1. Evaporator coil and Capillary tube

The HPHT Liquid refrigerant from the condenser is passed to the capillary tube. In the capillary tube the refrigerant expands. The LPLT Liquid refrigerant then passes to the Evaporator.

2. Evaporator Fan

Evaporator Fan draws air continously from the inside of the room through an Air Filter. The air is forced to pass over the evaporator coil by the fan and is cooled by the refrigerant. Consequently, the refrigerant evaporates by absorbing the heat from the air.

3. Mounting of Cooling unit.

Cooling unit may be floor mounted, wall mounted or ceiling mounted depending on the requirement

4. Controls.

When a controlled atmosphere is required in air conditioning, the humidity of the air is varied. When dry air is required, it is dehumidified by cooling or by dehydration. Air is humidified by circulation through water sprays.

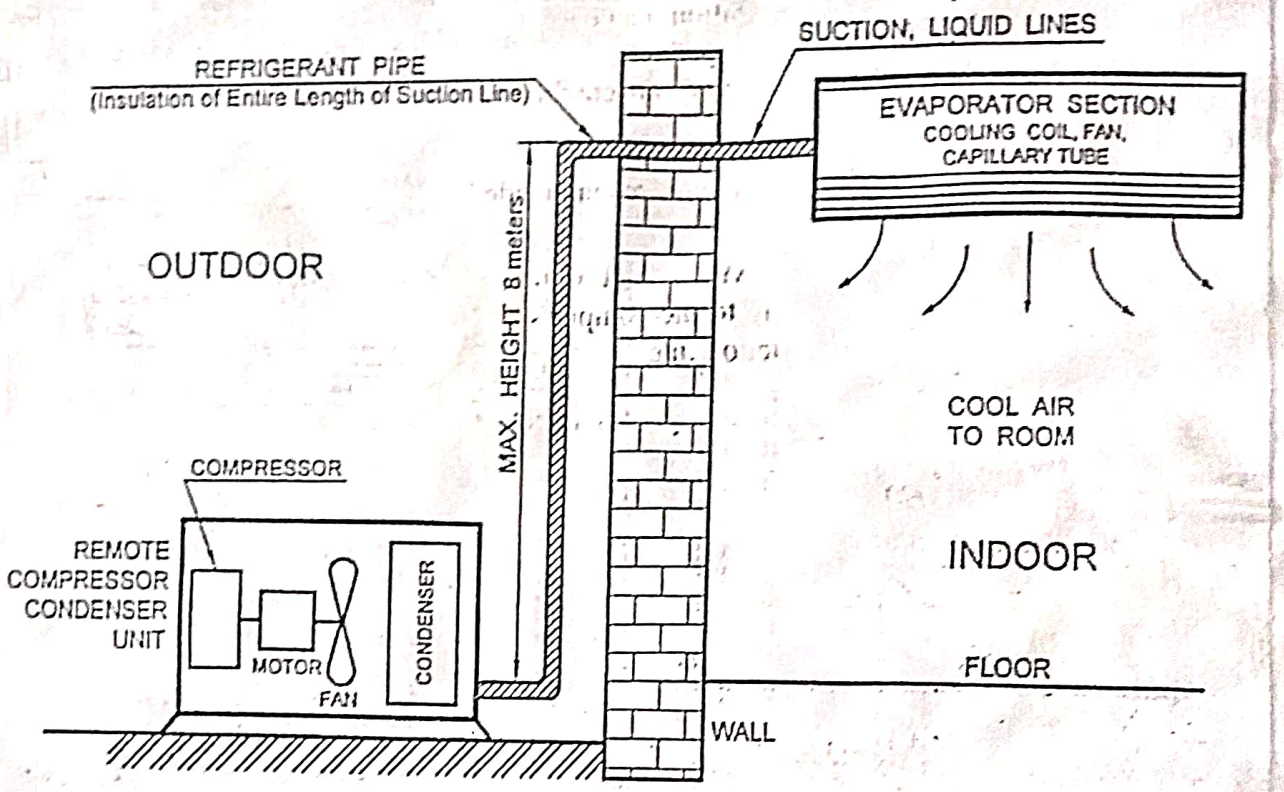


FIG. 4 SPLIT-TYPE ROOM AIR CONDITIONER

Condensing Unit (OUTDOOR UNIT)

1. Compressor

High temperature evaporated refrigerant from the evaporator is drawn by the suction of the compressor. The compressor compresses it and delivers it to the Condenser.

2. Condenser coil

The Condenser can be air cooled in the case of room air conditioner or water cooled in the case of Centralized air conditioner. If a water cooled condenser is to be used, the condenser is provided with connections for either city water or well water. For an air cooled condenser, these connections are not required.

3. Condenser Fan

The condenser fan draws the atmospheric air from the exposed side. The HPHT refrigerant passing inside the condenser condenses by giving-off the heat to the atmospheric air.

1.1 AIR CONDITIONING VS REFRIGERATION

Sl.No.	Refrigeration	Air Conditioning
1.	Refrigeration is the method of lowering down the temperature of a closed space to a value much less than that of its surrounding atmosphere.	Air conditioning is the method of controlling the temperature of a closed space to bring it to a value less or greater than that of its surrounding atmosphere.
2.	Temperature required in the refrigeration is much less than that required by air conditioning.	Temperature required in the air conditioning is much more than that required by refrigeration.
3.	Refrigeration helps to produce air conditioning.	Air conditioning does not help producing refrigeration.
4.	Required mainly for preservation of food stuff, blood, medicine, etc.	Required mainly for human comfort and maintaining working accuracy of machinery and equipments.

5. Condenser : Air or water is used as the cooling medium in the condenser. Air is used for refrigerators and window air conditioners. Water is used for large centralized air conditioning systems.

6. Expansion Valve.

The condenser is connected to an Expansion Valve. The pressure of the liquid passing through the expansion valve drops for reuse in the Evaporator.

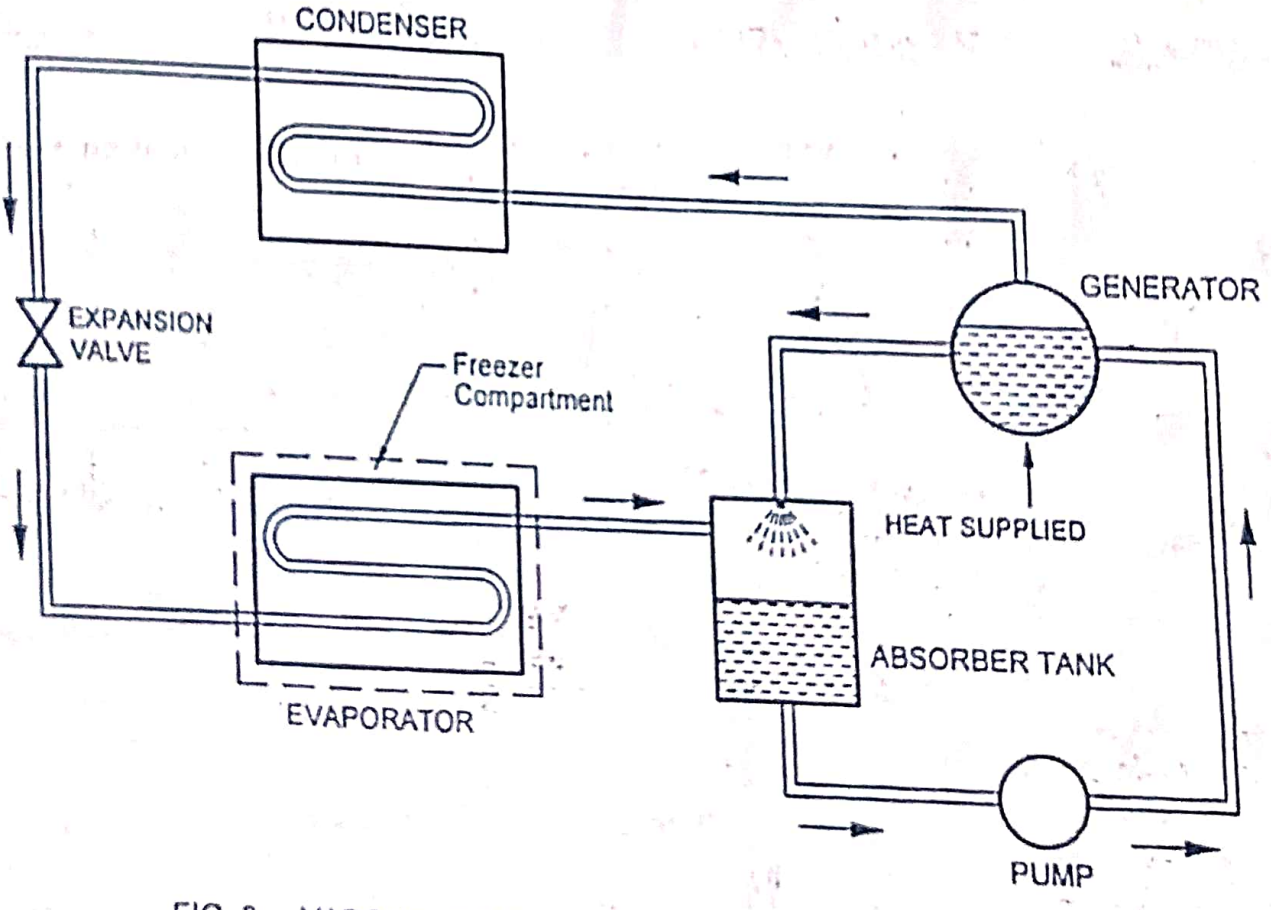


FIG. 3 VAPOUR ABSORPTION REFRIGERATION SYSTEM

viii) High Alumina Cement:-

It is manufactured by calcining a mixture of lime and bauxite.

ix) Blast Furnace Cement:-

In the manufacture of pig iron a large comes out as a waste product.

x) Acid Resistant Cement:

This cement is produced by adding acid resistant aggregated such as quartz, quartzite sodium silicate or soluble glass.

xi) Sulphate Resistant Cement:-

By keeping the percentage of tricalcium aluminate C_3A below five per cent in ordinary Cement this cement is produced.

iv) Rapid Hardening Cement:

This cement can be produced increasing lime content to avoid burning at high temperature while manufacturing cement

v) Low Heat Cement

In mass concrete works like construction of dams, heat produced due to hydration of cement will not get dispersed easily.

vi) Pozzulana Cement

Pozzulana is a volcanic power found in Italy. It can be processed from shales and certain types of clay

vii) Expanding Cement

This cement expands as it sets. This property is achieved by adding expanding medium like sulpho aluminate and a stabilizing agent to ordinary cement.

Types of Cement

In addition to ordinary portland cement there are many variation of cement Important varieties are briefly explained below:

i. White Cement

The cement when made free from colouring oxides of iron magnesse and chromium results into white cement

ii) Coloured Cement:-

The cement of desired colours are Produced by intimately mixing pigments with ordinary cement

iii) Quick setting Cement

Quick setting cement is produced by reducing the percentage of gypsum and adding a small amount of aluminum sulphate during the manufacture of cement

Advantages of precast method of construction:

* more energy efficient.
* Reduced health and safety risks.
* rigorous quality control.
* Economical to maintain
* Reduced debris and damaging.
* increasing site utilization.
* built from sustainable and recyclable materials
* Reduced building construction times.
* Reduced wastage.

Disadvantages of precast method of construction:

* Specialty skills for handling components at the construction site
* Initial cost in PMC is very high.
* multiple transportations involved are challenged.
* For handling PMC components, specialized types of equipment are required.

most common type Panels are:

* Open Panels.
* Closed Panels.
* Concrete Panels.
* Structural insulated Panels.
* Infill Panels.
* Curtain walling.
* Composite Panels.

Slab Construction:

The flat slab are versatile nature, because of
flat one they are used in construction. The flat slap
sides minimum depth and faster construction. the system also
ete column grides that are flexible. In comparison to
m forms of construction, flat slab are faster and more
mic in nature.

lding concrete formwork:

Insulating concreting formwork may be a building
m that was light weight formwork to support
ete walls whilst they're cast-in-site and which is then
in place as insulation.

construction

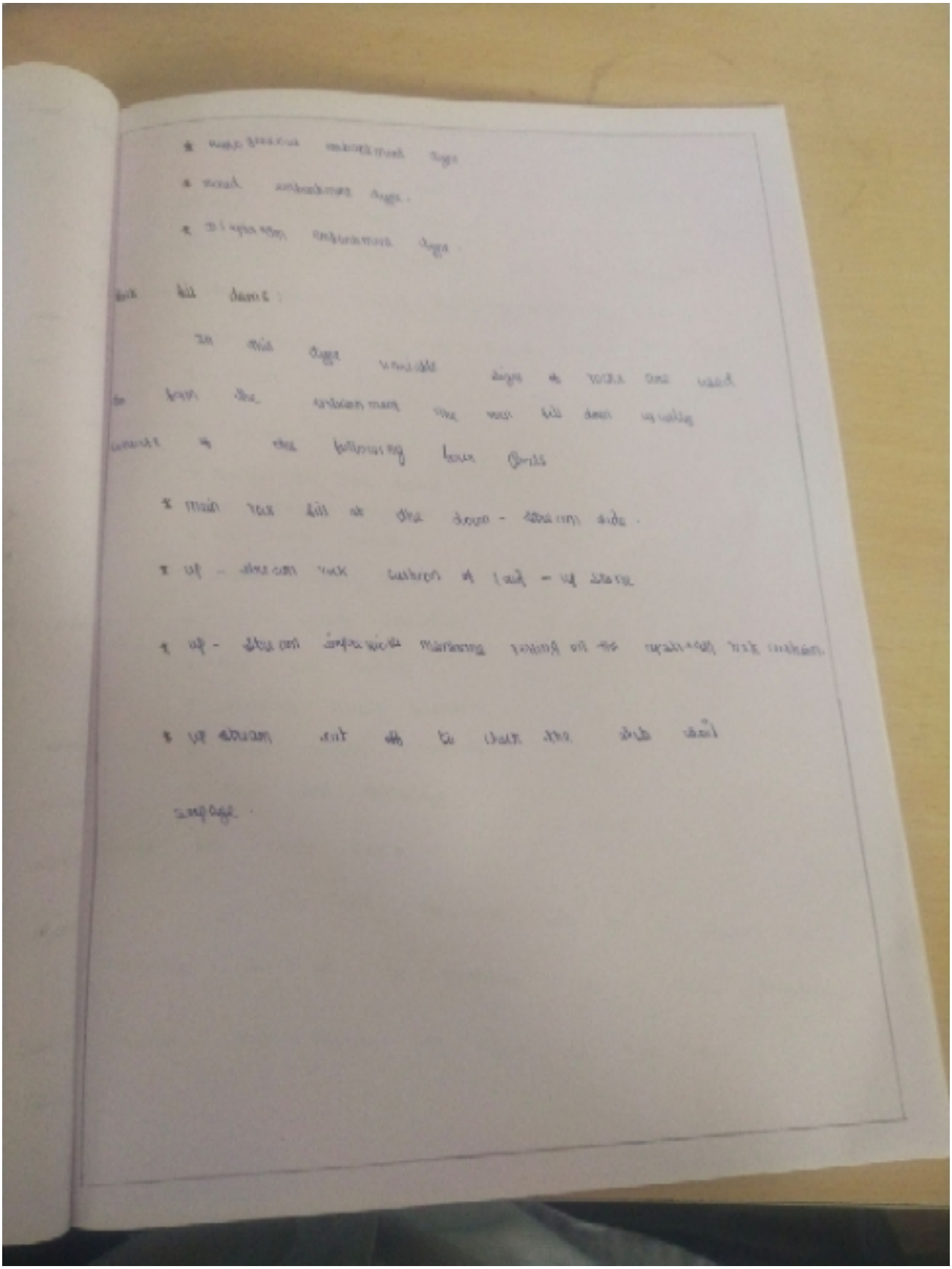
- Flat Panel System
- 3D volumetric construction
- Flat slab construction
- Framed shielding Panel
- Hybrid concrete construction
- Tilt - down masonry.
- Insulating concrete formwork.
- Precast concrete foundations.
- Tilt wall technology.

Flat Panel System.

Flat Panel units are built on a factory and

assembled on site for assembly into a three - dimensional

structure that includes wall, floor and roof Panels.



Buttress dams :

A buttress dam consists of a number of buttresses or piers. These piers divide the space into a number of equal panels and connected by horizontal arches or flat slabs. If the panels consist of flat slabs, it is known as deck type buttress dam.

Steel dam :

These dams are constructed with a frame work of steel with a thin skin plate as the water face. Steel dams are generally of two types.

* Direct strutted type.
* Cantilever type.

Timber dams :

A timber dam is constructed of frame work of timber struts and beams, with timber plank faces to resist water pressure. They are suitable in those where timber can be available in plenty.

Earth dams :

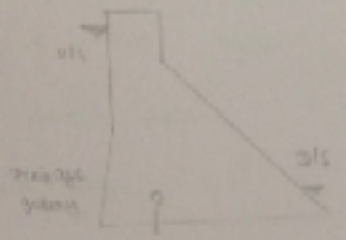
Earth dams are made of locally available soils and gravels. Therefore, these types of dams are used upto moderate heights only.

non - rigid dam :

Non rigid dams are dams which are constructed of non-rigid materials such as earth and rock fill.

gravity dam :

A gravity dam is the one in which the external horizontal pressure, water pressure, silt pressure, uplift pressure etc. are resisted by the weight of the dam itself.



Arch dams :

An arch dam is a dam curved in plan and carries a major part of its external horizontally to the abutments by arch action. The weight of arch dam is not counted on to resist materially in the resistance of external

loads.

Dams:

Classification of dams:

Storage dam:

Storage dam is constructed to store water in its upstream during the period of excess supply in the river.

Diversion dam:

Diversion dam supply raises the water level slightly in the river and thus provide of escaping or diverting water into another canals or other conveyance systems to place of use.

Detention dam:

A detention dam is constructed to store water during floods and release it gradually at a safe rate when the flood reduces.

Classification according to material:

Rigid dams

* Solid masonry gravity dam
* Solid concrete gravity dam
* Arched masonry dam
* Arched concrete dam
* Concrete buttress dam
* Steel dam
* Timber dam.

Wing walls:

These are the walls provided at both ends of the abutments to retain earth filling of the approach road.

Foundation for the piers and abutments:

The foundation of a bridge structure distributes the load from the piers and abutments over the larger area of the soil.

Super structure:

The super structure is that part of the bridge over [illegible] the traffic moves with safety.

Decking:

It is provided to allow the road surface to be built in over it. It may consist of a slab, trusses, arches etc...

Parapets or hand rails, guard stones:

These are the protective works provided on both sides of the deck along the roadways in order to safeguard the moving [illegible] and the passengers on a bridge. Foot path are also provided for pedestrian to walk along the bridge.

Bearing:

It is the part of the bearing structure provided to distribute the load coming from the superstructure and also to allow for longitudinal and angular movements.

Advantages of modern methods of construction

* More energy efficient
* Reduced Health and safety risks
* Rigorous quality control
* Economical to maintain
* Reduced defects and snagging
* Increasing site utilization
* Built from substainable and recyclable material
* Reduced building construction times
* Reduced wastage.

Disadvantages of modern methods of construction

Security risks for handling components at the construction site

Initial cost in MMC is very high

Multiple Transportation materials are required

For handling MMC components, specialised types of equipment are required

The system also provides column grides that are flexible in comparison to other forms of construction. flat slabs are faster and more economic in nature

iv) Insulating concrete Formwork

Insulating concrete formwork may be a building system that uses light weight formwork to support concrete walls whilst they're cast-in-situ and which is then left in place as insulation

v) Precast concrete foundations

The precast concrete system can be employed for the rapid construction of the foundation and is more suited for a bespoke design. The elements required for the construction of the foundation are constricted off-site and brought to the site and assembled. The manufactured product must have assured quality as specified by the designer.

The most common types of panels are:

- open panels
- closed panels
- concrete panels
- structural insulated panels
- infill panels
- curtain walling
- composite panels

ii) 3D volumetric construction

Three-dimensional units produced during a factory fully fitted out before being transported to site and stacked onto prepared foundations to make the dwellings volumetric construction is additionally mentioned as modular construction. These units can be made from a light gauge steel frame, timber frame, concrete and composites. volumetric construction is most effective when used for giant numbers of residential units, as could also be found in flats.

iii) Flat slab construction

The flat slabs are of versatile nature, because of this feature they are used widely in construction. The flat slap provides minimum depth and faster construction.

Mordern construction

The very basic need of a human is shelter. The construction methods have evolved significantly in recent times. efficiencies in both the buildings and the project are required. Mordern methods of constructions are becoming popular among builders and are being adopted in a large number of projects.

Methods of mordern construction

* precast flat panel system
* 3D volumetric construction
* Flat slab construction
* Precast cladding panels
* Hybrid concrete construction
* Thin-joint masonry
* Insulating concrete formwork
* Precast concrete foundations
* Twin wall technology.

1) Precast flat panel system

Flat-panel units are built in a factory and transported to site for assembly into a three-dimensional structure that includes wall, floor, and roof panels.

Earth dams

Earth dams are made of locally available soils and gravels. Therefore these type of dams are used upto moderate heights. Their construction involves utilization of materials in the natural state requiring a minimum of processing

i) Homogeneous embakment type

ii) Zoned embankment type

iii) Diaphragm embankment type

Rock fill dams:

In this type, variable sizes of rocks are used to form the embankment. The rock fill dam usually consists of the following four parts

* main rock fill at the down - steam side
* up - steam rock - cushion of laid - up stone
* up - steam impervious membrane resting on the upstream rock cushion
* up stream cut off to check the sub soil seepage.

ii) Non - Rigid dams:

Non - rigid dams are those which are constructed
f rigid materials such as masonry, concrete, steel or timber.
igid dams may be further classified as follows

i) Earth dam
ii) Rock fill dam

tel dams

Steel dams are constructed with a frame work of steel
th a thin skin plate as deck slab, on the upstream side. Steel
ms are generally of two types.

i) Direct strutted type
ii) cantilever type.

the direct strutted type, the load on the deck plate is
ried directly to the foundation inclined struts. In the
tilever type, the deck is formed by a cantilever truss. The
is anchored to the foundation at the u/s toe.

ber Dams:

A timber dam is constructed of framework of timber
ls and beams; with timber plank facing to resist water
ure. They are suitable in places where timber can be
ilable in plenty.

ii) overflow dam

An overflow dam is the one which is designed to convey surplus discharge over its crest.

Usually, in a multi purpose valley project, the two types of dams are combined. The main dam is kept as a non-overflow dam and some portion of dam is kept as overflow dam at some suitable location along the main dam.

c) classification according to material

i) Rigid dams
ii) Non-Rigid dams.

i) Rigid dams

- solid masonry gravity dam
- solid concrete gravity dam
- arched masonry dam
- arched concrete dam
- concrete buttress dam
- Steel dam
- Timber dam

ii) storage dam

Storage dam is constructed to store water to its upstream side during the periods of excess supply in the river and is used in periods of deficient supply

iii) Diversion dam

Diversion dam supply raises the water level slightly in the river during the periods head for carring or diverting water to ditches, canals or other conveyance systems to place of use.

iv) Detension dam

A detension dam is constructed to store water during floods and release it gradually at a safe rate when the flood reduces.

b) classification According to hydraulic design:

i) Non-overflow dam

ii) overflow dam

i) Non-overflow Dam

A non-overflow dam is the one in the which the top of the dam is kept at a higher elevation than the maximum expected high flood level.

Multipurpose reservoirs

A reservoir planned and constructed to serve not only one purpose but various purposes together is called a multipurpose reservoir

Reservoir designed for one purpose, incidentally serving other purposes, shall not be called a multipurpose reservoir

Hence a reservoir designed to protect the downstream areas from floods and also to conserve water for water supply, irrigation, industrial needs, hydroelectric purposes etc. shall be called as MULTIPURPOSE RESERVOIR.

Classification of Dams.

Dams may be classified into different categories, depending upon the basis of the classification

a) Classification according to use: Based on use, dams are classified as follows.

i) Storage dam

ii) Diversion dam

iii) Detension dam

18. DAMS

Introduction

A dam is an impervious barrier construction across a river to store water. The side on which water gets collected is called the upstream side, and the other side of the barrier is called the downstream side. The lake of water is collected in the upstream side is called as reservoir. This water is then utilized as and when it is needed.

Purpose of a dam

1. To store and control the water for irrigation.
2. To store and divert the water for domestic uses
3. To supply water for Industrial uses
4. To develop hydroelectric power plant to produce electricity
5. To increase water depths for navigation
6. To create storage space for flood control
7. To preserve and cultivate the useful aquatic life
8. For recreational purposes.

Road ways into

a) class AA bridges

b) class A bridges

c) class B bridges Classification according to the loading they are designed to carry.

Component parts of a bridge.

Broadly, a bridge can be divided into two major parts

1. substructure.
2. Super structure

1. substructure

The substructure consists of the following

a. Abutments
b. Piers
c. wing walls
d. Approaches
e. foundations for the piers and abutments

2. Super structure

The substructure consists of the following

a. Decking
b. Parapet or hand rails, guard stones
c. Bearing

In economic point of view, the bridges are constructed.

non- submergible bridges.

These type of bridges are the bridges whose floor levels are above the high flood level.

Life: under this, the bridges may be classified as.

a) permanent bridges

b) temporary bridges.

Types of super structure.

a) arch bridges

b) Truss bridges

c) portal frame bridges

d) Balanced cantilever bridges

e) suspension bridges etc ...

Span length.

a) culverts (span less than 6m)

b) minor bridges (span between 6 to 30m)

c) Major bridges(span above 30m)

d) long span bridges (span above 120m)

Loading:

Road bridges and culverts have been classified by Indian

the relative position of bridge floor:

a) Deck bridge.

b) Semi Through bridge

c) Through bridge.

Deck bridges are the bridges whose flooring are supported at the top of the super structure. Through bridges are the bridges whose flooring are supported at the bottom of the super structure. Semi-Through bridges are the are the whose flooring are support at some intermediate level of the super structure.

Function of purpose

a) highway bridges

b) Railway bridges

c) Foot bridges

d) viaduct bridges

e) Aquaduct etc.

Position of high flood level:

a) Submersible bridge

b) Non-submersible bridge.

Submersible Brideges

These types of bridges where floor levels are below the high flood level. During flood seasons, it allows the water to pass over the bridge submerging the communication route

1. BRIDGES

Introduction

A bridge is a structure providing passage over an obstacle without closing the way beneath.

The required passage may be for a road, a railway pedestrian or a canal of a pipeline. The obstacle to be crossed may be river, a road, a railway or a valley.

classification of Bridges.

Bridges can be classified into various types depending upon the following factors:

material used for construction:

a) Timber bridges b) masonry bridges

c) Steel bridges d) reinforced cement concrete bridges

e) Pre-stressed concrete bridges f) composite bridges.

Alignment

a) Straight or square bridges

b) Skew bridges

c) Straight or square are the bridges which are at right angles to the axis of the river. Skew bridges are not at right angles to the axis of the river.

Planning:

All buildings should be properly planned keeping in view the various requirements of a good buildings. Expect strength requirements all other requirements of a good buildings are taken care at the stage of planning strength requirements is taken care during structural design of building components. However in planning the building by-laws of the statutory authorities should not be violated. Planning of the building is an art combined with science. Principles of planning of buildings may be grouped into:

Orientation.
Energy efficiency.
Ventilation.
Other requirements.

UNIT 3

BUILDING COMPONENT AND INFRASTRUCTURE.

Elements of Buildings:

The following are the basic Elements of a building.

Foundation.
Plinth
Walls and columns
Sills, Lintels and chejjes
Doors and windows
Floors
Roofs.
Steps Stairs and lifts.
Finishing work.
Building Services.

Strength an stability:

Building should be capable of transferring the expected loads in beams walls Colluemn and foolings should be ensure safety None of the structural Components should buckle overturn and collapse.

Desired workability.
No segregation in transporting and placing
No bleeding
No Harshness.

Properties of Carbon Steel:

It is more tough and elastic compared to mild steel.

Welding is difficult.

It can be magnetized permanently

It is stronger in compression than in tensions.

It withstand shocks and vibrations better.

Test on Concrete:

The following are some of the important tests conducted on Concrete

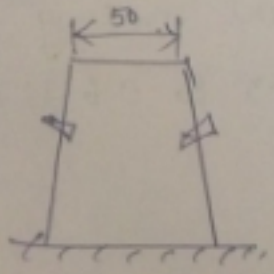
Slump test

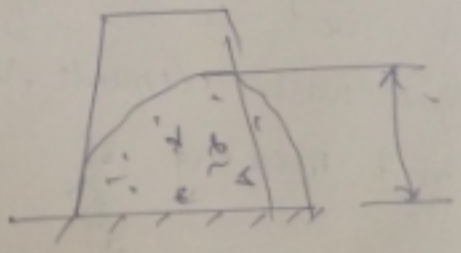
Compaction test.

Crushing strength ~~test~~ test

Slump test:

This test is conducted to determine the workability of Concrete. It needs a slump cone ~~test~~ for shape of a frustum of a cone with diameter at bottom 200mm and 50mm at top and 300mm high this cone is kept over a impervious platform and is filled with Concrete in four layers





Desirable properties concrete:

Appropriate quality and quantity of cement fine aggregate course aggregate and water should be used so that the green concrete has following properties.

Uses of Bricks:

As Building Blocks

For lining of ovens, furnaces and chimneys

For protecting Steel columns from fire

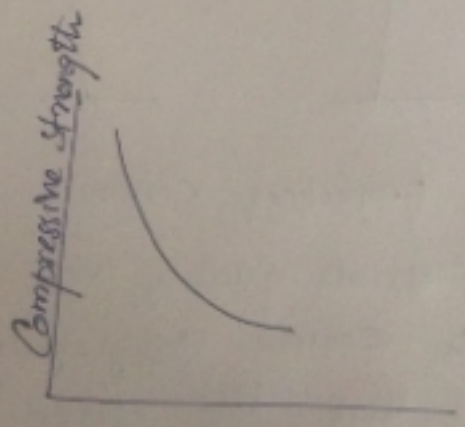
As aggregate in providing water proofing to RCC roofs

For pavers for footpaths and cycle tracks

For lining sewer lines.

Stress:

However Excess water reduce the Strength of Concrete shows the variation to Strength of Concrete with water Cement ratio. The achive required workability and at the same time good strength a water cement ratio of 0.4 to 0.45 is used in case of machine mixing and water Cement ratio 0.5 to 0.6 is used for hand mixing



Two methods are adopted.

Orientation by magnetic needle

Orientation by back sighting.

Methods of plane table survey:

Radiation.

Intersection.

Traversing.

Resection.

Types of Stone:

Stone used for Civil Engineering works may be classified in the following three ways

Geological.

Physical

Chemical.

Geological rocks.

Based on their origin of formation of Stone are classified in to three main groups

Igneous rocks

Sedimentary rocks

Metamorphic rocks

Igneous Rocks:

These rocks are formed by cooling and Solidifying of the rock masses from their molten.

magmatic condition of the material of the earth. Generally igneous rocks are strong and durable

Sedimentary Rocks:

Due to weathering action of water wind and frost existing rocks disintegrates the disintgrates. The materials is carried by wind and water, wind and frost existing most powerfull. medium Flowing water deposited its suspended materials at some points of obstacles to the flow. Then deposited layers of materials get Consolidated under pressure and by heat.

Metamorphic Rocks:

Previously formed igneous and sedimentary rocks undergo changes due to metamorphic action of pressure and internal heat: For Example due to metamorphic action granite becomes gneiss. trap and basalt change to schist and laterite limi stone change to marble.

Stratified rocks

Unstratified rocks

Two methods are adopted.

Orientation by magnetic needle

Orientation by back sighting.

Methods of plane table survey:

Radiation.

Intersection.

Traversing.

Resection.

Types of Stone:

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Igneous Rocks:

These rocks are formed by cooling and Solidifying of the rock masses from their molten.

Working Operations

Fixing
Setting
Levelling
Orientation.

Fixing:

Fixing the table to the tripod stand.

Setting

The table is set up at a convenient height say 1m above ground the legs of the stand are spread apart and firmly fixed into the ground the table is the centered this means that the points plotted on the sheet corresponding to the stations occupied should be exactly above the stations on the ground. This is done by means of the plumbing fork.

Levelling:

The table is then levelled either by ordinarly tilting the board or by ball and socket arrangement.

Orientation:

Orientation is the process of putting the plane table into some fixed direction so that line representing a certain direction on the drawing sheet is parallel to that direction on the ground.

Theodolite Survey:

The theodolite is the most precise instrument used for measurement of horizontal and vertical angles. It can be used for various surveying operations such as established grades setting out curves extending survey lines determining rl elevation.

Transit Theodolite

Non transit theodolite

Telescope.

A theodolite is provided with a telescope to sight the distant objects clearly. It mounted on a spindle known as horizontal axis.

Two spindle.

There are two spindles with axes one inside the other the outer axis hollowed in a ground conical to fit the central vertical axis which is a solid and conical.

Parts:

A telescope to provide line of sight.

A level tube to make the line of sight horizontal.

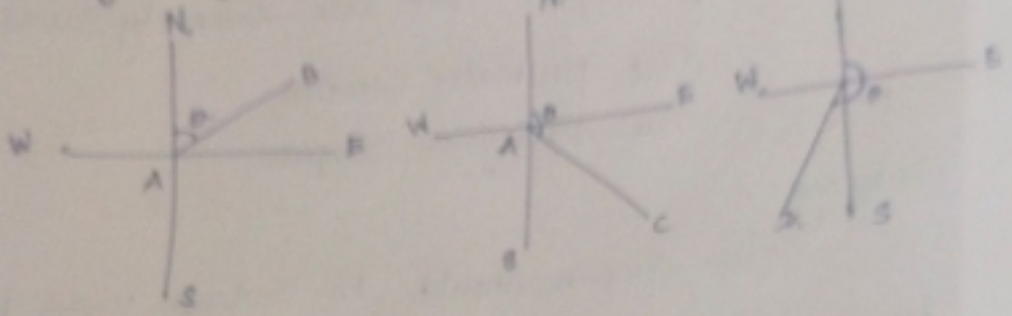
A levelling head to bring the bubble in its centre of run.

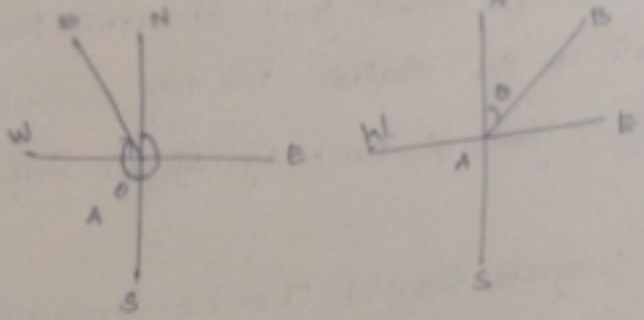
A tripod to support the instrument.

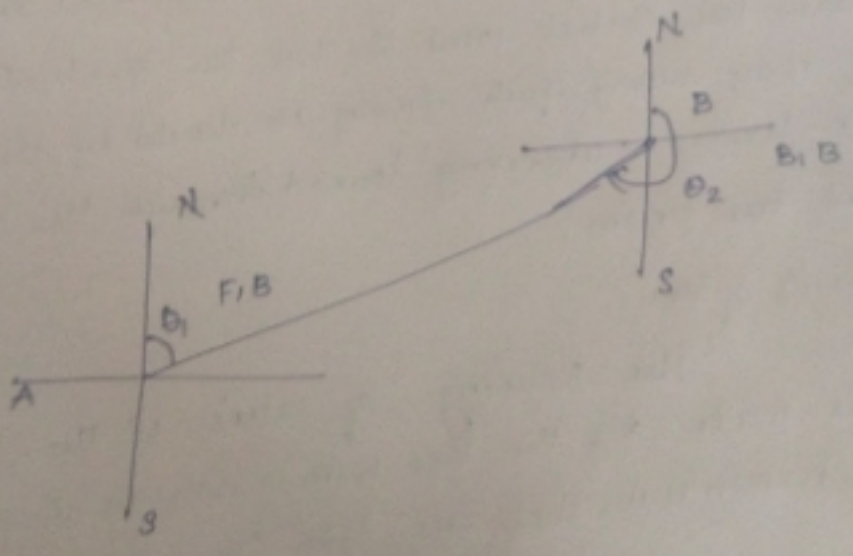
Designation of bearing:

The whole circle bearing system.

Quadrantal bearing system or natural bearing system:







Compass Surveying:

When the area to be surveyed is large, chain and compass surveying is preferable & compass is used to measure the magnetic bearing of a line. There are two forms of compass that are commonly used.

The prismatic compass.
The surveyors compass

Centering:

The Compass should be centered leveled by eye by means of a ball and socket joint observing bearing ranging rod at the station the peg marking the station and by adjusting the legs of the tripoid.

Levelling:

The Compass should then be leveled by eye by means the socket joint so that the graduated ring may swing quite freely It should by cleaned when levelled observing looked through the slit above the prism.

Bearing of line:

The Bearing of a line is the horizontal angle made by the line with a selected reference line called meridian. There are two types are there.

Magnetic Bearing

Bearing.

Cross Staff.

This is instrument used for setting out right angles to a chain line. It consists of eighter a frame or box with two pairs of vertical slits and is mounted on pole ishod for fixing in the ground

Open cross staff.

French Cross staff.

Adjustable Cross staff.

Advantage:

Chain surveying is suitable for fairly level ground

It does not requir costly equipments

Its used for preparing plans of smallerarea

Its simple

Disadvantage:

Its cannot used for large areas

Its not always accure

Mid-ordenate rule:

$$\text{Area} = (O_1 + O_2 \cdots - - - + On)d.$$

$O_1 O_2$ = the ordenates at the mid points of each divisions

n = number of divisions

L = length of base line

d = distance of each divisions.

Basic Civil and Mechanical Engineering

Unit II

Surveying and Civil Engineering Materials

Surveying :

Surveying is the art of determining the relative position of points on above or beneath the surface of the earth by means of direct or indirect measurements of distance, direction and elevation.

Primary divisions of Surveying :

Plane Surveying In plane Surveying the mean surface of the earth is considered as a plane and the spheroid shape is neglected as the surveys extend over small areas.

Geodetic Surveying The curve of earth is taken into account and all lying in the surface are curved lines and the triangles are spherical triangles Hence distances and areas are covered.

Classification of Surveying :

Chain Surveying
Compass Surveying
Theodolite Surveying
Plane table surveying
Tachometric Surveying.