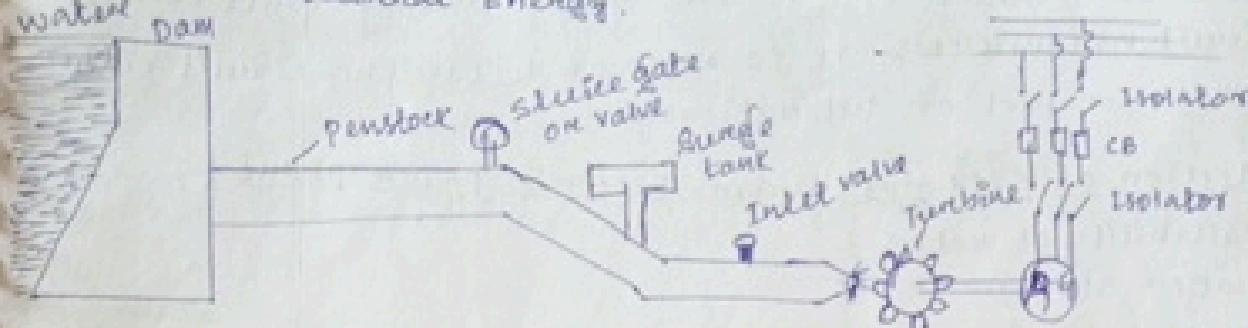


GENERATION OF ELECTRICAL POWER

(1) HYDRO ELECTRIC POWER PLANT

In hydroelectric Power plant the potential energy converted into electrical energy.



1. WATER RESERVOIR:-

It is the basic requirement of a hydro electric power plant. Water reservoir is used to store water which may be utilized to run the turbines to produce electric power. Water held in upstream reservoir is called storage whereas water behind the dam at the plant is called pondage.

2. DAM:-

A dam is a barrier to confine or raise water for storage or diversion to create a hydraulic head. A dam is usually made of masonry or some other material built at a suitable location across a river.

3 PENSTOCK:-

The term Penstock is generally used to a relatively short length of pipe connecting the prime mover with the main water way.

The design of penstock required special consideration as it has to work under high pressure developed under part load condition.

4 VALVE:-

To control the water which is flowing through penstock from dam to turbine.

5. SURGE TANK:- A surge tank is a small reservoir or tank in which the water level rises or falls to reduce the pressure swings so that they are not transmitted in full to a closed circuit.

6. TURBINE:- It is converted the Potential energy of water into mechanical energy which in turn is utilized run an electric generator to get electric energy.

7. AC GENERATOR:- The AC machine which converts mechanical energy into electrical energy.

(8) ELECTRIC HOUSE:

In electric house the electric part are having which control & help to flowing supply to consumer.

(a) Isolator:- which isolate the supply in any foul condition.

(b) Circuit Breaker(s):- It is make or break the circuit either

Remote control or automatically.

(9) Selection of Site for Hydro-Electric Power Plant:-

- Availability of water
- Water storage
- Water head
- Accessibility of the site
- Distance from load centre
- Type of the land at site.

(a) Availability of water:

The most important aspect of hydro-electric plant is the availability of water at the site since all other designs are based on it. Therefore the run-off data at the proposed site must be available before hand. It may not be possible to have run-off data at the proposed site but data concerning the rainfall over the large catchment area is always available.

(b) Water storage:

Since there is a wide variation in rainfall during the year, therefore, it is always necessary to store the water for continuous generation of power. The storage capacity can be calculated with the help of rear curve. Maxⁿ storage should expenditure on the project.

(c) Water head:

In order to generate a requisite quantity of power it is necessary that a large quantity of water at a sufficient head should be available. An increase in effective head, for a given off., reduces the quantity of water required to be supplied to the turbines.

(d) Accessibility of the site:

The site where hydro-electric plant is to be constructed should be easily accessible. This is important if the electric power generated is to be utilised at or near the plant site. The site selected should have transportation facility.

(8) Distance from the load centre:- It is of paramount importance that the power plant should be set up near the load centre this will reduce the cost of erection and maintenance of transmission line.

(9) Type of the land of the site:- The land to be selected for the site should be cheap and rocky. The ideal site will be one where the dam will have largest catchment area to store water at high head and will be economical in construction.

Advantages

- It requires no fuel as water is used for the generation of electrical energy.
- It is quite neat & clean as no smoke or ash is produced.
- It requires very small running charges because water is the source of energy which is available free of cost.
- It is comparatively simple in construction and requires less maintenance.
- It does not require a long standing time like a steam power station. In fact such plants can be put into service instantly.
- It is robust and has a longer life.

Disadvantages:-

- It involves high capital cost due to construction of dam.
- There is uncertainty about the availability of huge amount of water due to dependence on weather conditions.
- Skilled and experienced hands are required to build the plant.
- It requires high cost of transmission line as the plant is located in hilly areas which are quite away from the consumers.

(A) WATER TURBINES:-

Water turbines are used to convert the energy of falling water into mechanical energy. The principal types of water turbines are:-

- (i) Impulse (ii) Reaction turbine

(i) IMPULSE TURBINES:

- It is high head. In an impulse turbine, the entire pressure of water is converted into kinetic energy in nozzle and the velocity of the jet drives the wheel. The example of this type of turbine is the Pelton wheel.
- The force of water jet striking the buckets on the wheel drives the turbine. The quantity of water jet falling on the turbine is controlled by means of a needle or spear placed in the lip of the nozzle. The movement of needle is controlled by the governor. If the load on the turbine decreases, the governor pushes the needle into the nozzle thereby reducing the quantity of water striking the buckets. Reverse action takes place if the load on the turbine increases.

(ii) REACTION TURBINES:

- Reaction turbines are used for low and medium heads. In a reaction turbine, water enters the runner partly with pressure energy & partly with velocity head. The important types of reaction turbines are
 - (a) Francis turbines
 - (b) Kaplan turbines

(a) Francis turbines:

A Francis turbine is used for low to medium heads. It consists of an outer ring of stationary guide blades fixed to the turbine casing and an inner ring of rotating blades forming the runner. The guide blades control the flow of water to the turbine.

(b) Kaplan turbines

A Kaplan turbine is used for low heads and large quantities of water. It is similar to Francis turbine except that the runner of Kaplan turbine receives water axially, water flows radially inwards through regulating gates all around the sides, changing direction in the runner to axial flow. This causes a reaction force which drives the turbine.

Q1 STEAM POWER STATION (THERMAL STATION):-

A generating station which converts heat energy of coal combustion into electrical energy is known as a Steam Power Station.

- A steam power station basically works on the Rankine cycle. Steam is produced in the boiler by utilising the heat of coal combustion. This steam is then expanded in the turbine (i.e. Steam turbine) and is condensed in a condenser to be fed into the boiler again.
- The steam turbine drives the alternator which converts mechanical energy of the turbine into electrical energy. This type of power station is suitable where coal and water are available in abundance and large amount of electric power is to be generated.

Advantages:-

- The fuel (i.e. coal) used is quite cheap.
- less initial cost as compared to other generating stations.
- It can be installed at any place irrespective of the existence of coal. The coal can be transported to the site of the plant by rail or road.
- It requires less space as compared to the hydroelectric power station.
- The cost of generation is lesser than that of the diesel power station.

Disadvantages:-

- It pollutes the atmosphere due to the production of large amount of smoke and fumes.
- It is costlier in running cost as compared to hydroelectric plant.

② SCHEMATIC ARRANGEMENT OF STEAM POWER STATION:-

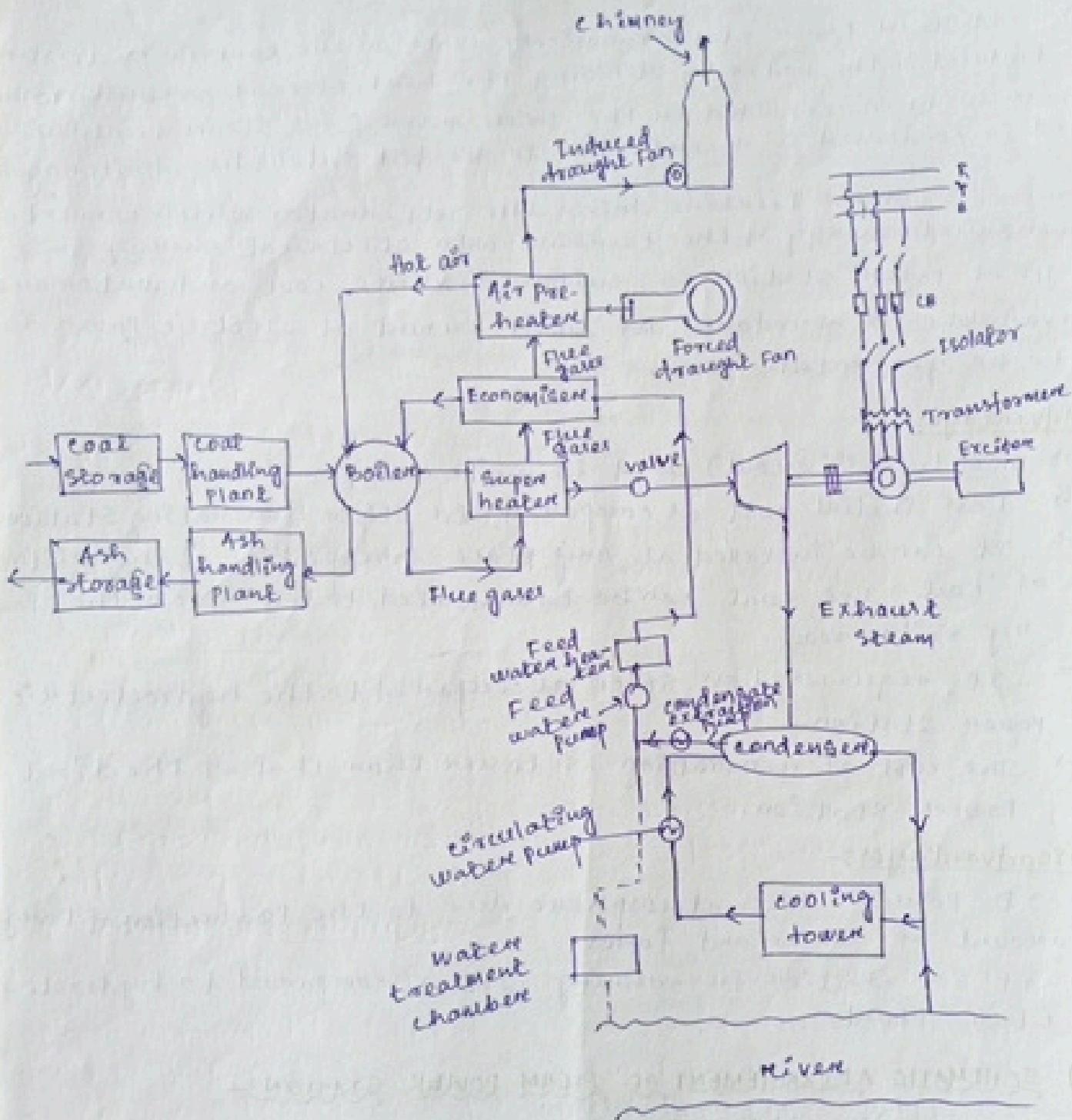
In steam power station supply involves the conversion of heat of coal combustion into electrical energy.

The whole arrangement can be divided into following stages

1. Coal & ash handling arrangement
2. Steam turbine
3. Steam generating plant
4. Alternator
5. Feedwater

1. COAL BOAT

Schematic arrangement of Steam Power Station



1. Coal & ash handling plant:-

The coal is transported to the power station by road or rail and is stored in the plant. Storage of coal is primarily a matter of protection against coal strike, failure of transportation system and general coal storage. From the coal storage plant, coal is delivered to the coal handling plant where it is pulverised (i.e. crushed into small pieces) in order to increase its surface exposure, thus promoting rapid combustion without using large quantity of excess air. The pulverised coal is fed to the boiler by belt conveyors. The coal is burnt in the boiler and the ash produced after the complete combustion of coal is removed to the ash handling plant and then delivered to the ash storage plant for disposal.

2. Steam generating plant:-

The steam generating plant consists of boiler for the production of steam and other auxiliary equipment for the utilisation of flue gases.

(i) Boiler:- The heat of combustion of coal in the boiler is utilised to convert water into steam at high temperature & pressure. The flue gases from the boiler make their journey through superheater, air pre-heater and are finally exhausted to atmosphere through the chimney.

(ii) Superheater:- The steam produced in the boiler is wet and is passed through a superheater where it is dried and superheated (i.e. steam temperature increased above that of boiling point of water) by the flue gases on their way to chimney. Superheating provides two principal benefits. Firstly, the overall efficiency is increased. Secondly, too much condensation in the last stages of turbine (which would cause blade corrosion) is avoided. The superheated steam from the superheater is fed to steam turbine through the main valve.

(iii) Economiser:- An economiser is essentially a feed water heater and draws heat from the flue gases for this purpose. The feed water is fed to the economiser before supplying to the boiler. The economiser extracts a part of heat of flue gases to increase the feed water temperature.

(iv) Air preheater:- An air preheater increases the temperature of the air supplied for coal burning by deriving heat from flue gas. Air is drawn from the atmosphere by a forced draught fan and is

Passed through air preheater before supplying to the boiler furnace.

The air preheater extracts heat from flue gases and increases the temperature of air used for coal combustion. The principal benefit of preheating the air are: increased thermal efficiency and increased steam capacity per square metre of boiler surface.

4) STEAM TURBINE:-

The dry and superheated steam from the superheater is fed to the steam turbine through inlet valve. The heat energy of steam when passing over the blades of turbine is converted into mechanical energy. After giving heat energy to the turbine, the steam is exhausted to the condenser which condense the exhausted steam by means of cold water circulation.

4) ALTERNATOR

The steam turbine is coupled to an alternator. The alternator converts mechanical energy of turbine into electrical energy. The electrical off from the alternator is delivered to the bus bar through transformer, circuit breakers and isolators.

5) Feed Water

The condensate from the condenser is used as feed water to the boiler. Some water may be lost in the cycle which is suitably made up from external source. The feed water on its way to the boiler is heated by water heaters and economiser. This keeps in raising the overall efficiency of the plant.

4) COOLING ARRANGEMENT:-

In order to improve the efficiency of the plant, the steam exhausted from the turbine is condensed by means of a condenser. Water is drawn from a natural source of supply such as a river, canal or lake and is circulating through the condenser. The circulating water takes up the heat of the exhausted steam & itself becomes hot. This hot water cooling out from the condenser is discharged at a suitable location down the river. In case the availability of water from the source of supply is not assured throughout the year, cooling towers are used. During the scarcity of water in the river, hot water from the condenser is passed on to the cooling tower where it is cooled. The cool water from the cooling tower is reused in the condenser.

B.1 CHOICE OF SITE FOR STEAM POWER STATIONS:-

- (i) Supply of fuel:- The steam power station should be located near the coal mines so that transportation cost of fuel is minimized. However if such a plant is to be installed at a place where coal is not available, then care should be taken that adequate facilities exist for the transportation of coal.
- (ii) Availability of water:- A huge amount of water is required for the condenser. Therefore, such a plant should be located at the bank of a river or near a canal to ensure the continuous supply of water.
- (iii) Transportation facilities:- A modern steam power station often requires the transportation of material and machinery. Therefore, adequate transportation facilities must exist i.e. the plant should be well connected to other parts of the country by rail, road, etc.
- (iv) Cost and type of land:- The steam power station should be located at a place where land is cheap and further expansion, if necessary, is possible. Moreover, the bearing capacity of the ground should be adequate so that heavy equipment could be installed.
- (v) Nearest to load centre:- In order to reduce the transmission cost the plant should be located near the centre of the load. This is particularly important if d-c supply system is adopted. However, if a-c supply system is adopted, this factor becomes relatively less important as it is because a-c power can be transmitted at high voltages with consequent reduced transmission cost.
- (vi) Distance from populated area:-

An huge amount of coal is burnt in a steam power station. Therefore, smoke and fumes pollute the surrounding area. This necessitates that the plant should be located at a considerable distance from the populated areas.

B.2 condensers:-

A condenser is a device which condenses the steam at the exhaust of turbine. It serves two important functions. Firstly, it creates a very low pressure at the exhaust of turbine, thus permitting expansion of the steam in the prime mover to a very low pressure. This helps in converting heat energy of steam into mechanical energy in the prime mover. Secondly, the condensed steam can be used as feed water to the boiler. It has two types:

- (i) Jet condenser (ii) Surface condenser

(3) NUCLEAR POWER STATION

→ A generating station in which nuclear energy is converted into electrical energy is known as a nuclear power station.

In nuclear power station, heavy elements such as Uranium (U^{235}) or Thorium (Th^{232}) are subjected to nuclear fission in a special apparatus known as reactor. The heat energy thus released is utilized in raising steam at high temperature and pressure. The steam runs the steam turbine which converts steam energy into mechanical energy. The turbine drives the alternator which converts mechanical energy into electrical energy.

→ It has been found that complete fission of 1 kg of Uranium (U^{235}) can produce as much energy as can be produced by the burning of 4,500 tons of high grade coal. Although the recovery of principal nuclear fuels (i.e. Uranium and Thorium) is difficult and expensive, yet the total energy content of the estimated world reserves of these fuels are considerably higher than those of conventional fuels, viz. coal, oil and gas.

(a) Advantages

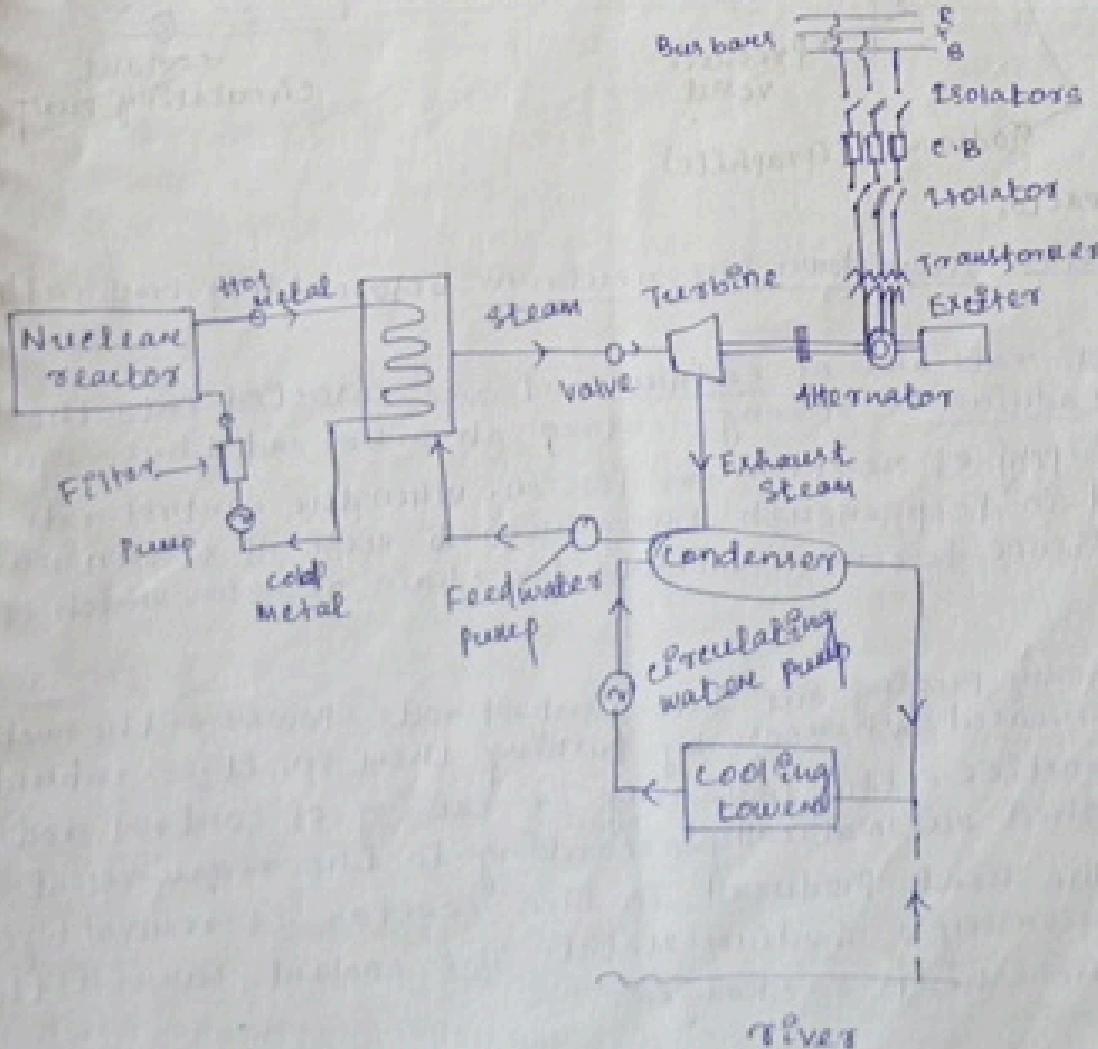
- The amount of fuel required is quite small. Therefore, there is a considerable saving in the cost of fuel transportation.
- A nuclear power plant requires less space as compared to any other type of the same size.
- It has low running charges as a small amount of fuel is used for producing bulk electrical energy.
- This type of plant is very economical for producing bulk electric power.
- It can be located near the load centres because it does not require large quantities of water and need not be near coal mines. Therefore, the cost of primary distribution is reduced.
- There are large deposits of nuclear fuels available all over the world. Therefore, such plants can ensure continued supply of electrical energy for thousands of years.
- It ensures reliability of operation.

① D.P.S advantages:-

- The fuel used is expensive and is difficult to recover.
- The capital cost on a nuclear plant is very high as compared to thermal power plants.
- The erection and commissioning of the plant requires greater technical know-how.
- The fission by-products are generally radioactive and may cause a dangerous amount of radioactive pollution.
- Nuclear power plants are not well suited for varying loads as the reactor does not respond to the load fluctuations efficiently.
- The disposal of the by-products, which are radioactive, is a big problem. They have either to be disposed off in a deep trench or in a sea away from sea-shore.

② SCHEMATIC ARRANGEMENT OF NUCLEAR POWER STATION:-

(i) Nuclear reactor (ii) Heat exchanger (iii) Steam turbine (iv) Alternator

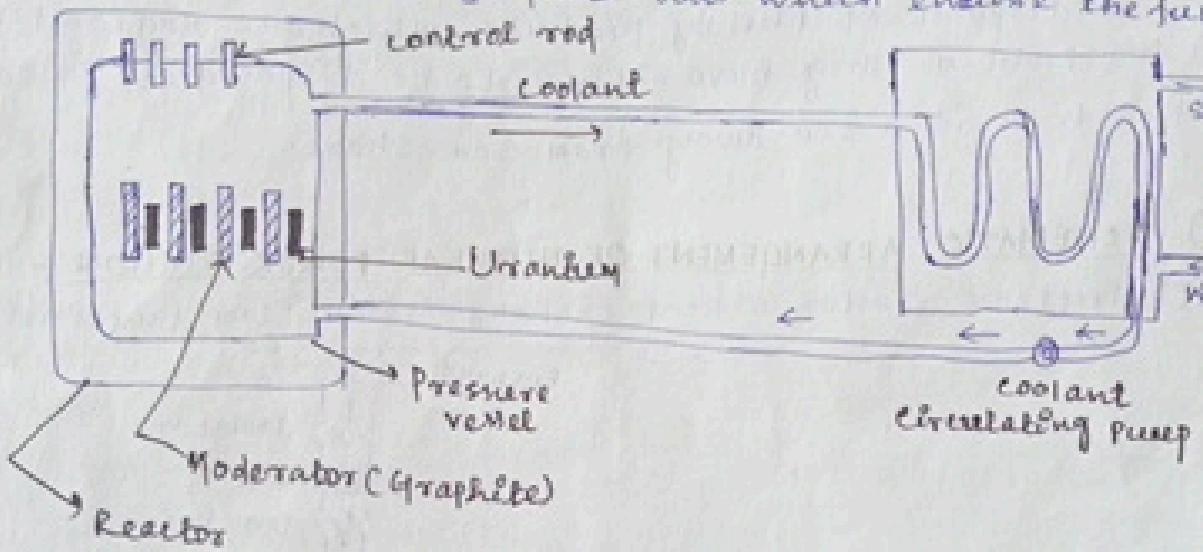


Tubes

④ NUCLEAR REACTOR:

It is an apparatus in which nuclear fuel (U^{235}) is subjected to nuclear fission. It controls the chain reaction that starts once the fission is done. If the chain reaction is not controlled, the result will be an explosion due to the fast increase in the energy released.

A nuclear reactor is a cylindrical steel pressure vessel and houses fuel rods of uranium, moderator and control rods. The fuel rods constitute the fission material and release huge amount of energy when bombarded with slow moving neutrons. The moderator consists of graphite rods which enclose the fuel rods.



- The moderator slows down the neutrons before they bombard the fuel rods.
- The control rods are of cadmium and are inserted into the reactor. Cadmium is strong neutron absorber and thus regulates the supply of neutrons for fission. When the control rods are pushed in deep enough, they absorb most of fission neutrons and hence few are available for chain reaction which therefore, stops.
- Therefore, by pushing out the control rods, power of the nuclear reactor is increased, whereas by pushing them in, it is reduced. In actual practice, the lowering or raising of control rods is accomplished automatically according to the requirement of load. The heat produced in the reactor is removed by the coolant, generally a sodium metal. The coolant carries the heat to the heat exchanger.

(i) Heat exchanger:

The coolant gives up heat to the heat exchanger which is utilized raising the steam. After giving up heat, the coolant is again fed to the reactor.

(ii) Steam turbine:

The steam produced in the heat exchanger is led to the steam turbine through a valve. After doing a useful work in the turbine, the steam is exhausted to condenser. The condenser condenses the steam which is fed to the heat exchanger through feed water pump.

(iii) Generator:

The steam turbine drives the alternator which converts mechanical energy into electrical energy. The output from the alternator which converts mechanical energy into is delivered to the bus-bar through transformer, circuit breakers and isolators.

④ Selection of site for nuclear power station:

(i) Availability of water:

As sufficient water is required for cooling purposes, therefore, the plant site should be located where ample quantity of water is available, e.g. across a river or by sea-side.

(ii) Disposal of waste:

The waste produced by fission in a nuclear power station is generally radioactive which must be disposed off properly to avoid health hazards. The waste should either be buried in a deep tunnel or disposed off in sea quite away from the sea shore. Therefore, the site selected for such a plant should have adequate arrangement for the disposal of radioactive waste.

(iii) Distance from populated areas:

The site selected for a nuclear power station should be quite away from the populated areas as there is a danger of presence of radioactivity in the atmosphere near the plant. However, at a precautionary measure, a dome is used in the plant which does not allow the radioactivity to spread by wind or under ground waterways.

(iv) Transportation facilities:

The site selected for a nuclear power station should have adequate facilities in order to transport the heavy equipment during erection and to facilitate the movement of the workers employed in the plant.