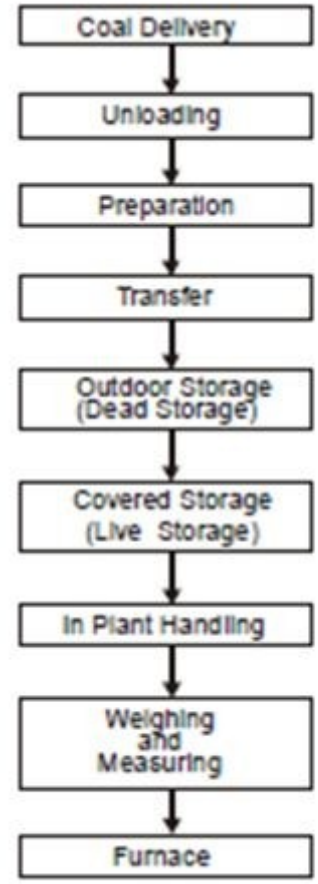
18ME81 Energy Engineering

Eighth Semester B.E. Degree Examination, July/August 2022

Module-1

1 a. Briefly explain the various step involved in coal handling (10 Marks)

The coal handling plant needs extra attention, while designing a thermal power station, as almost 50% to 60% of the total operating costs consists of fuel purchasing and handling. Fuel system is designed in accordance with the type and nature off fuel. Plants may use coal oil or gas as the fuel. The different stages in coal handling are shown below.



Steps in Coal Handling.

Coal delivery:The method of transporting coal to a power station depends on the location of the plant, but may be one or more of the following: rail, road, river or sea. Plants situated near river or sea may make use of the navigation facilities.

Unloading:The kind of equipment for unloading depends on how the coal is received. If the coal is delivered in dump trucks and if the plant site is favourable, then there is no need additional

unloading equipment. When coal transported by using by sea or rivers unloading bridge or tower and portable conveyors are used.

Preparation:The coal preparation plant may be located either near the coal receiving point or at the point of actual use. The coal preparation plant may include the following equipments a) Crushers b) Sizers c) Dryers and d)Magnetic separators.

Transfer:Transfer means the handling of the coal between the unloading point and the final storage point from where it is discharged to the firing equipment. The equipments used for the transfer of coal may be any one of the following or a suitable combination there of:a) Belt conveyors b) Screw conveyors c) Bucket Elevators d)Grab bucket Elevators e) Skip hoists and f) Flight conveyors.

Out door storage: Whether the storage is large or small, it needs protection against losses by weathering and by spontaneous combustion. With proper methods adopted even larger outdoor storage can remain safe. In order to avoid the oxidation of coal the compact layers are formed. To avoid spontaneous combustion air is allowed move evenly through the layers.

Indoor storage or Live storage: This is usually a covered storage provided in plants, sufficient to meet day's requirement of the boiler. Storage is usually done in bunkers made of steel or reinforced concrete having enough capacity to store the requisite of coal. From the coal bunkers coal is transferred to the boiler grates.

1 b. With a neat sketch, explain the working principle of Benson boiler.(10 Marks)

In Benson boiler the difficulty of bubble formation experienced in Lamont boiler is avoided by raising the boiler pressure to critical pressure (221.6 Bar) . The arrangement of the boiler components is as shown if the figure. The Benson boiler is the drum less once through boiler. This boiler takes the feed water in at one end and discharges it as superheated steam at the other end. Feed water flows through the radiant tube section to evaporate partly. Where major part of the water is converted in to steam. The remaining water is evaporated in the convection evaporator tubes. The saturated high pressure steam is further passes through super heater before leaving the unit.

Major problem that experienced with this boiler is the salt deposition. To avoid this difficulty the boiler is normally flashed out after every 4000 working hours to remove the salt. Capacity of this boiler is 150 tones / hr of steam generation with pressure 300 bar at 600 degC.

Advantages

1) There may be no pressure limitation and it may be as high as super critical.
2) Absence of drum and hence cost is less.
3) Evaporation is quick.
4) Light in weight.
5) Space re4quired is less.
6) Expansion problem is less compared to drum type boiler.

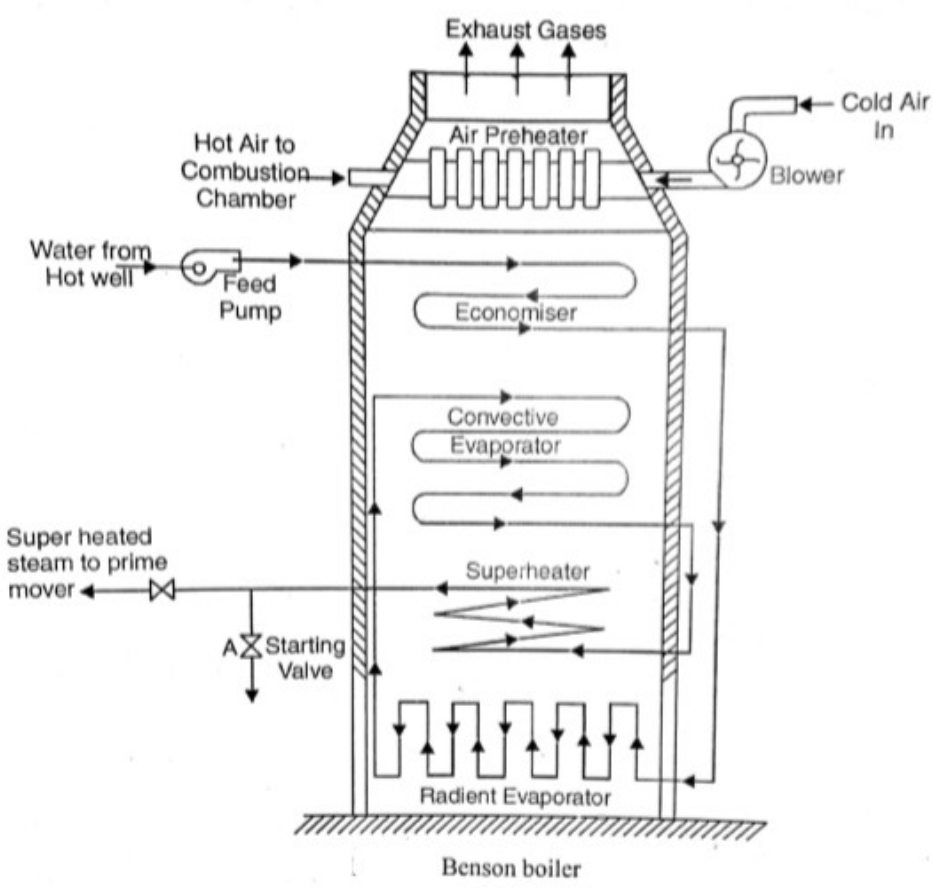
Disadvantage

1) The deposition of salt in evaporator tube is common.

2) Over heating of tubes incase of insufficient water supply.

3) It requires close coordination between steam generation and feed water supply.

4) There is a greater chance of corrosion of evaporator tubes.



2 a. With a neat sketch, explain the functions of super heater and air preheater in thermal power plant. (10 Marks).

Super heaters :

The function of the super heater is to remove the last traces of moisture from the saturated steam coming out of the boiler and to increase its temperature sufficiently above saturation temperature. Super heating of steam helps in improving the overall efficiency and it also avoids too much condensation in the last stages of the turbine which avoids the blade erosion. Super heaters helps in recovering as large as 40% of heat in steam generators.

Super heaters are classified in to three categories as:

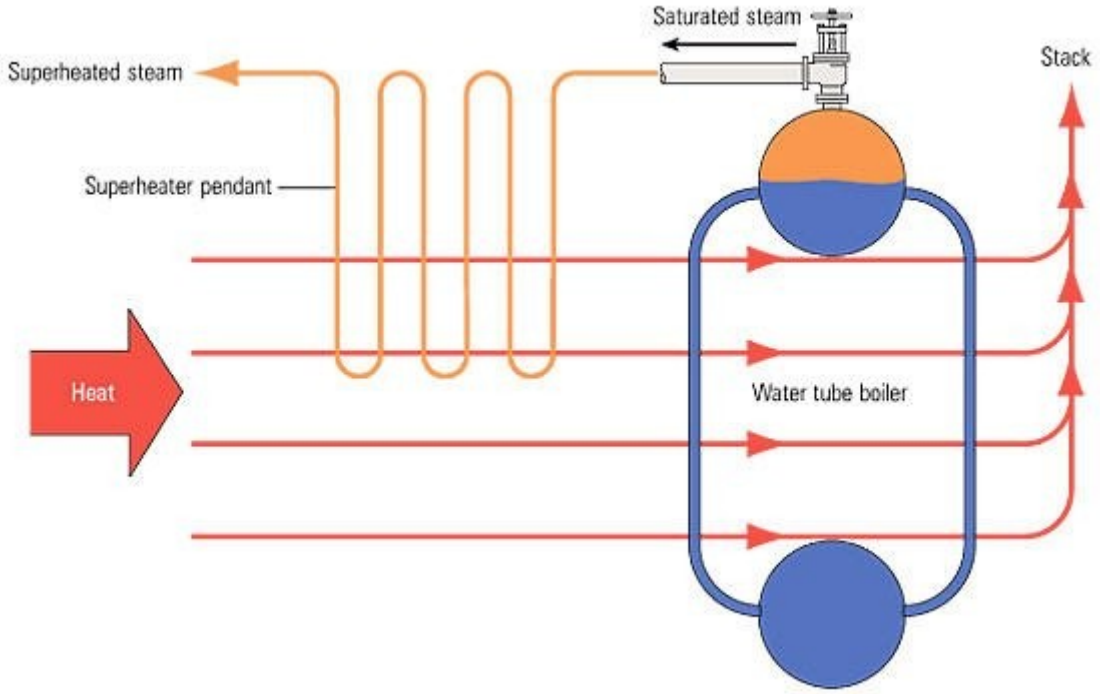
a) Convection zone heaters.

b) Radiation zone heaters.

c) External heaters.

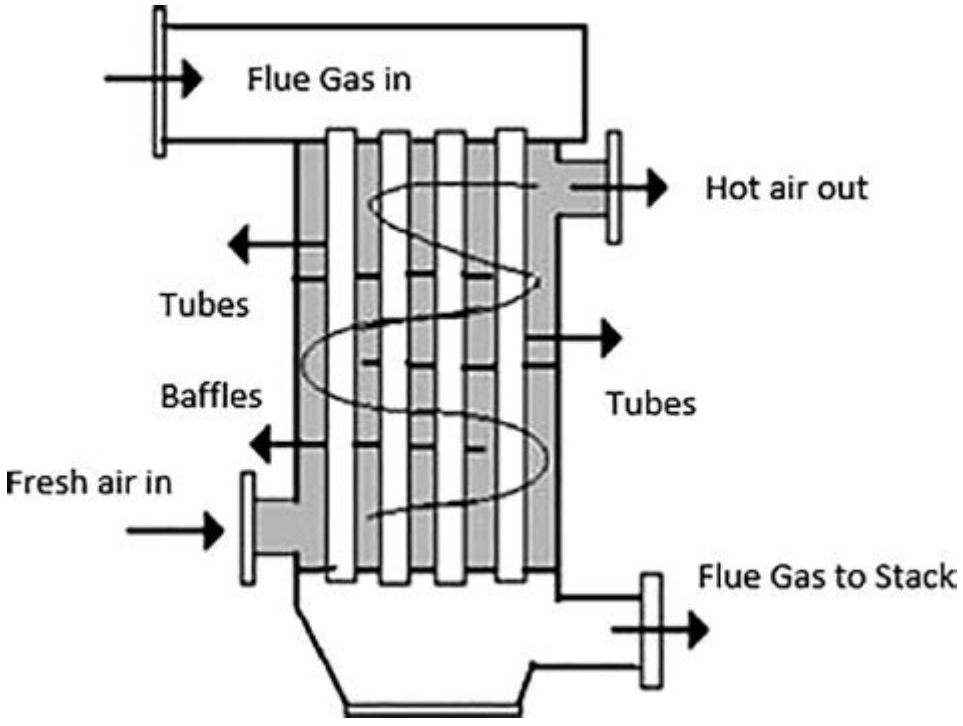
Convection zone super heaters are usually of the horizontal type, heat transfer takes place from hot gases to the super heater due to the convection . Due to chances of condensation during short time, shut down super heaters in the convection zone are invariably made as drainable type. Radiant super

heaters receive heat by direct radiation. Heat available to the radiant super heater does not increase at the same rate as steam mass flow within the tubes thus steam temperature decreases



Air preheaters

Air preheater utilize some of the heat energy left in the gases before exhausting them to atmosphere. The heat carried with the flue gases coming out of economizer is further utilized for preheating the air before supplying in to the combustion chamber. It helps in improving the efficiency of the boiler. Air preheaters are necessary equipments used for supply of hot air for drying the coal in pulverized mill and satisfactory combustion of fuel in furnace



Advantages of preheating air are

1) Improved combustion

2) Successful use of low grade fuel.

3) Increased thermal efficiency

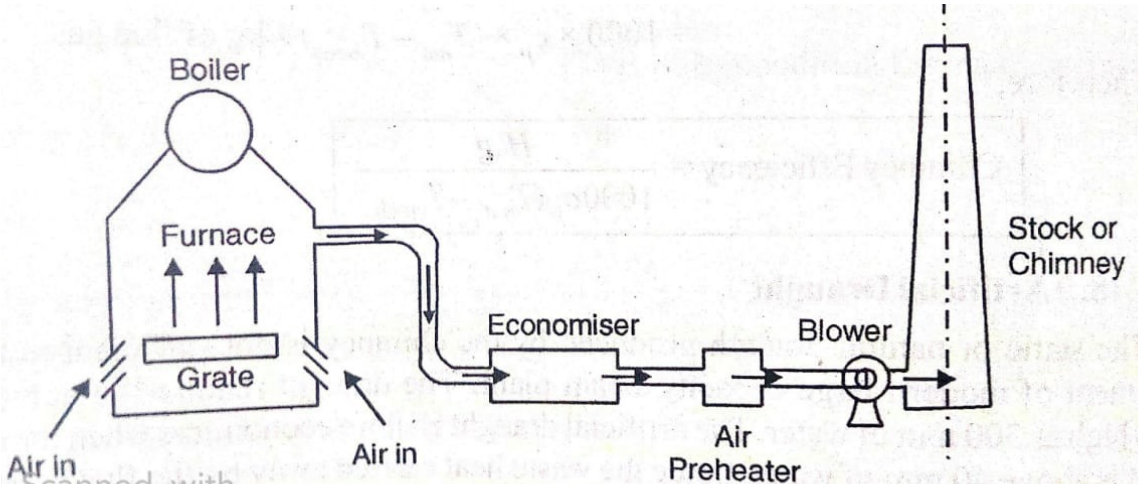
4) Saving in fuel consumption

5) Increased steam generation capacity.

2 b. With a neat sketch, explain the working of Induced draught cooling tower. (10 Marks)

Induced Draught: In this system, the blower is located near the base of the chimney instead of near the grate. The air is sucked in the system by reducing the pressure through the system below atmosphere. The induced draught fan sucks the burned gases from the furnace and the pressure inside the furnace is reduced below atmosphere and induces the atmospheric air to flow through the furnace. The action of the induced draught is similar to the action of the chimney. The draught produced is independent of the temperature of the hot gases therefore the gases may be discharged as cold as possible after recovering as much heat as possible in air preheater and economiser.

This draught is used generally when economizer and air pre-heater are incorporated in the system. The fans should be located at such a place that the temperature of the gas handled by the fan is lowest. The chimney is also used in this system and its function is similar as mentioned in forced draught but total draught produced in induced draught system is the sum of the draughts produced by the fan and chimney. The arrangement of the system is shown in figure.



Module-2

3 a. Name solar radiation measuring instruments and explain pyranometer with a neat sketch to measure beam and diffused radiation (10 Marks)

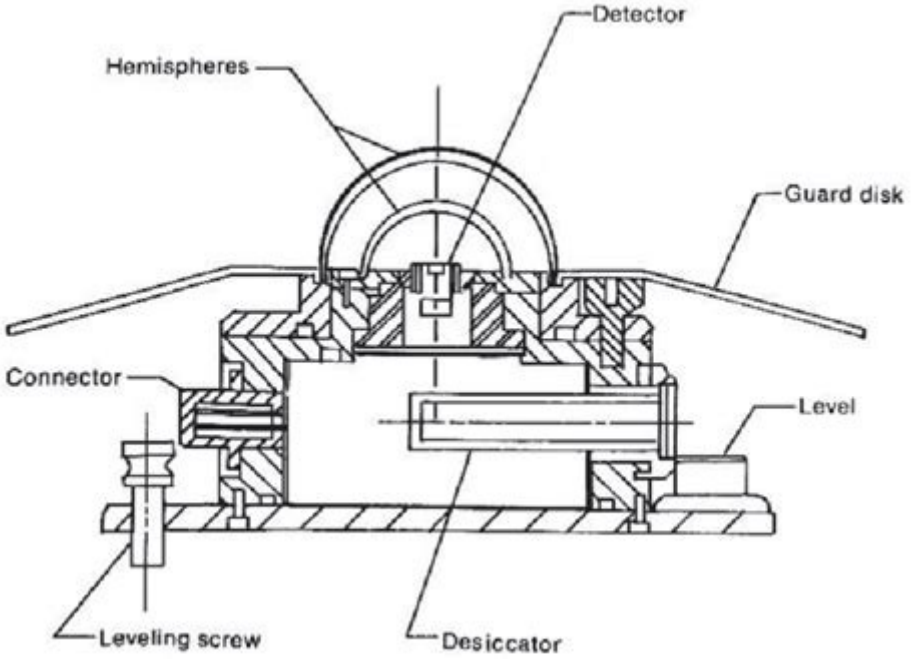
Solar radiation data are measured mainly by the following instruments:

(a) Pyranometer

(b) Pyrheliometer

(c) Sunshine recorder

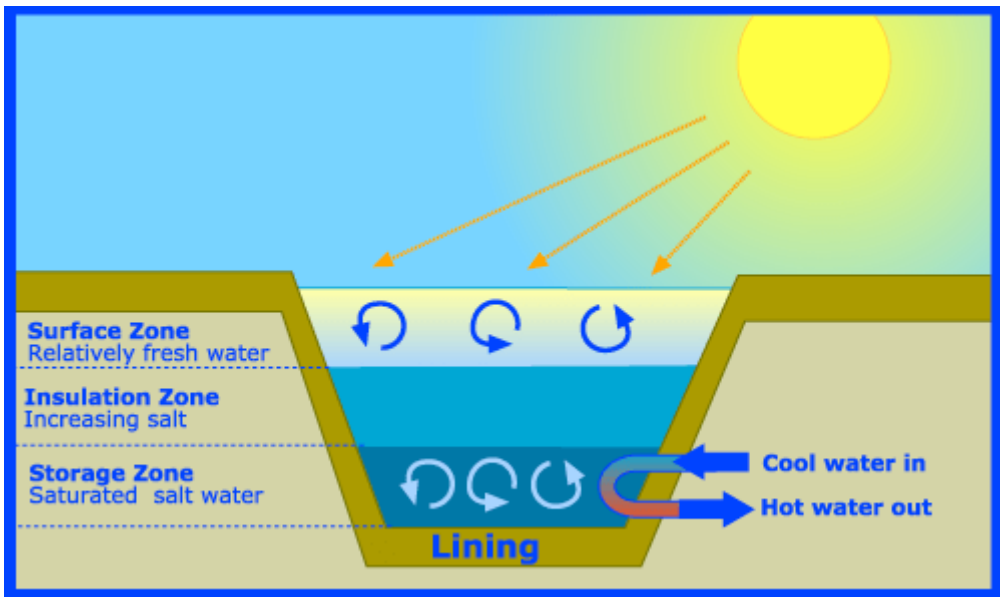
Pyranometer: A precision pyranometer is designed to respond to radiation of all wavelengths and hence measures accurately the total power in the incident spectrum. It contains a thermophile whose sensitive surface consists of circular, blackened, hot junctions, exposed to the sun, the cold junctions being completely shaded. The temperature difference between the hot and cold junctions is the function of radiation falling on the sensitive surface. The sensing elements is covered by two concentric hemispherical glass domes to shield it from wind and rain, This also reduced the convection currents. A radiation shield surrounding the outer dome and co-planar with the sensing element, prevents direct solar radiation from heating the base of the instrument.



3 b. With the help of a neat sketch, explain the construction and working principle of solar pond. (10 Marks)

Solar ponds is very shallow , around 2m deep with a absorbing black surface at the bottom. Bottom of the pond is well insulated against the loss of heat to the ground. Transparent fibre glass cover provided over the pond permits the solar radiation but reduces losses by radiation and convection. If pure water is used in the pond temperature rise is limited only to a few degrees due to loss of energy in natural convection currents. The temperature in the pond can be increased by using salt water with increasing salinity towards the bottom from top. In this method pure water is placed at the top of the pond which acts as the insulator against the loss of thermal energy . Salts like magnesium chloride , sodium chloride or sodium nitrate are dissolved in the water, the concentration varying from 20 to 30% at the bottom to almost zero at the top. In salt solar pond has three zones with following salinity with depth. I) Surface convection zone (0.3 – 0.5 m) , salinity <5% ii) Non convective zone 1 to 1.5 m , salinity increases with depth iii) Storage zone or lower convective zone

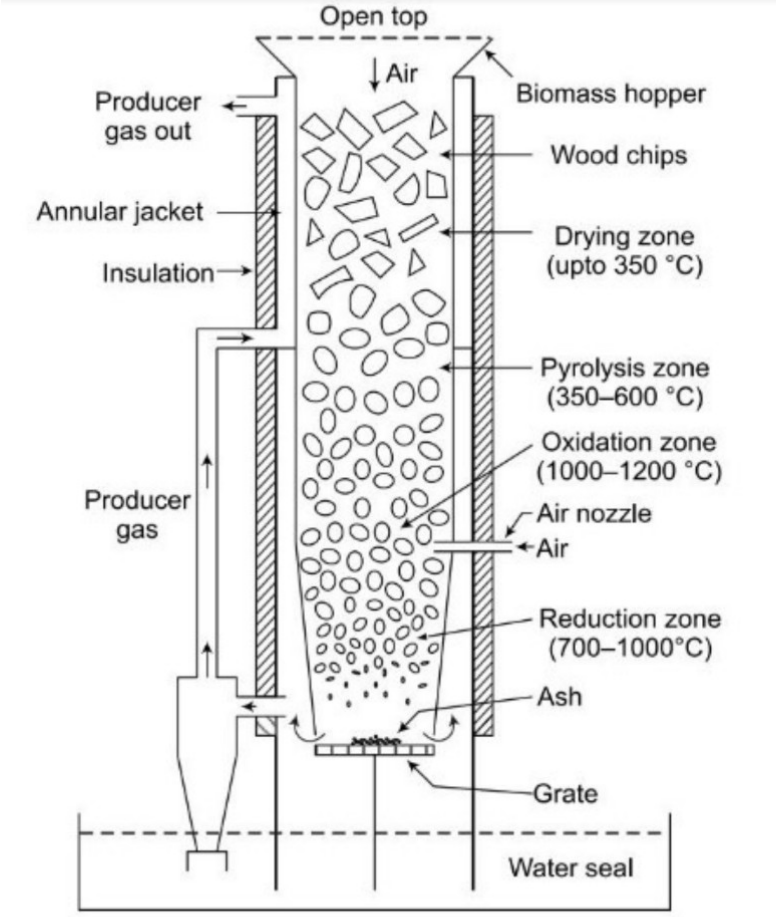
1.5 to 2 m, salinity around 20% . Typical value of salt concentration at the top surface is 20 kg/m^3, increasing to 300 and 260 Kg/m^3 , for magnesium chloride and sodium chloride respectively at the bottom. The salt water next to the absorbing surface when heated its density decreases but this density still remains higher than that of the water above . This avoids the mixing of the bottom hot salt water with the top less salinity water .It helps in maintenance of the stability of the solar pond . Hence the top surface of the solar pond remains cooler compared to bottom and acts as the insulator against the loss of energy stored. In this method it is possible to achieve the temperatures as large as 93^{o}C. Thus solar pond can be defined as the artificially constructed pond in which significant temperature rises are caused to occur in the lower regions by preventing convection. It is necessary to add periodically concentrated solutions at the bottom, and wash the surface with fresh water to maintain the concentration gradient in the presence of diffusion effects.



4a. Explain the working of Down draft gasifier with a neat sketch.(10 Marks)

In steady state operation, heat from the combustion zone (oxidation zone), near the air nozzle is transferred upwards by radiation, conduction and convection causing wood chips to pyrolyse and lose 70-80 per cent of their weight. These pyrolysed gases burn with air to form CO, CO_2, H_2 and H_2O, thereby raises the temperature to 1000-1200 °C. The product gases from combustion zone further undergo reduction reaction with char to generate combustible products like CO, H_2 and CH_4. Generally about 40-70 per cent air is drawn through open top depending on the pressure drop conditions due to size of wood chips and gas flow rate. This flow of air opposite to flame front helps in maintaining homogeneous air/gas flow across the bed. Combining the open top with air nozzle towards the bottom of the reactor helps in stabilizing the combustion zone by consuming the uncovered char left and also by preventing the movement of the flame front to the top. As a consequence, the high temperature zone spreads above the air nozzle by radiation and conduction, aided by airflow from the top. The tar thus is eliminated in the best possible way by creating a high

temperature-oxidizing atmosphere in the reactor itself. The gas produced is withdrawn from an exit at the bottom and reintroduced in the annular jacket for heat recovery.

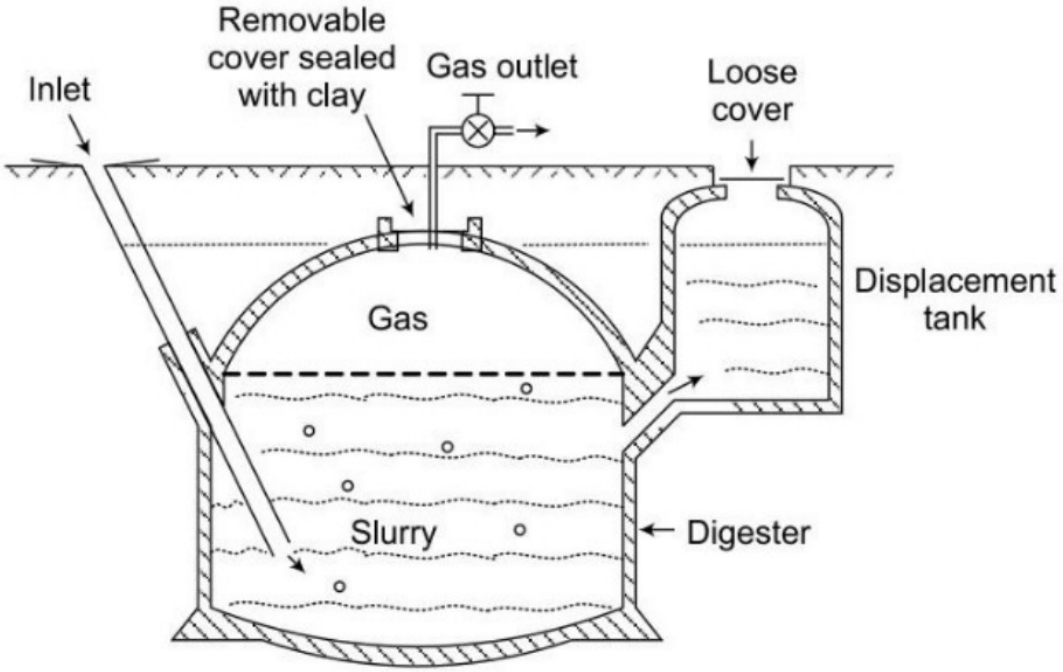


4 b. With a neat sketch, explain the working principle of Janta biogas digester.(10 Marks)

Fixed Dome (Constant Volume) Type Biogas Plants

This plant is more economical as only masonry work is required. Gas pressure in the dome varies depending on the production/consumption rate. By construction a dome structure is very strong for outside pressures but a weak one for inner pressures. As gas pressure is exerted from inside out, the dome structure may fail if proper care is not taken in its construction. The dome is constructed underground to maintain pressure over it. Skilled masonry workmanship is required for construction of dome. In case of any leakages/cracks the plant may fail. Many variations of this basic design are developed to reduce the cost by making use of different materials to suit local conditions.

The slurry enters from inlet and the digested slurry is collected in a displacement tank. Stirring is required if raw material is crop residue. There is no bifurcation in the digester chamber and therefore the gas production is somewhat less as compared to floating point design. The gas produced is stored in the dome and displaces the liquids in inlet and outlet, often leading to gas pressure as high as 100 cm of water. The gas occupies about 10 per cent of the volume of the digester. As complete plant is constructed underground, the temperature tends to remain constant and is often considerably higher than ambient temperature in winter.

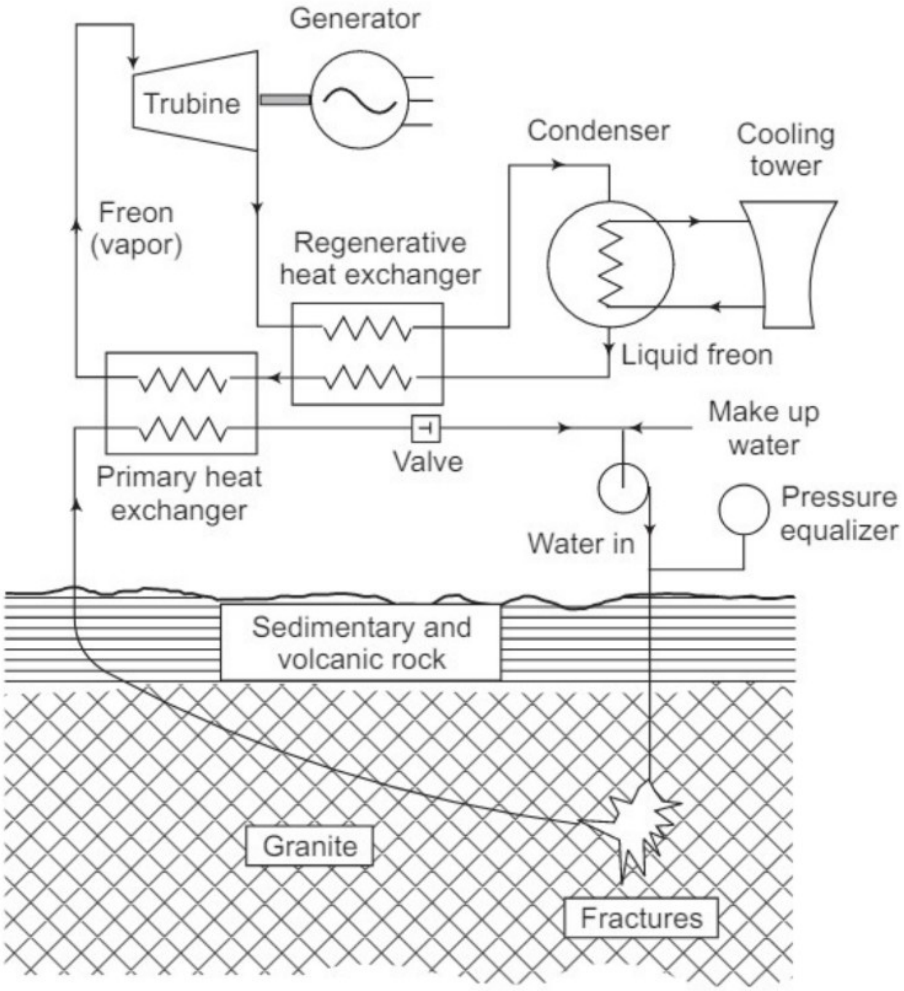


Module-3

5a. With a neat sketch, explain the working of Hot dry rock geothermal plant. (10 Marks)

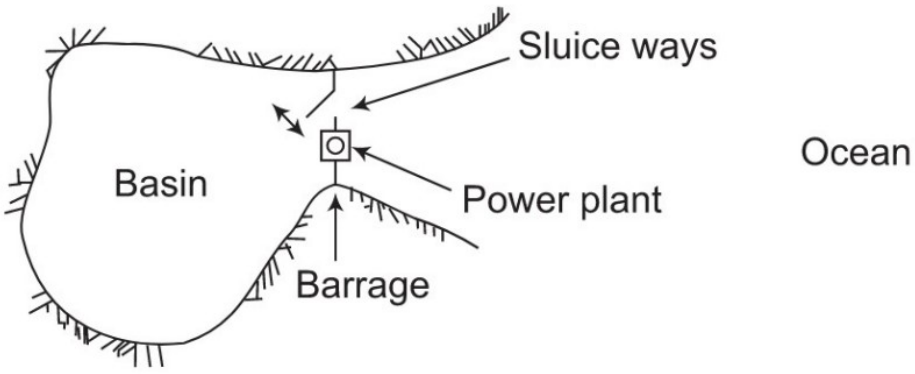
Hot Dry Rock Resources

There are regions underground at temperatures exceeding 200°C, with little or no water. The rocks are impermeable and/or there is no surface water in the vicinity. Such resources up to a depth of 5 km are estimated to be significant and worthy of development as a source of energy. Hot dry rocks are much more common than hydrothermal reservoirs and more accessible, so their potential is quite high. The recovery of heat from HDR involves forming a man-made reservoir by drilling deep into the hot rocks and then cracking it to form cavity or fractures. Such a system is known as “Enhanced Geothermal Systems” (EGS), also sometimes called engineered geothermal systems. This can be achieved by (i) detonating high explosive at the bottom of the well, (ii) nuclear explosion or (iii) hydraulic fracturing. Hydraulic fracturing, which is performed by pumping of water at high pressure into the rock formation, is commonly used in oil and gas fields to improve the flow. It appears that the quantity of conventional explosives required would be uneconomically large, nuclear explosives are associated with environmental and safety issues and therefore hydraulic fracturing seems to be more promising. To recover heat, water is pumped into the cracks from the surface, and withdrawn by another well at a distance. Injection and production wells are joined to form a circulating loop through this man-made reservoir to achieve a steady flow of high temperature water (or water-steam mixture). Electricity can be generated by binary fluid system as shown in figure. When heat is extracted, the rock cools down and new cracks are developed due to temperature gradient. Thus the resource keeps on expanding.



5 b. With a neat sketch, explain the arrangement of single basin and double basin for tidal power plant. (10 Marks)

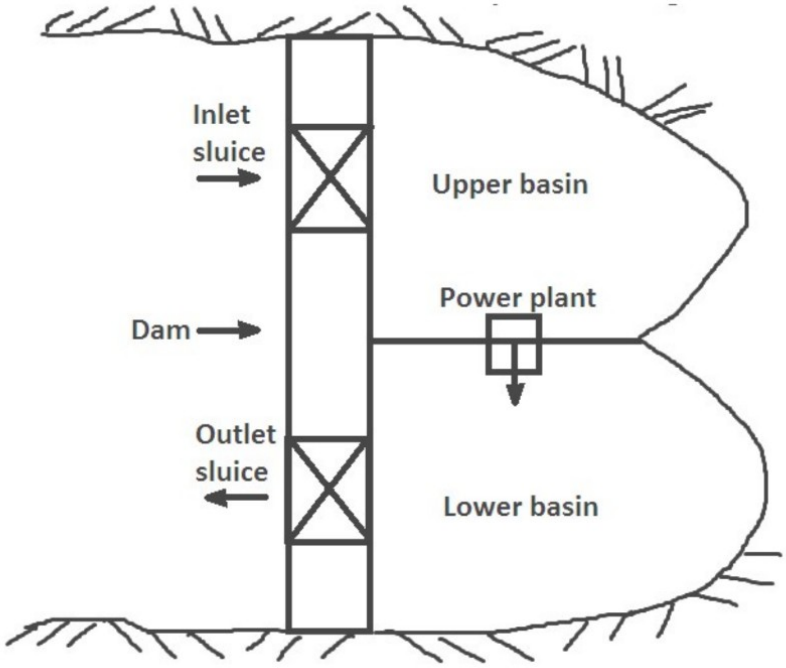
Single Basin Tidal power plant



Single Effect Scheme Single basin scheme has only one basin as shown in Figure In single effect scheme, power is generated during either filling or emptying the basin. Two types of operation cycles are possible. In ebb generation cycle operation, the sluice way is opened to fill the basin

during high tide. Once filled the impounded water is held till the receding cycle creates a suitable head. Water is now allowed to flow through the turbine coupled to generator till the rising tide reduces the head to the minimum operating point. The flow is held till the next generating cycle.

Double Basin Tidal power plant

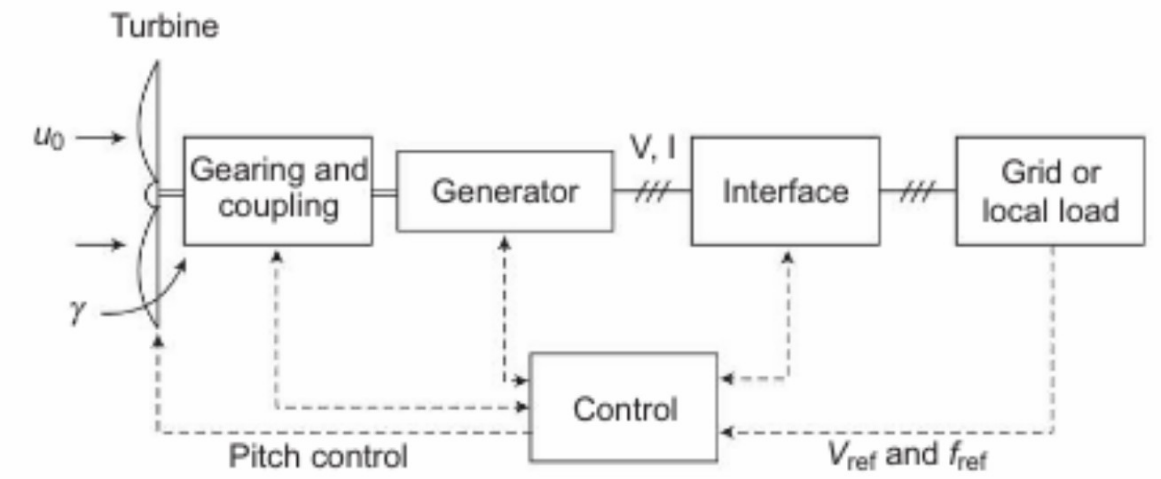


In this system, the turbines are located in between the two adjacent basins, while the sluice gates are as usual embodies in the dam across the mouths of the two estuaries. At the beginning of the flood tide, the turbines are shut down, the gates of upper basin are opened and those of the lower basin are closed. The upper basin is thus filled up while the lower basin remains empty. As soon as the rising water level in upper basin provides sufficient difference of head between the two basins, the turbines are started. The water flows from the upper to the lower basin through the turbines, generating power. The power generation thus continues simultaneously with the filling up the upper basin. At the end of the flood tide, the upper basin is full and the water level in it is the maximum, its sluice gates are closed. When the ebb tide gets lower than the water level in lower basin, its sluice gates are opened. The water level in the lower basin, which was arising and reducing the operating head, starts falling with the ebb. This continues until the head and water level in upper basin is sufficient to run the turbines. With the next flood tide the cycle repeats itself. With this twin basin system, a longer and more continuous period of generation per day is possible. The small gaps in the operation of such stations can be filled by thermal power.

6 a. With a block diagram, explain the basic components of wind energy conversion system. (10 Marks)

A wind energy conversion system converts wind energy into some form of electrical energy. In particular, medium and large scale WECS are designed to operate in parallel with a public or local

ac grid. This is known as grid-connected system. A small system, isolated from grid, feeding only to local load is known as autonomous, remote, decentralized, stand alone or isolated power system. The turbine shaft speed is stepped up with the help of gears, with fixed gear ratio, to suit the electrical generator and fine-tuning of speed is incorporated by pitch control. This block acts as drive for the generator. Use of variable gear ratio has been considered in the past and was found to add more problems than benefits. DC, synchronous or induction generators are used for mechanical to electrical power conversion depending on the design of the system. The interface conditions the generated power to grid quality power. It may consist of power electronic converter, transformer and filter, etc. The control unit monitors and controls the interaction among various blocks. It derives the reference voltage and frequency signals from the grid and receives wind speed, wind direction, wind turbine speed, etc., processes them and accordingly controls various blocks for optimal energy balance.



6 b. With a neat sketch, explain horizontal axis and vertical axis wind machines. (10 Marks)

Wind turbines are broadly classified into two categories. When the axis of rotation is parallel to the air stream (i.e. horizontal), the turbine is said to be a Horizontal Axis Wind Turbine (HAWT), and when it is perpendicular to the air stream (i.e. vertical), it is said to be a Vertical Axis Wind Turbine (VAWT). The size of the rotor and its speed depends on rating of the turbine.

HAWTSs have emerged as the most successful type of turbines. These are being used for commercial energy generation in many parts of the world. Their theoretical basis is well researched and sufficient field experience is available with them.

Main parts are as follows:

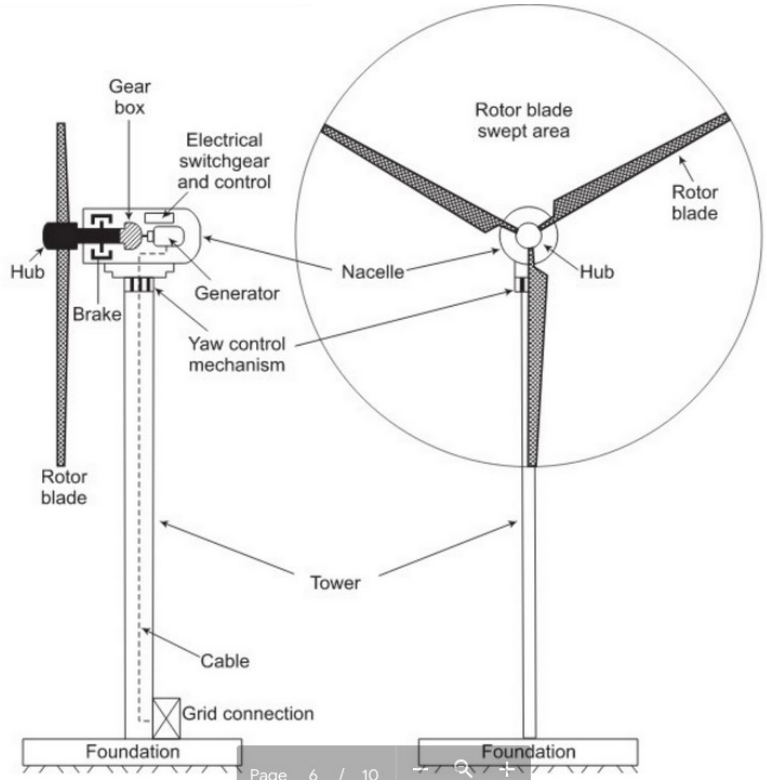
(a) Turbine Blades: Turbine blades are made of high-density wood or glass fiber and epoxy composites. They have airfoil type cross-section.

(b) Hub: The central solid portion of the rotor wheel is known as hub. All blades ate attached to the hub. Mechanism for pitch angle control is also provided inside the hub.

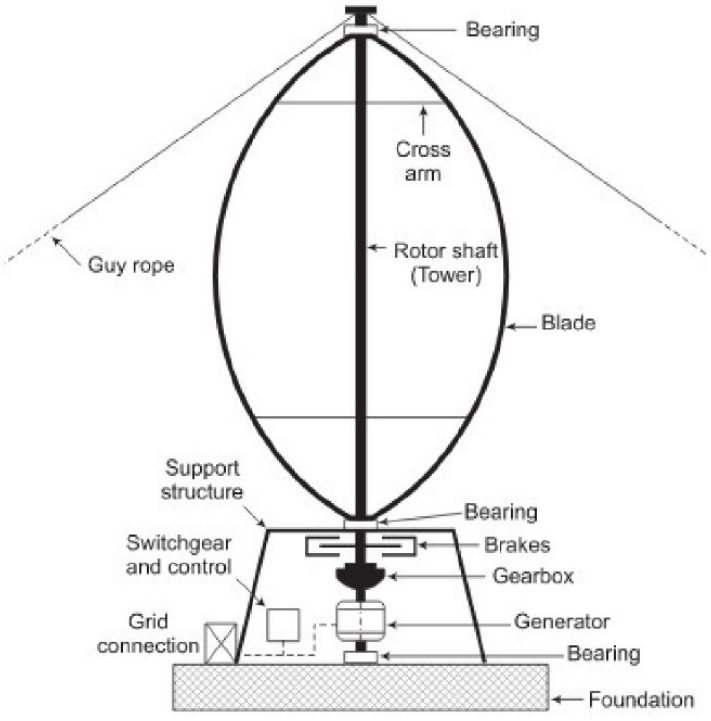
(c) Nacelle: The term nacelle is derived from the name for housing containing the engines of an aircraft.

(d) Yaw Control Mechanism: The mechanism to adjust the nacelle around vertical axis to keep it facing the wind is provided at the base of nacelle.

(e) Tower: Tower supports nacelle and rotor. For medium and large sized turbines, the tower is slightly taller than the rotor diameter. The rotor is attached to nacelle, mounted at the top of a tower.



Vertical Axis Wind Turbine (VAWT)



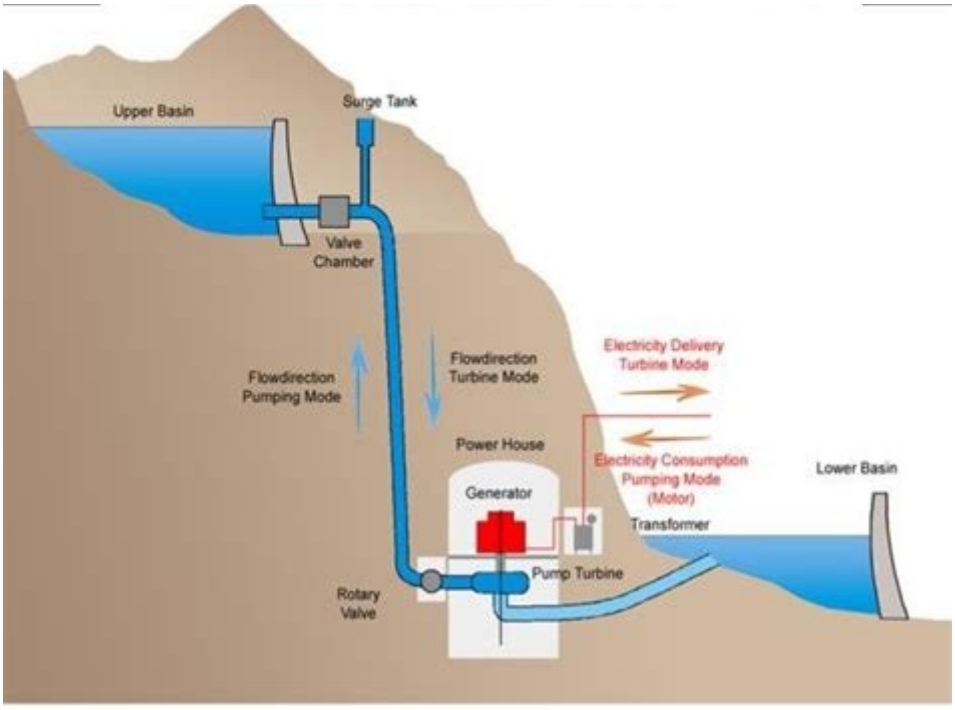
VAWT are in the development stage and many models are undergoing field trial. Main attractions of a VAWT are:

- It can accept wind from any direction, eliminating the need of yaw control.
- Gearbox, generator etc. are located at the ground, thus eliminating the heavy nacelle at the top of the tower. This simplifies the design and installation of the whole structure, including tower.
- The inspection and maintenance also gets easier
- It also reduces the overall cost.

Module-4

7 a With a neat sketch, explain pumped storage hydroelectric power plant. (10 Marks)

Water after working in the turbine stored in the tail race pond. During low load periods this water is pumped back in to the head reservoir using an extra power available. This water can be again used for generating power during peak load periods. Pumping of water may be done seasonally or daily depending upon the conditions of the site and the nature of the load on the plant. Such plants are usually interconnected with steam or diesel engine plants so that off peak capacity of interconnecting stations is use in pumping water and the same is used during the peak load periods



Advantages:

1) There will be an increase in the plant capacity with low cost.

2) Operating efficiency of the plant is high.

3) There is an improvement in the load factor.

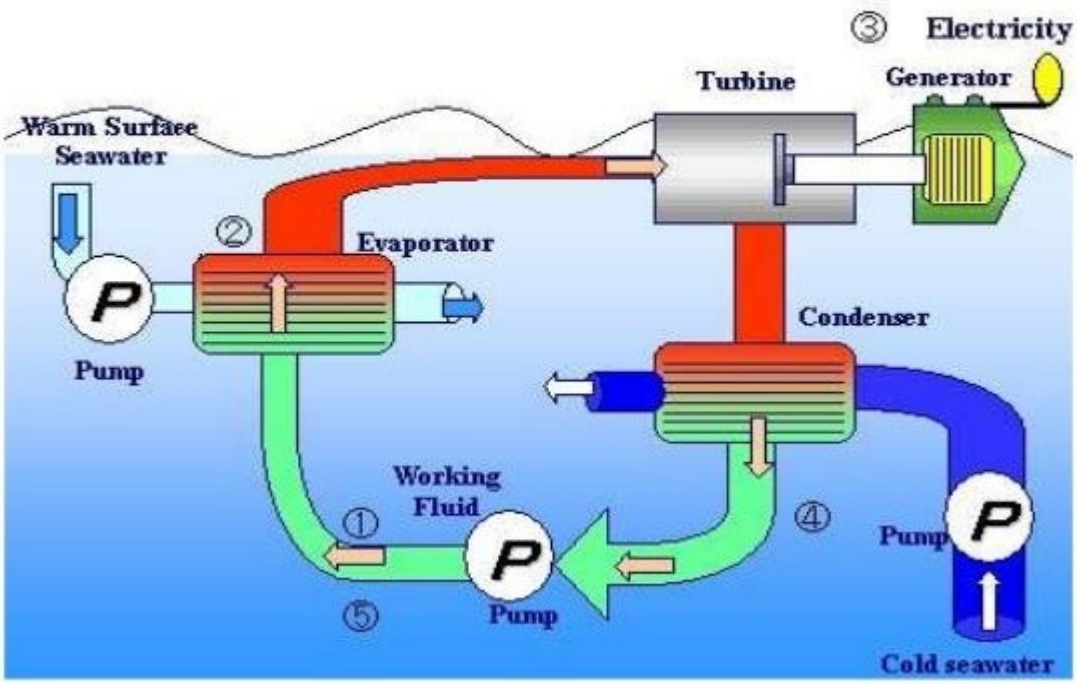
4) The hydroelectric plant becomes partly independent of stream flow conditions.

In this type of plants reversible turbine pump units are used. These units can be used as turbine while generating power and as pump while pumping water to storage. With the use of reversible turbine pump sets, additional capital investment on pump and its motor can be saved.

8 a. With a diagram, explain closed Rankine cycle OTEC system. (10 Marks)

Closed OTEC cycle

The closed cycle utilizes the ocean's warm surface and cold deep waters as heat source and sink, respectively, but requires a separate working fluid that receives and rejects heat to the source and sink via heat exchangers. The working fluid may be ammonia, propane or Freon. When high pressure liquid ammonia enters the evaporator absorbs heat from the water which is circulating and converted in to high pressure vapour. This vapour expanded in to low pressure vapour in the turbine. Low pressure ammonia vapour is condensed in to low pressure liquid ammonia in condenser. In order to remove the heat from vapour in the condenser cold water from depth of sea is used. Low pressure liquid ammonia is converted in to high pressure liquid ammonia using pump and supplied back in to the evaporator for repeating the cycle. The operating pressure is much higher compared open cycle thus smaller and hence less costly . But it requires very large heat exchangers. Instead of usual heavier and more expensive shell and tube heat exchangers, In Anderson cycle thin plate heat exchangers are used.



8 b. List the problems associated with Ocean Thermal Energy Conversion (OTEC). (04 Marks)

Problems associated with OTEC

1) OTEC plants sites are always located away from the load centers .
2) The availability of suitable temperature differences between surface water and deep cold water is restricted to equatorial regions.
3) The power transmission cost from the OTEC plant to load center is very high.
4) The power generation system gives less efficiency.
5) Large heat exchangers are required and hence the cost of the power generated increases.
6) The bio fouling is a major problem encountered in most power plants.
7) In the manufacture of heat exchangers costly , non corrosive materials must be used this further increases the overall cost of the plant.
8) The initial investment required is high.
9) Construction of the plant in the rough sea is very difficult.

8 c. Explain the following terms related to hydroelectric power plant:
(1) Surge tank. (ii) Penstock (06 Marks)

Surge tank

Surge tank is open 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. Important functions of the surge tank are:

1) It reduces the distances between the free water surface and turbine thereby reducing the water hammer effect of the penstock and also protect the up stream tunnel from high pressure rises.
2) It serves as the supply tank to the turbine when the water in the pipe is accelerating during increased load conditions as a storage tank when the water is decelerating during the reduced load conditions.
3) It acts as relief valve when ever there is variations in water pressure in the penstock.

Penstock

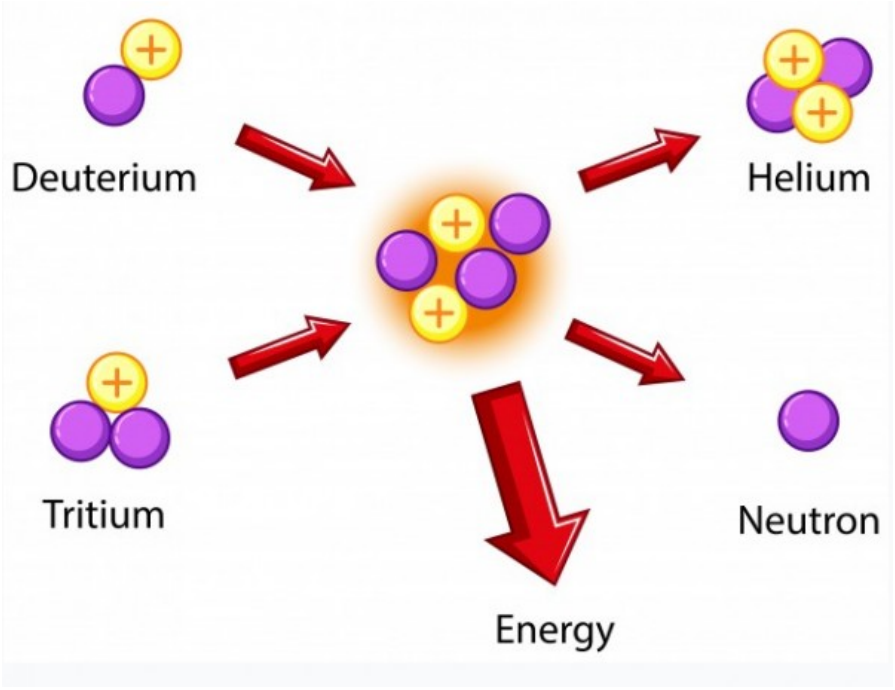
It is an closed conduit used for supplying water to the turbine from forebay under pressure. Penstocks are used where slope is too great for canal. The regulating forebay has a small storage capacity to care for minor flow fluctuations . It has an automatic spillway to discharge overflow when turbine shut down suddenly. In different ways we can arrange to supply water to the turbines.

i) One penstock for one turbine. In such a case water is supplied independently to each turbine from a separate penstock
ii) Single penstock for the entire plant.: In this case penstock should have as many branches as the number of hydraulic turbines.
iii) Multiple penstocks but each penstock should supply water to at least two hydraulic turbines.

Module-5

9 a. Explain the principle of release of nuclear energy by fusion and fission reaction. (10 Marks)

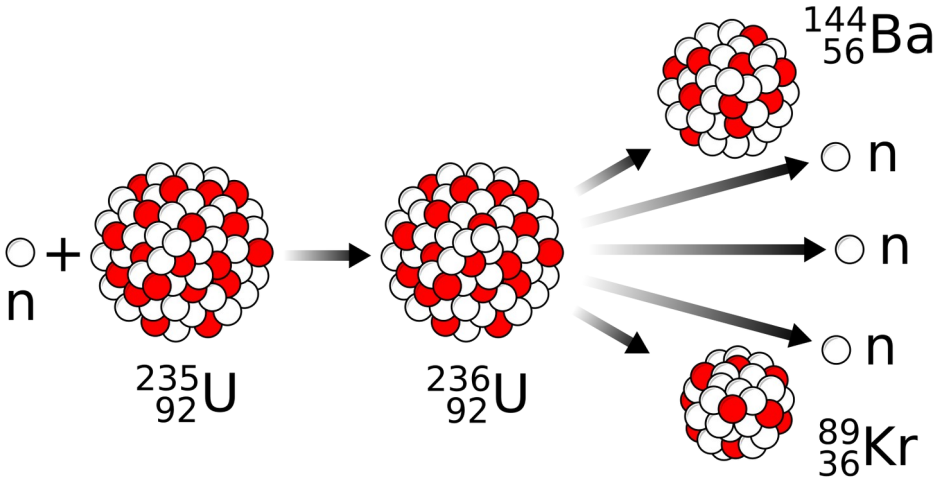
Nuclear fusion



Nuclear fusion is the process of combining or fusing two lighter nuclei in to a stable and heavier nuclide. In this process also large quantity of energy released because mass of the product nucleus is less than the masses of the two nuclei which are fused. Several reactions between nuclei of low mass can be initiated by accelerating one or the other nucleus in a suitable manner. These are often fusion process accompanied by release of energy. How ever the nuclear fusion reaction can not be regarded as much significance for the utilisation of nuclear energy. To have a practical value fusion reaction must be self sustaining ,i.e., more energy must be released than is consumed in initiating the reaction.

Nuclear fission

In this type of process heavy nucleus is divided in two equal number of fragments. Fission can be caused by bombarding with high energy particles, Protons, X-rays as well as neutrons. How ever neutrons are most suitable for fission, they require less kinetic energy to collide with nuclei. Two or three neutrons are released for each neutron absorbed in fission, and can thus keep reaction going . Isotopes like U233, U235 and Pu239 can be fissioned by neutrons of all energies , where as isotopes U238, Th232 and Pu240 are fissionable by high energy only.



9 b. Write a short note on Nuclear fuels used in the reactors. (05 Marks)

The fuels which are commonly used are Natural Uranium containing 0.7% U235 or Enriched Uranium containing 1.5 to 2.5 % U235. In addition to natural nuclear fuels some of artificial or man-made fuels such as Pu239, Pu241,U 233 are also used. Considering the necessary requirement of fission process and its availability economically the fuels used in reactors are uranium, plutonium and thorium. U235 is easily available nature with concentrations up to 0.7% and its content increases up to 90% in enriched uranium. The nuclear fuels is available in three states solid, liquid and gas. In reactors fuel is mostly used in solid state or in the form of solution dissolved in water. The liquid metal reactors are in practical use. The fuel used in the reactors is in the form of rods or plates. The fuel rods are surrounded by the moderator. The fuel rods are clad with stainless steel or zirconium to prevent oxidation. The minimum amount of fuel required to maintain chain reaction is known as critical mass. The fuel core must contain at least the critical mass and more often, slightly larger than the critical mass in order to maintain the chain reaction.

10 a. Explain the following:

(i) Reactor shielding. (ii) Radioactive waste disposal. (10 Marks)

<u>Reactor shielding</u>

The common nuclear radiation emitting from nuclear reactors are in the form of γ-rays, neutrons, X-rays, α-Rays and β-Rays.

The nuclear radiation if it is not prevented, will have very bad effects on the human life and biological plants. The desirable properties of the good shielding materials are.

1) It must have ability to absorb more radiation with minimum thickness.

2) It must be fire resistant.

3) The strength of the material should remain constant under the influence of radiations.

4) It must have high density and it must contain light materials.
5) Density of the material must remain constant.
The use of best neutron absorber shield is beneficial. The combination of light and heavy elements in the shield is best , the use of laminated construction or the use of iron concrete. The latter consists of iron mixed in barytes concrete, or alternatively limonite is used partially to replace barytes in the mix. Example for shielding materials include Water, Iron, cement and concrete, Tantalum, Lead, Bismuth and Boron.

Radioactive waste disposal.

Used fuel in a nuclear power plant is highly radioactive and can contaminate air or water and if absorbed by a living organisms, it can cause biological damage. Disposal of radioactive waste is therefore a problem which requires consideration right from the planning stage.
Various methods used for the disposal of radioactive waste are given below.
a) Storage in tanks on site. Solid and liquid wastes are stored in concrete or stainless steel tanks at site . During storage period the radioactivity decays and then the waste is disposed of either in the sea or buried under the ground.
b) Dilution: Disposal of liquids after dilution to safe limits, in the rivers or sea is also done. Gases are also left off in air after dilution. Before disposal in the dilutent the radioactivity of the gas or liquid being discharged is reduced to acceptable levels.
c) Sealed containers: Radioactive liquid and solid wastes are put in sealed containers which prevent the radioactive contamination . These sealed containers are then disposed of at sea where they are quickly and completely covered with mud in the bottom.
d) Underground burial. Another alternative is the burial of wastes direct in the ground . How ever burial ground must be isolated from the public and water must not be able to seep through as it may cause radioactive contamination of drinking water supplies.

10 b. With a neat sketch, explain the working of Pressurized Water Reactor (PWR). (10 Marks)

In pressurized water reactor (PWR), heat generated in the nuclear core is removed by water circulating at high pressure through the primary circuit. The heat is transferred from primary to secondary circuit in a heat exchanger, or boiler, there by generating the steam in the secondary circuit. As such the steam in the turbine is not radioactive and need not be shielded. The pressure in the primary circuit maintained high using pressurizer so that boiling of water will not takes place. In order to vary the pressure in the primary circuit electric heating coils are used in the pressurizer.
PWR produces only saturated steam. By providing separate furnace steam formed from the reactor could be super heated.
Advantages:
1) The coolant used is cheap and easily available.

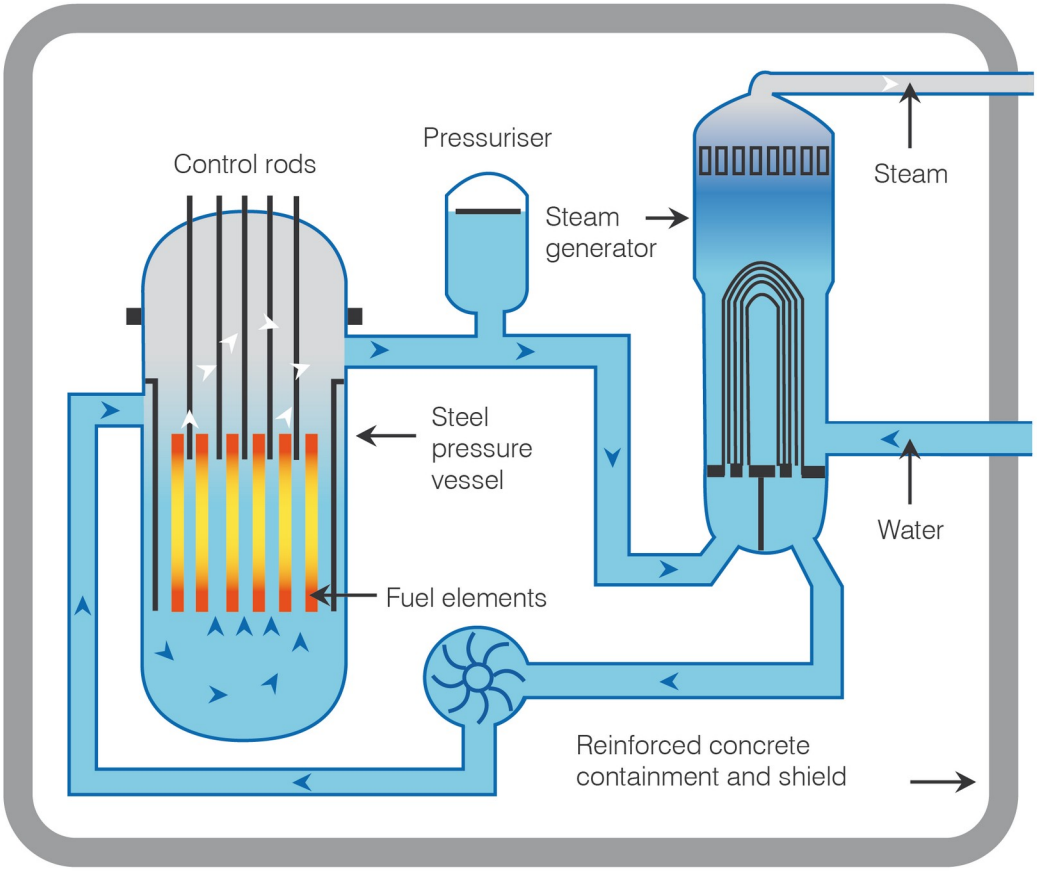
2) The reactor is compact, small in size and power density is high.

3) Fission products remain in the reactor and are not circulated.

4) There is a complete freedom to inspect and maintain the turbine, feed water heaters, and condensers during the operation.

5) Small number of control rods are required.

6) The fuel costs are less as the reactor extracts more energy per unit weight of fuel



Disadvantages:

1) High primary circuit pressure requires strong pressure vessel and so high capital costs.

2) Severe corrosion problems.

3) Reprocessing of fuel is very difficult.

4) The reactor must be shut down for recharging.

5) Fuel fabrication is very difficult.

6) Thermal efficiency of secondary loop is very poor.

7) Designing of the vessel against the thermal stresses is very difficult.