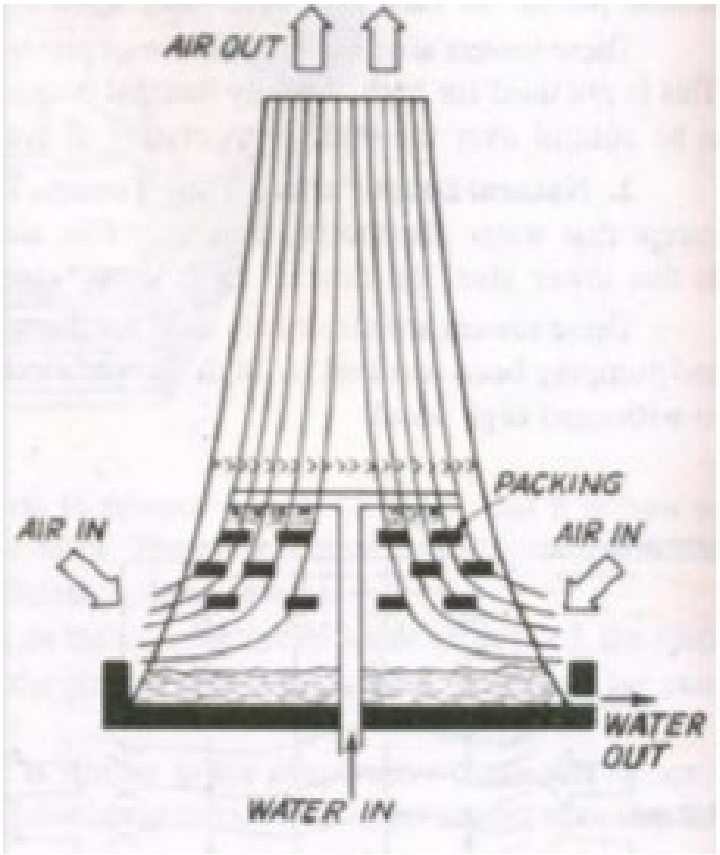
Energy Engineering

IAT 1 Solutions

1 Define cooling tower and explain hyperbolic cooling tower with a neat sketch.

A cooling tower is a heat rejection device, which extracts waste heat to the atmosphere though the cooling of a water stream to a lower temperature. The type of heat rejection in a cooling tower is termed "evaporative" in that it allows a small portion of the water being cooled to evaporate into a moving air stream to provide significant cooling to the rest of that water stream. The heat from the water stream transferred to the air stream raises the air temperature and its relative humidity to 100%, and this air is discharged to the atmosphere.

The cooling towers are desired when positive control on the temperature of water is required, the space occupied by the cooling system is considerable factor and the plant is situated near load centre and far away from the adequate natural resources of cooling water.

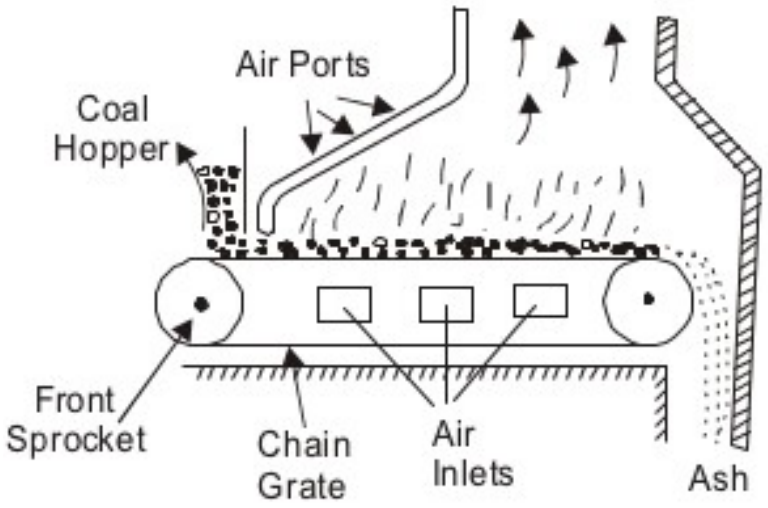


The arrangement of hyperbolic cooling tower is shown in figure below. It is steel reinforced concrete structure mostly slack (empty space) and the bottom 10 m above the air-intake contains packing over which warm water flows. The shape of the stack is circular in plan and hyperbolic in profile. The hyperbolic cooling tower makes use of the difference in temperature between the ambient air and the hotter air inside the tower. It works as follows:

- Hot air moves upwards through the tower (because hot air rises)
- Fresh cool air is drawn into the tower through an air inlet at the bottom.
- Due to the layout of the tower, no fan is required

These cooling towers are mostly only for large heat duties because large concrete structures are expensive.

2 Sketch and explain chain grate stoker.



Mechanical stokers are commonly used to feed solid fuels into the furnace in medium and large size power plants. A chain grate stoker is a mechanical stoker where the chain travels over two sprocket wheels, one at the front and one at the rear of furnace. The travelling chain receives coal at its front end through a hopper and carries it into the furnace. The ash is tipped from the rear end of chain. The speed of grate (chain) can be adjusted to suit the firing condition. The air

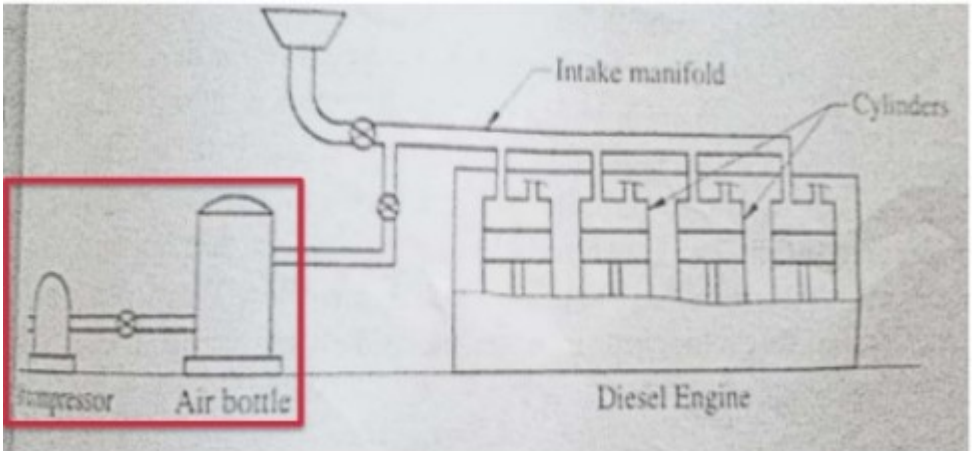
required for combustion enters through the air inlets situated below the grate. Stokers are used for burning non-coking free burning high volatile high ash coals.

Advantages of chain grate stokers are:

- It is simple in construction and operation.
- Its initial and maintenance costs are very low.
- It doesn't have ash cleaning problems.
- Combustion control is simple, by control of feed or chain speed, along with the air supply.
- Its combustion efficiency is high.

3. Explain different starting methods for diesel engine

Compressed Air System: Compressed air system is used to start large diesel engines. In this system compressed air at a pressure of about 20 kg per sq. cm is supplied from an air bottle to the engine an inlet valve through the distributor or through inlet manifold. In a multi-cylinder engine compressed air enters one cylinder and forces down the piston to turn the engine shaft. Meanwhile the suction stroke of some other cylinder takes place and the compressed air again pushes the piston of this cylinder and causes the engine crank shaft assembly to rotate. Gradually the engine gains momentum and by supplying fuel the engine will start running.



Electric Starting: Electric starting arrangement consists of an electric motor which drives a pillion which engages a toothed rim on engine flywheel. Electric power supply for the motor is made available by a small electric generator driven from the engine. In case of small plants a

storage battery of 12 to 36 volts is used to supply power to the electric motor. The electric motor disengages automatically after the engine has started. The advantages of electric starting are its simplicity and effectiveness.

Starting by an Auxiliary Engine: This method uses a small petrol engine connected to the main engine through a clutch and gear arrangement. Firstly, the clutch is disengaged and petrol engine is started by hand. Then clutch is gradually engaged and the main engine is cranked for starting. Automatic disengagement of clutch takes place after the main engine has started.

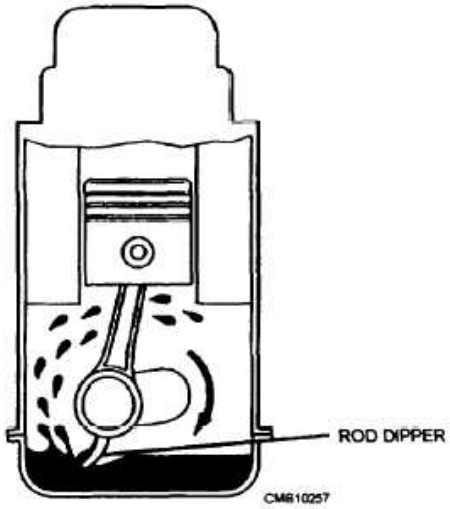
Explain the necessity of cooling and lubrication of diesel engine. Sketch and explain splash lubricating system.

Cooling System of Diesel Power Plant: During combustion process the peak gas temperature in the cylinder of an internal combustion engine is of the order of 2500 K. Maximum metal temperature for the inside of the combustion chamber space are limited to much lower values than the gas temperature by a large number of considerations and thus cooling for the cylinder head, cylinder and piston must therefore be provided.

Lubrication: Frictional forces cause wear and tear of rubbing parts of the engine and thereby the life of the engine is reduced. This requires that some substance should be introduced between the rubbing surfaces in order to decrease the frictional force between them. Such substance is called lubricant. The lubricant forms a thin film between the rubbing surfaces and prevents metal to metal contact. The various parts of an I.C. engine requiring lubrication are cylinder walls and pistons, high end bearing and crank pins small end bearing and gudgeon pins, main bearing cams and bearing valve tappet and guides and timing gears etc.

Splash system: This system is used on some small four strokes, stationary engines. In this case the caps on the big ends bearings of connecting rods are provided with scoops which, when the connecting rod is in the lowest position, just dip into oil troughs and thus direct the oil through holes in the caps to the big end bearings. Due to splash of oil it reaches the lower portion of the cylinder walls, crankshaft and other parts requiring lubrication. Surplus oil eventually flows back

to the oil sump. Oil level in the troughs is maintained by means of an oil pump which takes oil from sump, through a filter.

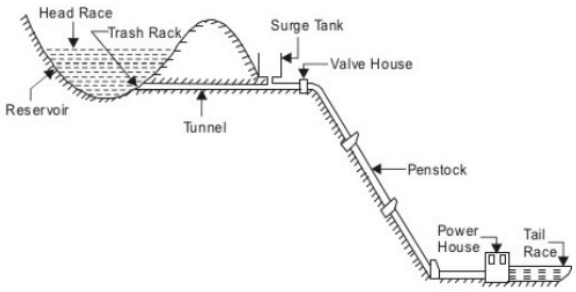


5. Classify Hydro-electric plants.

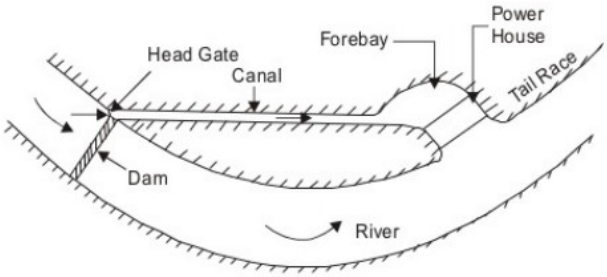
The hydro-power plants can be classified as below:

- Storage plant: The power plant can be classified on the basis of head roughly in the following manner:
    - High head plants: About 100 m and above.
    - Low head plants: about 30 to 500 m.
    - Medium head plants: Upto 50 m.
- Run-of-river power plants
    - With pondage
    - Without pondage.
- Pumped storage power Plants.

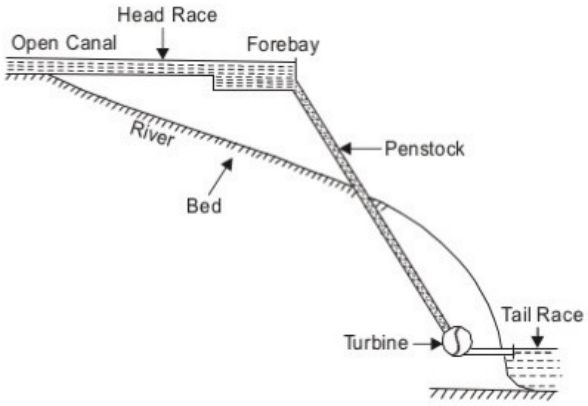
High head plants: In such plants, the water from the main reservoir is carried through tunnels up to the surge tank, from where it is taken through the penstock to the turbine. The Pelton wheel turbine is most suitable for high head plants.



Low Head Power Plants: In such plants, a dam is built on the river and the water is diverted into a canal which conveys the water into a forebay from where the water is allowed to flow through turbines. Kaplan turbine is usually used in low head plants.

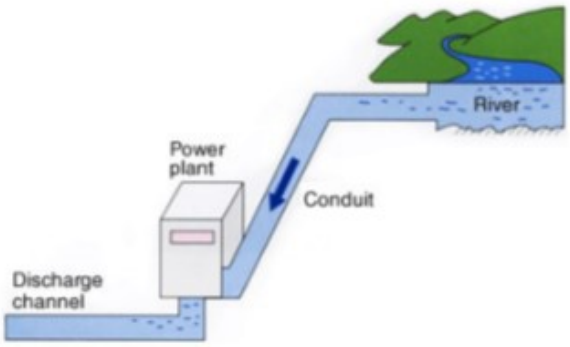


Medium Head Plants: In these plants, the river water is usually tapped off to a forebay on one bank of the river as in the case of a low head plant. From the forebay, the water is then led to the turbines through penstocks.

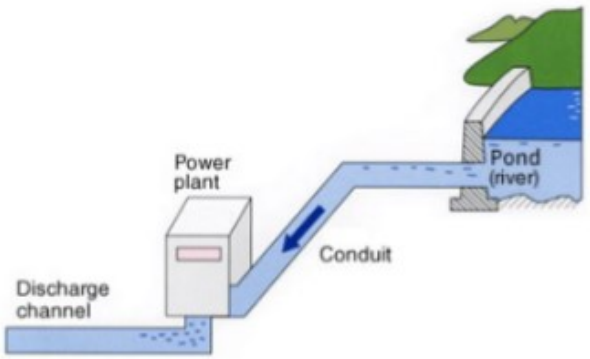


Run-off River Plants without Pondage: In such plants water is not stored, but only the running water is used for power generation.

Run-off River Plants with Pondage: In such plants, the excess water available during rainy seasons is stored in the reservoirs.

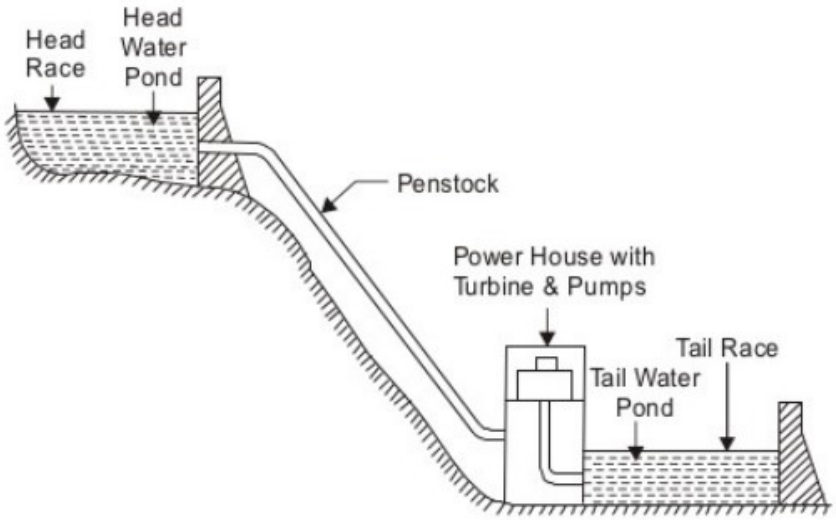


Run-off River Plants without Pondage



Run-off River Plants with Pondage

Pumped Storage Power Plants:



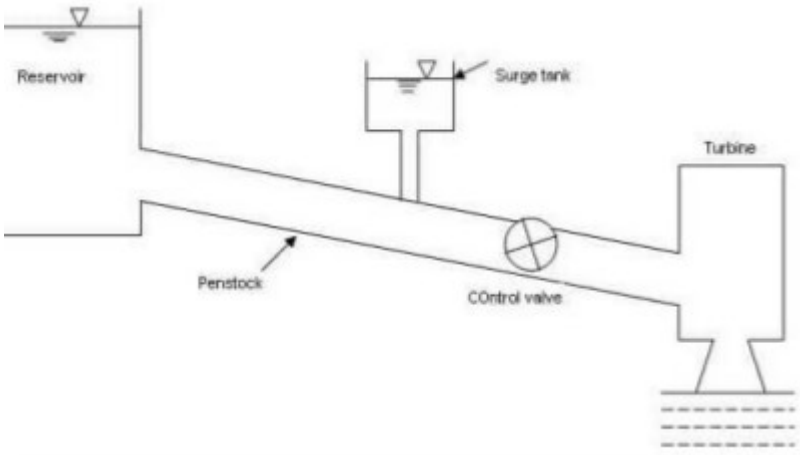
The construction comprises of a tail water pond and a head water pond connected through a penstock. The generating pumping plant is at the lower end. During off peak hours, some of the surplus electric energy being generated by the base load plant, is utilized to pump the water from tail water pond into the head water pond and this energy will be stored there. During times of

peak load, this energy will be released by allowing the water to flow from the head water pond through the water turbine of the pumped storage plant.

6 Explain the necessity of using components like surge tank, gates and valves in hydel power stations.

Surge tank: Surge tank is an open tank which is often used with pressure conduit of considerable length. The main purpose of providing surge tank is to reduce the distance between the free water surface and turbine there by reducing the water hammer effect on penstock and also protect upstream tunnel from high pressure raises. It also serves as a storage tank when the water is accelerating during increased load conditions and as a storage tank when the water is decelerating during reduced load conditions. Function of Surge Tank

- Reduce the water hammer effect
- Acts as a relief valve
- Acts as a temporary reservoir



Gates: Water from the reservoir is allowed to flow through the penstock to the turbine. The amount of water which is to be released in the penstock can be controlled by a control gate. When the control gate is fully opened, maximum amount of water is released through the penstock.

Control valves: The control valves are used in hydel plants to regulate the flow of water at the intake and the discharge end. Two types of valves:

- Needle valve
- Tube valve