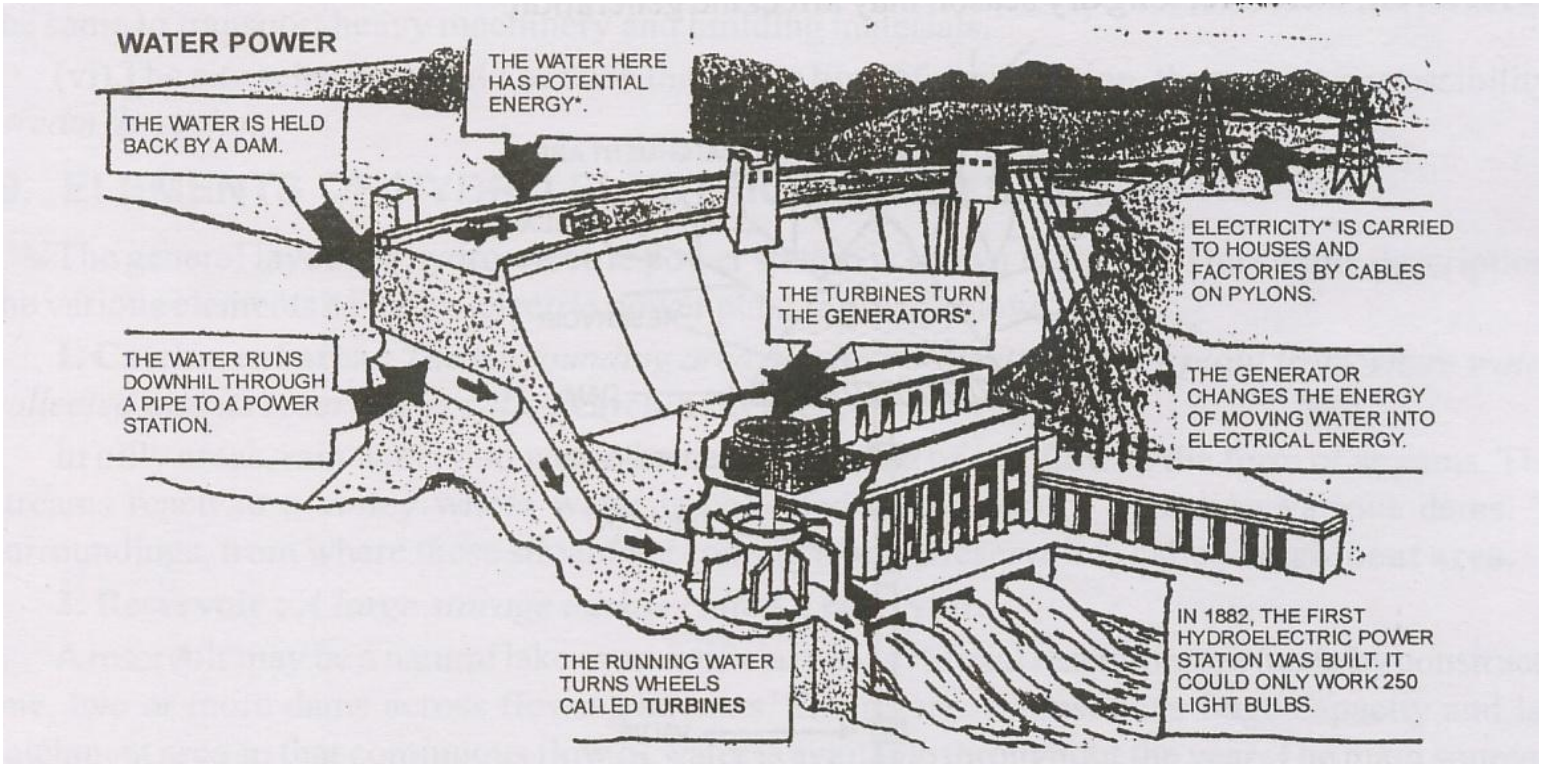
Hydro power plant

UNIT 4

Hydro-Electric Power Station

A power station in which potential energy of water is converted into electrical energy is called hydro-electric power station. In this type of station, a huge quantity of water at sufficient head must be available. So it is located in hilly areas where dams can built at suitable place to store large quantity of water in artificial reservoirs. When the water falls, through pen stock, on the blade of turbines , potential energy is converted into mechanical energy. Generators are coupled with turbine which convert mechanical energy into electrical energy.

Hydro-Electric Power Station



Advantages of Hydro-Electric Power Station

Due to limited reserves of fuels and increasing demand of electrical power, the hydro- electric power stations are becoming more and more popular.

Advantages :Following are the main advantages:

1. As no fuel is used , so no charge for transportation.
2. Operating cost is low because only operators are required.
3. Low maintenance cost
4. As these are in hilly areas so cost of land is small.

Advantages of Hydro-Electric Power Station

5. The efficiency is high approximately 80 to 90 %.
6. It is very neat and clean as there is no smoke, ash and dust.
7. It can be put into service instantly.
8. The plant has long life.
9. The plant has constant frequency.
10. These plants are flood control and use for irrigation purposes.

Disadvantages of Hydro-Electric Power Station

1. The capital cost is high.
2. As it built in hilly areas, so the cost of transmission power is high.
3. The power generation depends on nature and in dry season the generation of power reduces.
4. It requires large area for reservoir and dam.
5. It takes long time for erection.

Selection of site for hydro –electric Power Plant

The following are the main factors for selection of site :

1. The plants should be installed where adequate quantity of water is available.
2. The reservoir should have huge capacity and large catchment area.
3. Water collected behind dam has sufficient head to deliver more potential energy.
4. Land should be strong to withstand weight of dam.
5. Transportation facilities are available.

Elements of hydro power station

1. Catchment area
2. Reservoir
3. Dam
4. Spillways
5. Valve house
6. Surge tank
7. Racks
8. Penstock

Elements of hydro power station

9. Water turbines
10. Draft tube
11. Tail race
12. Alternator
13. Control room
14. Switch yard

Catchment Area

The surrounding area of a hydro-electric plant from where water is collected into reservoir is called catchment area.

In hilly areas, rain water and water from melting of ice . These reach to valley where water is collected by erecting the dams. The surrounding from where these stream are coming into reservoir is called catchment area.

Reservoir

A large storage tank of water is called reservoir.

A reservoir may be natural or artificial lake. The reservoir must have huge capacity and large catchment area so that continuous flow of water is available throughout the year. The main source of water are rainfall in the catchment area and melting of snow in the mountains.

Dam

A strong wall with large base, behind which water is stored is called a dam

A dam , according to its structural material, performs two following functions ;

1. It creates the necessary water head
2. Store water in the reservoir

Dam is suitably designed to resist against sliding, overturning and rupturing.

Spillways

The ways or passages for water to be released from the dam, when water increases beyond its safe level are called spillways.

At a particular level spillways are constructed on the dams. They act as safely valves for the dam. During rainy seasons, water reaching in the reservoir increases beyond the capacity of reservoir, then surplus water is released through these spillways to the downstream.

Valve house

The cabin in which controls are kept to operate the valves of the gates of the penstocks is called valve house. It is situated at the start of penstock and contains main valve which control the flow of water.

Surge Tank

An open tank connected to the penstock which regulates water supply through the penstock is called surge tank.

A surge tank is built just before the turbine. In case sudden closing of water turbine, the surge tank absorbs the water hammerage by increasing water level in it.

If it is not provided the water hammerage damage the penstock.

Racks

At the entrance of tunnel racks are provided to prevent the floating and other maters to the turbine.

The space between the bars varies from 40 mm to 200 mm in accordance with the minimum width of water passage through the turbine.

Penstocks

Huge steel or reinforced steel pipes that carries large quantity of water from valve house to the scroll case of the turbines are called penstocks.

In case of low and medium head power plants each turbine is provided with its own penstock, whereas in case of high head power plants a single penstock is used.

Water Turbines

A device that converts the potential energy of water into mechanical energy is called water turbine. The type of turbine use depends upon the head of water.

According to action , they are classified as :

Impulse turbine

Reaction turbine

Impulse Turbines

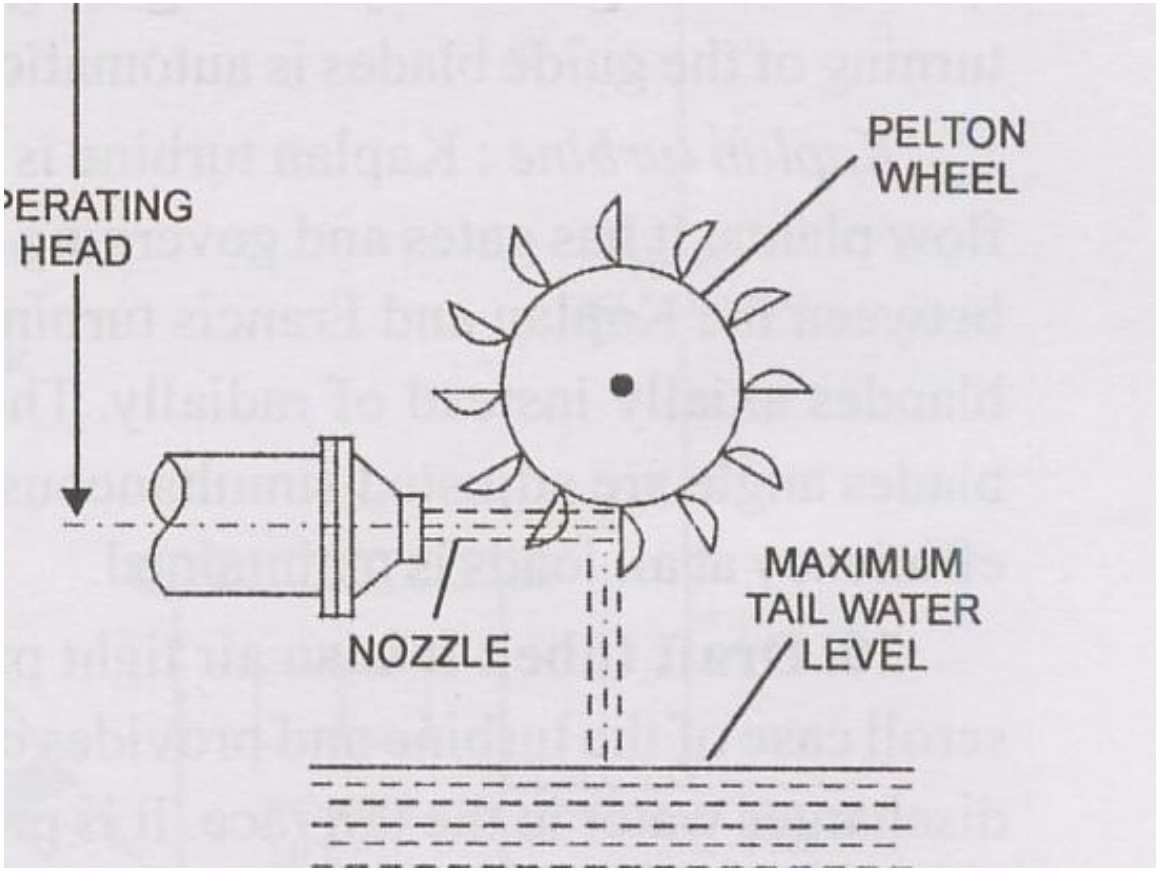
In an impulse turbine the whole head of water is converted into kinetic energy before it enters the wheel. During flow, pressure remains same and due to change of velocity both direction and magnitude, the water exerts a driving force on wheel and thus kinetic energy is converted into mechanical energy.

Impulse turbines are usually employed in high head power plants.

Reaction Turbines

In the reaction turbine water may enter the wheel partly with pressure energy and partly with velocity head. During the passage through wheel both pressure and velocity of water are reduced and water gives up its energy to the wheel, which converts into mechanical energy.

Impulse turbines are usually employed in low and medium head power plants.



Turbine

When water flows from penstock to turbine, it rotates and thus produce mechanical energy.

Turbines

Pelton Turbine : It is a impulse turbine and used for low flow and high head.

Francis Turbine : It is a reaction turbine and used for low and medium head plant.

Kaplan Turbine : It is a reaction turbine and used for low head and large flow plants.

Draft Tube

It is an air tight pipe of suitable diameter. It is connected at the bottom of the scroll case of turbine and provide outlet for water coming from turbine . It discharge the water in the tail race.

Tail Race

Draft tube discharges water in the tail race, which may lead it to the same stream or to another.

Alternator

An alternator is coupled to the turbine, which converts mechanical energy into electrical energy. The alternators employed in these power plants are of salient pole type, operating at slow speeds.

Control Room

In the control room all the controlling equipments, protective devices, indicating instruments etc. are placed on the pannels.

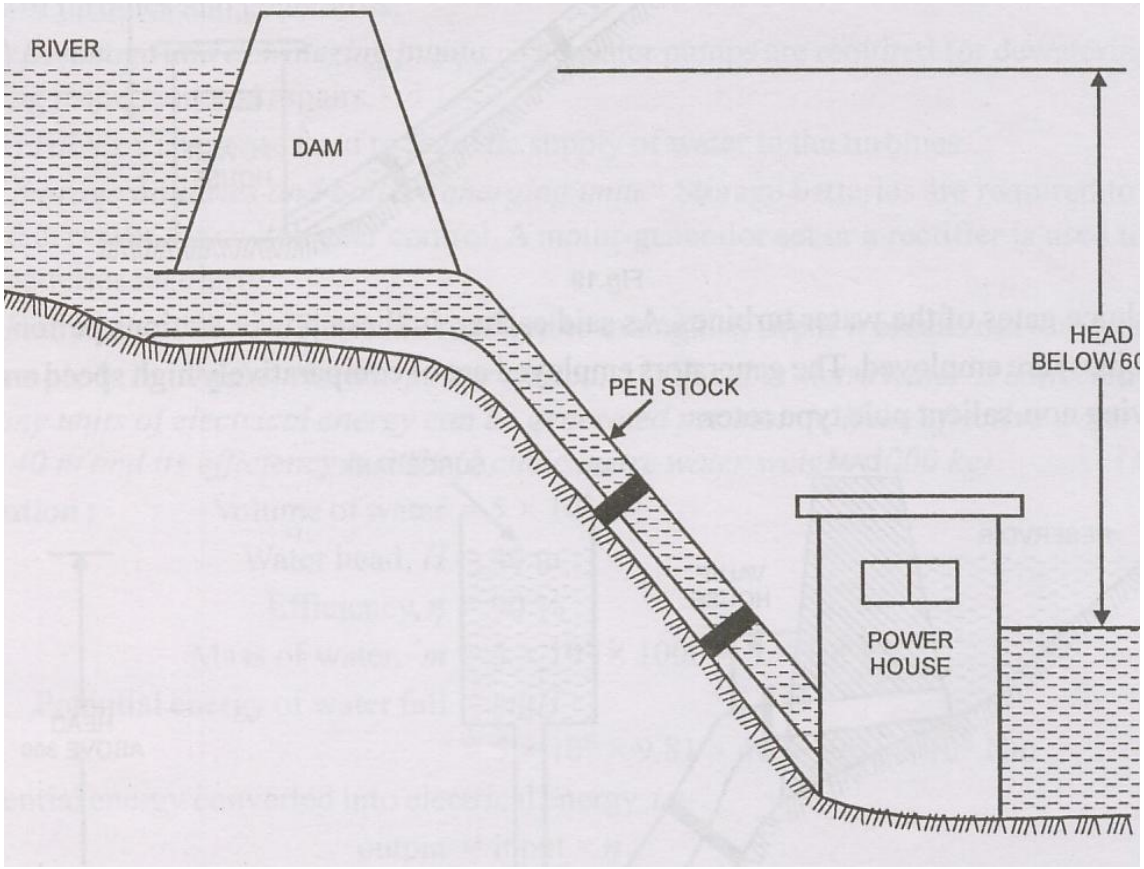
Electrical equipments like transformers, circuit breakers, CT’s, PT’s etc. are installed in switch yard.

Classification of hydro station

On the basis of operating head, hydro –electric power stations may be classified as :

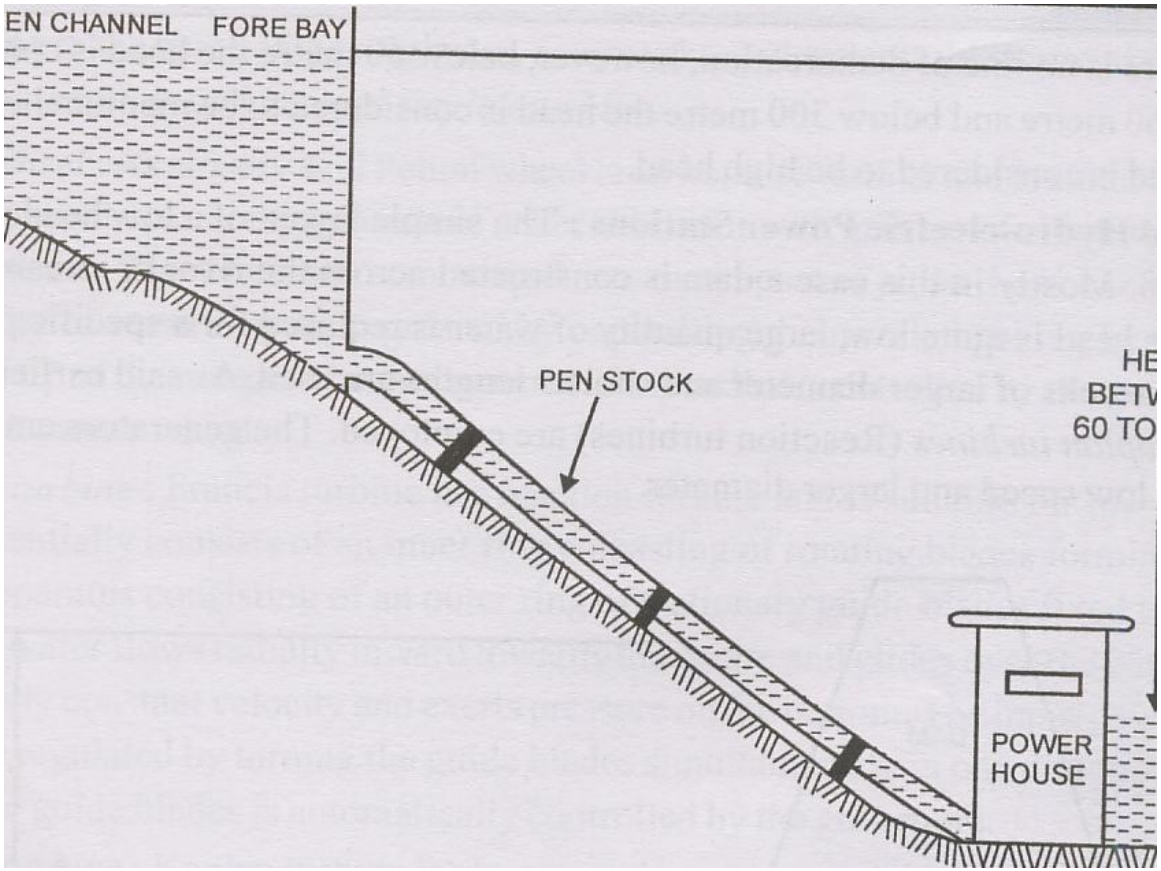
1. Low head power stations
2. Medium head power stations
3. High head power stations

Below 60 meter head is considered as low head, between 60 to 300 meter the head is medium and above 300 meter head is considered as high head.



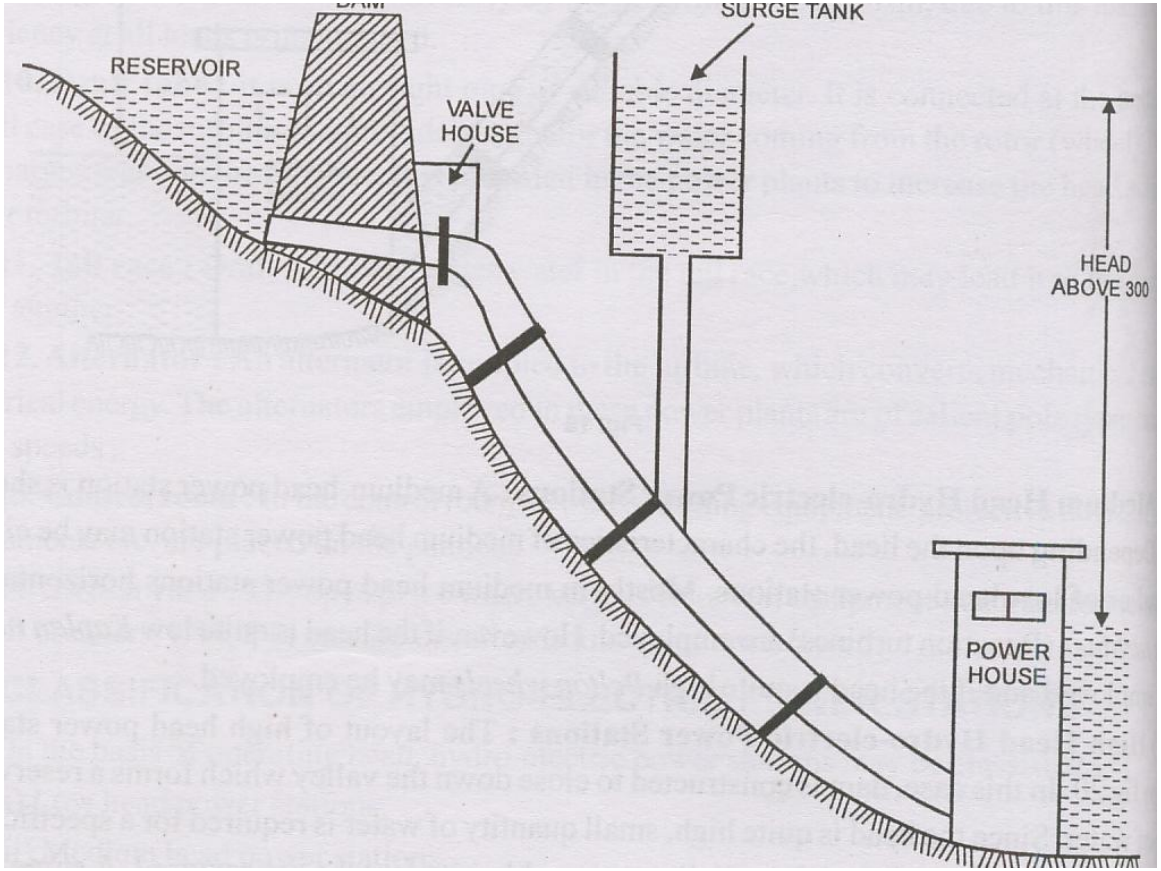
Low head power station

The dam is constructed across the river. As the head is low large quantity of water is required for specific power output , therefore penstock of large diameter and short in length.



Medium head power station

Depending upon the head, these power stations are either high head or low head power stations.



High head power station

Since the head is quite high, small quantity of water is required for specific power output. Thus penstock of small diameter and longer lengths are required.