

1.2 HYDROELECTRIC POWER PLANT

A generating station which utilizes the potential energy of water at a high level for the generation of electrical energy is known as a hydro-electric power station. The schematic arrangement of a modern hydro-electric plant is shown in Fig.1.3.

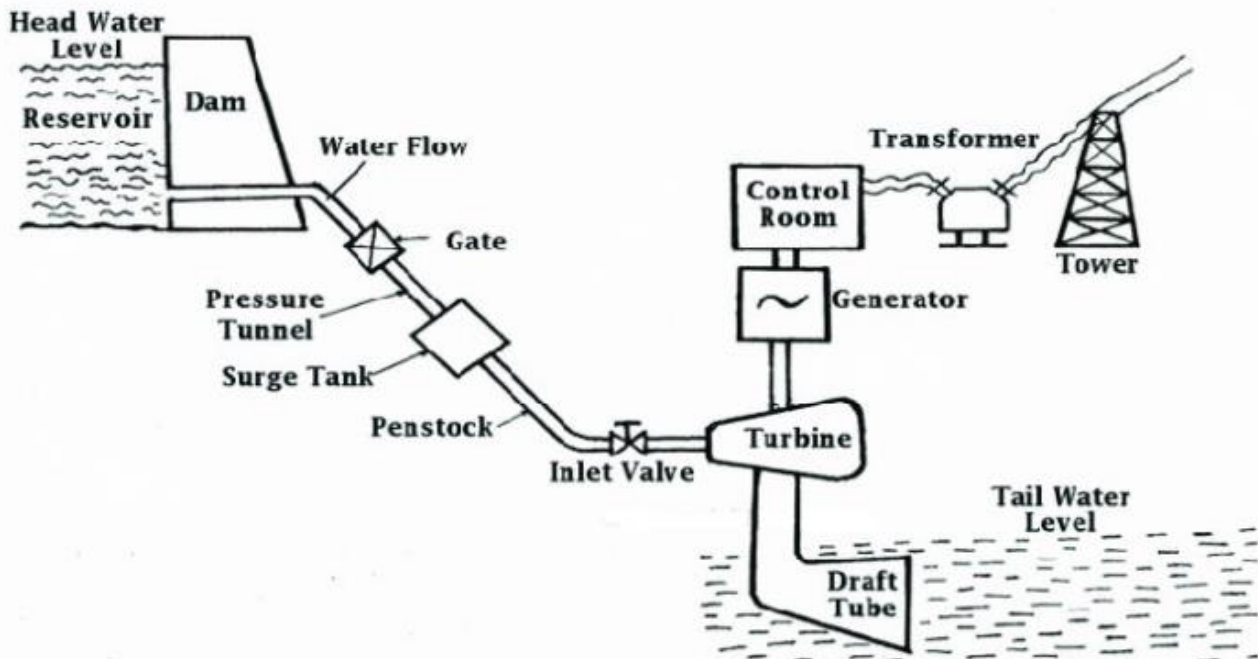


Fig 1.3 Schematic Arrangement of Hydro Power Plant

(Source: https://www.researchgate.net/figure/Hydroelectric-Power-plant-and-its-basic-components-adapted-from-2_fig1_344326460)

Hydro-electric power stations are generally located in hilly areas where dams can be built conveniently and large water reservoirs can be obtained. In a hydro-electric power station, water head is created by constructing a dam across a river or lake.

+ DAM:

A dam is a barrier which stores water and creates water head. Dams are built of concrete or stone masonry, earth or rock fill. The type and arrangement depends upon the foundation conditions, local materials and transportation available, occurrence of earthquakes and other hazards. The dam is constructed across a river or lake and water from the catchment area collects at the back of the dam to form a reservoir.

+ SPILLWAYS:

There are times when the river flow exceeds the storage capacity of the reservoir.

Such a situation arises during heavy rainfall in the catchment area. In order to discharge the surplus water from the storage reservoir into the river on the downstream side of the dam, spillways are used. Spillways are constructed of concrete piers on the top of the dam. Gates are provided between these piers and surplus water is discharged over the crest of the dam by opening these gates.

HEADWORKS:

The headworks consists of the diversion structures at the head of an intake. They generally include booms and racks for diverting floating debris, sluices for bypassing debris and sediments and valves for controlling the flow of water to the turbine. The flow of water into and through headworks should be as smooth as possible to avoid head loss and cavitation. For this purpose, it is necessary to avoid sharp corners and abrupt contractions or enlargements.

SURGE TANK:

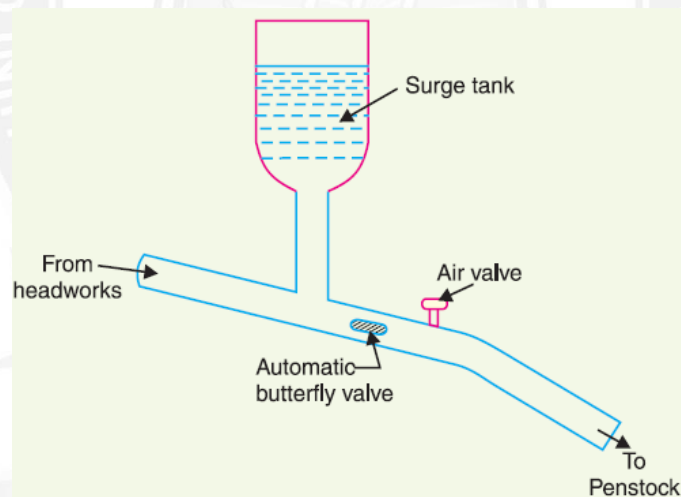


Fig 1.4 Surge Tank

(Source: 'Principles of power system,' V.K.Mehta, Rohit Mehta)

A surge tank (open from top) as shown in fig.1.4 is built just before the valve house and protects the penstock from bursting in case the turbine gates suddenly close due to electrical load being thrown off.

- When the load on the turbine decreases, the governor closes the gates of turbine, reducing water supply to the turbine. The excess water at the lower end of the conduit rushes back to the surge tank and increases its water level. Thus the conduit is prevented from bursting.

- *When load on the turbine increases*, additional water is drawn from the surge tank to meet the increased load requirement. Hence, a surge tank overcomes the abnormal pressure in the conduit when load on the turbine falls and acts as a reservoir during increase of load on the turbine.

✚ PRESSURE TUNNEL:

A pressure tunnel is taken off from the reservoir and water brought to the valve house at the start of the penstock.

✚ VALVE HOUSE:

The valve house contains main sluice valves and automatic isolating valves. The former controls the water flow to the power house and the latter cuts off supply of water when the penstock bursts. From the valve house, water is taken to water turbine through a huge steel pipe known as penstock.

✚ PENSTOCKS:

Penstocks are open or closed conduits which carry water to the turbines. They are generally made of reinforced concrete or steel. Concrete penstocks are suitable for low heads (< 30 m) as greater pressure causes rapid deterioration of concrete. The steel penstocks can be designed for any head; the thickness of the penstock increases with the head or working pressure.

✚ WATER TURBINES:

The water turbine converts hydraulic energy into mechanical energy. The turbine drives the alternator which converts mechanical energy into electrical energy. The principal types of water turbines are:

- i. Impulse turbines
 - a. Such turbines are used for high heads.
 - b. The example of this type of turbine is the Pelton wheel shown in fig.1.5.
- ii. Reaction turbines
 - a. Reaction turbines are used for low and medium heads.
 - b. The important types of reaction turbines are :
 - (i) Francis turbines (ii) Kaplan turbines

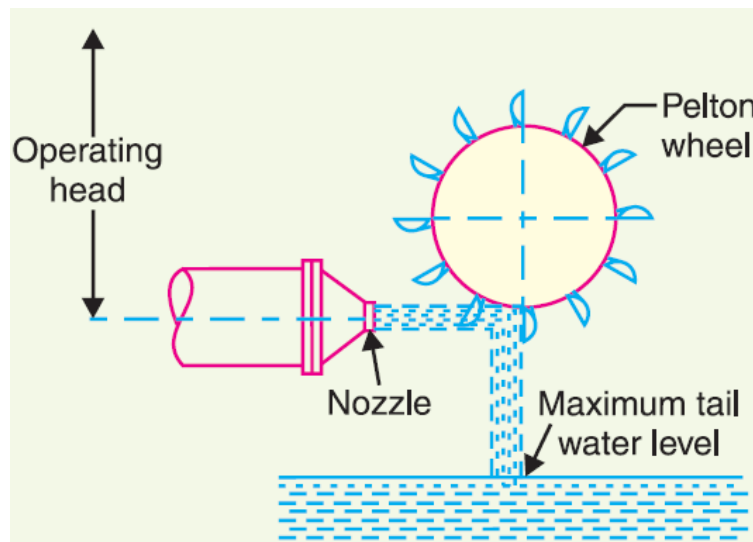


Fig 1.5 Pelton Wheel

(Source: 'Principles of power system,' V.K.Mehta, Rohit Mehta)

Choice of Site for Hydro-electric Power Stations:

The following points should be taken into account while selecting the site for a hydro-electric power station:

a) Availability of water

Since the primary requirement of a hydro-electric power station is the availability of huge quantity of water, such plants should be built at a place (e.g., river, canal) where adequate water is available at a good head.

b) Storage of water

There are wide variations in water supply from a river or canal during the year. This makes it necessary to store water by constructing a dam in order to ensure the generation of power throughout the year. The storage helps in equalizing the flow of water so that any excess quantity of water at a certain period of the year can be made available during times of very low flow in the river. This leads to the conclusion that site selected for a hydro-electric plant should provide adequate facilities for erecting a dam and storage of water.

c) Cost and type of land

The land for the construction of the plant should be available at a reasonable price. Further, the bearing capacity of the ground should be adequate to withstand the weight of heavy equipment to be installed.

d) Transportation facilities

The site selected for a hydro-electric plant should be accessible by rail and road so that necessary equipment and machinery could be easily transported.

Advantages:

- It requires no fuel as water is used for the generation of electrical energy.
- It is quite neat and 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 starting time like a steam power station. In fact, such plants can be put into service instantly.
- It is robust and has a longer life.
- Such plants serve many purposes. In addition to the generation of electrical energy, they also help in irrigation and controlling floods.
- Although such plants require the attention of highly skilled persons at the time of construction, yet for operation, a few experienced persons may do the job well.

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 lines as the plant is located in hilly areas which are quite away from the consumers.