# HYDRO-ELECTRIC POWER PLANT

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**HYDRO-ELECTRIC POWER PLANT**
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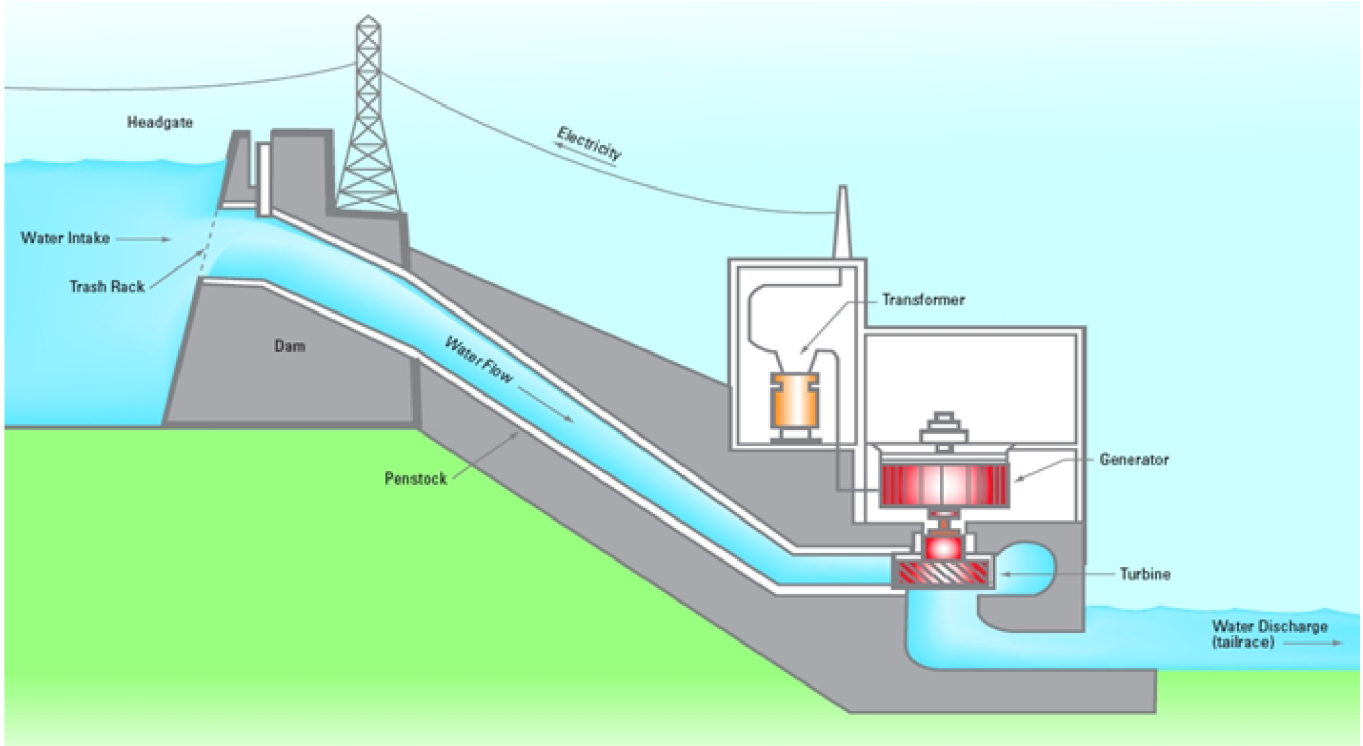
# HYDRO POWER PLANT

## ♦AIM:- TO STUDY ABOUT HYDRO POWER PLANT.

Hydroelectricity is one of the main forms of energy in use today. Its use is being promoted in many countries of the world as a renewable and non-polluting source of energy. Hydroelectricity is produced in a hydroelectric power plant. In this plant, the water is released from a high location. The potential energy present in the water is converted into kinetic energy, which is then used to rotate the blades of a turbine. The turbine is hooked to the generator which produces electricity.

## ♦BLOCK DIAGRAM:-




## ♦COMPONANTS:-

The water flowing in the river comprises of kinetic energy and potential energy. In hydroelectric power plants the potential energy of water is utilized to produce electricity. There are eight important components of the hydroelectric power plant. All these components and their working have been described below:

- Dam
- Water reservoir
- Intake or control gates
- The penstock
- Water turbines
- Generators
- Transformer
- Tailrace

**1) DAM:-** The dam is the most important component of hydroelectric power plant. In fact the name 'dam' is considered to be synonymous to the 'hydroelectric power plant.' The dam is built on a large river that has abundant quantity of water throughout the year. The dam is built at location where the height of the river is sufficiently high so as to get maximum possible potential energy from water.

**2) WATER RESERVOIR:-** Water reservoir is the place behind the dam where water is stored. The water in the reservoir is located at the height above the rest of the dam structure. The height of water in the reservoir decides how much potential energy water possesses. Higher the height of water more is its potential energy. The high position of water in the reservoir also enables it to move downwards effortlessly due to gravity. The height of water in the reservoir is higher than the natural height of water flowing in the river, hence water in reservoir is considered to be altered equilibrium. This also helps to increase the overall potential energy of water, which helps ultimately produce more electricity in the power generation unit.

**3) INTAKE OR CONTROL GATES:-** These are the gates built on the inside of the dam. The water from reservoir is released and controlled through these gates. These are called inlet gates because water enters the power generation unit through these gates. When the control gates are opened the water flows due to gravity through the penstock and towards the turbines. The water flowing through the gates possesses potential as well as kinetic energy.

**4) THE PENSTOCK:-** The penstock is the long pipe or the shaft that carries the water flowing from the reservoir towards the power generation unit that comprises of the turbines and generator. The water in penstock possesses kinetic energy due to its motion and potential energy due to its height.The total amount of power generated in the hydroelectric power plant depends on the height of the water reservoir and the amount of water flowing through the penstock. The amount of water flowing through the penstock is controlled by the control gates.

**5) WATER TURBINES:-** The water flowing from the penstock is allowed to enter the power generation unit that comprises of the turbines and generator. When water falls on the blades of the turbine the kinetic and potential energy of water is converted into the rotational motion of the blades of the turbine. Due to rotation of blades the shaft of the turbine also rotates. The turbine shaft is enclosed inside the generator. In most of the hydroelectric power plants there are more than one power generation units comprising of the turbine and generator.

There is large difference in height between the level of turbine and level of water in the water reservoir. This difference in height, also called as head of water, decides the total amount of power that can be generated in the hydroelectric power plant.

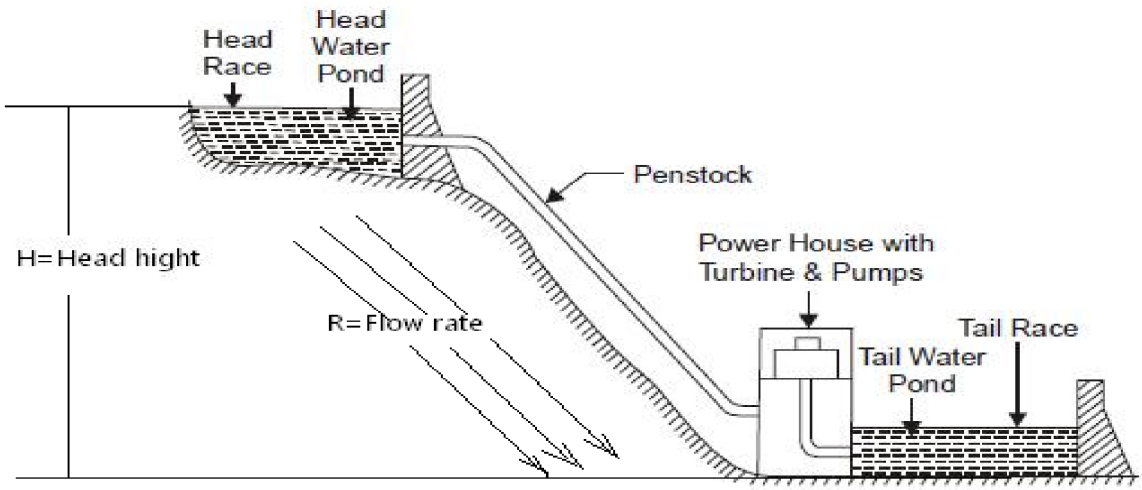
**6) GENERATORS:-** It is in the generator where the electricity is produced. The shaft of the water turbine rotates in the generator, which produces alternating current in the coils of the generator. It is the rotation of the shaft inside the generator that produces magnetic field which is converted into electricity by electromagnetic field induction. Hence the rotation of the shaft of the turbine is crucial for the production of electricity and this is achieved by the kinetic and potential energy of water. Thus in hydroelectricity power plants potential energy of water is converted into electricity.

**7) TRANSFORMER:-** The electricity generated inside the generator is not of sufficient voltage. The transformer converts the alternating current produced from within the generator to the high voltage current. Current is supplied to the supply coil, from where it passes to the outlet coil. The power supply from the transformer is connected to the nation grid, from where the power is distributed for the domestic and industrial use.

**8) TAILRACE:-**

The water that has been used to rotate the turbine blades and turbines shaft leaves the power generation unit entering the pipeline called as the tailrace. From here the water flows into the main river. The height of water in the tailrace is much below the height of water in the water reservoir behind the dam. The potential energy of water in the tailrace has been used to generate electricity.
The water flowing out from the tail race joins the natural flow of water. During the rainy seasons when there is excess water in the dams, it is allowed to overflow through the gates in water reservoir to the low level natural flow of water. If the river is very large, then multiple dams can be constructed across the river at various locations.

## ♦WORKING PRINCIPLE OF HYDRO-ELECTRIC POWER PLANT:-




The water flowing in the river possesses two type of energy: the kinetic energy due to flow of water and potential energy due to the height of water. In hydroelectric power plants or dams potential energy of water is utilized to generate electricity.
The formula for total power that can be generated from water in hydroelectric power plant due to its height is given by
**P = rhg**
Where: P is the total power that can be produced in watts
r- is the flow rate of water measured in cubic meters per second.
h- is called height of water measured in meters. It is also head of water. It is difference in height between the source of water (from where water is taken) and the water's outflow (where the water is used to generate electricity, it is the place near the turbines).
g- is the gravity constant 9.81 m/second square

The formula clearly shows that the total power that can be generated from the hydroelectric power plants depends on two major factors: the flow rate of water or volume of flow of water and height or head of water. More the volume of water and more the head of water more is the power produced in the hydroelectric power plant.
To obtain the high head of water the reservoir of water should as high as possible and power generation unit should be as low as possible. The maximum height of reservoir of water is fixed by natural factors like the height of river bed, the amount of water and other environmental factors. The location of the power generation unit can be adjusted as per the total amount of power that is to be generated. Usually the power generation unit is constructed at levels lower than ground level so as to get the maximum head of water.
The total flow rate of water can be adjusted through the penstock as per the requirements. If more power is to be generated more water can be allowed to flow through it.

## ♦CLASSIFICATION OF HYDRO-PLANT:-

In hydro-plants, water is collected behind the dam. This reservoir of water may be classified as either storage or pondage according to the amount of water flow regulation they can exert. The function of the storage is to impound excess river flow during the rainy season to supplement the low rates of flow during dry seasons. They can meet the demand of load fluctuations for six months or even for a year. Pondage involves in storing water during low loads so that this water can be utilized for carrying the peak loads during the week. They can meet the hourly or weekly fluctuations of load demand. With poundage, the water level always fluctuates during operations It rises at the time of storing water, falls at the time 'off drawing water, remains constant when the load is constant.
The hydro-power plants can be classified as below:

1. Storage plant
(*a*) High head plants
(*b*) Low head plants
(*c*) Medium head plants.

2. Run-of-river power plants
(*a*) With pondage
(*b*) Without pondage.

3. Pumped storage power Plants.

### ☯STORAGE PLANT:-

**1) LOW HEAD HYDROELECTRIC POWER PLANTS:-**
The low head hydroelectric power plants are the ones in which the available water head is less than 30 meters.
**2) MEDIUM HEAD HYDROELECTRIC POWER PLANTS:-**
The hydroelectric power plants in which the working head of water is more than 30 meters but less than 300 meters are called medium head hydroelectric power plants.
**3) HIGH HEAD HYDROELECTRIC POWER PLANTS:-**
In the high head hydroelectric power plants the head of water available for producing electricity is more than 300 meters and it can extend even up to 1000 meters.

## ☯RUN-OF-RIVER POWER PLANTS:-

**1) RUN-OFF RIVER HYDROELECTRIC PLANTS WITHOUT POND:-**
In the run-off river type of hydroelectric power plants the running water of the river is used for the generation of electricity. There is no facility for storing the water.
**2) RUN-OFF RIVER HYDROELECTRIC PLANTS WITH POND:-**
These types of run-off river hydroelectric power plants usually produce the power during peak loads. During the day-time and off-peak periods they don't produce power and the water is stored in large pond.

## ☯PUMPED STORAGE POWER PLANTS:-
These plants supply the peak load for the base load power plants and pump all or a portion of their own water supply.

## ♦SELECTION OF SITE FOR A HYDRO-ELECTRIC POWER PLANT:-

Some point that should be given importance while selecting a site for Hydro-electric power stationis given below.
**1) AVAILABILTY OF WATER:-**
Since the primary requirement for a hydro electric power station ,is the availability of huge amount of water such plants should be built at a place(eg.river,canal)where adequate water is available at a good head.
**2) STORAGE OF WATER:-**
There are wide variations in water supply from a river or canal during the year.This makes its necessary to store water by constructing a dam inorder to ensure the generation of power through out the year.The storage helps in equalising 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 hydro electric plant should provide adequate facilities for erecting a dam and storage of water.
**3) COST AND TYPE OF LAND:-**
The land for the construction of plant should be available at a reasonable price.Further ,the bearing capacity of the soil should be adequate to withstand the installation of heavy equipment.
**4) TRANSPORTATION FACILITIES:-**
The site selected for the hydro-electric plant should be accessible by rail and road so that necessary equipment and machinery could be easily transported.
It is clear from the above mentioned factors that ideal choice of site for such a plant is near a river in hilly areas where dam can be conveniently built and large reservoirs can be obtained.

## ♦ADVANTAGES & DISADVANTAGES OF HYDRO POWER PLANTS:-

**☯ADVANTAGES:**

1. Renewable source of energy thereby saves scares fuel reserves.
2. Economical source of power.
3. Non-polluting and hence environment friendly.
4. Reliable energy source with approximately 90% availability.
5. Low generation cost compared with other energy sources.
6. Indigenous, inexhaustible, perpetual and renewable energy source.
7. Low operation and maintenance cost.
8. Possible to build power plant of high capacity.
9. Plant equipment is simple.
10. Socio-economic benefits being located usually remote areas.
11. Higher efficiency, 95%to98%.
12. Fuel is not burned so there is minimal pollution
13. Water to run the power plant is provided free by nature
14.It's renewable - rainfall renews the water in the reservoir, so the fuel is almost always there.

**☯DISADVANTAGES:**

1. Susceptible to vagaries of nature such as draught.
2. Longer construction period and high initial cost.
3. Loss of large land due to reservoir.
4. Non-availability of suitable sites for the construction of dam.
5. Displacement of large population from reservoir area and rehabilitation.
6. Environmental aspect reservoirs verses river ecology.
7. High cost of transmission system for remote sites.
8. They use up valuable and limited natural resources
9. They can produce a lot of pollution
10.Companies have to dig up the Earth or drill wells to get the coal, oil, and gas
11.For nuclear power plants there are waste-disposal problems.

## ♦KEY FACTS ABOUT HYDRO POWER PLANT:-

☯World-wide, about 20% of all electricity is generated by hydropower.
☯Hydropower is clean. It prevents the burning of 22 billion gallons of oil or 120 million tons of coal each year.
☯Hydropower does not produce greenhouse gasses or other air pollution.
☯Hydropower leaves behind no waste.
☯Hydropower is the most efficient way to generate electricity. Modern hydro turbines can convert as much as 90% of the available energy into electricity. The best fossil fuel plants are only about 50% efficient.
☯Hydropower is the leading source of renewable energy. It provides more than 97% of all electricity generated by renewable sources. Other sources including solar, geothermal, wind, and biomass account for less than 3% of renewable electricity production.
☯Water is a naturally recurring domestic product and is not subject to the whims of foreign suppliers.

## ♦HYDRO POWER PLANTS IN INDIA:-

| STATION | STATE | CAPACITY (MW) |
|---|---|---|
| Srisailam Dam | Andhra Pradesh | 1,670 |
| Nagarjunasagar | Andhra Pradesh | 965 |
| Sardar Sarovar | Gujarat | 1,450 |
| Baspa-II | Himachal Pradesh | 300 |
| Nathpa Jhakri | Himachal Pradesh | 1,500 |
| Bhakra Dam | Punjab | 1,325 |
| Dehar | Himachal Pradesh | 990 |
| Baira Suil | Himachal Pradesh | 180 |
| Chamera-I | Himachal Pradesh | 540 |
| Chamera-II | Himachal Pradesh | 300 |
| Pong | Himachal Pradesh | 396 |
| Uri Hydroelectric Dam | Jammu & Kashmir | 480 |
| Dulhasti | Jammu & Kashmir | 390 |
| Salal | Jammu & Kashmir | 690 |
| Sharavathi | Karnataka | 1,469 |
| Kalinadi | Karnataka | 1,225 |
| Linganamakki Dam | Karnataka | 55 |
| Bansagar Dam | Madhya Pradesh | 425 |
| Bargi Dam | Madhya Pradesh | 105 |
| Madikheda Dam | Madhya Pradesh | 60 |
| Omkareshwar | Madhya Pradesh | 520 |
| Indira Sagar | Madhya Pradesh | 1,000 |
| Loktak | Manipur | 105 |
| Koyna | Maharashtra | 1,920 |
| Mulshi Dam | Maharashtra | 150 |
| Jayakwadi Dam | Maharashtra | 12 |
| Rangeet | Sikkim | 60 |
| Teesta-V | Sikkim | 510 |
| Tanakpur | Uttarakhand | 120 |
| Dhauliganga-I | Uttarakhand | 280 |
| Loharinag | Uttarakhand | 600 |

## ♦CONCLUSION:-

Hydropower is the cheapest way to generate electricity today. No other energy source, renewable or nonrenewable, can match it. Producing electricity from hydropower is cheap because, once a dam has been built and the equipment installed, the energy source-flowing water-is free.
Although Hydropower does present a few environmental problems the inherent technical, economic and environmental benefits of hydroelectric power make it an important contributor to the future world energy.

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