



Chapter 4...

Hydro Power Stations

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 - 4.1.1 Definitions of Terms and their Significance in Capacity of Power Plant
 - 4.2 Layout of Hydro-electric Power Plant (Station)
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 - 4.5 Merits and Demerits of Hydro-electric Power Stations
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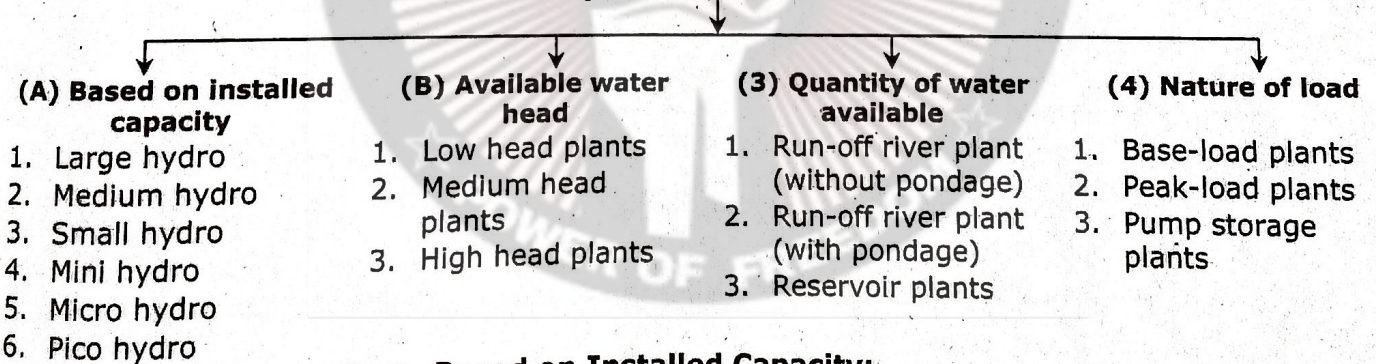
INTRODUCTION

(A) Basic Concept of Hydro-Power Generation:

- Generating stations are the energy conversion power stations. In hydro electric power stations, a large quantity of water is stored in dams. Thus, there is a potential energy. The stored water from the high head is carried down by penstocks (pipes) to lower heads upto water turbine. This system converts potential energy into kinetic energy which is utilized to drive water turbines converting it into mechanical energy, which is utilized to drive the generator converting mechanical energy into electrical energy.

(B) Classification of Hydro Power Plants:

Hydro-Power Plants



(C) Classification of Plants Based on Installed Capacity:

Table 4.1

Sr. No.	Type	Installed capacity range	Feeding to
1.	Large Hydro	More than 100 Mega Watt	Large Grid System
2.	Medium Hydro	15 MW to 100 MW	General Grid System
3.	Small Hydro	1 MW to 15 MW	General Grid System
4.	Mini Hydro	100 kW to 1 MW	Isolated
5.	Micro Hydro	5 kW to 100 kW	Feeding to small rural, remote places
6.	Pico Hydro	Upto 5 kW	Individual industry or small area



4.1 SELECTION OF A SITE OF HYDROELECTRIC POWER PLANT

Following are the factors to be taken into account at the time of selecting a site for hydro project:

- (i) Ample quantity of water at a reasonable head should be continuously available as far as possible throughout the year.
- (ii) The site should be such that it is possible to construct a dam economically to store the water. Preferably there should be high, strong mountains on the two sides of a river.
- (iii) At the site selected it should have strong foundation or the cost of foundation should be minimum.
- (iv) There should be no possibility of future sources of leakage of water.
- (v) The dam or reservoir constructed should have large catchment area so that the water in it should never fall below the minimum level.
- (vi) The site should be approachable by road.
- (vii) There should be possibility of stream diversion during the period of construction.
- (viii) It should be near to load centre, so that cost of transmission lines is reduced.
- (ix) Local supplies of sand, gravel etc. should be available, otherwise it will increase the cost of plant.

4.1.1 Definitions of Terms and their Significance in Capacity of Power Plant

(a) Hydrology:

System related with water in termed as hydrology. It relates with mass of water, head of water, flow of water (quantity). From the above data the work that water can do can be calculated, which can be utilized to decide upon the installed capacity of hydro power stations.

(b) Surface Run-off:

It is that portion of precipitation which makes its way towards streams, lakes or oceans. Run-off can be possible only when the rate of precipitation exceeds the rate at which water infiltrates into the soil and after small and large depressions on the soil surface get filled up with water. Also losses due to evaporation have be deducted. In general the run-off is given by

$$R = P - E$$

where

$$R = \text{Run-off}$$

$$P = \text{Precipitation}$$

$$E = \text{Evaporation}$$

(c) Evaporation:

It is the transfer of water from liquid to vapour state.

(d) Precipitation:

This includes all the water that falls from atmosphere to the earth surface. It is mainly of two types:

- (i) Liquid precipitation (Rainfall)
- (ii) Solid precipitation (Snow, Hail)

(e) Significance of these on capacity of power plant:

As we have seen previously, Run-off = Precipitation - Evaporation, where precipitation of water in vapour due to atmospheric variations. Hence we are able to know the quantity of water available (stored) in a dam or lake, which can be used for production of hydro-power. Also knowing the head of water and quantity of water that will be used per/sec. or per/hr. etc. can be calculated then using Bernoulli's equation the power in kw is determined, which decides the installed capacity.



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4.2 LAYOUT OF HYDROELECTRIC POWER PLANT (STATION)

- Hydro-electric plants require continuous flow of water with large amount of hydraulic energy. Such a source can be a natural lake or reservoir at the high level or it can be formed by constructing a dam across a river.
- Fig. 4.1 represents a layout of hydro-electric plant using a reservoir formed by constructing a dam. The water surface in the reservoir is known as **head-race level**.
- Water from storage reservoir is carried through penstocks to power house. The penstocks are pipes of cast iron or R.C.C. which carry water under pressure from reservoir to a turbine. When there is a distance between reservoir and power house, small reservoirs are provided near the power house and they are known as forebays and penstocks are connected to forebays. They are used to temporarily store water when not required by plant and supply the same when required.

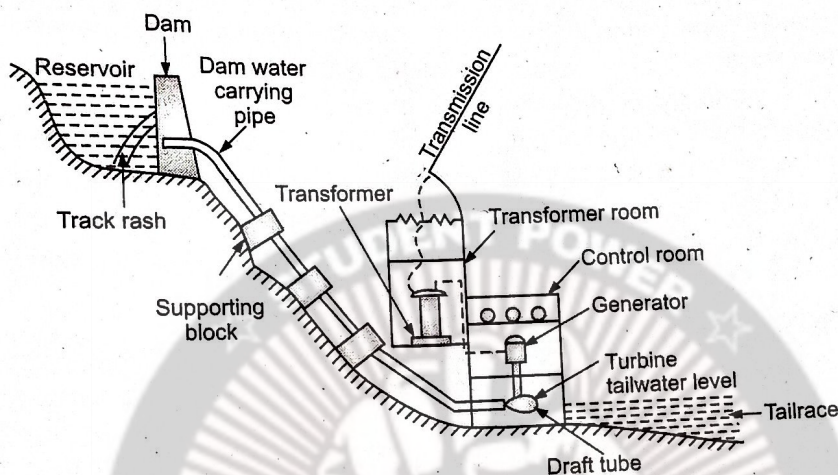


Fig. 4.1: General arrangement of hydroelectric power plant in elevation

- Water after passing through the turbines is discharged in the tail race. The water from tail race joins the natural stream of water at some point away from the power house or it may flow to the same river on which the dam is built on downstream.

4.2.1 Working of Power Plant and Function of Different Components

- Reservoir:** It is required to store the water, which is used to run the turbine.
- Dam:** It facilitates collection of water at suitable head, which can be used throughout the year by proper controls.
- Trash rack:** It prevents entry of debris which might damage the wicket gates and turbine runners or may choke nozzles of impulse turbines.
- Forebay:** It serves as a regulating reservoir. In case of plants having forebay, no surge tank is required as the surge due to change in load will be absorbed by the forebay itself.
- Surge tank:** This is a tank provided near the turbine. As the load on the turbine decreases suddenly, water flow to the turbine reduces suddenly. This causes a hammer effect on penstock. This effect is absorbed by the surge tank by providing space for the additional water.
- Penstock:** It is a pipe line of cast iron for taking water from the intake work and forebay to the turbines.



10. All questions are covered in the commercial value of coal.

- (g) **Power house:** It is generally located at the foot of the dam and near the reservoir. It is located in such a way that the use of maximum possible head can be utilized at the turbines.
- (h) **Prime mover:** Prime movers convert the kinetic energy of water into mechanical energy. Commonly Pelton wheel, Francis, Kaplan, and Propeller type turbines are used as prime movers.
- (i) **Spill way:** This may be considered as a sort of safety valve for the dam. A spill way serves to discharge excess water in the reservoir beyond the full permissible level.
- (j) **Intake:** Since water level in the reservoir is below the crest of the spill way, some inlet has to be provided to draw water from the reservoir as required. Level of intake is decided by the maximum drawdown of the reservoir, providing for the requirement that the intake should be sufficiently below the minimum reservoir level so as to prevent air being drawn in, it should be arranged as high as possible. With such choice intake is less likely to be affected by floating trash. Also there will be less chance of interruption due to ice. For locations where there will be wide fluctuations of water level, intake towers are often used. Screens or trash racks are used to prevent debris passing into the water passage.
- (k) **Tail race:** The tail race is a water way to lead water discharged from the turbine to the river. Water level of the tail race should be kept high enough so as to avoid cavitation near the runners when the Francis or Kaplan turbines are used.

4.3 TYPES OF TURBINES

The turbines used in hydro-electric power plants as prime movers of alternator can be classified in following ways:

(a) According to the type of flow of water. (b) According to the action on fluid.

(a) According to the type of flow of water, consider the three axes.

(i) **Axis along the shaft of the machine:** The machines having flow of water along this axis are called axial flow turbines.

(ii) **Axis along the radius:** The machines in which the water flows along the radius are called as radial flow turbines.

(iii) **Axis along the tangential directions:** The turbines using this type of flow are called tangential flow turbines.

(b) According to action on fluid the turbines are divided into the following categories:

(i) **Impulse turbines:** In these type of turbines, the whole of pressure energy available in water is first converted into kinetic energy and the water at atmospheric pressure impinges the blades of the turbine. This type of turbine is mostly used in a Pelton wheel type.

(ii) **Reaction turbines:** In these type of turbines, part of the available pressure energy of water is converted into kinetic energy in the guide apparatus, before it strikes the blades of the turbine. The pressure at all stages of the reaction turbines is not atmospheric.

These type of turbines, used at present, are Francis, Kaplan and Propeller type.

We will restrict our discussion and study in brief about Pelton wheel, Francis and Kaplan type of turbines which are most commonly used in hydro-electric plants as prime movers.

(1) Pelton Wheel:

Pelton wheel has a rotor equipped with buckets along the whole periphery. The buckets used are elliptical in shape.



- Refer Fig. 4.2. In these type of turbines the total available head of water is first converted into kinetic energy and the water having this type of large kinetic energy is directed to impinge on the buckets by means of strong water jet through one or two jets.
- Due to impact of water on the buckets of rotor, it will start turning or rotating.
- The buckets are formed in two halves with a splitting at the centre in such a way that the jet after hitting in the centre deflects sideways and then falls into the tail race at a low velocity which is of the order of about 10% to 15% of the initial velocity.
- For making use of available energy in water properly, the velocity of the discharge water should be less as possible as it can be.
- In order to increase the output power, number of jets may be increased upto 4 and may be spaced at equal distance along the circumference of the wheel as shown in Fig. 4.2 (c).
- The increase in number of nozzles requires the bending of water pipe supplying water to these jets, which cause disturbance in water flow. Hence, for increasing the power output, double wheels may be used instead of increasing the number of nozzles.

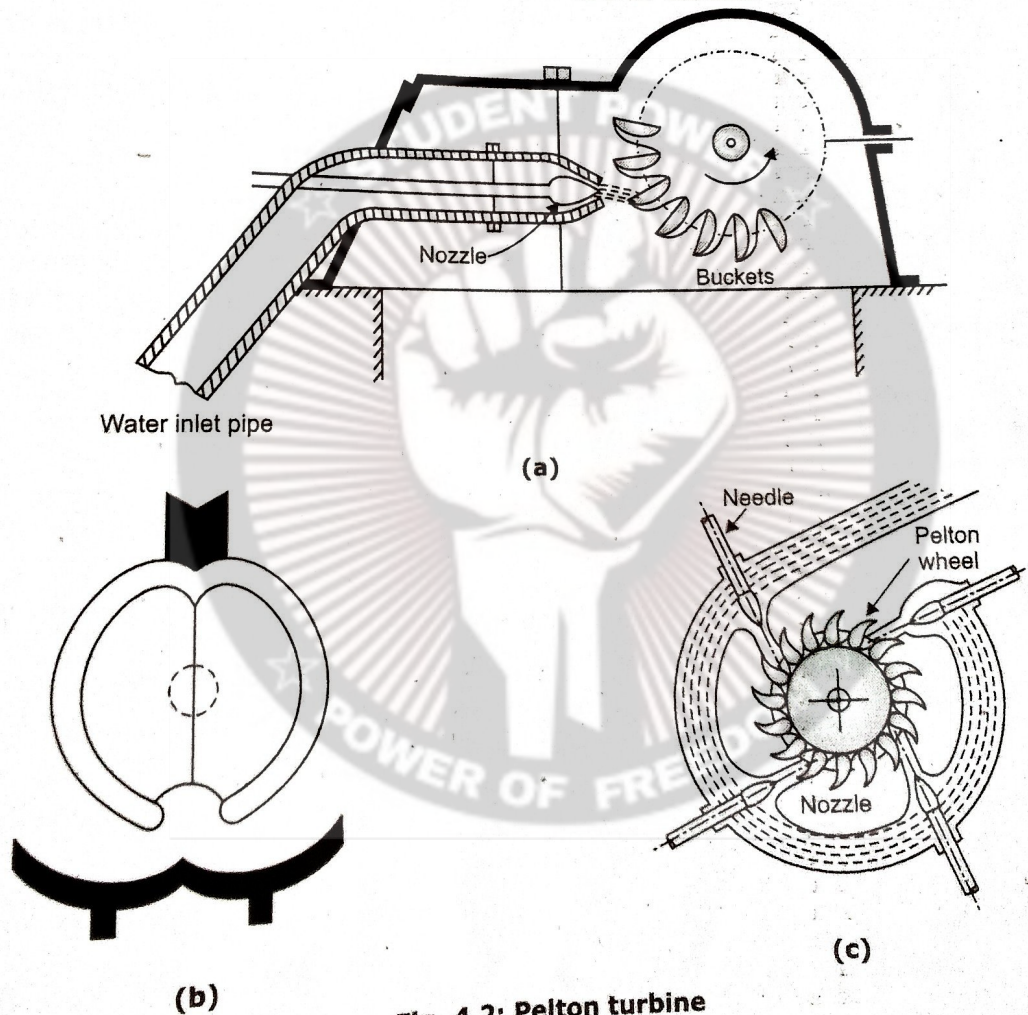


Fig. 4.2: Pelton turbine

(2) Francis Turbine:

- It is a reaction type turbine. In such turbines, the total available head of water is partly used in the form of pressure energy and partly in the form of kinetic energy. They are mostly used for medium heads of water. The main parts of the Francis turbine are as follows:



- Analysis of coal :
- To determine the commercial value of coal following tests are carried out :-
- i) Proximate analysis

(a) Guide apparatus:

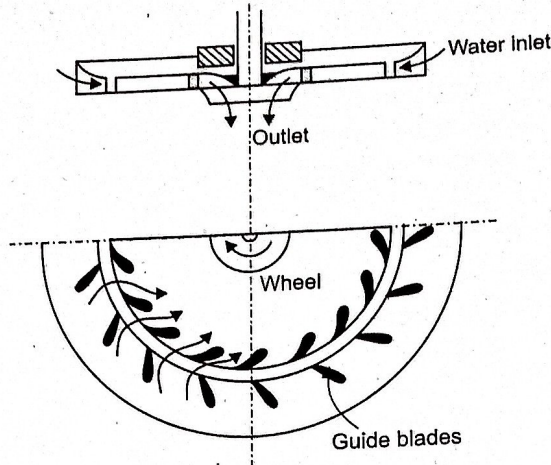


Fig. 4.3: Francis turbine

- It is an outer ring of stationary guide blades, which are fixed to the casing. The casing distributes water evenly to the guide blades.
- In some cases, stay vanes are also provided in the casing to guide water into the guide vanes. They are casted in sections and fitted together if size is large.

(b) Inner ring:

- The wheel or runner carrying the rotating blades is called the inner ring.
- Refer Fig. 4.3, the water flows radially inwards and leaves at the centre axially. The pressure of the water at discharge may fall greatly which may result into chances of cavitation. As the pressure of water is less than atmospheric pressure, it is required to provide a draft tube for discharge of water directly into tail race, its end is kept submerged in water to avoid entrance of air.
- The Francis turbines are constructed in two forms:
 - Horizontal type.
 - Vertical type.
- The horizontal types are more accessible and provide higher speeds, but large capacity turbines are generally vertical types.
- The guide blades are so designed that they can be turned along the axis parallel to the turbine axis for regulating the quantity of water. They can be moved in one direction or the other direction simultaneously depending upon how the water passage is controlled.
- These type of turbines have high efficiency at 3/4 f.l. and full-load. They can be designed for high speeds, hence their diameter and weight are less. At low speed its efficiency may fall to about 65% from about 92% on f.l.

(3) Kaplan Turbines:

- The Kaplan turbines are reaction type turbines. They are also low-head turbines and hence for same output as that of Francis turbines they require large quantity of water.
- It has gate and governing mechanism similar to Francis turbine but in Kaplan runner the water strikes the turbine blades axially. Kaplan turbine consists of 3 to 6 blades which reduce the frictional resistance.
- The relative setting of inlet and outlet channels in Kaplan turbines are set in the manner shown in Fig. 4.4. Due to low head quantity of water required is large in such turbines.
- To feed this uniformly to the runner, the walls of the spiral casing in combination with the guide blades are not adequate and they are supplemented by the two curved guide walls.
- These turbines run at **realme** **Shot on realme C30s** have an efficiency of about 90% at all loads.

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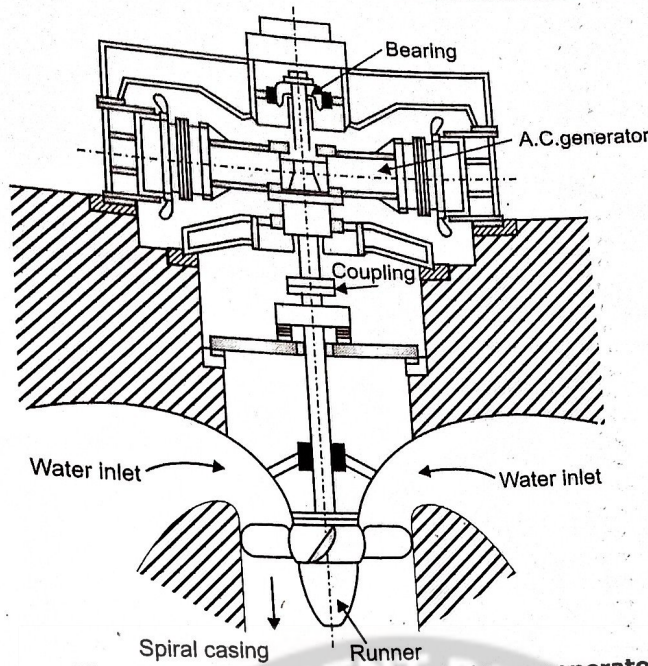


Fig. 4.4: Kaplan turbine coupled to a generator

4.3.1 Comparison between Different Types of Turbines

- The following table gives the comparison of different types, as regard with its type, head required for operation and specific speeds at which they can operate.

Table 4.2

Sr. No.	Type of Turbine	Classification	Head, meters	Specific speed, r.p.m.
1.	Pelton wheel	Impulse	90 - 1100 m	10 - 40
2.	Francis	Reaction	14 - 300 m	95 - 440
3.	Kaplan	Reaction	3 - 30 m	550 - 830

4.3.2 Types of Generators used in Hydroelectric Power Plant

- Generators used are three phase, alternating current 3.3 kV, 11 kV, 50 Hz synchronous generators. The armature is housed in the stator consisting of a core and a frame.
- The core acts as a magnetic circuit. It is built from thin electrical quality sheet steel laminations and is given a shape of heavy steel rings. The core is enclosed in the welded steel frame. The rotor is salient pole type and is the heaviest part of the machine.
- The rotor houses the D.C. excitation winding and consists of a rim, salient poles, spokes and a hub.
- The rim is used for spacing and securing the poles, it is made of metal cores and carry the excitation winding coils. The spokes are welded to the inside of rim at one end and the hub at the other end.
- The hub serves to mount the rotor on the main shaft. D.C. excitation to the rotor pole coils is supplied by means of brushes which rest on slip-rings rotating with the rotor.
- The pole coils are connected in series to form the excitation winding which is excited by D.C. at 110 or 220 volts. Formerly the excitation was supplied by small D.C. generators driven through pilot exciters from the turbo generators shaft.



→ approximate analysis :- It gives indication about
 and bearing properties of water following
 It gives the

- In modern generators, static excitation system is frequently used. The rotor poles are spaced very close together to form a continuous external diameter.
- The thrust bearing is one of the parts of the generator. It takes up and transmits the load imposed by rotating parts and the pressure on the turbine runner to the structural elements of the power house.
- Different types of thrust bearings may be used, it may be of plate type, roller type, spring type or kingsbury type, or it may be the oil pressure type.
- Load equalization improves the performance of the bearing. Mechanical power developed by turbines is transmitted to the rotor of the generator as the shaft of turbine and rotor shafts are rigidly coupled. The rotor rotates at constant speed N r.p.m.
- The stator consists of a 3-phase winding, consisting of large number of turns in each phase.
- The turns are formed by insulated copper rods laid in the slots of the stator. The rods are connected with jumper windings to form the complete turn.
- Speed of water turbines is much less. The rotational speed of turbines is related with the frequency of induced voltage by the following relation:

$$N = \frac{120 f}{P}$$

where,

N = Speed in r.p.m. of turbine

f = Frequency of induced voltage which should be 50 in India

and

P = Number of poles of generator

- Hence, in case of turbines running at low speed, the number of poles will be more, so that frequency of 50 Hz is maintained constant.
- The power output = $\sqrt{3} V_L I_L$ volt amperes and real power output = $\sqrt{3} V_L I_L \cos \phi$, watts, where $\cos \phi$ is load p.f.
 Reactive power = $\sqrt{3} V_L I_L \sin \phi$
- Generally, the power output of such plants is measured in Mega-watt, which is equal to watt/ 10^6 .
- These generators run at low speed. If air cooling is used, then efficiency varies from 95% to 97.5% depending upon size.
- The voltages generated by hydro generator are 3.3 kV, 6.6 kV or 11 kV at 50 Hz. Transient reactance varies from 15% for high speed to 30% for low speed machines. The short circuit ratio is between 1 and 1.2.
- A proper value of flywheel effect is very essential. In case of small systems it should have a reasonably large value for satisfactory speed regulation under sudden changes in load, while in case of a system consisting of large number of generators operating in parallel the value should be sufficient to avoid hunting and ensure stability under transient and fault conditions.
- The exciters are provided to supply the field winding of generators. They are D.C. shunt or compound generators. Their capacity is about 0.5 to 3% of the main generator capacity. In some cases, pilot exciters are used to excite the main exciter and are fixed to the same shaft of the generator. The exciter voltage is generally 110 V, 220 volts.

4.4 CLASSIFICATION OF HYDRO PLANTS ACCORDING TO NATURE OF LOAD

- According to nature of load, the plants are classified as follows:
 - (i) Base-load plants, (ii) Peak-load plants, (iii) Pumped storage plants for peak-loads.
 - (i) **Base-load plants:** These are the plants which operate to supply the load on the base portion of the load curve. The load on such plants is practically constant. They are generally of large capacity. The load factor is high. Hydro plants which have large storage capacity are most suitable as base-load plants. Run-off river plants without pondage can also be used as base-load plants.

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(ii) Peak-load plants: Run-off river plants with pondage can be used as peak-load plants. Depending upon the reservoir, the plant can supply the load. If the pondage is enough, it can supply a large portion of the load. Reservoir plants with sufficient storage or large catchment area can be used as base-load or peak-load plants as required.

(iii) Pumped storage plants: Such type of plant is as shown in Fig. 4.5. They are used when the available quantity of water for generation is insufficient. Generally, a storage pond is built to store water at head race and tail race. The water passing through the turbines is stored in tail race pond and it is pumped back by the generating system working as a motor and stored in the head-race pond again, during the off peak-load hours of the system. Water is drawn from the pond through the penstock to operate the turbine. These type of plant can be operated only in interconnected systems.

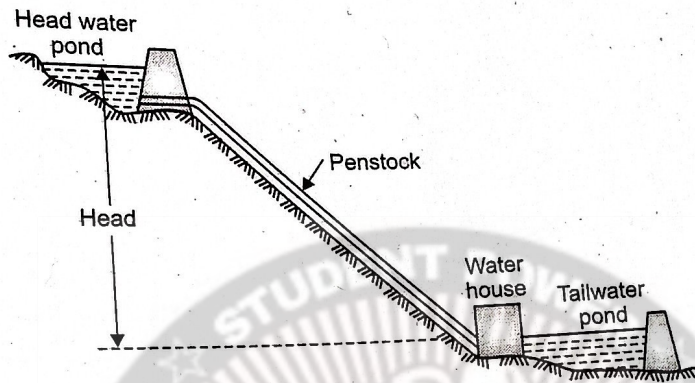


Fig. 4.5: Pumped storage plant

4.5 MERITS AND DEMERITS OF HYDRO-ELECTRIC POWER STATIONS

- Hydro-electric power stations have the following advantages:
 - (i) It is simple in construction, is robust and requires low maintenance cost.
 - (ii) No preparation time is required, hence can be put in service instantly.
 - (iii) It responds to changing loads without difficulty.
 - (iv) There are no standby losses.
 - (v) Few experienced people are required to run the plant.
 - (vi) No fuel is burnt, hence is pollution free.
 - (vii) A single unit of very high output can be used.
 - (viii) Running charges are very small.
 - (ix) Efficiency of the plant remains constant if proper maintenance is carried out.
 - (x) Plant is quite neat and clean.
 - (xi) Water discharged from the turbines can be used for irrigation and other purposes.
- Following are the disadvantages of hydro-electric power stations:
 - (i) Capital cost of generators, civil engineering work etc. are enormously high.
 - (ii) As the plants are in hilly area away from the population, long distance transmission lines are required, which cost very much.
 - (iii) As storage of water is dependable on rains, long dry seasons will affect on the delivery of power.

4.6 LIST OF HYDRO POWER STATIONS WITH CAPACITIES AND NUMBER OF UNITS IN THE STATE

Sr. No.	State	Place	Unit and capacity	Installed capacity
1.	Maharashtra	Koyana	ST. I and II 4 × 70 MW 4 × 80 MW	} 600 MW
2.	Maharashtra	Koyana	ST. III 4 × 80 MW	
3.	Maharashtra	Koyana	ST. IV 4 × 250 MW	1000 MW
4.	Maharashtra	KDPH	2 × 18 MW	36 MW
5.	Maharashtra	Vaitarna	1 × 60 MW	60 MW
6.	Maharashtra	Bhatgar	1 × 16 MW	16 MW
7.	Maharashtra	Tillari	1 × 66 MW	66 MW
8.	Maharashtra	Bhira	2 × 40 MW	80 MW
9.	Maharashtra	Eldari	3 × 7.5 MW	22.5 MW
10.	Maharashtra	Veer	2 × 4.5 MW	9.0 MW
11.	Maharashtra	Radhanagari	4 × 1.2 MW	4.8 MW
12.	Maharashtra	Paithan	1 × 12 MW	12 MW
13.	Maharashtra	Vaitarna D.T.	1 × 1.5 MW	1.5 MW
14.	Maharashtra	Pawana	1 × 10 MW	10 MW
15.	Maharashtra	Panshet	1 × 8 MW	8 MW
16.	Maharashtra	Kanher	1 × 4 MW	4 MW
17.	Maharashtra	Varasgaon	1 × 8 MW	8 MW
18.	Maharashtra	Bhatsa	1 × 15 MW	15 MW
19.	Maharashtra	Dhom	2 × 1 MW	2 MW
20.	Maharashtra	Ujani	1 × 12 MW	12 MW
21.	Maharashtra	Manikdoh	1 × 6 MW	6 MW
22.	Maharashtra	Dimbhe	1 × 5 MW	5 MW
23.	Maharashtra	Surya	1 × 6 MW	6 MW
24.	Maharashtra	Warna	2 × 8 MW	16 MW
25.	Maharashtra	Terwanmedhe	1 × 0.2 MW	0.2 MW
26.	Maharashtra	Dudhganga	2 × 12 MW	24 MW
27.	Andhra Pradesh	Mackund	3 × 17 MW 3 × 21.25 MW	} 114.75 MW
28.	Andhra Pradesh	Upper Sileru	2 × 60 MW	
29.	Andhra Pradesh	Lower Sileru	6 × 100 MW (V plan)	600 MW
30.	Andhra Pradesh	Shri. Sailam	4 × 110 MW 7 × 110 MW (V plan)	} 1210 MW
31.	Assam	Umiam (Stage I)	4 × 9 MW	
32.	Bihar	Subarnarekha	2 × 9 MW	} 54 MW
33.	Jammu and Kashmir	Ujh project	2 × 65 MW	
			4 × 24 MW 1 × 12 MW 1 × 9 MW	} 117 MW

approximate analysis :- It gives implication about
and burning properties of coal favouring
It gives the

Sr. No.	State	Place	Unit and capacity	Installed capacity
34.	Jammu and Kashmir	Chanani Hydel Project	5 × 4.66 MW	23.3 MW
35.	Jammu and Kashmir	Lower Jhelum	7 × 16 MW	112 MW
36.	Kerala	Sabarigiri	6 × 50 MW	300 MW
37.	Kerala	Shalayar	3 × 18 MW	54 MW
38.	Kerala	Iddiki	V plan	39 MW
39.	Chennai	Kuttiadi	3 × 25	75 MW
40.	Chennai	Parambi Kulam	Three Stages	185 MW
41.	Chennai	Periyar	4 × 35	140 MW
42.	Chennai	Kundha 4 Stages	180 MW Stage III 245 Stage IV 110	} 535 MW
43.	Chennai	Mettur tuned	4 × 50 MW	
44.	Chennai	Kodayar	1 × 60 MW 2 × 40 MW (IV plan)	} 140 MW
45.	Mysore	Sharavathi	Stage I 178.2 Stage II 534.6 Stage III 178.2	
46.	Orissa	Balimela	8 × 60 MW V plan	480 MW
47.	Punjab	Bhakra-Nangal	5 × 90 MW 2 × 24 MW 1 × 29 MW 2 × 24 MW 1 × 29 MW 4 × 120	} 1084 MW
			3 × 15 MW	
48.	Punjab	Upper Bari Doab Canal	3 × 33	99 MW
49.	Rajasthan	Jawahar Sagar	6 × 50	300 MW
50.	Uttar Pradesh	Rihane	1 × 11.25	} 433.5 MW
51.	Uttar Pradesh	Yamuna	2 × 17	
			1 × 11.25 MW	
			1 × 17 MW	
			4 × 60 MW	} IV Plan
			4 × 30 MW	
		Obra	3 × 33 MW	99 MW
52.	Uttar Pradesh	Jaldhaka	3 × 9 MW	27 MW
53.	West Bengal	Maithan	3 × 20 MW	60 MW
54.	West Bengal	Panchet hill	1 × 40 MW	40 MW
55.	West Bengal	Tilaiya	2 × 2 MW	4 MW
56.	West Bengal			

Proximate and burning analysis:- It gives indication about the commercial value of coal following properties of coal.

4.7 COMPARISON OF VARIOUS POWER STATIONS

Sr. No.	Comparison point	Steam thermal power station	Nuclear power station	Diesel power station	Gas power station	Hydro electricity power station
1.	Initial cost	Lower than hydro or nuclear plant	Cost is very very high	Cost is very less	Lesser	Initial cost is high as dam construction
2.	Site	Where ample quantity of coal is available	Away from thickly populated areas due to radioactive pollution	At any place	Where fuel is available. Load centre away from populated areas	Where ample supply of water is available in hilly areas
3.	Running cost	Higher due to coal quantity.	Minimum running cost	Highest due to oil cost	Moderate cost	Practically nil (No fuel)
4.	Fuel transport cost	Maximum	Minimum	Higher than hydro.	Moderate	Nil
5.	Cleanliness	Not clean atmosphere polluted	Less than hydro and diesel plant	More clean	Cleaner than steam plant	Cleanest
6.	Efficiency	About 20% only	More efficient than steam plant	35% (more than steam plant)	Very very less, about 20% only	85% most efficient
7.	Starting time	A lot more time to start	Started easily	Quick start	Very short time required	Instant start
8.	Maintenance cost	Very higher	Very high as trained persons are employed	Very very less	Moderate	Very low
9.	Transmission and distribution cost	Low as location is near load centre	Low as located near load centres	Very very low	Low	Very high as located away from load centres
10.	Space required	Large space required	Minimum space required	Less space required	Less space required	Very very large space required

EXERCISE

1. Write a note on energy conservation.
2. Give the classification of hydro power plants.
3. As per size (capacity) give the installed capacity and use of hydro plant.
4. Give the various factors for selection of site for hydro plant.
5. Draw a layout of hydropower plant and explain.
6. Explain the working of different components of hydro power plant.
7. Give the classification of turbines used in hydro plant.
8. Draw a neat sketch of Pelton wheel and explain.
9. Draw a neat sketch of Francis turbine and explain.
10. Draw a neat sketch of Kaplan turbine and explain.
11. Give the classification of hydro plants according to quantity of water. Explain in brief.
12. Give the classification of hydro plants according to available head.
13. Give advantages and disadvantages of hydro plant.
14. Write a note on generator used in hydro plant.
15. List the hydro power plants, their location, unit and installed capacity.