Module-1

Hydroelectric Power Plants

HYDROLOGY

- Hydrology deals with the occurrence & distribution of water over & under the earth surface.

- The study of how the major bodies of water have shifted, expanded and changed land masses is an example of hydrology.

- Its primary objective is the study of the interrelationship between water and its environment.

RUN OFF

- Part of precipitation which is available as stream flow.
- Run off = Total precipitation – Total evaporation
- Part of precipitation is absorbed by soil & percolated into the ground & will reach the catchment area through the underground channels.
- Total run off = Direct run off through land surface + Run off through seepage.
- Factors affecting run off are rainfall intensity, amount & duration, Nature of soil, Size & shape of catchment area.
- The unit of run off are m^3/s or day-second metre

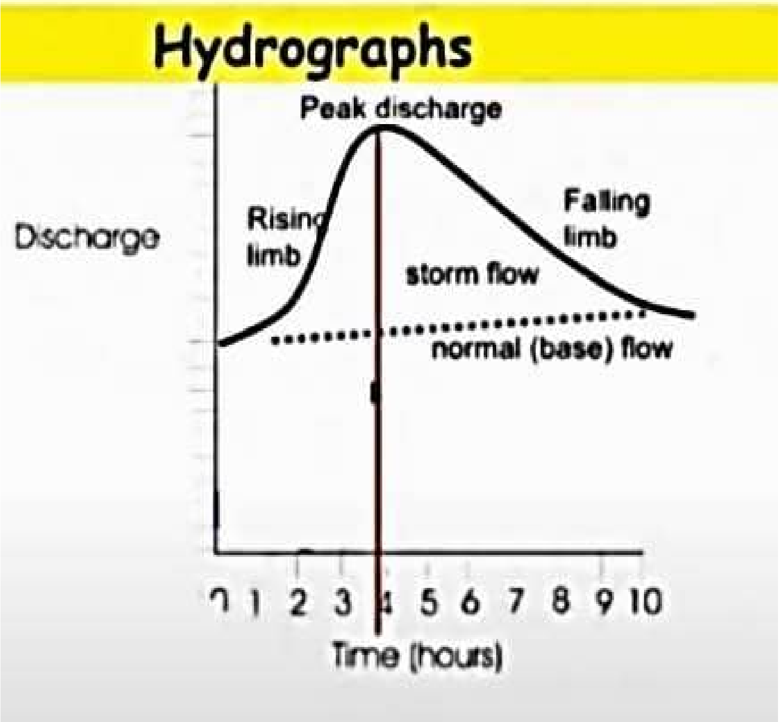
STREAM FLOW

- It is defined as the amount of water in a river channel, typically expressed as the volume of flow passing a defined point over a specific time period.

- It is determined by measuring stream velocity and multiplying by the river cross sectional area.

HYDROGRAPH

- It is the plot between discharges versus time of the flow.
- This is used to evaluate peak discharge from a location.
- Hydrograph indicates the available power from the stream at different times of the day or year.
- It provides average, maximum & minimum run off during the period.



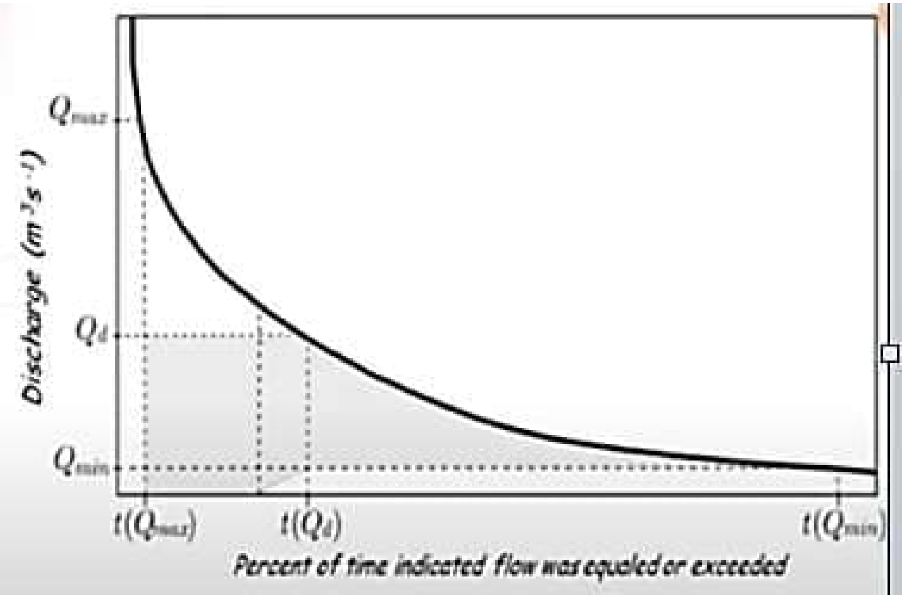
FLOW DURATION CURVE

- Flow duration curve is the plot of discharge versus percentage of time for which the discharge is available.
- Discharge can be in cubic meters per second, week or unit of time.
- If head at which the flow is available is known the discharge can be calculated in terms of Kilowatt power
- $P = (0.736/75)\ Q\ \rho\ \eta\ h$ KW

  Where Q = Discharge in m^3/Sec

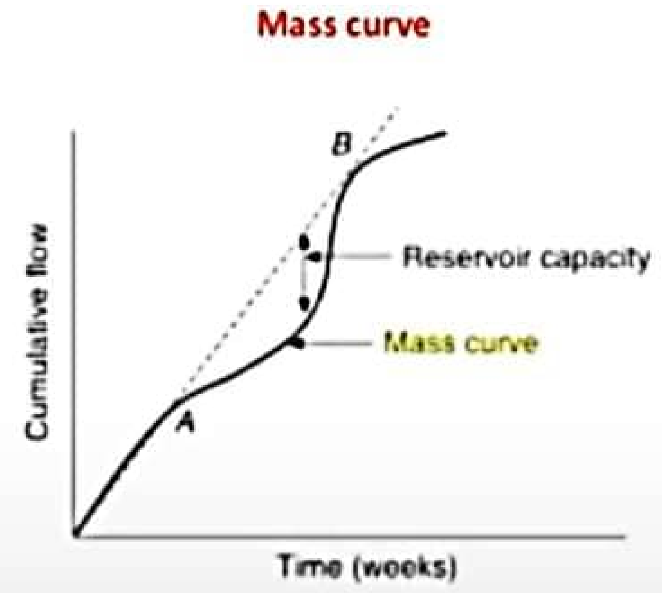
  ρ = Density of water, η = Efficiency

  h = Available head in meters



MASS CURVE

- It is the cumulative volume of water that can be stored from a stream flow versus time in days, weeks or months.
- It indicates the total volume of run off in m^3 up to a certain time.
- The unit used for storage is either cubic metre or day second metre.
- The capacity of plant is based on the storage capacity which can be modified by storage for same mass curve.
- The water stored in dams is pondage & water stored in upstream reservoirs is storage.



Reservoir capacity

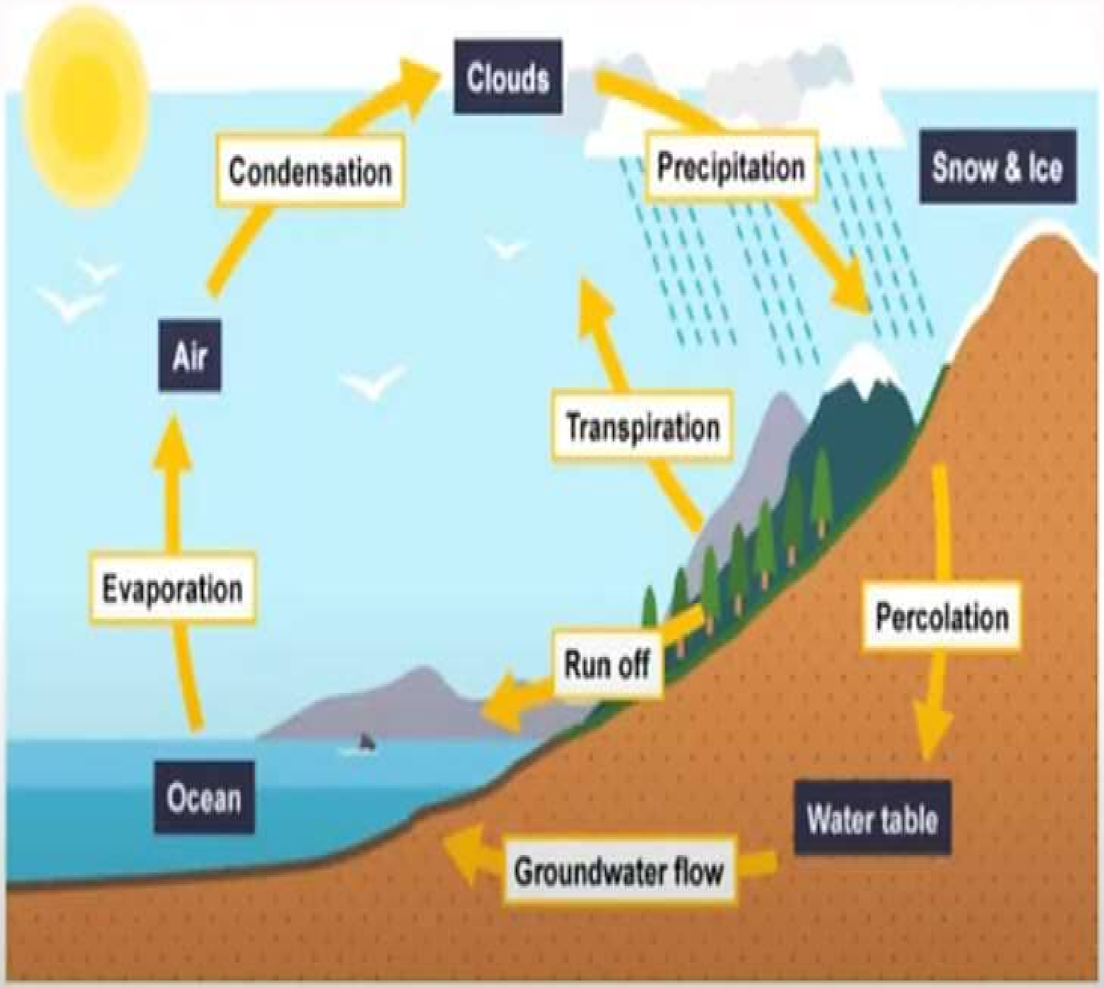
- depends upon the inflow available and demand
- inflow in the river is always greater than the demand, there is no storage required
- if the inflow in the river is small but the demand is high, a large reservoir capacity is required

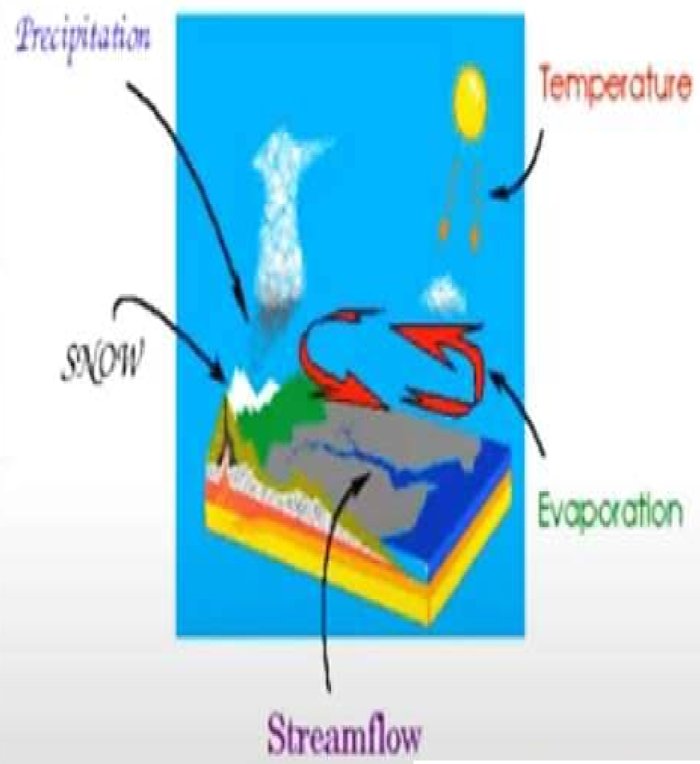
DAM STORAGE

- It is defined as impounding of a considerable amount of excess runoff during seasons of surplus flow for use in dry seasons.

- This is accomplished by constructing a dam across the stream at a suitable site and building a storage reservoir on the upstream side of the dam.

HYDROLOGICAL CYCLE





EVAPORATION

- It is the process by which water from solid or liquid state is converted into vapour form (gaseous state).
- Evaporation includes total rainfall that is returned to atmosphere from land & water surfaces.
- Evaporation by transpiration.

CONDENSATION

- It is the process by which water vapour changes it's physical state from a vapour, most commonly, to a liquid.
- Condensation is brought about by cooling of the air or by increasing the amount of vapor in the air to its saturation point.

PRECIPITATION

- The total condensation of moisture that reach the earth in any form

    ie., Rains, Ice, Hails, Dew & Frost.
- The cause of precipitation other than dew & frost is adiabatic expansion of air.

PERCOLATION

- It is the movement of water though the soil, and it's layers, by gravity and capillary forces.

TRANSPIRATION

- It is the biological process that occurs mostly in the day.

RUNOFF

- It is flow from a drainage basin or watershed that appears in surface streams.

Hydroelectric Power Plants

- Hydroelectric power is the power obtained from the energy of falling water
- Hydroelectric power plant is the power plant utilizing the potential energy of water at a high level for generation of Electrical energy.
- In hydroelectric power stations, water head is created by constructing a dam across a river or lake.

- If harnessed this can be converted into kinetic energy & this kinetic energy is converted to M.E by allowing the water to flow through the turbine.
- This mechanical energy is utilized to run an electric generator which is coupled to the turbine Shaft.
- The pressure head of water or Kinetic energy of water is utilized to drive the turbines coupled to alternators for generation of power.

- $P = W Q H \eta \times 9.81 \times 10^{-3}$ KW

Where

P = Power generated by the plant

W = Specific weight of water in kg/m^3

Q = Rate of flow of water in m^3/s

H = Height of head in meters and

η = Efficiency

- In order to meet the demand of electric power for industrial, agricultural, commercial & domestic purposes.

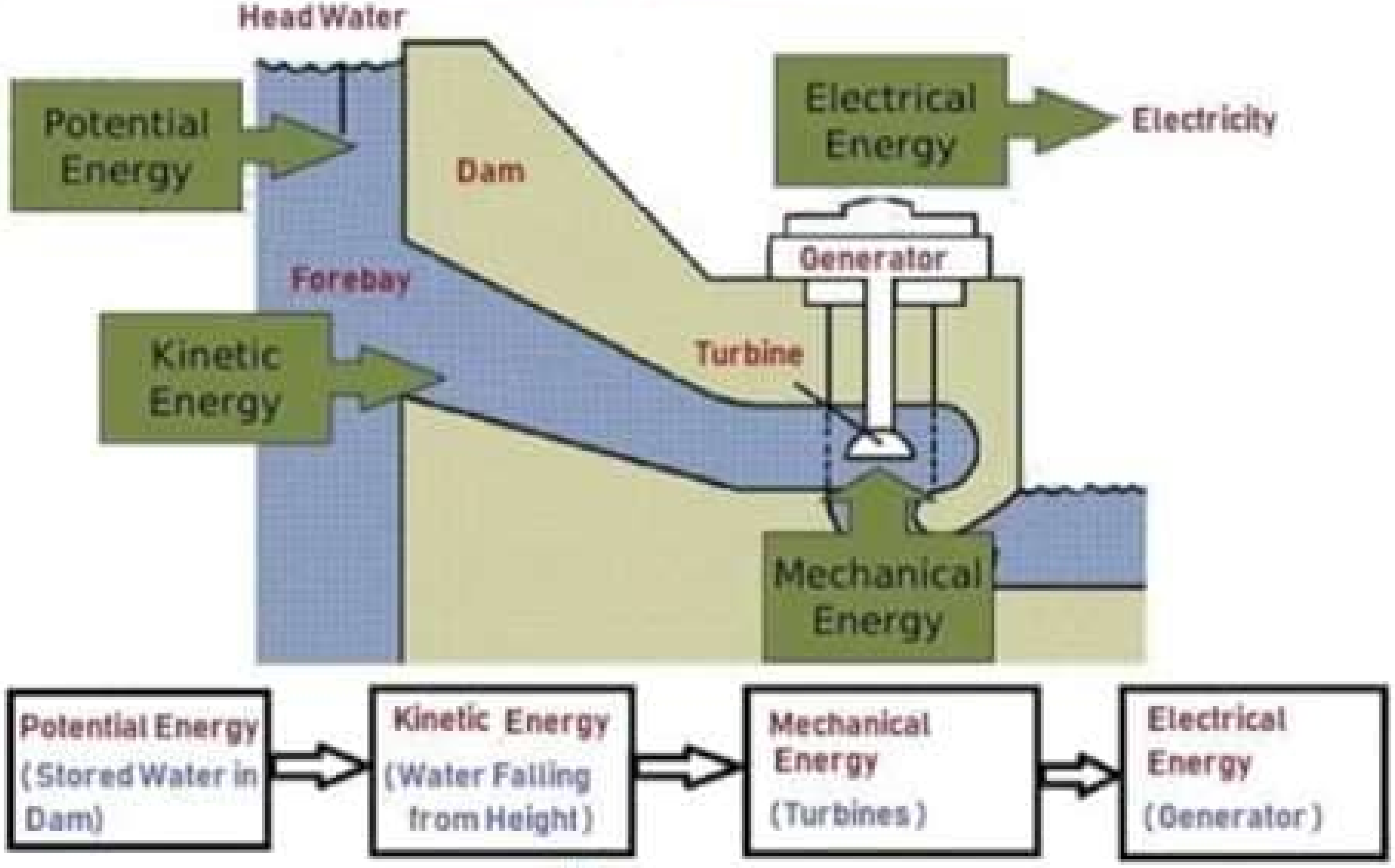
- A water power site is usually developed to supply electric power.

- Hydro electric power plants is usually located in hilly areas where the dam can be build easily & large reservoirs can be obtained.

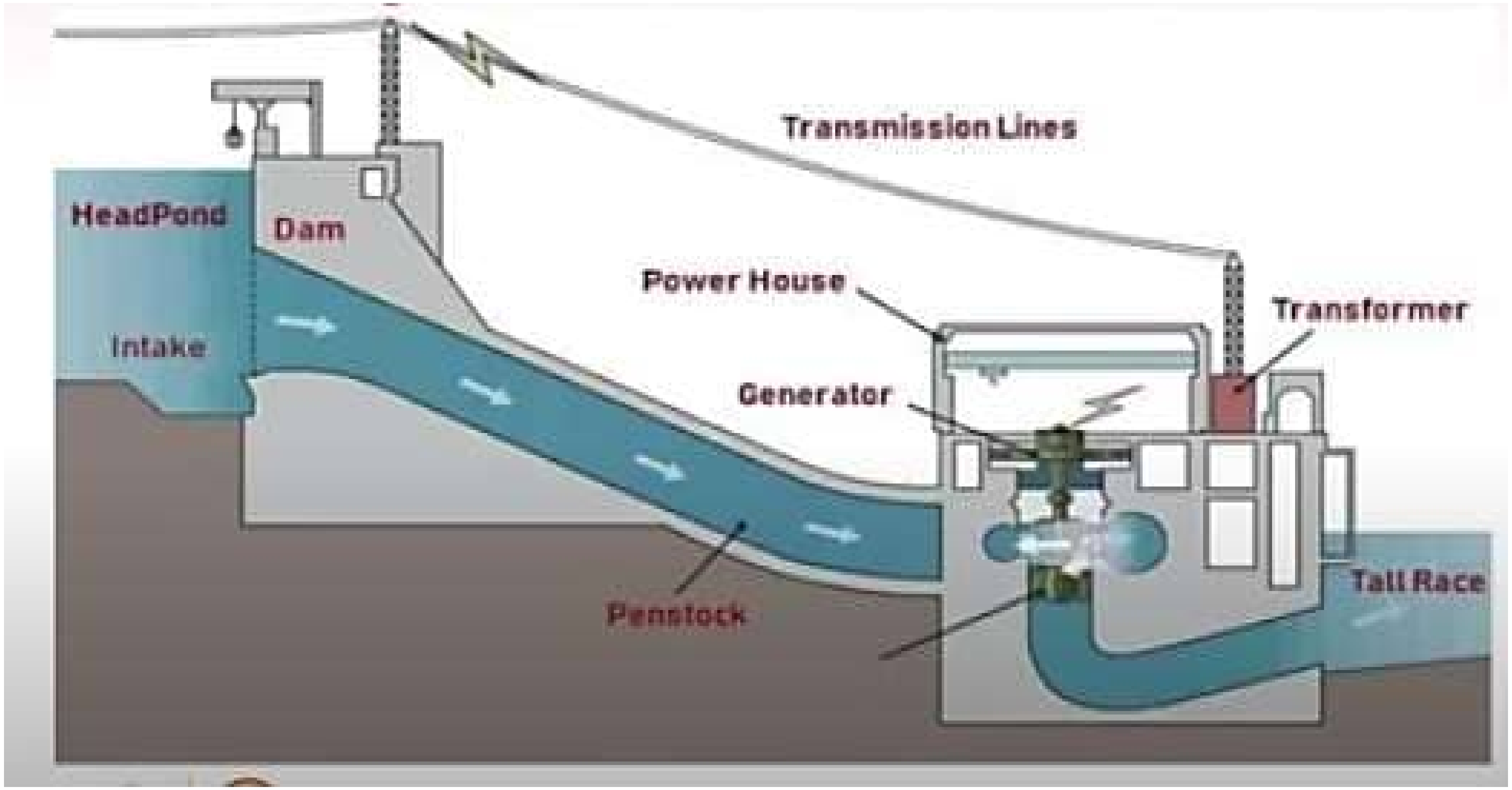
- Most of the High head power sites naturally lie in hilly areas.

- Medium & Low head site developments, usually occupy the steep plateaus & the plains.

Basic Block Diagram of Energy Conversion in Hydroelectric Power Plant



How does Hydro Electric Power Plant Work



How Many Hydro Electric Power Station

Hydro Power	Capacity	Description
Large-hydro	> 100MW	Usually feeding a large electricity grid.
Medium-hydro	15 – 100MW	Usually feeding a grid
Small-hydro	1 – 15MW	Usually feeding into a grid
Mini-hydro	100kW – 1MW	Stand alone scheme
Micro-hydro	Up to 100kW	Provide power for small community or rural industry in remote area.
Pico-hydro	Under 5kW	Require only small capacity

Applications of Hydro Electric Power Plant

- Unlike other source of energy, Hydroelectric Power Plant helps in generating Eco Friendly Energy.
- They help in creating Recreational Facilities.
- It also helps in Flood Risk Management.
- The water from the dam is used for Agricultural Irrigation Facility.

Merits of Hydroelectric Power Plants

- No fuel is required here, as water is source of energy. Hence operating costs are low and no problems in handling and storage of fuels.
- Plant will be neat & clean because no ash or smoke is produced.
- It is highly reliable & is cheapest in operation & maintenance.

- Hydro stations are able to respond to rapidly changing loads without loss of efficiency.
- These plants are robust & have got longer life.
- Highly skilled people are needed only at the time of construction but later on only few experienced persons will be required.

- It can run & synchronized in few minutes.
- Cost of land is not a problem, as the hydro stations are situated away from the developed areas.
- The efficiency of these plants does not fall with the age.
- These plants are used for flood control & irrigation purpose.

Demerits of Hydroelectric Power Plants

- It requires large area.
- Power generation by the hydro-plant is only dependent on the quality of water available, which in turn depends on rain.
- Long transmission lines are required as plants will be located in hilly areas which are away from load centre.
- Its construction cost is enormously high
- During the dry year, the power production may be curtailed or even discontinued. This availability of power from such plants is not much reliable.

Selection of site for Hydroelectric Power Plant

- **Availability of Water**
  - ✓ Water energy can be available in form of Potential energy or Kinetic energy.
  - ✓ Stations should be built where adequate water is available.
  - ✓ Normally water is collected in reservoirs during the during the rain & used for production throughout the year.

- **Water Storage**
  - ✓ When kinetic energy is low it is preferable to have the reservoirs to collect the water for use of electricity production
  - ✓ Due to variation in rainfall it is necessary to store the water in reservoirs
  - ✓ The storage capacity is calculated by mass curve.

❑ Water Head

- ✓ Availability of head depends upon the topography of area.
- ✓ High head means high potential energy.
- ✓ An effective head reduces the quantity of water to be stored & handled by penstocks, screens & turbines therefore capital cost of plant is reduced.

❑ Accessibility of Site

- ✓ The site should be easily accessed by rail or road for transporting the plant equipment's.

❑ Water Pollution

- ✓ Polluted water may cause excessive corrosion & damage to metallic structures, hence good quality water is essential.

❑ Availability of Land

- ✓ The land should be cheap in cost & rocky in order to withstand weight of large structure.

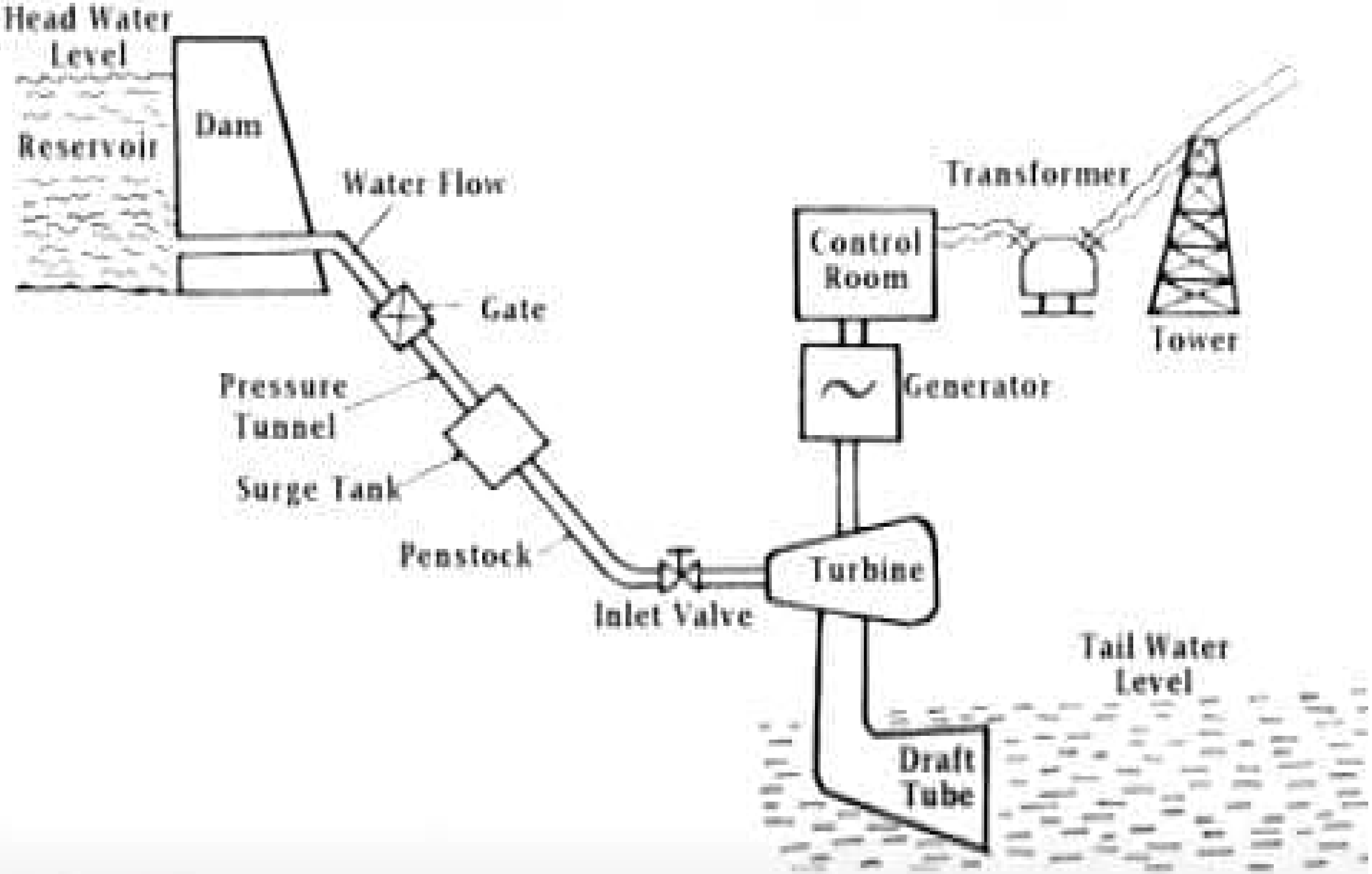
❑ Large Catchment Area

- ✓ The reservoir should have large catchment area , so that level of water in reservoir will not fall below the minimum required in dry season.

❑ Distance from Load Centre

- ✓ The generating stations are located far away from load centre.
- ✓ Hence for economical transmission of power, the routes & distances need active consideration.

GENERAL ARRANGEMENT OF HYDEL PLANT



ELEMENTS OF HYDROELECTRIC POWER PLANTS

- Reservoir
  - ✓ The function or purpose of reservoir is to store the water during rainy season and supply the same during dry season. This is in simple, water storage area.
- Head Race
  - ✓ They carry water to the turbines from the reservoir.

ELEMENTS OF HYDROELECTRIC POWER PLANTS

❑ Dam

- ✓ The function of dam is to increase the height of the water level behind it which ultimately increases the reservoir capacity.
- ✓ The dam also helps in increasing the working head of the power plant.
- ✓ Dams are generally built to provide necessary head to the power plant.

❑ Forebay

- ✓ The function of forebay is to act as regulating reservoir temporarily storing water when the load on the plant is reduced and to provide water for initial increment of an increasing load while water in the canal is being accelerated.
- ✓ Forebay may be considered as an enlarged body of water just above the intake to storage water temporarily to meet hourly load fluctuations.

ELEMENTS OF HYDROELECTRIC POWER PLANTS

❑ Trash Rack

- ✓ The water intake from the dam or from the forebay is provided with trash rack.
- ✓ The main function of trash rack is to prevent the entry of any debris which may damage the turbine runners.
- ✓ During winter season when water forms ice, to prevent the ice from clinging to the trash racks, they are often heated electrically.

❑ Spillway

- ✓ The function of spillway is to provide safety of the dam.
- ✓ Spillway should have the capacity to discharge major floods without damage to the dam and at the same time keeps the reservoir levels below some predetermined maximum.

ELEMENTS OF HYDROELECTRIC POWER PLANTS

❑ Penstock

- ✓ A penstock is a huge steel pipe which carries water from the reservoir to the turbine.
- ✓ Potential energy of the water is converted into kinetic energy as it flows down through the penstock due to gravity.

❑ Draft Tube

- ✓ The draft tube is a part of the reaction turbine.
- ✓ An air tight pipe of suitable diameter attached to the runner outlet and conducting water down from the wheel & discharging it under the surface of water in tail race.

ELEMENTS OF HYDROELECTRIC POWER PLANTS

❑ Surge Tank

- ✓ Surge tanks are usually provided in high or medium head power plants when considerably long penstock is required.
- ✓ A surge tank is a located near the beginning of penstock
- ✓ The water level in the surge tank rises or falls to reduce the pressure swings in the penstock
- ✓ A tank connected to a pipe carrying a liquid and intended to neutralize sudden changes
- ✓ of pressure in the flow by filling when the pressure increases and emptying when it drops.

ELEMENTS OF HYDROELECTRIC POWER PLANTS (

- Control Gate
  - ✓ 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.
- Tail Race
  - ✓ Water is discharged into the tail race after passing through, the turbine which carriers it into the river.
  - ✓ The discharge from all the turbines is collected in the tailrace at its beginning by means of branch channels.
  - ✓ The tailrace may discharge into Original River.

❑ Generator

- ✓ A generator is mounted in the power house and it is mechanically coupled to the turbine shaft.
- ✓ Kinetic energy of the water drives the turbine.
- ✓ When the turbine blades are rotated, it drives the generator and electricity is generated which is then stepped up with the help of a transformer for the transmission purpose.

❑ Power House

- ✓ The purpose of the power house is to support and house the hydraulic and electrical equipment.

ELEMENTS OF HYDROELECTRIC POWER PLANTS

❑ Prime mover or Hydro Turbine

- ✓ Water from the penstock is taken into the water turbine.
- ✓ Turbine converts hydraulic energy into mechanical energy.
- ✓ The mechanical energy developed by a turbine is used in running an electric generator.
- ✓ The turbine is mechanically coupled to an electric generator.
- ✓ There are two main types of water turbine: Impulse turbine and Reaction turbine.
- ✓ Impulse turbines are used for large heads
- ✓ Reaction turbines are used for low and medium heads.

CLASSIFICATION OF HYDRO-ELECTRIC POWER PLANT

CLASSIFICATION - BASED ON WATER FLOW REGULATION

- Run off river power plants without pondage
  - ✓ Water is not stored here, it uses the water as it comes. So this type of power station is not suitable for constant steady load.
  - ✓ This type of plan cannot use all the time.
  - ✓ There is no control on flow of water.
  - ✓ Generating capacity depends primarily on rate of flow of water.
  - ✓ During high flow and low load period, water is wasted.
  - ✓ During rainy season, some of the water is wasted without using for generation of power.
  - ✓ During low run off period due to low flow rates, the generating capacity of plant is low.

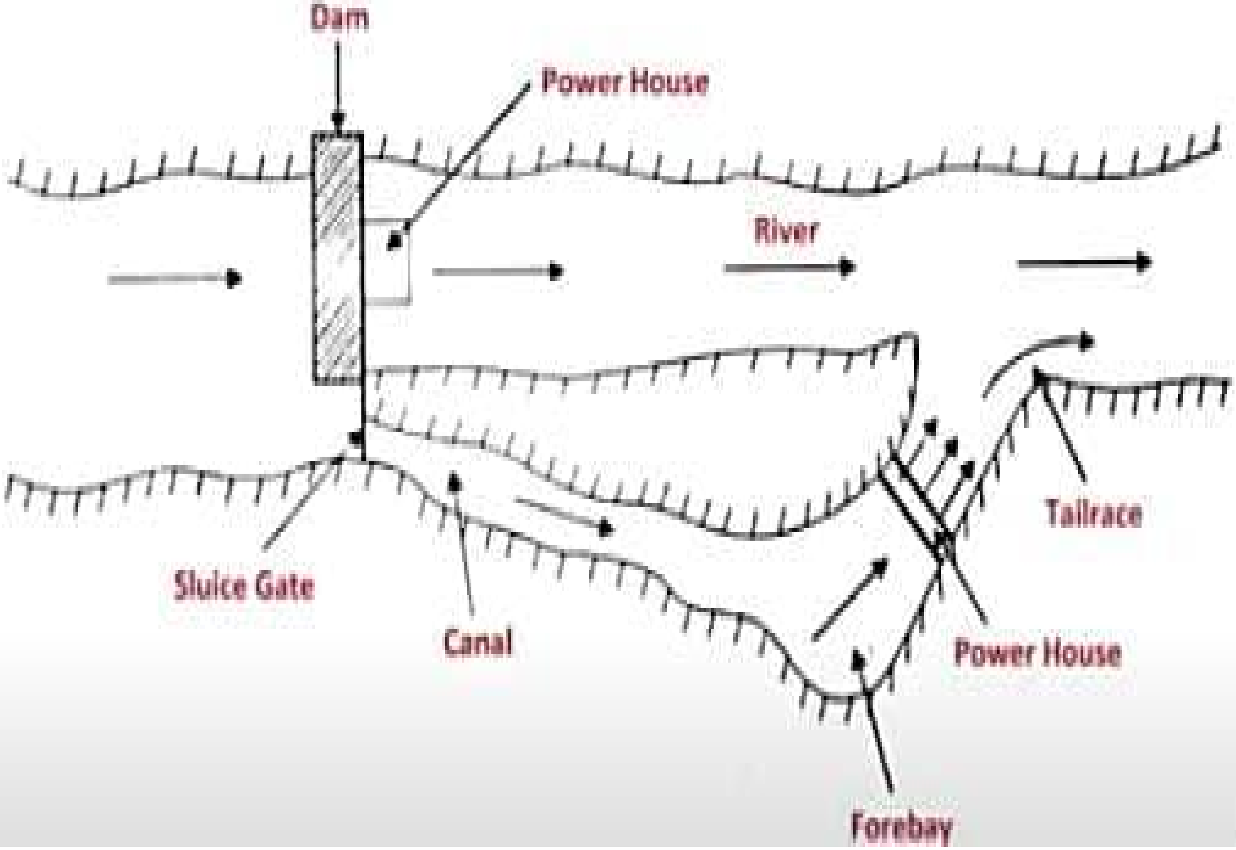
❑ Run off river power plants with pondage

- ✓ Usefulness of run off river is increased by pondage
- ✓ Pondage permits the storage of water in off peak periods & use of this water in peak periods
- ✓ These plants can be used in parts of load curve requirements, within certain limitations
- ✓ During high flow periods, these plants may be used as base load & during lean flow periods these plants may be used to supply peak loads only.

❑ Reservoir Power Plant

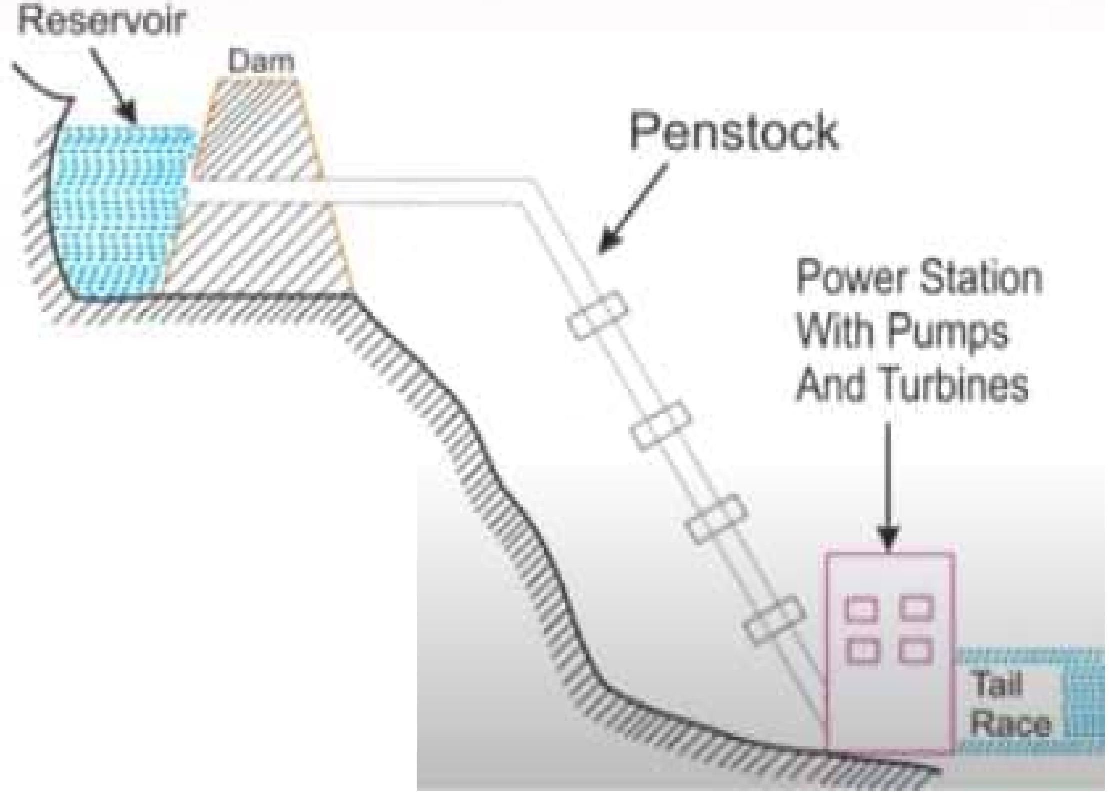
- ✓ Most hydroelectric power plant in the world is reservoir power plant.
- ✓ Water is stored in big reservoir behind the dam and water is available throughout the year even in dry season.
- ✓ It is possible to control the flow of water & use it more effectively.
- ✓ This type of power plant is very efficient.
- ✓ This can be used as both base load and peak load as per the requirement.

CLASSIFICATION - BASED ON WATER FLOW REGULATION



CLASSIFICATION - BASED ON WATER HEAD

Low Head Hydro Electric Power Plant

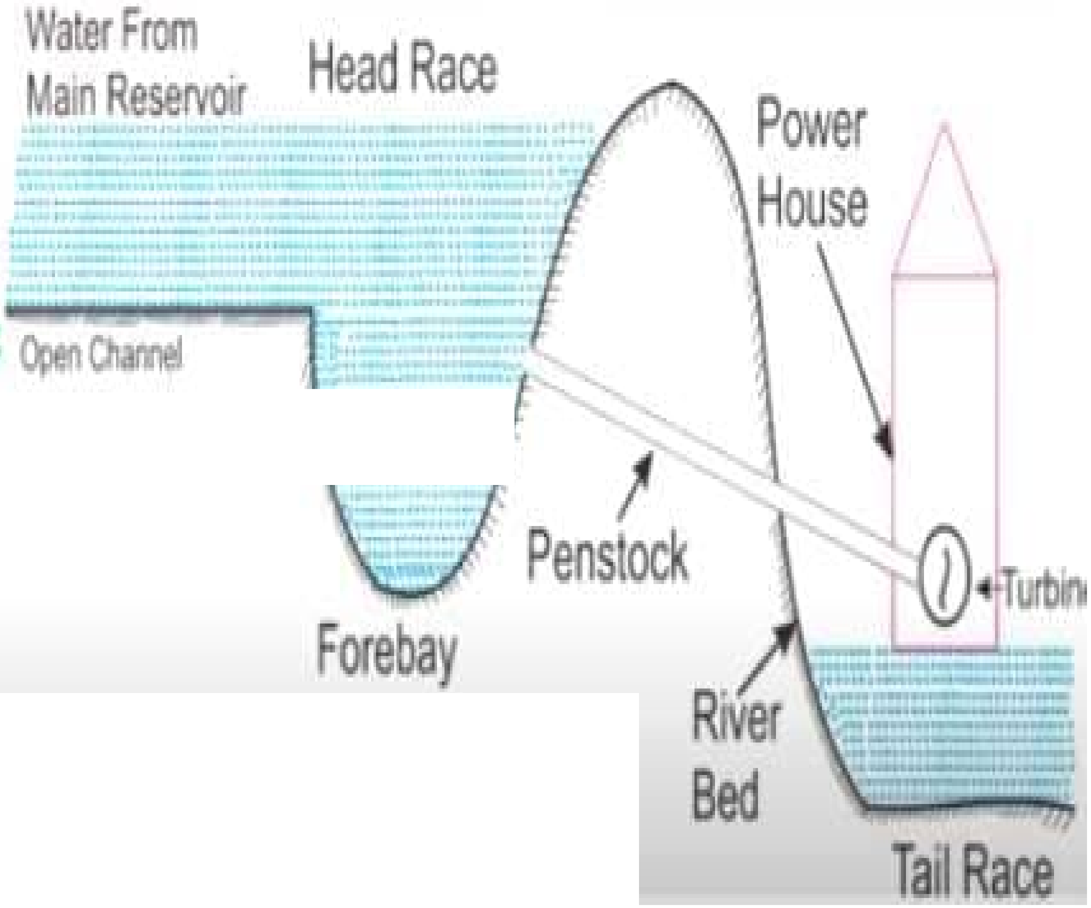


LOW HEAD HYDRO ELECTRIC POWER PLANT

- The operating head of this plant is less than 30 meters
- Francis, Kaplan or propeller turbines are used for this type of hydro electric power plant.
- To create a low head , dam construction is essential.
- Water resource level i.e. river or pond is placed just behind the dam to create a necessary water head level. Water is led to the turbine through the penstock.
- This type of hydro plant is located just below the dam and it creates a useful water level as well.
- No surge tank is required for this plant, dam itself discharge the surplus water from the river.
- Science head is low, huge amount of water is required for desire output. That's why large diameter and low length pipe is used for this plant.

CLASSIFICATION - BASED ON WATER HEAD

Medium Head Hydro Electric Power Plant



MEDIUM HEAD HYDRO ELECTRIC POWER PLANT

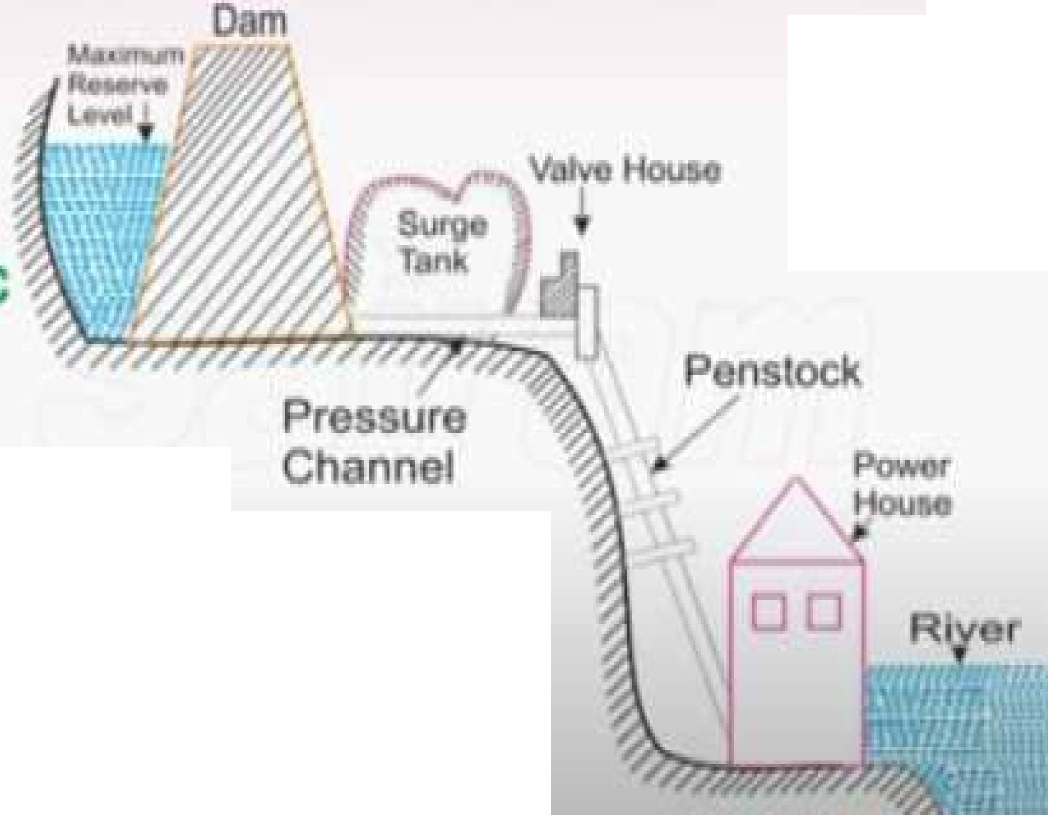
- The operating head is less than 300 meters, but mor meters
- The reservoir is formed by the construction of dam.
- The power channel is usually an open canal which conveys the water from reservoir to a fore bay situated at the commencement of pipeline.
- Francis turbines are normally used in such power plants.

MEDIUM HEAD HYDRO ELECTRIC POWER PLANT

- ✓ A forebay is used for medium head hydro electric power plant.
- ✓ This forebay is worked as a surge tank.
- ✓ Forebay is tapped with the river and water is led to the turbine via penstock.
- ✓ Forebay is just beginning of penstock.
- ✓ For low head plant forebay itself serves as a surge tank.

CLASSIFICATION - BASED ON WATER HEAD

High Head Hydro Electric Power Plant



HIGH HEAD HYDRO ELECTRIC POWER PLANT

- ✓ The operating head of this power plant is more than 300 meters.
- ✓ A dam is constructed such level that maximum reserve water level is formed.
- ✓ A pressure tunnel is constructed which is connected to the valve house.
- ✓ Water is coming from reservoir to valve house via this pressure tunnel and it is the starting of penstock.
- ✓ For high head more than 500 meters, Pelton Wheel turbine is used and for lower head Francis turbine is useful.

- ✓ A surge tank is also constructed before valve house which reduces water hammering to the penstock in case of sudden closing of fixed gates of water turbine.
- ✓ Surge tank also store some extra water which is useful for pick load demand because it will serve extra water to the turbine.
- ✓ Valve house consists of a main valve sluice valves and automatic isolating valves, which operate on bursting of penstock and cut off further supply of water to penstock.
- ✓ The penstock is a connecting pipe which supplies water from valve house to turbine.

CLASSIFICATION - BASED ON TYPE OF LOAD SUPPLY

❑ Base Load Hydro Electric Power Plant

- ✓ This is a large capacity power plant.
- ✓ This plant work as a base portion of load curve of power system, that's why it is called base load plants.
- ✓ Base load plant is suitable for constant load.
- ✓ Load factor of this plant is high and it is performed as a block load.
- ✓ Run off river plants without pondage and reservoir plants are used as base load plants.

CLASSIFICATION - BASED ON TYPE OF LOAD SUPPLY

- Peak Load Hydro Electric Power Plant
  - ✓ This plant is suitable for peak load curve of power system.
  - ✓ When demand is high,
  - ✓ This type of plant do their job very well.
  - ✓ Run off river plants with pondage can be employed as peak load plants.
  - ✓ If water supply is available, it generates large portion of load at a peak load period.
  - ✓ It needs huge storage area.
  - ✓ Reservoir plants can be used as peak load plants.
  - ✓ This type of plant can serve power throughout the year.

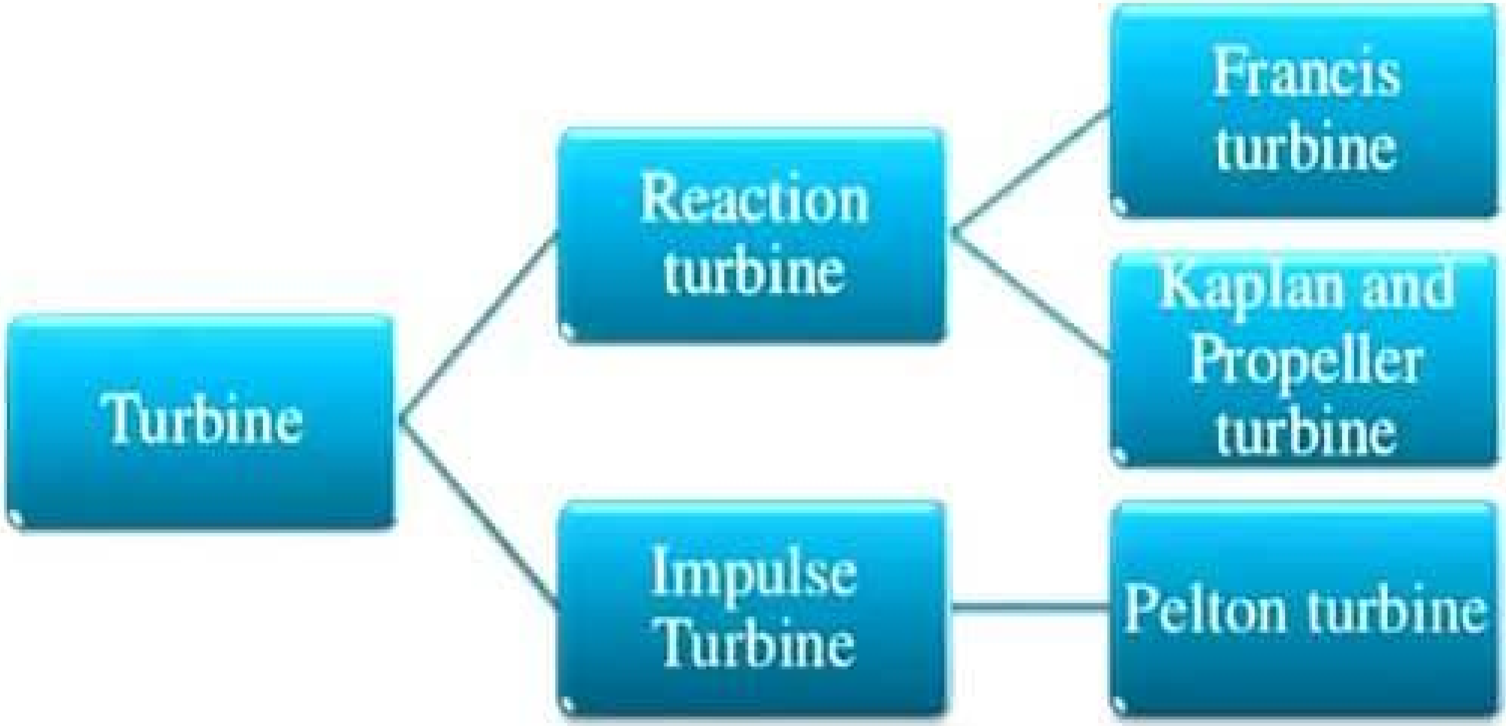
CLASSIFICATION - BASED ON TYPE OF LOAD SUPPLY

❑ Pumped Storage Hydro Electric Power Plant

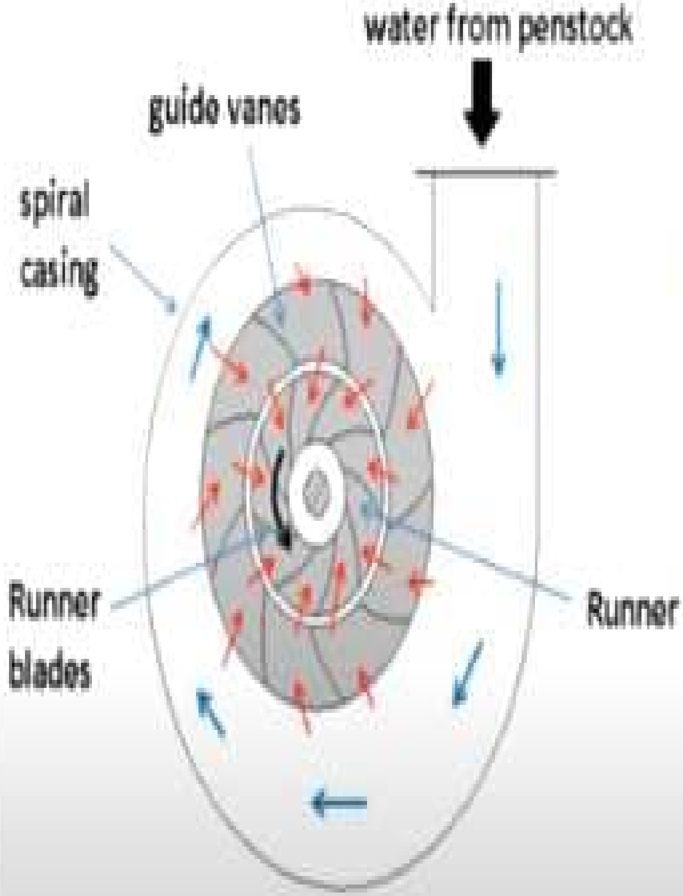
- ✓ This is unique design of peak load plants.
- ✓ Here two types of water pond is used, called upper head water pond and tail water pond.
- ✓ Two water ponds are connected each other by a penstock.
- ✓ Main generating pumping plant is lower end.

- ✓ During the off load period, surplus energy of this plant is utilized to pumping the lower head pond water to upper head pond water.
- ✓ This extra water is used to generate energy at peak load periods.

Classification of Water Turbines

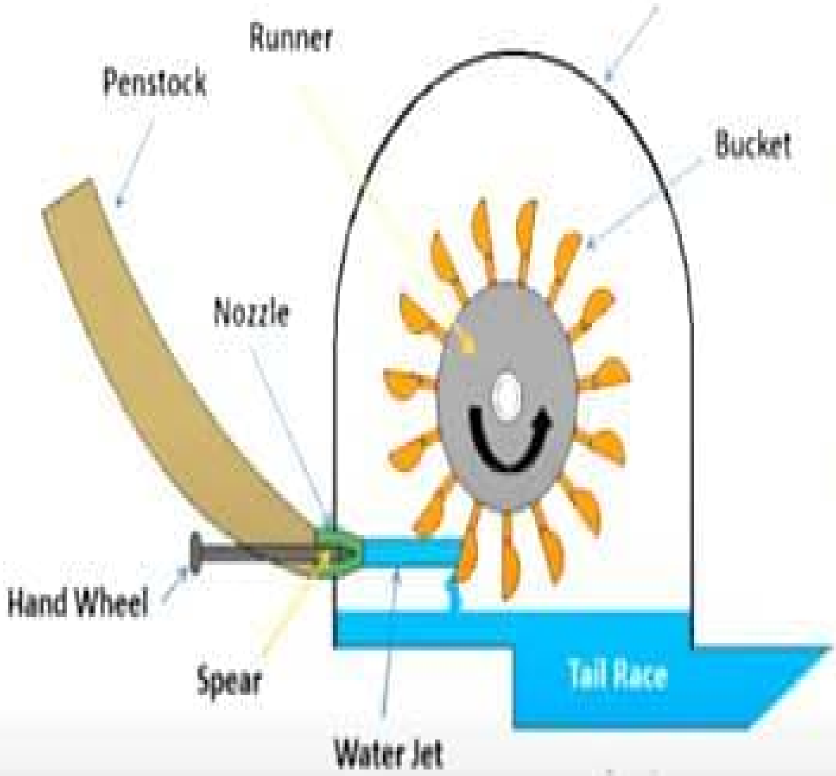


Reaction Turbine



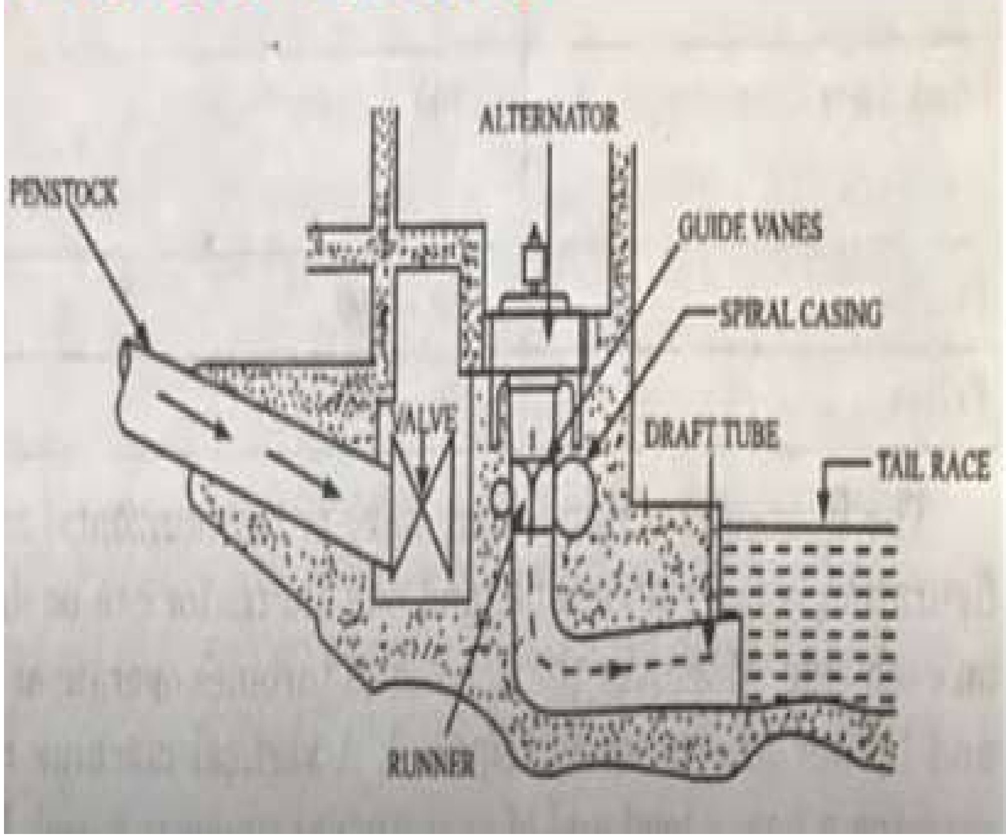
- The energy is in both Kinetic and Pressure form. e.g: Tubular, Bulb, Propeller, Francis turbine.
- In a reaction turbine, the water enters the wheel under pressure and flows over the vanes.
- As the water flowing over the vanes is under pressure, therefore wheel of the turbine runs full and may be submerged below the tailrace or may discharge into the atmosphere.
- The pressure head of water, While flowing over the vanes, is converted into velocity head and is finally reduced to the atmospheric pressure before leaving the wheel.

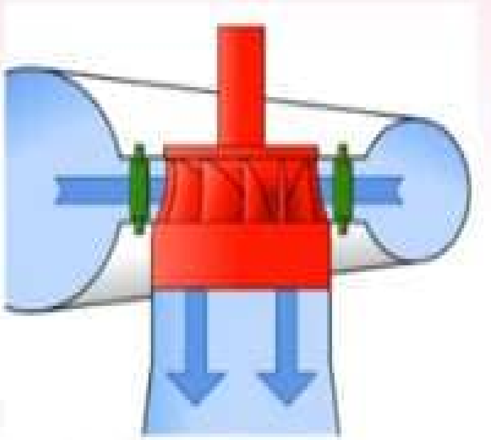
Impulse Turbine



- The energy is in the form of kinetic form. e.g: Pelton wheel, Turbo wheel.
- The potential energy of the water is converted into kinetic energy by passing it through a nozzle.
- Once we have high speed water jet, we can use its impact to rotate a turbine.

Francis Turbine





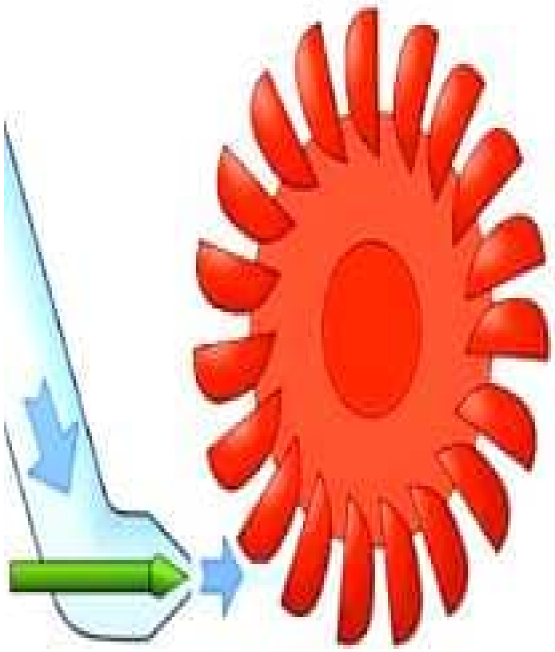
Francis Turbine

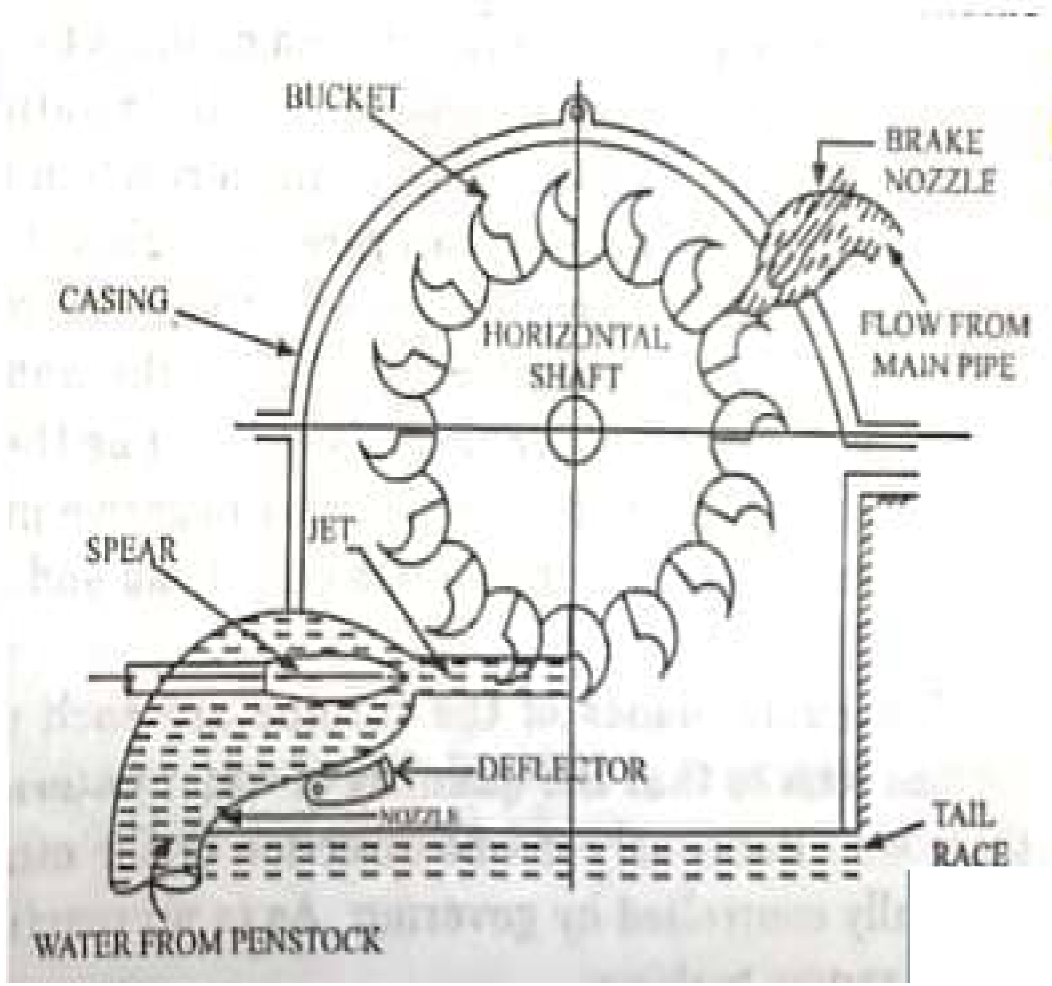
- The water enters the turbine through the outer periphery of the runner in the radial direction and leaves the runner in the axial direction, and hence it is called 'mixed flow turbine'.
- They develop power partly due to velocity of water & due to the difference in pressure acting on front & back of runner buckets.
- In these turbines water guides over the blades with small velocity & exerts pressure.
- The water flow radically inwards & changes to downward reaction while passing through runner.

Francis Turbine

- As water is passes over the rotating blades of runner both pressure and velocity of water is reduced causing reaction force driving turbine
- Water is discharged through tail race through a closed tube of increasing cross section draft tube.
- The guide blades are each pivoted about an axis in parallel with the turbine axis so that the quantity of water entering the turbine may be regulated by turning them simultaneously.
- A Francis turbine is suitable for medium heads (45m to 400 m) and requires a relatively large quantity of water.

Pelton Turbine





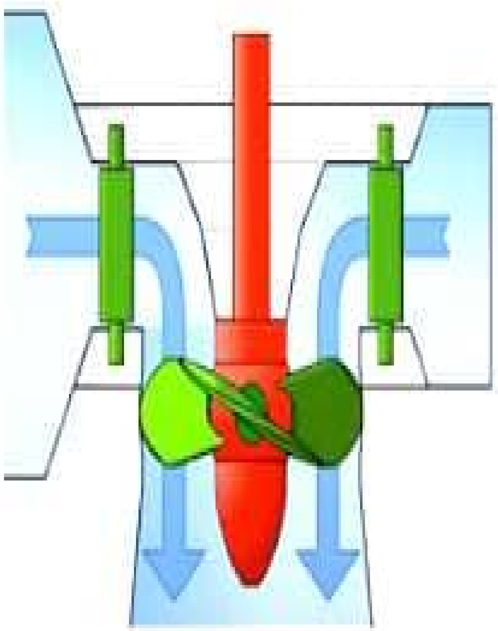
Pelton Turbine

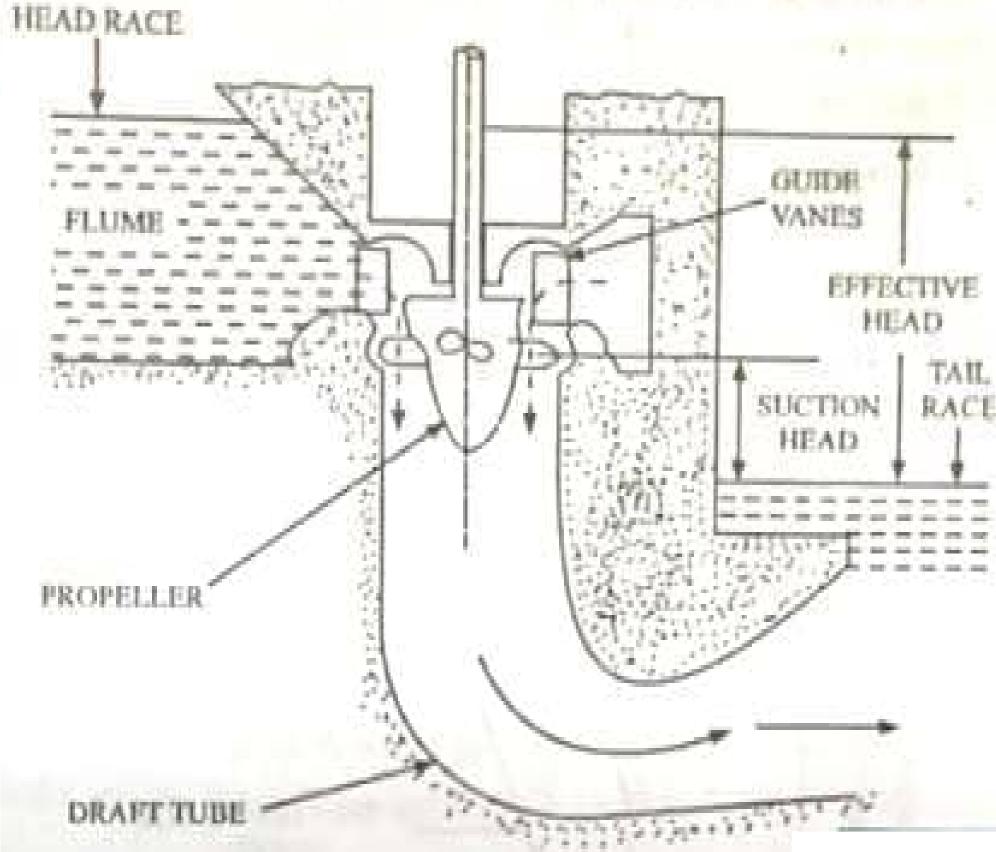
- It consists of a rotor equipped with elliptical shaped buckets along the periphery of the turbine.
- The rotor of runner is cast steel, Bronze or Stainless steel.
- The water impinges on the turbines which causes the motion of rotor.
- The quantity of water discharged is controlled by controlling the nozzle opening by means of needle placed in nozzle tip.
- The movement of needle is controlled by governor.

Pelton Turbine

- When the load on turbine reduces the governor pushes the needle into nozzle, thereby reduces the quantity of water striking buckets.
- Majority are horizontal shaft type, this has two nozzles.
- The buckets are bolted on to the runner but integral casting of buckets with runner is also possible.
- This turbine is not suitable for water heads below 200 meters.

Kaplan Turbine



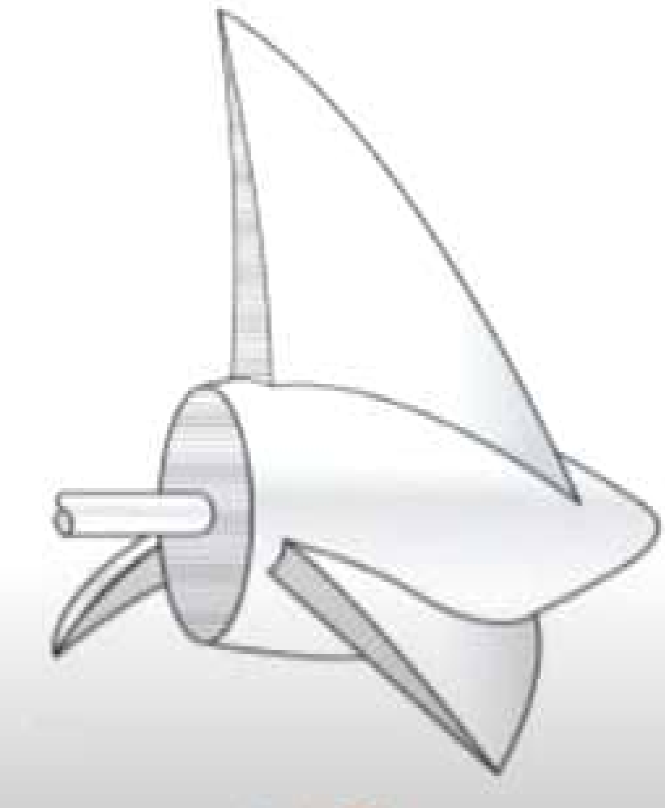


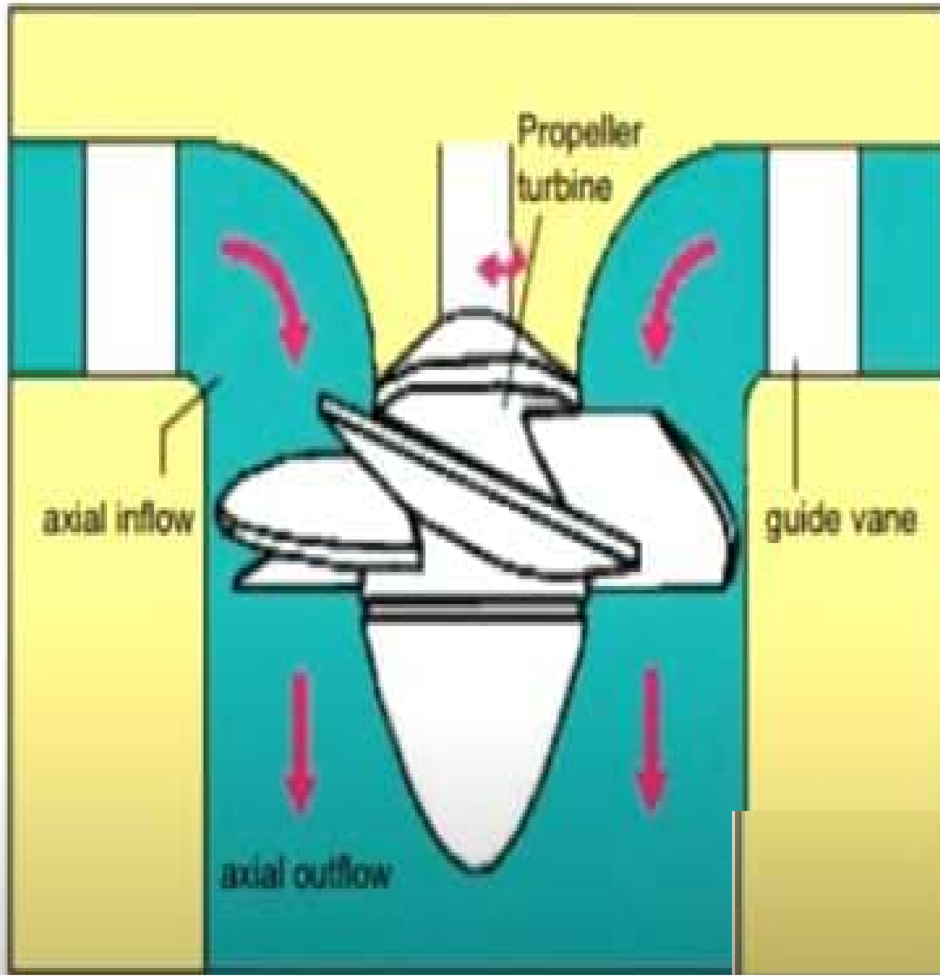
Kaplan Turbine

Kaplan Turbine

- This is reaction turbine & has gate governing mechanism similar to that of Francis.
- The water flow strikes the blades axially and receives water radially.
- This water flow radially inwards through regulating gates all rounds the sides, changing direction in the runner to axial flow & causing reaction force which drives turbine.
- They are Vertical shape shaft.
- This has highest specific speed, is suitable for low head & large flow plants.
- The runner blades are less in Kaplan turbines (3 to 6).
- A Kaplan turbine with adjustable runner blades and adjustable guide vanes is double regulated while one with only adjustable runner blades.

Propeller Turbine





Propeller Turbine

- Propeller turbines are most useful for low-head applications such as slow- running, lowland rivers.
- The head of water is typically 10 m or less.
- Axial flow reaction type turbine.
- There has got no provision for changing the runner blade angle while turbine is in motion.
- In such a turbine, the blades are cast integrally with the hub.
- Though its construction is simple & easy but its efficiency falls sharply at reduced loads, therefore such a turbine is kept fully loaded for efficient operation.

CHARACTERISTICS OF WATER TURBINES

❑ Head

- ✓ Reaction turbine of various turbines can be used for operating heads upto 500m and pelton turbines are used for operating heads above 500 m.

❑ Turbine Setting

- ✓ A pelton turbine is always set usually 2 m above the tail race level.
- ✓ Francis turbine is placed at a level very near or below tail race level.

CHARACTERISTICS OF WATER TURBINES

❑ Runaway Speed

- ✓ This is the maximum speed at which a turbine wheel would run with all gates open so as to allow all possible inflow under maximum head.
- ✓ The generator coupled to the turbine must be capable of withstanding full run away speed of turbine.

❑ Constant Speed Curves

- ✓ In hydroelectric power plants, the turbines operate at constant speed
- ✓ The discharge & head vary so as to keep the speed constant, the turbine output is measured by brake arrangement.

CHARACTERISTICS OF WATER TURBINES

❑ Specific Speed

- ✓ Speed of a geometrically similar turbine that would develop one metric horse power under a head of one metre.
- ✓ The specific speed of turbine is given by

$$N_s = \frac{N\sqrt{P_t}}{H^{1.25}}$$

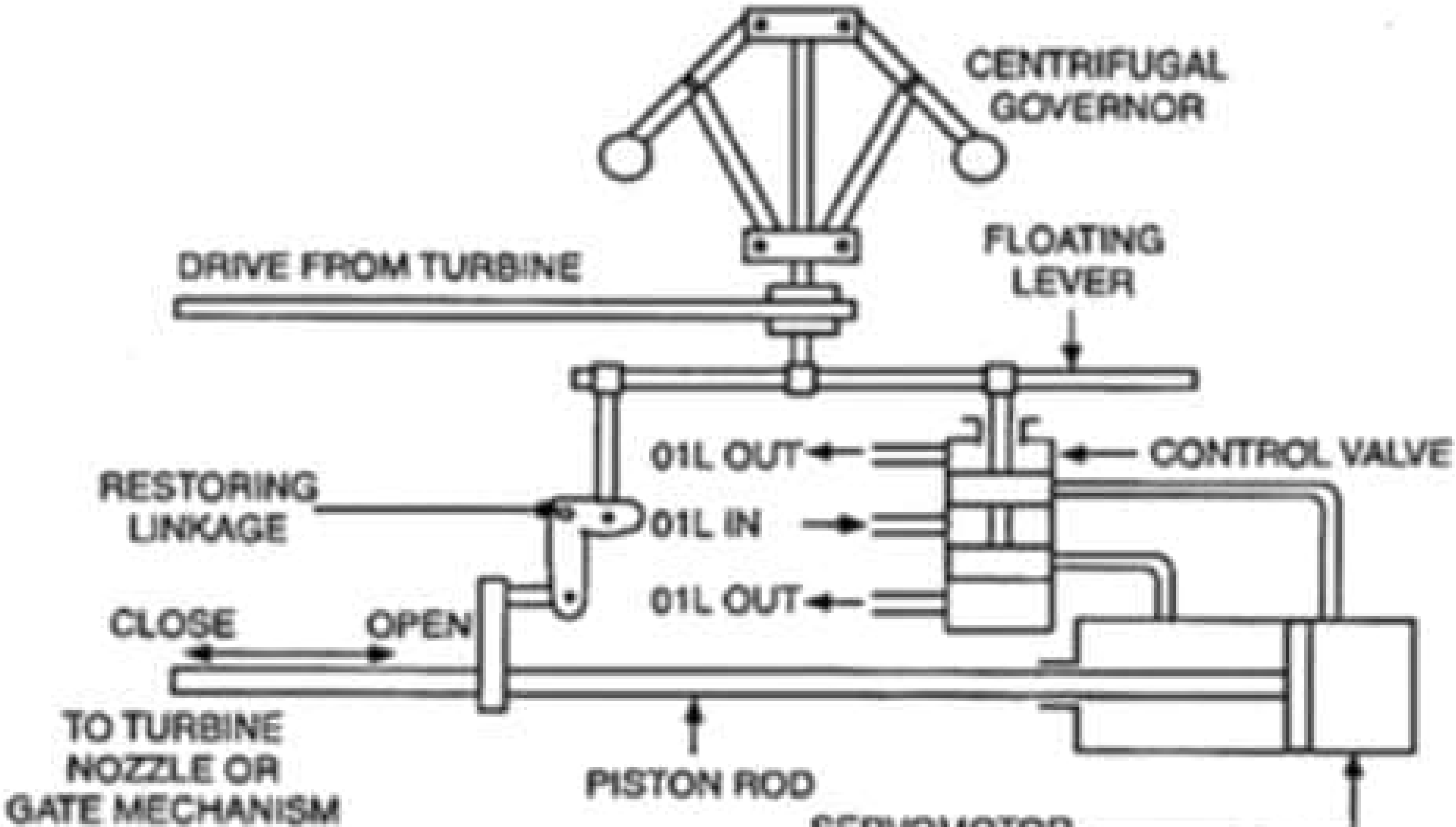
Where Ns = Specific rotational speed in metric units

N = Rotational speed of Turbine

P_t = Output in metric hp

H = Effective head in metres

GOVERNING OF WATER TURBINES



GOVERNING OF WATER TURBINES

- To have electrical output of constant frequency it is necessary to maintain the speed of the alternator driven by the turbine.
- This is controlled by the flow of water entering the turbine by the automatic adjustment of guide vanes in reaction turbine & nozzle needle in the case of impulse turbines.
- At the time of decrease in load on the impulse turbines, the governor reduces the water from the power nozzle & surplus water is diverted with the help of auxiliary relief nozzle.
- In case of reaction turbines, there are pressure regulators for discharging the water from the casing to the tail race, at the time of drop in load.

GOVERNING OF WATER TURBINES

- The speed responsive element usually fly ball mechanism or centrifugal governor.
- Control valve to supply fluid under pressure to the servomotor in order to actuate the turbine control mechanism.
- The use of control valve & servomotor is to amplify the small force created by the fly balls.
- The restoring mechanism to hold the servomotor in fixed position when turbine output & load demand are equalised.
- Fluid pressure supply required for action of servomotor.
- Centrifugal governor may be belt driven or by small electric motor

SELECTION OF WATER TURBINE

- Selection of water turbine depends on various factors such as working head, available discharge, speed, output & nature of load.
- The effective head under which the turbine is to operate gives the first guide to selection of turbine.
- For high head i.e 500 m Pelton turbine is employed
- For 30 m above & 500 m below Francis turbine is employed.
- For low head below 70 m, propeller turbine is used.
- In some cases for 200 m both Pelton & Francis turbine can be used.
- A runner of higher specific speed will generate more power for same head resulting in small size of turbo alternator & power house.

UNDERGROUND HYDRO POWER PLANT

- An underground hydro power plant is one in which whole of the generating equipment is placed in an underground chamber.
- They are two types of layout for underground power plants
- Head development: The plant is situated near the intake & has long tail race tunnel.
- Tail development: The plant is located at the end of a long pressure tunnel & has a short tail race

UNDERGROUND HYDRO POWER PLANT (contd.)

- Advantages
  - ✓ better rocking bearing properties,
  - ✓ lower maintenance cost,
  - ✓ smaller surge tanks,
  - ✓ minimum problem of land acquisition,
  - ✓ easier design of tail race, tunnel,
  - ✓ lower initial cost in some cases,
  - ✓ no risk of forest fire hazard.

SMALL HYDROELECTRIC POWER PLANT

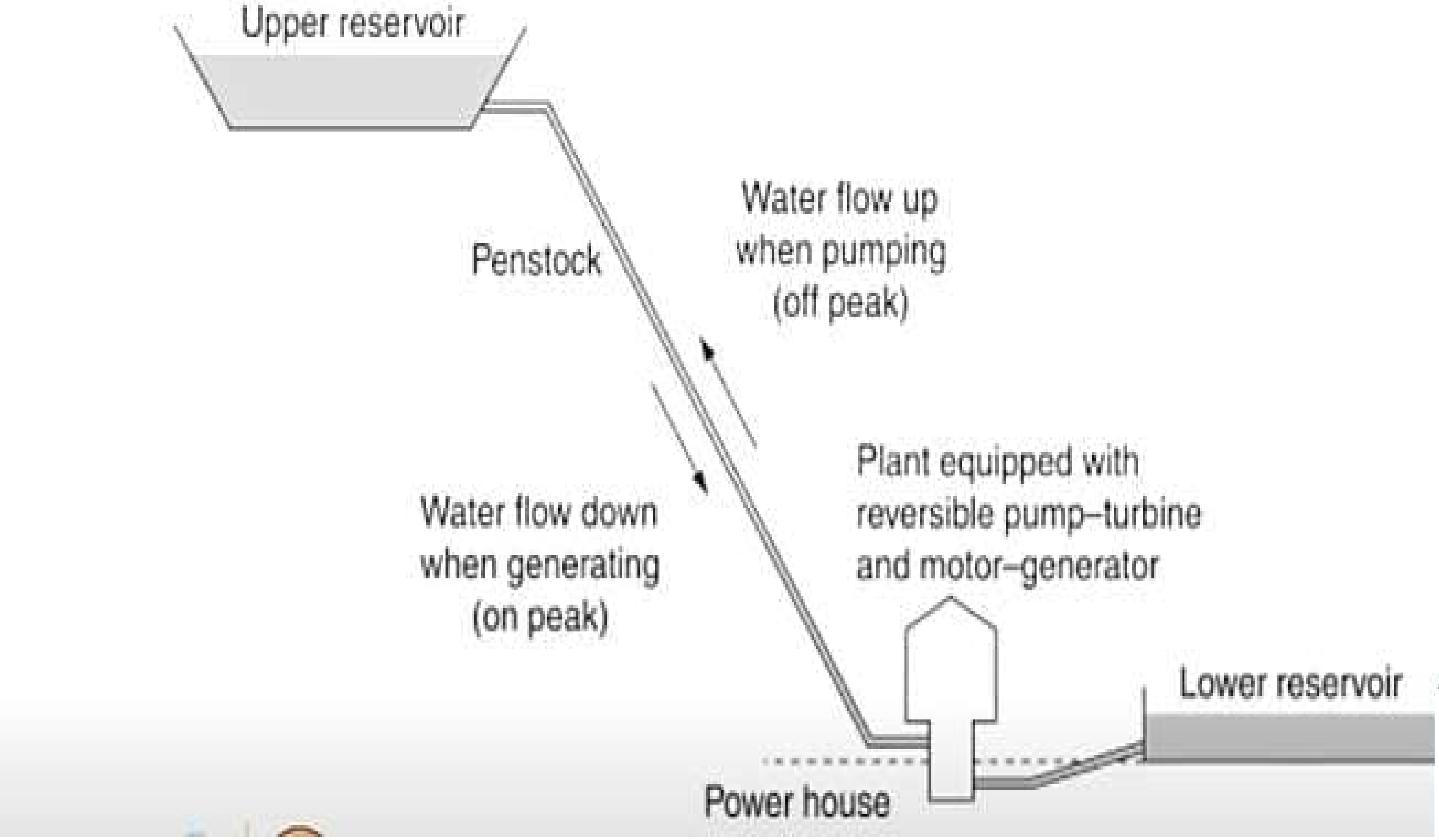
SMALL HYDROELECTRIC POWER PLANT

- Mini hydro plants of capacity around 1-5MW & micro hydro plants of capacity less than 1 MW fall under this category.
- These are becoming more popular due to raising fuel cost of thermal plants & long construction period for large hydro plants.
- Small hydro power plants are simple in operation, reliable, need minimal maintenance & more effective.
- Small hydro schemes are very useful for small isolated groups of consumers & are likely to be technically & economically feasible at any site where adequate flow & head are available.

SMALL HYDROELECTRIC POWER PLANT (contd.)

- Advantages
  - ✓ almost no disadvantages
  - ✓ no costs related with the distribution of electricity
  - ✓ no negative impact on nearby ecosystems
  - ✓ cheap maintenance

PUMPED STORAGE HYDROELECTRIC POWER PLANT



PUMPED STORAGE HYDROELECTRIC POWER PLANT

- These plants generate electricity during the peak load hours and pump water back from the tailrace side to the high reservoir during off peak hours called pumping phase.
- These plants uses Francis turbine.
- During peak hours turbine drives the generator & plant generates electrical energy while during off peak hours the generator operates as motor & drives the turbine which now works as the pump raising the water from trail race to head.
- This reduces the capital cost of the plant & improves the operating efficiency & thus resulting in economical operation.

PUMPED STORAGE HYDROELECTRIC POWER PLANT

❑ ADVANTAGES

- ✓ Peak loads can be supplied at a lower cost than that when supplied by steam & nuclear power plants.
- ✓ It offers great flexibility in operation.
- ✓ They have the ability to take up loads in short time.
- ✓ In the event of extra demand coming up suddenly on the system, such plants can be immediately switched on to meet the demand.
- ✓ Free from environmental pollution.

CHOICE OF SIZE & NUMBER OF GENERATOR UNITS

- The load on power station is never constant but varies at different timings of the day owing to varying demands & the generating plant should have the capacity to meet the maximum demand.
- If one unit is made to meet the maximum demand of power station, the plant will be operating on full load only for short duration & will be running light or even practically on no load for rest of the day.
- In order to maintain reliability & continuity of supply at all times, another unit of equal capacity is required.
- With one unit, reliability of operation is reduced. If the unit is under repair then continuity of supply is lost unless there is second unit present which increases capital cost.

CHOICE OF SIZE & NUMBER OF GENERATOR UNITS

- Alternatively the small generating units can be chosen such that to work on suitable portions of load curve in such a way that each will operate on at load giving maximum efficiency.
- With increase in number of units, area required is more & cost, maintenance is more.
- Therefore compromise to be made in selection of size & no of generating units.
- Small number of units & to fit them on the load curve.
- Neither we should go for single generating unit of larger capacity nor for large number of generating units of smaller sizes