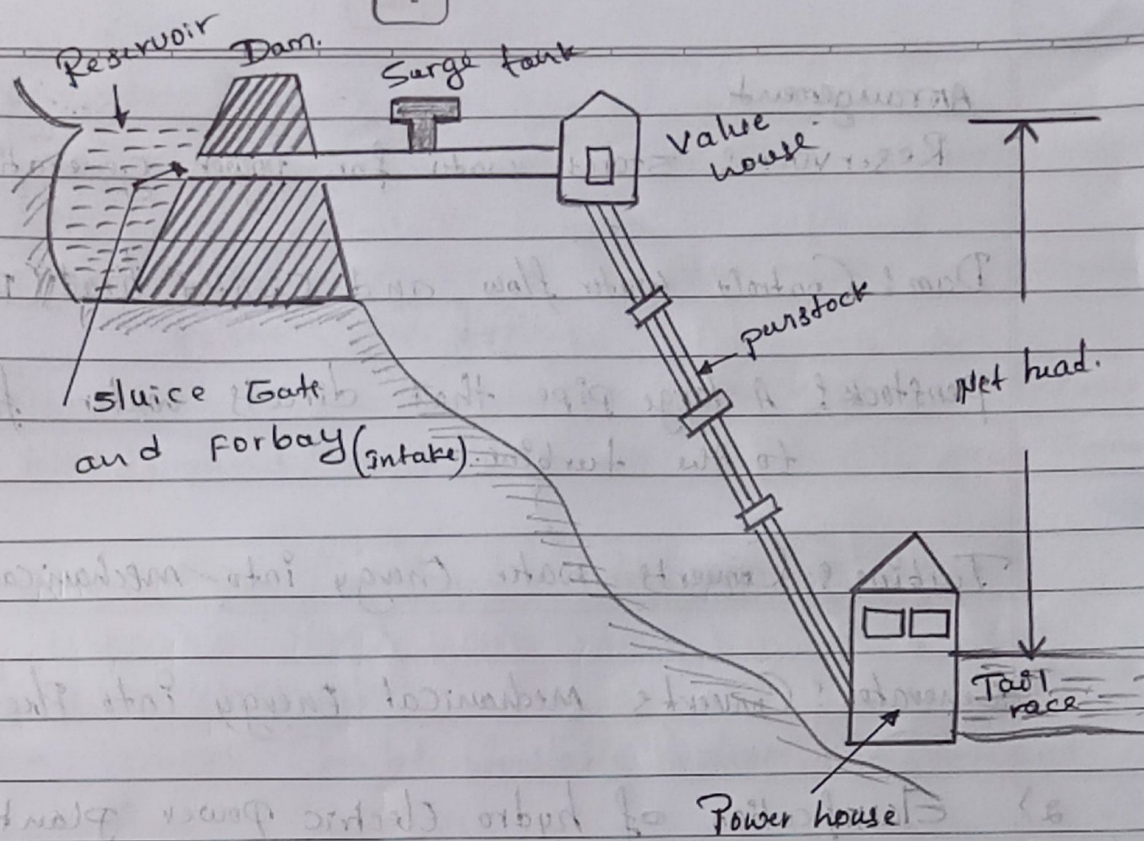


SCHEMATIC DIAGRAM OF HYDRO-ELECTRIC PLANT:

Operation:

- 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.

Arrangement

Reservoir: Stores water for power generation.

Dam: Controls water flow and Creates head (pressure difference)

Penstock: A large pipe that directs water from the reservoir to the turbine.

Turbine: Converts water Energy into mechanical Energy.

Generator: Converts Mechanical Energy into Electrical Energy.

2) classification of hydro Electric power plant

Based ON HEAD: (WATER PRESSURE DIFFERENCE)

- High head (~~Below~~ Above 100 m)
  Uses pelton turbines. ex: mountainous regions.
- Medium-Head (30-100m)
  Francis turbines
- Low head (below 30 mtr)
  Kaplan turbines.

Based ON Capacity:

- Large Hydro (below 100MW)
- Medium Hydro (10-100 MW)
- Small Hydro (1-10 MW)
- Mini Hydro (100kW - 1MW)
- Micro Hydro (upto 100 kW)

Based on operation:

- Run-Of-River – Directly uses river flow without storage
- Storage plant – Uses reservoirs to store water for controlled power generation.
- Pumped Storage – pumps water to a higher reservoir during low demand and releases it during peak demand

3) Selection of Site for Hydroelectric power plant.

1) Availability of Water:

- water energy can be Available in from of Potential Energy of kinetic Energy.
- Station 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.

2) 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

3) water head.

- Availability of head depends upon the topography of Area.
- High head means high potential Energy.

- An effective head reduces the Quality of water to be stored & handled by Penstocks, screens & turbines therefore Capital Cost of plant is reduced.

4) Accessibity of Site.
- The site should be easily accessed by rail or road for transporting the plant equipments.

5) Water Pollution.
- polluted water may Cause excessive Corrosion & damage to metallic structures, hence good quality water is essential.

6) Availability of Land.
- The land should be cheap in Cost & rocky in order to withstand weight of large structure.

7) 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.

8) 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.

4) Merits

- 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.
- It can run & synchronized in few minutes.
- The efficiency of these plants does not fall with the age.
- These plants are used for flood Control & irrigation purpose.

Demerits

- 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.
- It's Construction Cost is enormously high.
- During Dry year, the power production may be curtailed or even discontinued, This availability of pow from such plants is not much reliable.

5) HYDROGRAPH:

- It is plot b/w discharges Versus time of the flow.
- This is used to evalute peak discharge from a location.
- Hydrograph Indicates the Available power from the steam 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 = Distance in m^3/sec

ρ = Density of water, η = Efficiency

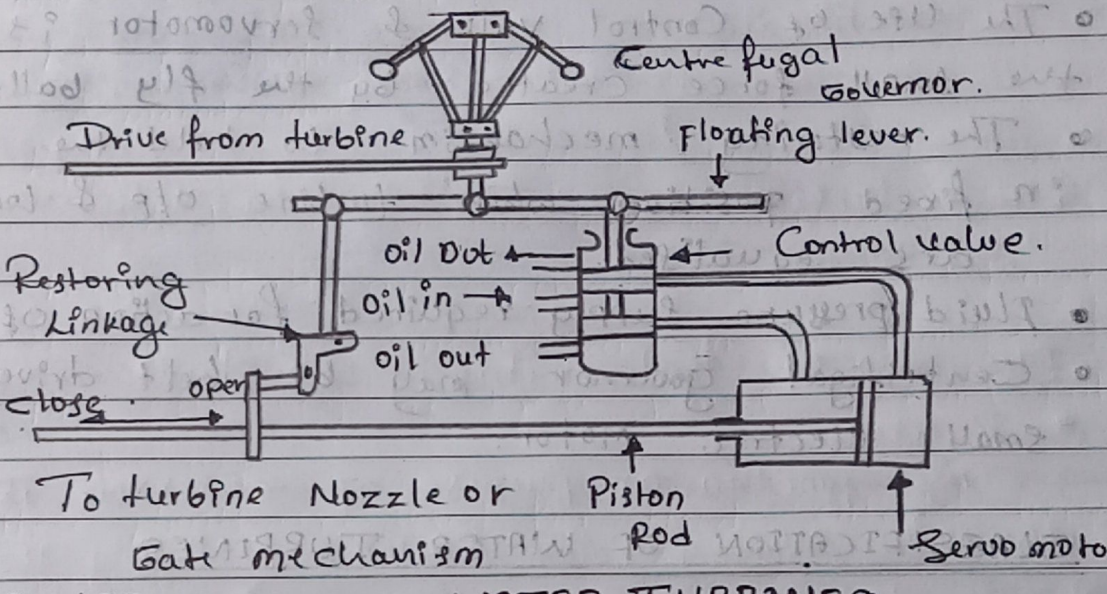
h = available head in meters.

MASS CURVE:

- It is the Cumulative volume of water that can be stored from a steam flow versus time in days, weeks or month.
- 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.

6)

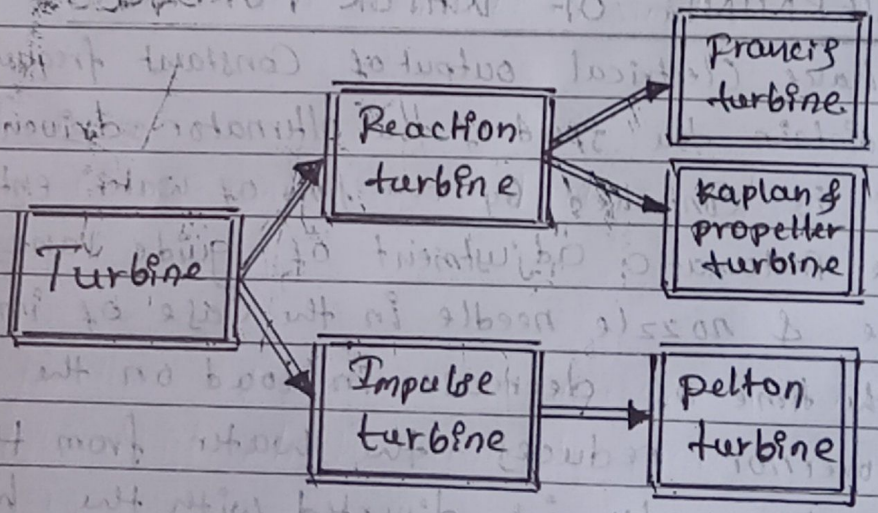


GOVERNING OF WATER TURBINES

- 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.

- 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 o/p & load demand are equalised.
- Fluid pressure supply required for action of servomotor
- Centrifigal governor may be belt driven or by small electric motor.

7) CLASSIFICATION OF WATER TURBINES



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 & change to downward reaction while passing through runner.

Kaplan turbine:

- This is reaction turbine & has gate governing mechanism similar to that of Francis.
- The water flow strikes the blades axially and recieves 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.

Propeller turbine:

- propeller turbines are most useful for low-head applications such as flow-running, lowland rivers.
- The head of water is typically 10m or less.
- Axial flow reaction type turbine.
- In such a turbine, the blades are cast integrally with the hub.
- There has got no provision for changing the runner blade angle while turbine is in motion.

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 300 meters.

8) 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.

- 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.

• Foreby:

• 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.

• 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.

• Spillways.

• 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.

- **Penstock**
  - A penstock is a huge steel pipe which carries water from the reservoir to the turbine.

- **Draft Tube**
  - The draft tube is a part of the reaction turbine

- **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 is the surge tank rises of falls to reduce the pressure swings in the penstock.

- **Control Gate.**
  - water from the reservoir is allowed to flow through the penstock to the turbine.
  - The amount of water which is to 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 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.

Power house

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

Prime mover or Hydro Turbine

- water from the penstock is tanken 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.
- Impulse turbines are used for large heads.
- Reaction turbines are used for low and medium heads.

9) water Hammer: A pressure surge caused when water flow is suddenly stopped or changed in pipelines, leading to potential damage to pipes and equipment.

Function of a Surge tank:

- Acts as a buffer to absorb sudden pressure changes
- prevents damage to penstocks and turbines.
- Ensures steady water flow and Reduced oscillations

10) The hydrological cycle.

1) Evaporation - water turns into vapor due to heat.

2) Condensation - water vapor forms Clouds.

3) Precipitation - water falls as rain, snow or hail.

4) Runoff & Infiltration - water flows into rivers or seeps into the ground, replenishing lakes and groundwater.

5) storage & Recirculation - water is stored in reservoirs, glaciers, and oceans. Continuing the cycle.