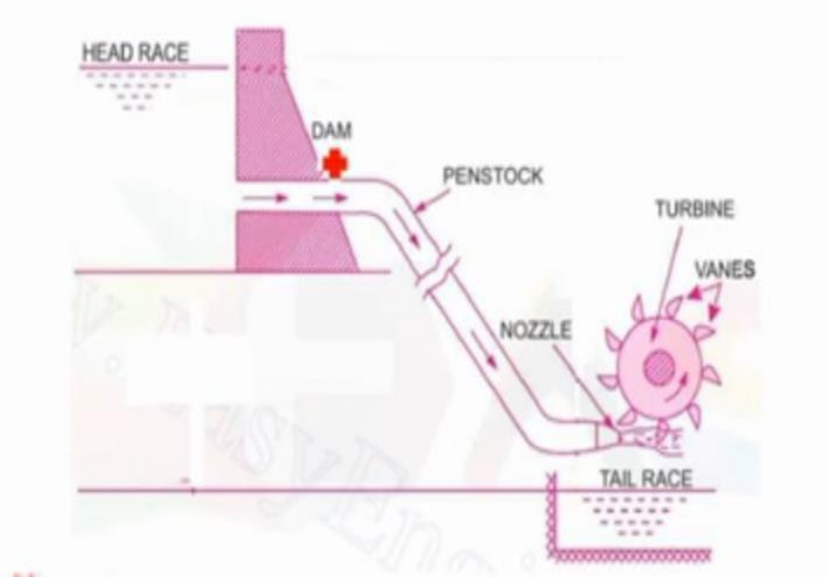
HYDRAULIC MACHINES

- Machines which convert hydraulic energy into mechanical energy or mechanical energy into hydraulic energy is known as hydraulic machine.
- Hydraulic machines are classified into hydraulic turbines and hydraulic pumps
- Hydraulic turbine converts hydraulic energy into mechanical energy
- **H**ydraulic pumps convert mechanical energy into hydraulic energy

HYDRAULIC TURBINES



CLASSIFICATION of HYDRAULIC TURBINE

A. According to Head :-

1. **High head turbine :-** Head available at the inlet of turbine is more than 250 m
   ex :- pelton Turbine
2. **Medium head turbine:-** Head available at the inlet of turbine is between 60 m to 50m Ex :- Francis Turbine
3. **Low head turbine :-** Head available at the inlet after being is below 60 m
   Ex :- Kaplan Turbine

B. According to Specific speed

A. **High specific speed turbine :-** specific speed is between 255 RPM and 860 RPM Ex :- Kaplan Turbine

B. **Medium specific speed turbine :-** Specific speed is between 51 RPM and 255 RPM Ex:- Francis Turbine

C. **Low specific speed Turbine :-** Specific speed is between 30 RPM and 51 RPM Ex :- Pelton turbine

C. According to the direction of flow of water in the runner

1. Tangential flow turbine :- waters hits the runner tangentially Ex :- pelton Turbine

2..Radial flow turbine :- waters hits the runner radially Ex :- Francis Turbine

3. Axial flow Turbine :- waters hits the runner axially Ex :- Kaplan Turbine

D. According to the action of water

1. Impulse turbine :-water process only K.E at the inlet of the turbine Ex:- Pelton Turbine

2. Reaction turbine :- water posses both K.E and P.E at the inlet of turbine Ex:- Francis Turbine.

PELTON TURBINE

- Pelton turbine is also known as pelton wheel
- It is named after L.A Pelton
- It is a high head, low specific speed, tangential , impulse turbine.
- K.E to mechanical energy

Nozzle and Flow regulating arrangement

 Nozzle help to increase the velocity and thus K.E of the incoming water.

 The conical shaped spear head help to regulate the quantity of water striking the bucket.

 When this spear move in word the nozzle open decreases and quantity water entering the turban reduce.

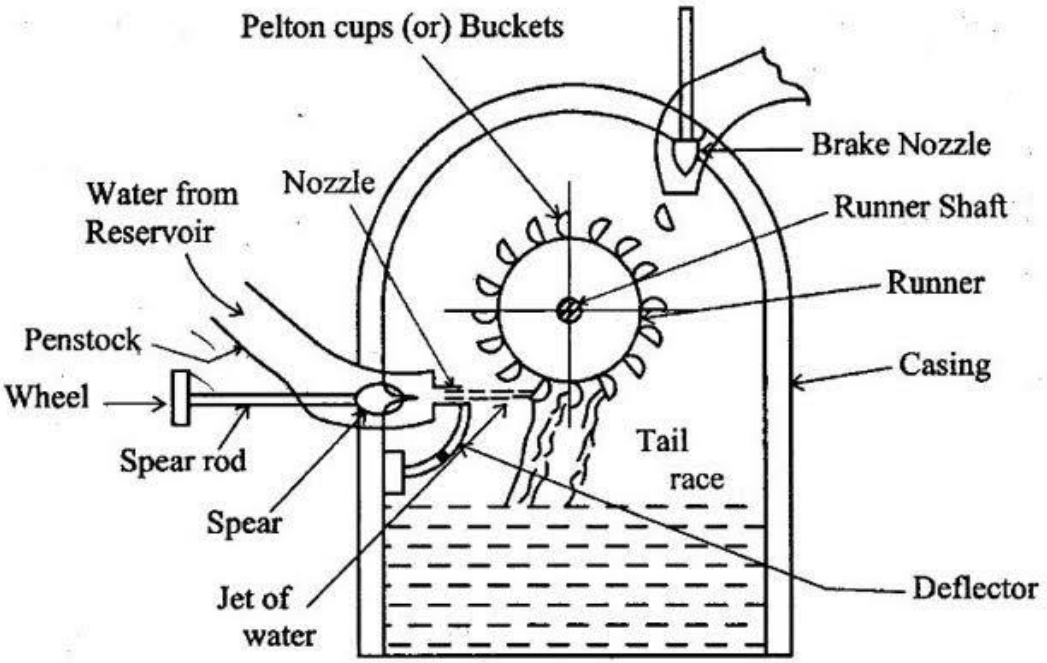
 When the spear move outward the nozzle it increases and the quantity of water entering the turbine increases.

Runner and bucket :-

 Runner is a circular disc on the periphery of which a number of bucket are evenly fixed.

 Bucket is the form of double hemispherical bowl. Each section is divided by a splitter

 Splitter divided the jet into two equal parts



Casing:-

- Casing is used to prevent the splashing of water and to discharge the water to tail race.

Breaking nozzle :-

- When the nose is fully closed by moving this spear in the forward direction, then the amount of water striking the runner reduce to zero.
- But the runner continues to rotate due to its inertia
- Breaking nozzle is provided to stop the runner in a show time which direct the jet of water on the back of the bucket.

WORKING :-

Nozzle direct the water against the bucket fixed amount the runner, when the high velocity water strikes the bucket the water exert pressure on the bucket and the runner and then turbines shaft revolves.

FRANCIS TURBINE

- It was developed by J.B Francis
- Francis turbine is the most widely used reaction turbine
- It is medium head , medium specific speed, mixed flow, reaction turbine.

SPIRAL CASING:-

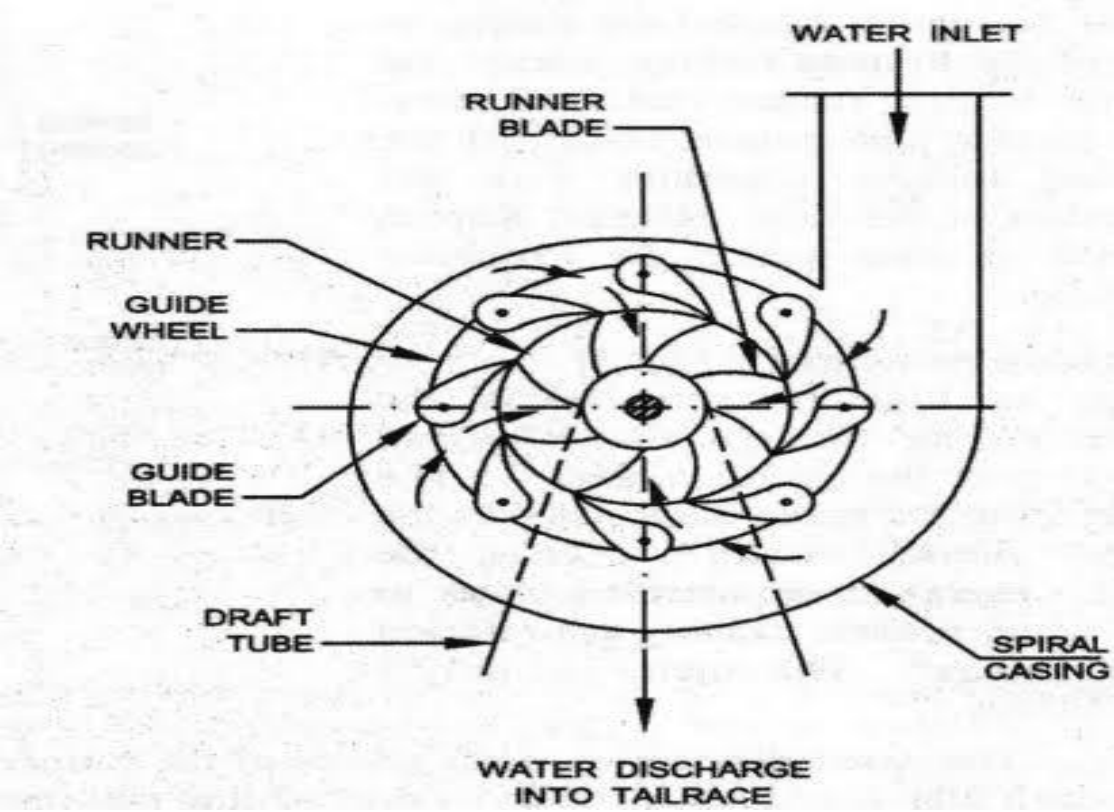
- Spiral casing acts like an air tight container.
- It evenly distribute the water to guide vane.
- As the water flow through the spiral casing the velocity of the water increases and hence water enters the guide vanes at the uniform velocity.

Guide Vanes:-

- Guide vanes are fixed around the runner vanes.
- They guide the water from the spiral casing to runner vanes .
- Position of guide vanes can be varied about pivot center.
- Guide vanes also act like nozzle and help to increase velocity of the water.
- They also controls the amount of water going to the runner vanes.

Runner Vanes:-

- Runner Vanes are fixed around the runner
- Runner vanes have aero foil shape
- As the water flows across the runner Vanes , a high pressure region will be produced at one side and a low pressure region on another side
- Due to this pressure difference, the runner rotates.
- The water also causes anything impulse force which also help the rotation of the runner vanes.



Draft Tube :-

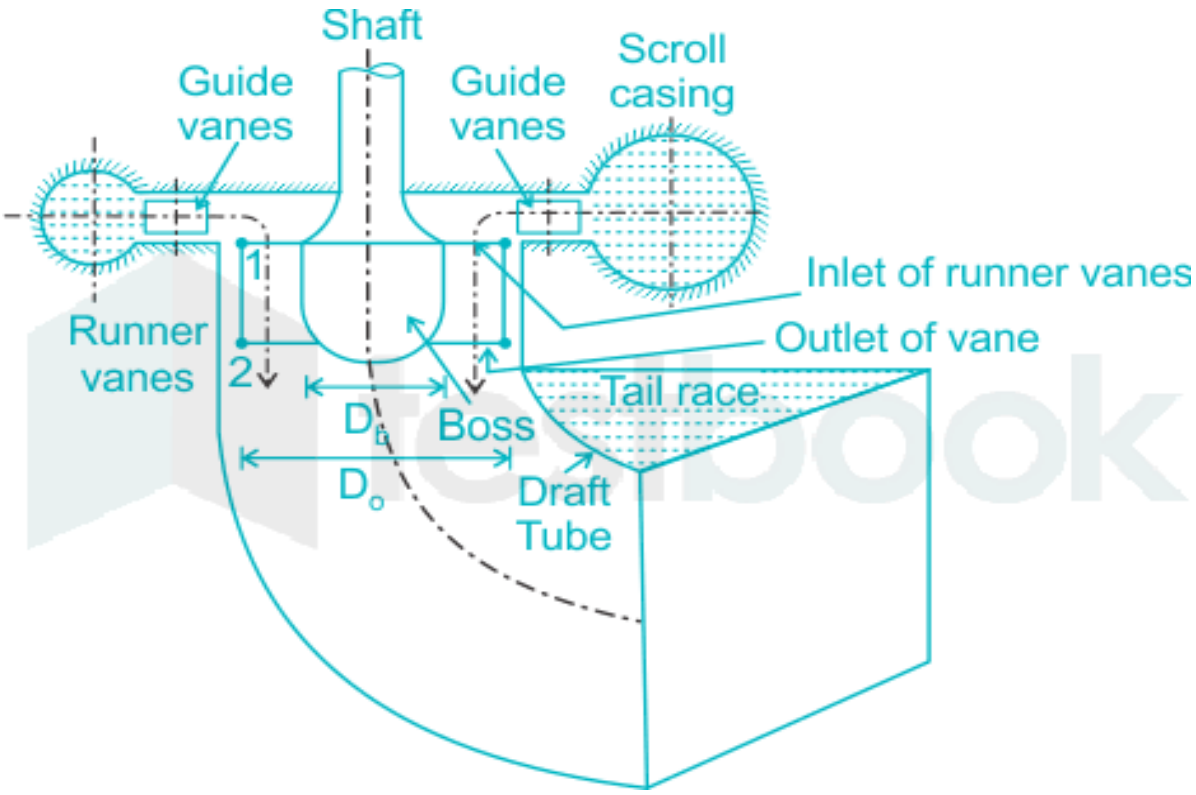
- It helps to discharge water from turbine to tail race.

WORKING :-

- Water from pen stock enters the spiral casing at high pressure. Water then enters the guide vanes. Guide vanes guide the water to runner vane. Due to the aero foil shape the of the runner, a high pressure difference will be create across the runner Vanes and runner start rotating. Impulse force of the water also help the rotation of runner. Then the water discharge through the draught tube.

KAPLAN TURBINE

- It was developed by vikton Kaplan
- Kaplan turbine is modified form of Francis turbine.
- It is a low head , low specific heat and reaction turbine.
- Kaplan turbine have high efficiency typically over 90%.



Scroll Casing :-

- It is the casing with guides the water and control the water passage.
- Spiral casing act like an air tight container.
- It evenly distribute the water to guide Vanes.

Guide vanes :-

- They guide the water from the spiral casing to runner Vanes .
- Position of guide vanes can be varied about pivot center
- They also control the amount of water going to the runner vanes.

Runner :-

- It is connected to the turbine shaft.

Hub :-

- It is the part of runner in which blade are mounted.

WORKING :-

- Water from the pen stock enter into this scroll casing. From scroll casing water they flow through the guide vanes. after passing through the guide vanes water turns through 90° in

the axial direction. Water movers over the runner blades and as a result the runner shaft rotates .

PUMPS

- Convert mechanical machine which convert mechanical energy into hydraulic energy .
- Used to pump a liquid from lower pressure area to higher pressure area.
- To increase flow rate.
- To move liquid from lower elevation to higher elevation.

Classification of pumps

Pumps can be classified into two types :-

- Positive displacement pump or Hydrostatic pump
- Non positive displacement pump or Roto-dynamic pump

Positive displacement pump or Hydrostatic pump

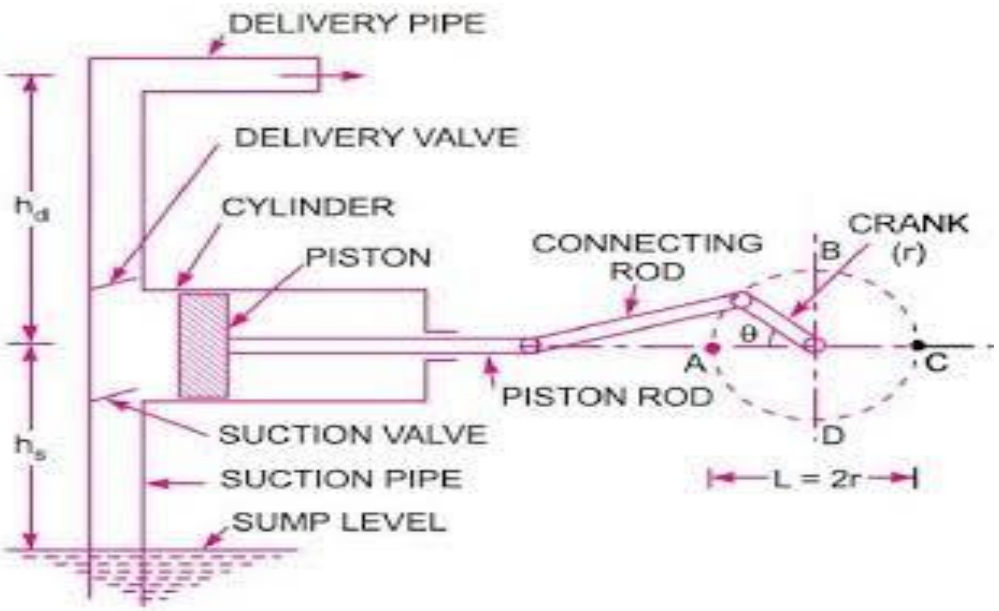
- This pump makes a fluid more by trapping a fixed amount and forcing (displacing) that trapped volume into the discharge pipe.
- Fully closing the delivery pipe will result in mechanical failure of the pipe.
- Their construction is complex and they consists of several moving parts.
- Their maintenance cost is very high.
- Their suitable for low discharge at high pressure
- More space
- There initial cost is also very high.
- They can handle high viscous flow more efficiently.
- Eg :- Reciprocating pumps, Gear pumps.

Non positive displacement pump or Roto-dynamic pump

- These pumps generates high rotation velocity then convert the resulting kinetic energy of the liquid to pressure energy.
- Their construction is simpl and they consists of less number of moving parts.
- Their maintenance cost is low.
- They are suitable for high discharging at low pressure.
- Less space .
- Their initial cost is low.
- They are not suitable for handling viscous flow.
- Eg :- Centrifugal pump axial pump etc .

Reciprocating pumps

- The reciprocating pump is positive displacement pump.
- It stuck and raises the liquid by actually displacing with a piston.
- The piston execute a reciprocating motion is closely fitting cylinder.
- The following are main parts
    1. Cylinder
    2. Piston
    3. Section valve
    4. Delivery valve
    5. Section pipe
    6. Delivery pipe
    7. Crank and connecting rod mechanism.



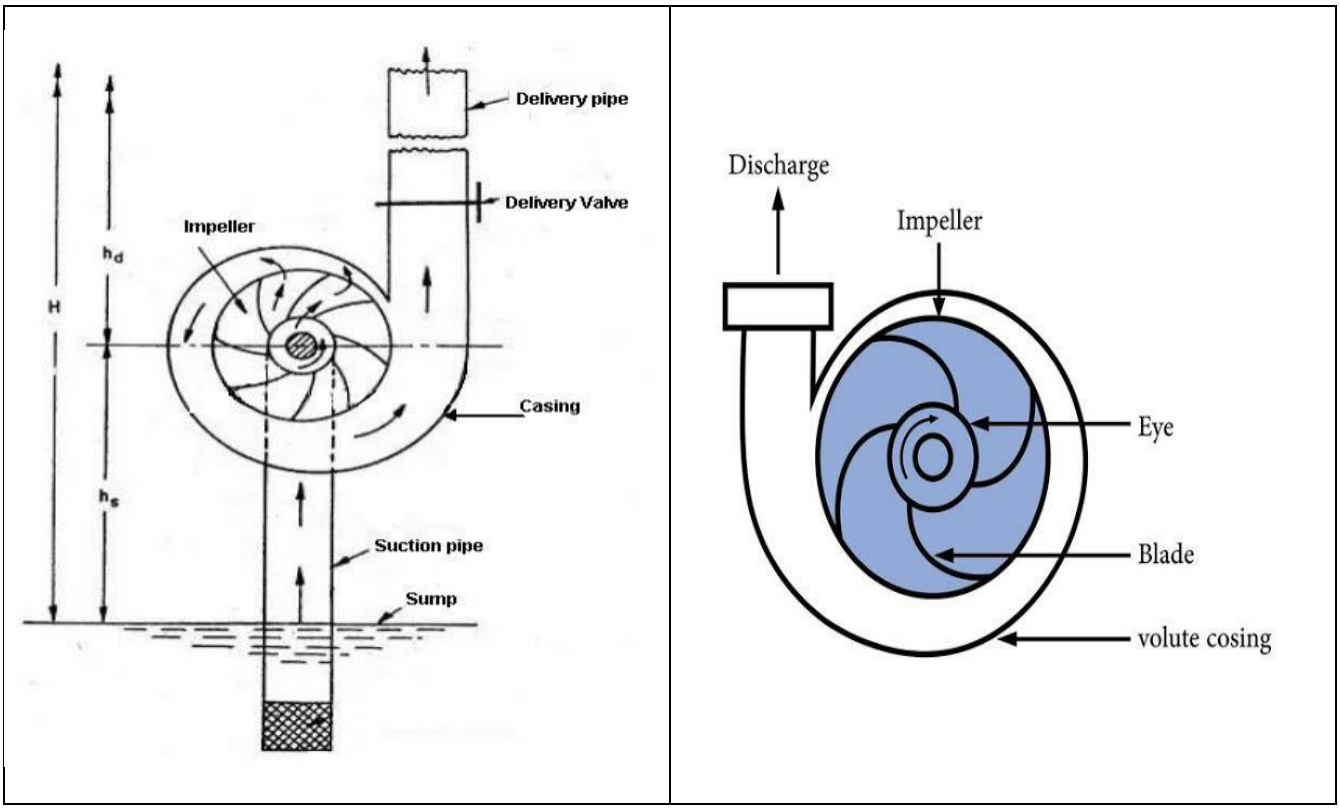
WORKING :-

- Crank is rotated by using an electric motor.
- As the crank rotates the piston inside the cylinder reciprocates by means of a connecting rod.
- After piston move from inner death center to outer dead center the volume inside this cylinder increase and the vacuum will be created inside the cylinder.
- As a result the section valve open and water will enter the cylinder through the section valve.
- This stock is called section stock.
- After reaching the outer dead Centre the piston start move towards Inner dead center.

- During this talk the inlet valve closes and pressure inside the cylinder increases and delivery valve open.
- The high pressure water then discharge through the delivery valve.

Centrifugal pump

- Centrifugal pump act as a reverse of an inward radial flow reaction Turbine.
- Flow is in radial outward direction.
- Work on the principle of centrifugal action.



- The water enter the pump at the Centre of the rotating impellers .
- Impeller in rotating motion force water out towards the circumference due to centrifugal force effect.
- Due to this negative pressure gets generate at the Centre of the pump so water is sucked from the sump via section pipe which is connected to the pump.

- The K.E high velocity water is convert into pressure energy because of diverging passage of casing.