* Hydraulic or Water Turbines:-

⇒ A hydraulic turbine is defined as a prime mover in which hydraulic energy of water is transformed into mechanical energy, in form rotary motion & further generates hydro-electric power when rotor is coupled to a generator.

* classification:

(1) A/c hydraulic action.
   (a) Impulse: high head & less quantity of water flow.
   (b) Reaction: low head & high quantity of water flow.

(2) A/c to head of source of water:-
   (1) High head turbine
   (2) Medium — " —
   (3) Low — " —

(3) Direction of flow of water:-
   (a) Tangential flow turbine
   (b) Radial — " —
   (c) Axial — " —
   (d) mixed — " —

(4) A/c to position of shaft:-
   (a) Horizontal shaft turbine
   (b) Vertical — " —

(5) A/c to discharge of water:-
   (a) High discharge
   (b) Low discharge.

(6) A/c Speafic speed:
   (a) Low speafic speed.
   (b) Medium
   (c) High

$$\text{Speafic speed } (N_s) = \frac{N\sqrt{P}}{H^{5/4}}$$

⇒ Construction :

Same as in single acting compressor.

⇒ working principle :-

same, just add it happens on either sides. as we have different compartments for suction & delivery.

Applications :-

* Single stage single acting reciprocating compressor

⇒ (1) If suction and delivery take place on one side of piston only, the compressor is known as single acting compressor.

(2) In single acting reciprocating air compressor only single side of piston is used for compression of air.

(3) Piston is directly driven by connecting rod & crankshaft enclosed in piston is used for compression of air.

(4) It require less floor space for installation.

(5) Gives one delivery stroke per revolution of crank shaft ($n = N$)

(6) Single acting reciprocating air compressors are always vertical.

⇒ Construction:

(1) Reciprocating compressor is type of positive displacement compressor, because it displace fixed amount of air, (constant air delivered)

(2) It consists of cylinder, piston, inlet & discharge valve etc, it is driven through connecting rod & crank.

⇒ Working principle:

(A) Suction stroke:-

→ If piston moves downwards, pressure inside cylinder falls below atmospheric pressure. Due to this pressure difference, inlet valve gets opned & air is sucked in cylinder at inlet pressure untill piston completes the suction stroke. Crank shaft is driven through prime mover, the inter valve.

(B) Delivery stroke:

(1) Delivery valves are mounted in cylinder head. Valves are pressure differential type i.e; valves automatically open & closes depending on pressure diff. across valves between outside & cylinder pressure.

(2) Piston moves upwards, pressure inside cylinder goes on increasing till it reaches delivery pressure. Delivery valve gets opned & air is delivered

(3) At end of delivery stroke, small quantity of air, at high pressure expands to aid suction (air at clearance volume)

(4) At this stage inlet valves gets opned as a result of which fresh air is sucked into cylinder, & cycle is repeated.

* Double acting air reciprocating compressor

(1) If suction & delivery of air takes place on both sides of piston is known as double acting compressor.

(2) It gives two delivery stroke per revolution of crankshaft (n = 2N). Most heavy duty compressors are double acting.

(3) Double acting compressor require more space as compared to single acting vertical compressor. As both side of piston are exposed to rapid change in temp. & pressure, there is chance of leakage.

(4) Double acting ~~cylinder~~ compressors are always horizontal.

* Pelton Turbine (Impulse turbine) :-

→ It is a tangential flow impulse turbine named after American engineer L.A. Pelton. This is suitable for high head & low quantity of water.

I] Assumptions:

(1) Fluid is assumed to be incompressible
(2) cross-sectional area of jet is constant

II] Diagram.

III] Working principle:-

(1) water is stored in reservoir behind dam & is made to flow through penstock to nozzle fitted at end of penstock which is kept close to runner.

(2) Nozzle delivers high velocity water jet & impinge on bucket tangentially.

(3) Impact of water jet cause momentum thus rotating wheel. Hence mechanical work is produced.

(4) Quantity of water discharged by nozzle is regulated by conical needle or spear. Axial movement of spear is controlled by governing mechanism.

(5) mechanical work produced at runner shaft is converted into electric power by means of electrical generator which is coupled to turbine shaft. After leaving turbine runner, water falls into tail race.

* Components:

(1) Nozzle & flow regulating mechanism.

(1) A nozzle is fitted at end of penstock near turbine. Nozzle converts potential energy of water into kinetic energy before jet strikes bucket.

(2) Nozzle is provided with conical needle or spear to regulate quantity of air comming out of nozzle, thereby controlling speed of runner.

(3) Spear can be moved in axial direction by operating manually by a hand wheel in small units & automatically by governing mechanism in larger unit.

(4) When spear is moved in forward direction in nozzle, it reduces nozzle exit area, hence quantity of water flow striking bucket is reduced.

(5) If spear is moved backword, it increases flow rate of water.

(2) Runner & bucket:-

(1) It is a circular disc made of cast iron or forged steel & fixed to horizontal shaft.

(2) Buckets (more than 15) are fixed at equidistance around periphery of runner. Shape of bucket resembles hemispherical cup or bowl.

(3) Each bucket is divided into two symmetrical parts by dividing wall known as splitter or bucket are made of cast iron & for high head it is made of bronze or stainless steel.

(5) Bucket & runner are cast integrally as one piece or buckets may be bolted individually to runner for easy replacement of bucket whenever it is damaged.

(6) Jet of water shikes on splitter. Purpose of splitter is to split jet into two equal parts. Jet is deflected sideways in opposite direction through angle of 160-170° (ϕ = 10 & 20')

(7) Ideal angle of deflection of jet is 180°, but this cannot be achived in pratice as then jet leaving bucket will strike back of succeeding bucket, thereby decreasing efficiency of wheel.

(3) Casing:

Casing does not perform any hydraulic func^n
It is made of C.I (cast iron) or steel.

(1) To prevent splashing of water.
(2) To lead water to tail race &
(3) safeguard persons against accident

(4) Braking jet:

(1) i. when nozzle is completly closed by moving spear in forward direction, the amount of water shiking runner is reduced to zero, but due to inertia runner continue to rotate for considerable time.

(2) In order to bring runner to rest in the shortest possible time, a small nozzle is provided which directs jet through brake nozzle opposite to direction of rotation.

(3) This jet of water is breaking jet.

(5) Deflector :-

(1) when there is sudden reduction in load it would result in propogation of strong pressure waves in penstock. In order to avoid such situation deflector is provided which is hinged to casing.

(2) when there is reduction in load, deflector temporarily deflects jet & a small portion of water jet strikes bucket. Spear needle is then slowly brought in flow in pipeline is gradually reduced.

Advantage
Application
Disadvantage
} please google & write.

* Francis Reaction Turbine :-

It is inward flow reaction having radial ~~reaction~~ discharge at outlet & is named after american engineer J. B Francis.

In modern francis turbine water enters runner from guide vane radially & discharge out of runner axially, hence it is mixed flow reaction turbine.

It operates under meadium head & requires moderate quantity of of water.

Diagram. - Ppt

Components :

1. scroll casing
2. Guide mechanism
3. Runner
4. Draft tube.

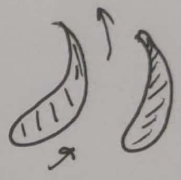
Working :-

1. Water from reservoir flow to turbine through penstock & enters scroll casing, hence casing & runner are always full of water. from scroll casing, water passes to guide blades.
2. Aerofoil shaped guide blade allow water flow smoothly without shock. Thereafter, water enters runner with low velocity & high pressure.
3. As water flows through runner direction of flow of water is changed from axial to radial & a part of pressure energy goes on changing to kinetic energy & hence runner rotate at high speed
4. Mechanical work produced in runner shaft is converted into electrical power by generater which is coupled with runner shaft.

(5) water from runner is discharged into tail race after passing through draft tube.

* Comparision bet^{n} Impulse & Reaction Turbine:-

Impulse	Reaction
(1) All available head is converted into K.E in nozzles.	(1) only part of available head is converted into K.E in guide blades.
(2) water from nozzle comes out in form of jet which impinges on bucket of runner.	(2) water first enters guide blade & flows to moving blade.
(3) Flow of water over runner is at constant atmospheric pressure.	(3) Flow of water over the runner is under pressure which gradually decreass from inlet to outlet.
(4) Work done due to change in kinetic energy of jet.	(4) most of work is done due to change in pressure head & very small amount of work is due to change in kinetic energy.
(5) possible to regulate the flow without loss.	(5) It is not possible.
(6) High head & low discharge	(6) Low to medium & medium to high head.
(7) small in size	(7) Larger in size.

(8) Only blade in front of nozzle are in action.	(8) All blades are in action.
(9) Run at high speed.	(9) Run at comporatively low speed.
(10) Governing is done by needle valve fitted into nozzle.	(10) Governing is done by guide blade assembly.
(11) efficiency around 88%	(11) efficiency about 95%
(12) Shape of blade. 	(12) 
(13) It is not susceptible to cavitation	(13) Runner blade & draft tube may be damaged due to cavitation.
(14) Cost is least.	(14) Costlier.