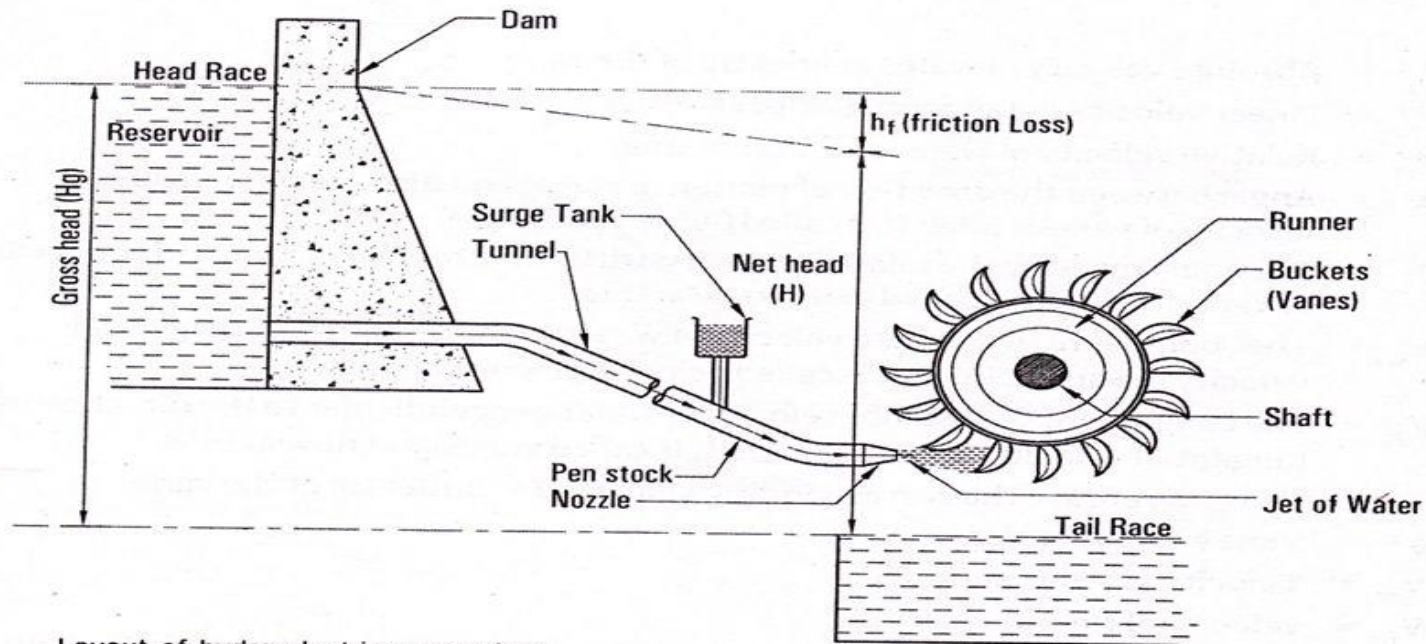


Hydraulic Turbine

Hydroelectric power plant

HYDROELECTRIC POWER PLANT



Layout of hydro-electric powerplant
with pelton wheel

- A **turbine** is a rotary engine that extracts energy from a fluid flow and converts it into useful work

Eg: steam turbine, gas turbine, hydraulic turbine

- Hydraulic Turbines transfer the kinetic energy and potential energy of water into a rotation .
- We can generate electricity by coupling to electric generator

CLASSIFICATION OF HYDRAULIC TURBINES:

1. BASED ON FLOW PATH

- Axial Flow
- Radial Flow
- Tangential Flow
- Mixed Flow



Classification of Hydraulic Turbines: Based on flow path

- **Axial Flow Hydraulic Turbines:** flow path of the liquid mainly parallel to the axis of rotation. Eg: Kaplan turbine
- **Radial Flow Hydraulic Turbines:** liquid flowing mainly in a plane perpendicular to the axis of rotation.
- **Tangential Flow Hydraulic Turbines:** liquid flowing mainly in a plane tangential to the turbine. Eg: Pelton turbine



Classification of Hydraulic Turbines: Based on flow path

Mixed Flow Hydraulic Turbines: For most of the Hydraulic Turbines used there is a significant component of both axial and radial flows. They are called as Mixed Flow Turbines.

Francis Turbine is an example of mixed flow type, in Francis Turbine water **enters in radial** direction and **exits in axial** direction.



CLASSIFICATION OF HYDRAULIC TURBINES

2. BASED ON WORKING PRINCIPLE

- Impulse turbine
- Reaction turbine

Classification of Hydraulic Turbines: working principle

Impulse Turbine: The pressure of liquid does not change while flowing through the rotor of the machine. Pressure change occurs only in the nozzles of the machine. Eg : Pelton Turbine.

The energy to rotate an impulse turbine is derived from the kinetic energy of the fluid flowing through the nozzles.

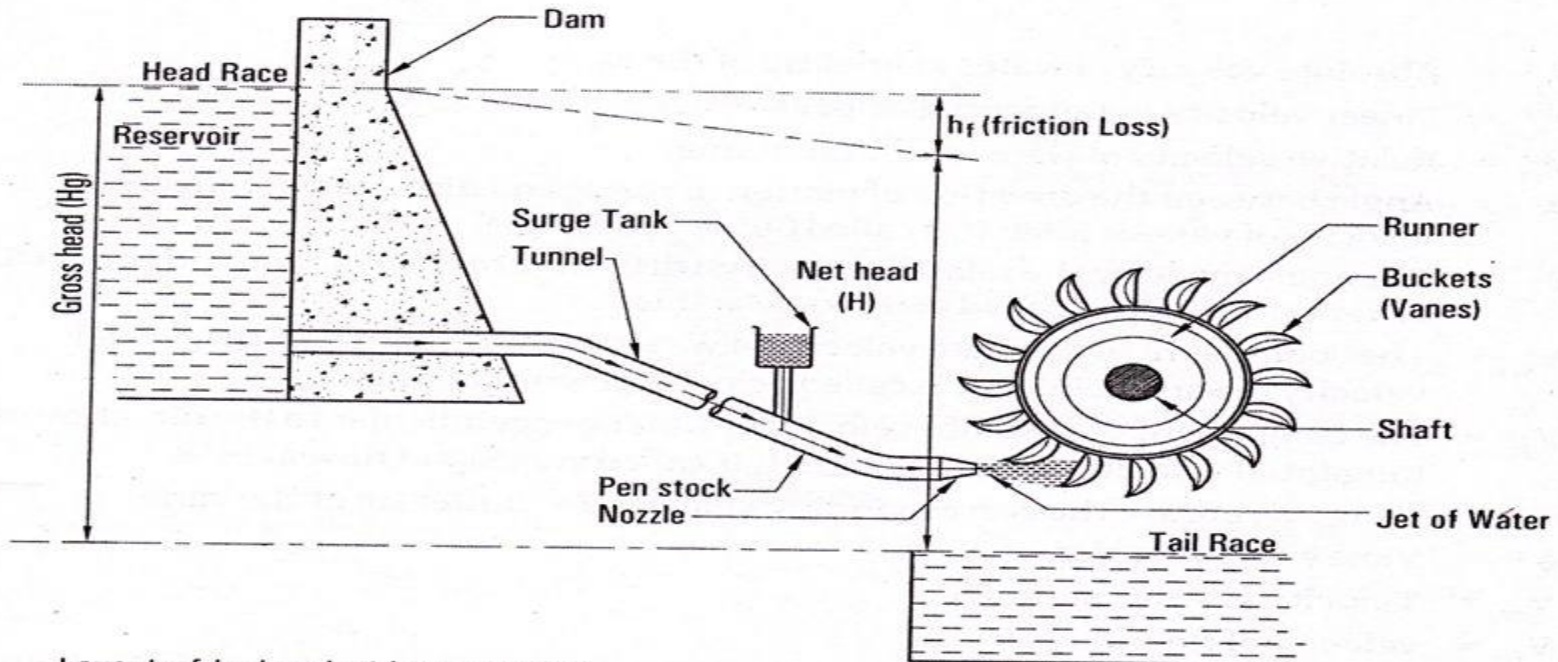
Classification of Hydraulic Turbines: working principle

Reaction Turbine: The pressure of liquid changes while it flows through the rotor of the machine. The change in fluid velocity and reduction in its pressure causes a reaction on the turbine blades. Eg: Francis and Kaplan Turbines

Impulse turbine

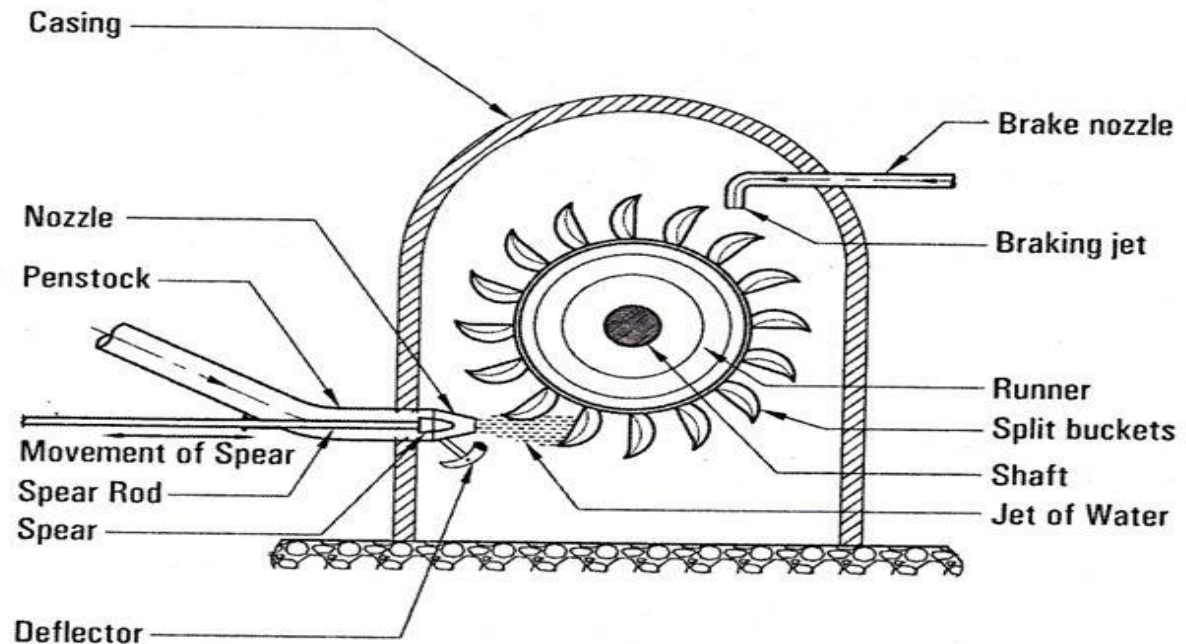


PELTON TURBINE POWER PLANT



Layout of hydro-electric powerplant with pelton wheel

PELTON TURBINE



Pelton turbine

- **Parts of pelton turbine**

Nozzle with flow regulating arrangement

- Runner with split buckets

- Casing

- Braking nozzle

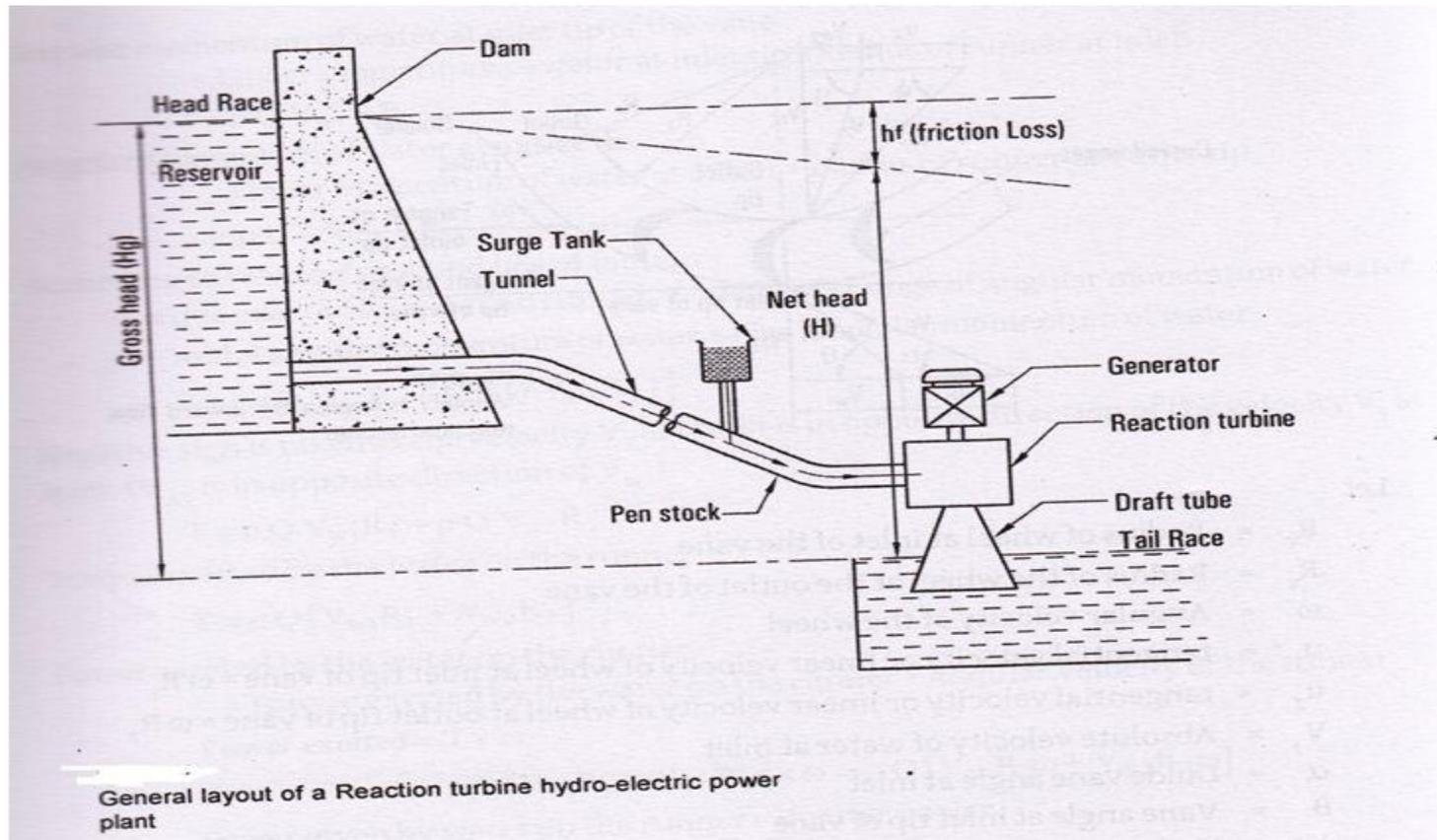
- **The Basic Working Principle**

When a high speed water jet injected through a nozzle hits buckets of Pelton wheel; it induces an impulsive force. This force makes the turbine rotate. The rotating shaft runs a generator and produces electricity. Pelton turbine transforms kinetic energy of water jet to rotational energy

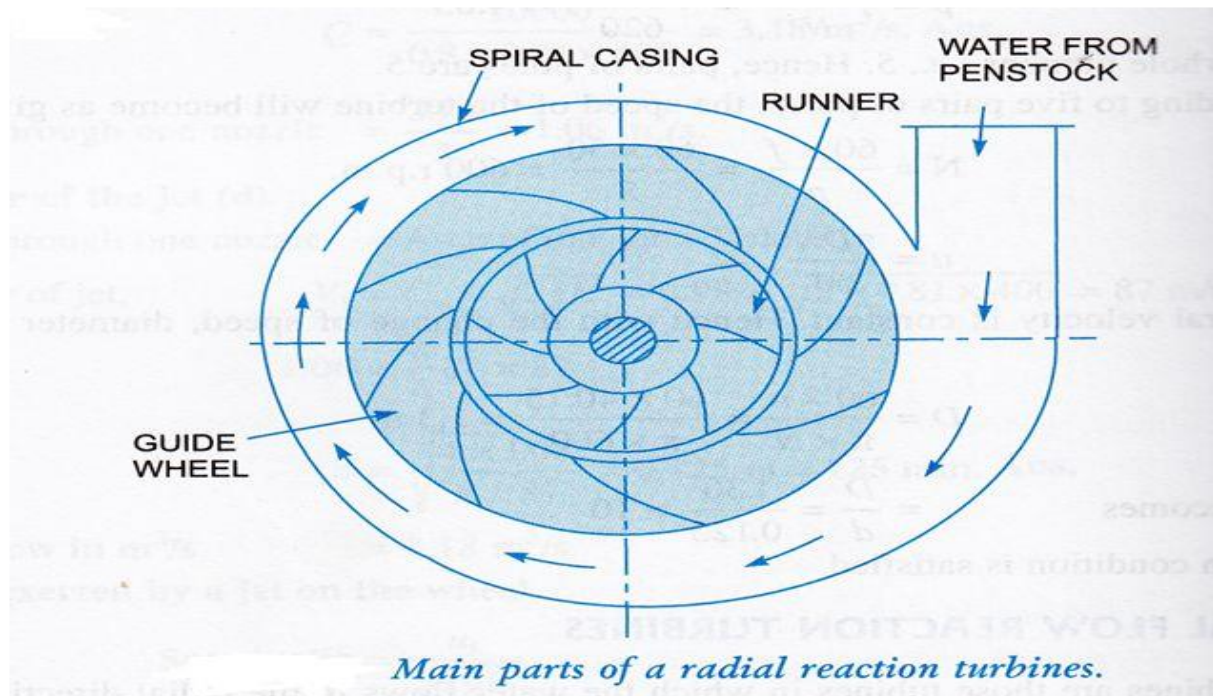


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REACTION TURBINE



Francis Turbine



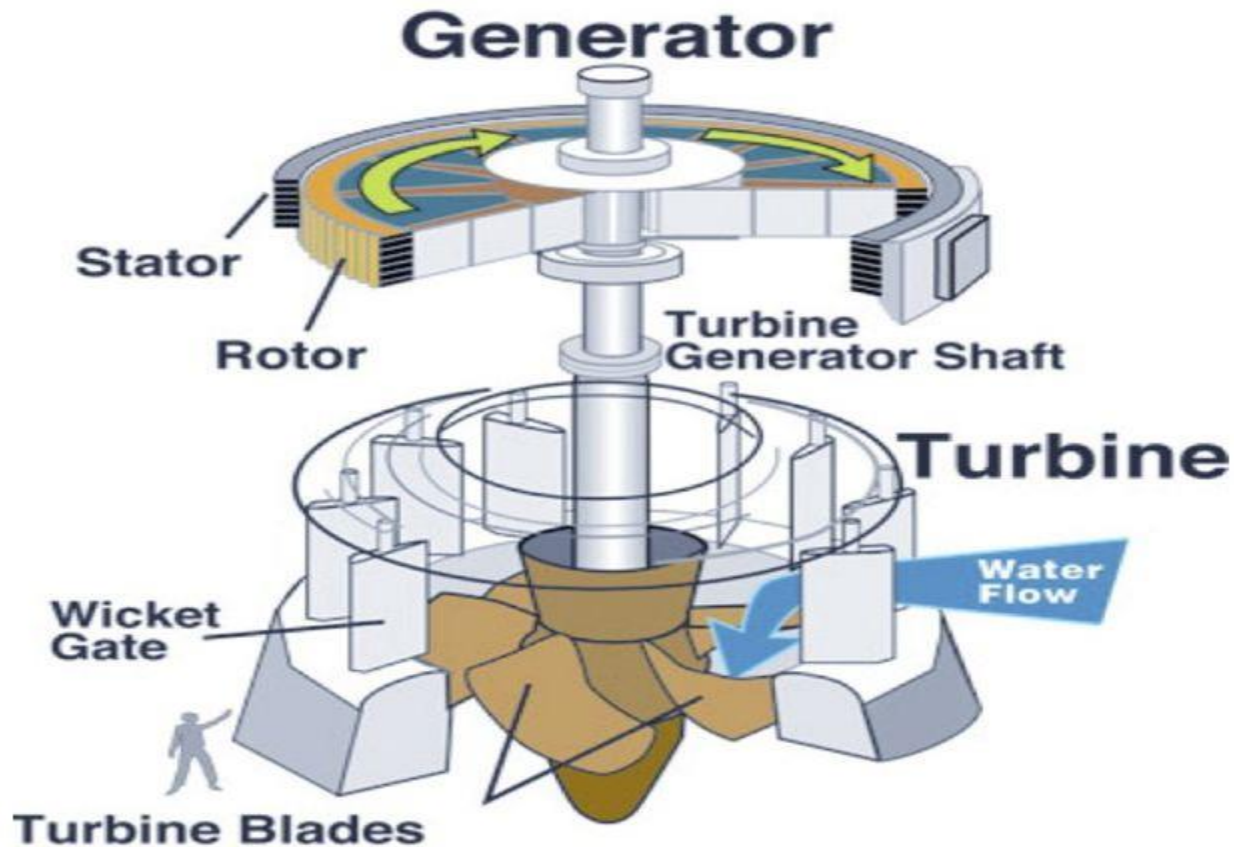
- Francis Turbine: Penstock: It is a large size pipe which conveys water from the upstream to the dam/reservoir to the turbine runner. Spiral Casing: It constitutes a closed passage whose cross-sectional area gradually decreases along the flow direction; area is maximum at inlet and nearly zero at exit. Guide Vanes: These vanes direct the water on to the runner at an angle appropriate to the design, the motion of them is given by means of hand wheel or by a governor.
- Governing Mechanism: It changes the position of the guide blades/vanes to affect a variation in water flow rate, when the load conditions on the turbine change. Runner and Runner Blades: The driving force on the runner is both due to impulse and reaction effect Draft Tube: It is gradually expanding tube which discharges water, passing through the runner to the tail race.

- **WORKING Francis turbine operates under medium heads.**

Water is brought down to the turbine through a penstock and directed to a number of stationary blades fixed all around the circumference of the runner. These stationary blades are called as guide vanes. Water under pressure, enters the runner from the guide vanes towards the center in radial direction and discharges out of the runner axially.

- Due to the difference of pressure between guide vanes and the runner (called reaction pressure), the motion of runner occurs. As the water flows through the runner its pressure and angular momentum reduces, This will produce a reaction force on the runner blades. The pressure at inlet is more than that at outlet. The moment of runner is affected by the change of both the potential and kinetic energies of water. After doing the work the water is discharged to the tail race through a closed tube called draft tube

Kaplan Turbine:



- **It is a axial flow reaction turbine**
Kaplan turbine water flows parallel to the axis of rotation of the shaft. It is a axial flow reaction turbine. It is suitable when large quantity of water at low head is available. Main parts are Guide vanes Hub with vanes or runner of the turbine Draft tube
- **For Kaplan turbine shaft of the turbine is vertical**
Lower end of the shaft is made larger called HUB or BOSS The vanes are fixed on the hub & hence it acts as a runner. The vanes of the hub are adjustable for Kaplan turbine

SL NO	IMPULSE TURBINE	REACTION TURBINE
1	Impulsive force is rotating the turbine	Reaction force is rotating turbine
2	Pressure of liquid is decreasing in nozzle before entering to turbine	Pressure decreases as it flows over the blades
3	Blades are of symmetrical profile	Blades having aerofoil profile
4	The size of turbine is small for the same power output	Size of reaction turbine is large for the same power output
5	Whole pressure energy of water is converted into kinetic energy before passed onto turbine wheel	Part of pressure energy only converted to kinetic energy
6	Water discharges directly from turbine wheel to tail race	Water discharges into a draft tube then it is finally discharged to tail race
7	Pressure of water will be atmospheric as it flows over moving blades	Pressure of water continuously decreases as it flows over the blades