Steam Turbines

A Steam Turbine is an engine that converts heat energy from pressurized steam into mechanical energy where the steam is expanded in the turbine in multiple stages to generate the required work. Steam turbine engines are used to produce electricity.

Types of Steam Turbines

- **Impulse Steam Turbine**

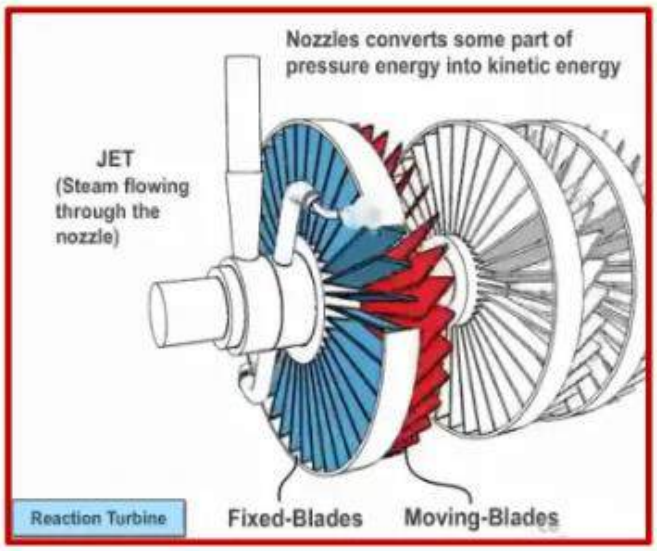
The basic idea of an impulse steam turbine is that a jet of steam from a fixed nozzle pushes against the rotor blades and impels them forward. So the impulse force of high-velocity steam exerts a force on the blade to turn the rotor. The kinetic energy of the steam is transferred to the rotating wheel by momentum transfer within the blades. Pelton Wheel, Banki Turbine, etc are typical examples of Impulse turbine.

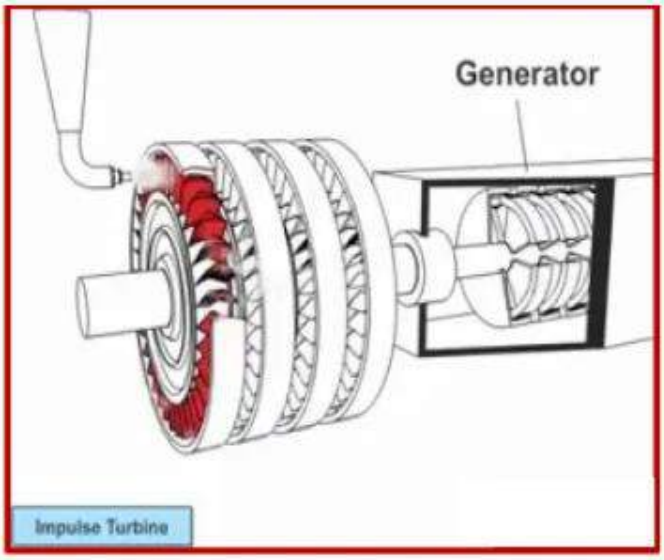
- **Reaction Steam Turbine**

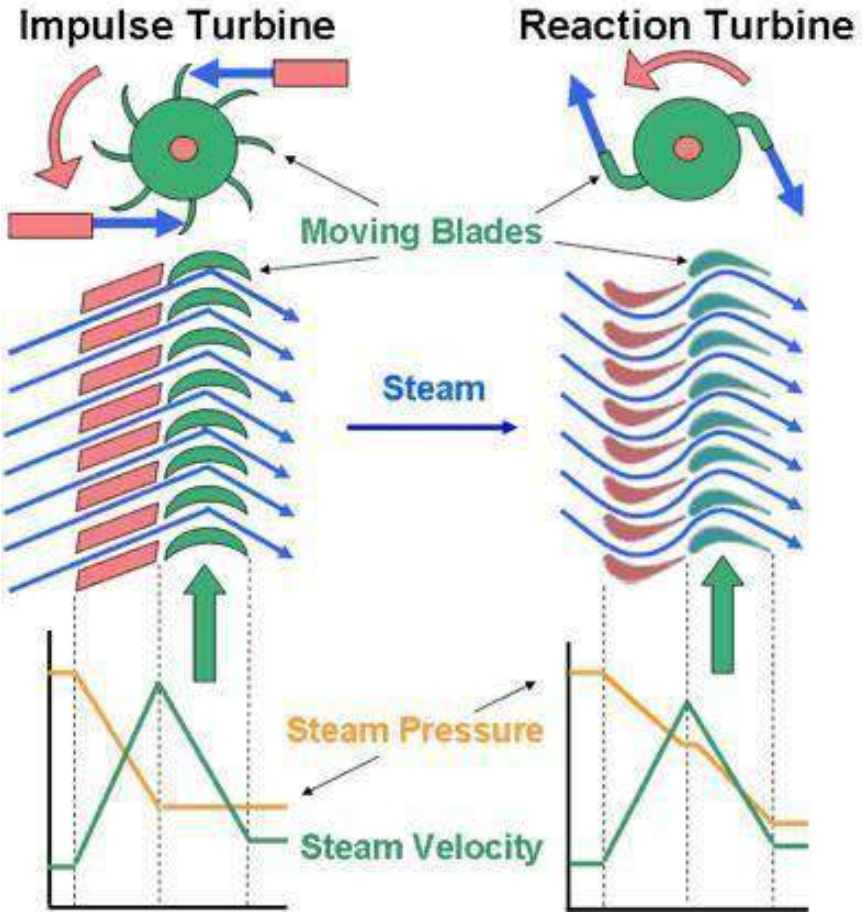
In the reaction steam turbine, a jet of steam flows from a nozzle on the rotor (the moving blades) by fixed blades designed to expand the steam. The rotor gets its rotational force from the steam as it leaves the blades. Roughly 50% of the output power is generated by the impact force and the other 50% from the reaction force by the steam expansion. Francis Turbine, Kaplan Propeller turbine, Deriaz turbine, etc are examples of reaction turbine.

The main difference between impulse and reaction turbine lies in the way in which steam is expanded while it moves through them such that:

- In the impulse type steam turbine, the steam expands in the nozzle and its pressure doesn't change as it moves over the blades.
- In the reaction type, the steam expands continuously as it passes over the blades and thus there is a gradual fall in pressure during expansion.


Nozzles converts some part of pressure energy into kinetic energy
JET
(Steam flowing through the nozzle)
Reaction Turbine
Fixed-Blades
Moving-Blades


Generator
Impulse Turbine


Impulse Turbine
Reaction Turbine
Moving Blades
Steam
Steam Pressure
Steam Velocity

LOSSES IN STEAM TURBINE

Losses are all-time very important for manufacturing any machine. That's why Manufacturer takes special attention for manufacturing any machine. We know an ideal machine which has 100% gross efficiency will do the equivalent work to the isentropic enthalpy. It means turbine uses every single bit of heat drop produced by steam.

But practically turbine's work done is much less than isentropic heat drop of the steam used. Because some internal losses occurred at the time of its operation. These losses are directly affected by the turbines output as well as its efficiency

Though there are several losses in a turbine, but here we will discuss some important internal losses in the turbine.

- **Nozzle Friction Loss :-**

It is a very important loss for Impulse Turbine. When steam passes through the nozzles, friction loss occurs and the formation of eddies. Friction occurs in the nozzle due to the factor of nozzle efficiency and it is the ratio of actual enthalpy drop to isentropic enthalpy drop.

- **Blade Friction Loss :-**

This loss is important for both Impulse and Reaction turbine . Blade friction loss is due to the steam's gliding over the blades and friction of the surface of the blades

- **Wheel Friction Loss :-**

When steam passes through the rotating turbine wheel, it produces some resistance on the turbine wheel. As a result, it rotates in lower speed from its original speed. It is the loss in both Impulse and Reaction turbine. The total frictional loss is about 10% of total turbine loss.

- **Losses due to mechanical friction :-**

This loss is for turbine's bearing. Mechanical friction loss is due to the friction between the shaft and wheel bearing and also the regulating valve of the turbine. This loss may be reduced by proper lubrication of the moving parts of the turbine. This loss occurs both Impulse and Reaction turbine.

Steam Condensers

Steam condensers are devices in which the exhaust steam from the steam turbine is condensed by means of cooling water. Condensation can be done by removing heat from exhaust steam using circulating cooling water. During condensation, the working substance (steam) changes its phase from vapour to liquid and rejects latent heat.

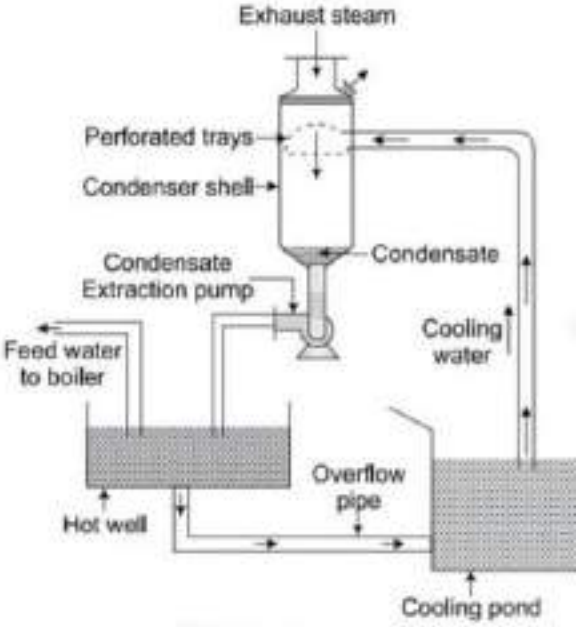
The main advantages of a steam condenser in a steam power plant are as follows:

- It increases the efficiency of the power plant due to increased enthalpy drop.
- It reduces temperature of the exhaust steam which also results in more work output.
- The condensed steam can be reused as feed water for boiler which reduces the cost of power generation.

Types of condensers

Mixing type condensers (Parallel flow jet condenser)

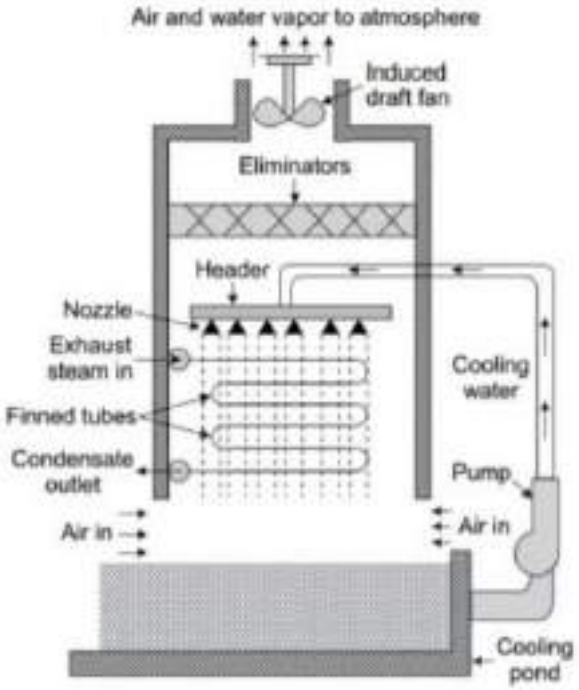
In parallel flow jet condenser both the steam and the water enters from the top and flows in the same direction. The exhaust steam is condensed when it mixes up with water. The condensate and the cooling water are delivered to the hot well from where surplus water flows to the cooling pond through an overflow pipe. Sometimes a single pump know as wet air pump is used to remove both air and the condensate but generally separate air pump is used to remove air as it gives a great vacuum.



Parallel Flow Jet Condenser

Non-mixing type condensers (Evaporative condenser)

In evaporative condenser the steam flows enters the gilled pipes and flows backwards and forwards in a vertical plane. The water pump sprays water on the pipes which condenses the steam. The quantity of cooling water needed to condense the steam can be reduced by causing the circulating water to evaporate which decrease the temperature. The remaining water is collected in the cooling pond.



Evaporative Condenser