MODULE I

STEAM TURBINE

STEAMTURBNES

The steam turbine is a prim-mover in which the potential energy of steam istransferred Into kinetic energy and later in its turn transferred into the mechanical energyofrotation of The turbine shaft.

Based on action of steam the steam turbines may be classifiedas

(i) Impulse turbine
(ii) Reaction turbine
(iii) Impulse and reaction turbine

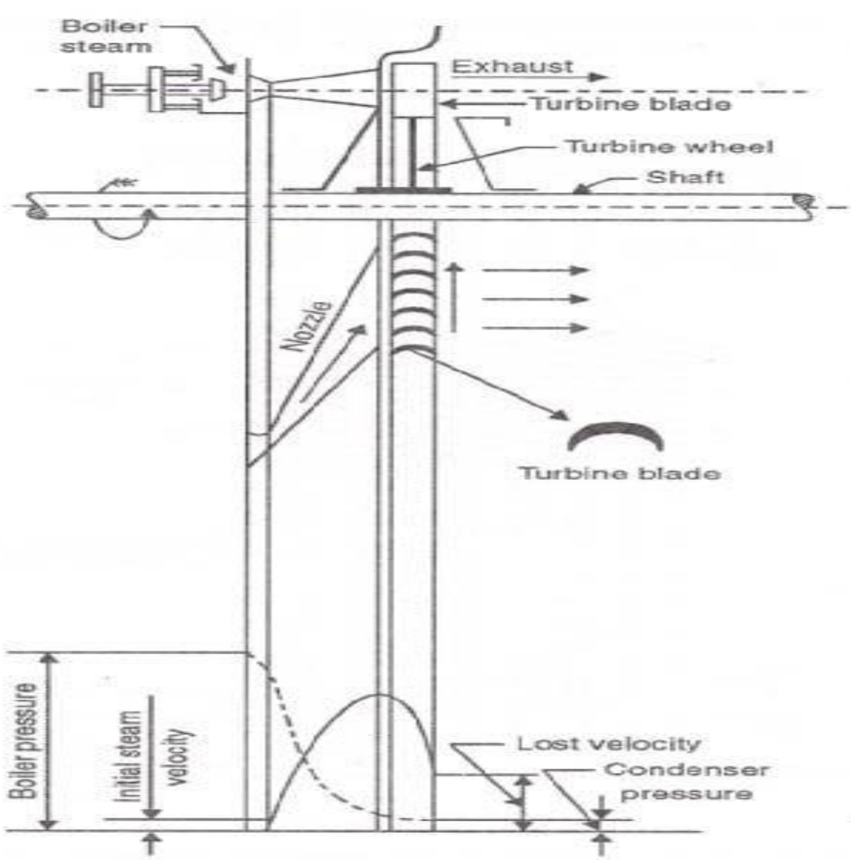
According to the direction of steam flow

(i) Axial flow turbine
(ii) Radial flow turbine

According to the number of stages

(i) Single stage turbine
(ii) Multi stage turbine

Simple Impulse turbine

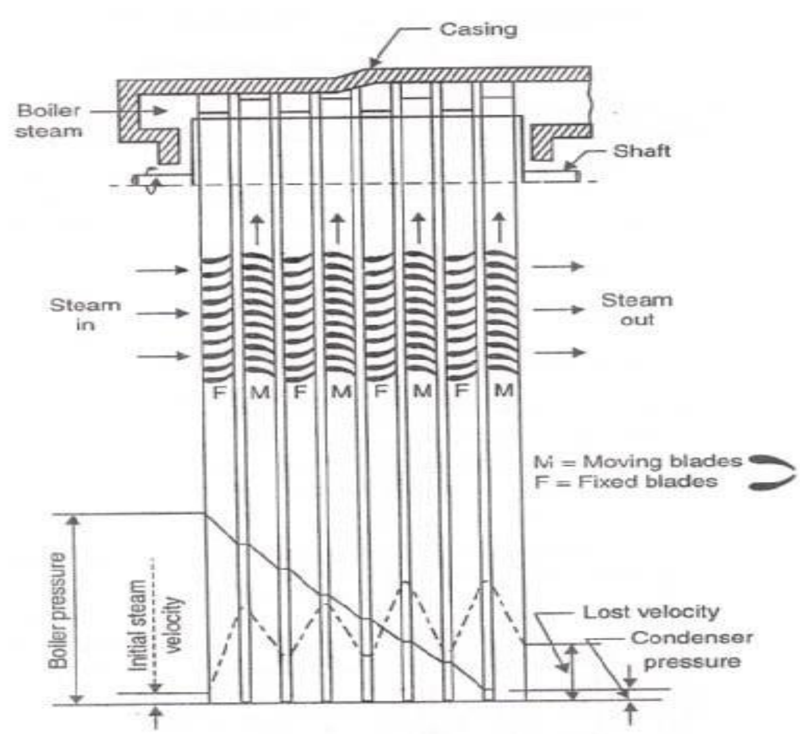


An impulse turbine runs by the impulse of steam jet. In this turbine the steam isfirst made to flow through a nozzle. Then the steam jet impinges on the turbine blades. The steam jet after Impinging on the rotor blades glides over the concave surface of the blades and finally Leaves the turbine.

A De-Laval turbine is the simple impulse turbine and is commonly used with fixed nozzles and a rotor with a ring of blades inside a casing. The surface of the blades are

Generallyverysmoothtominimizethefrictionallosses.Thebladesaregenerallymadeof Special steel alloys. Steam supplied to an impulse turbine expands completely in the nozzle. As the steam flows through the nozzle its pressure falls from steam chest pressure to Condenser pressure. Due to this relatively higher ratio of expansion of steam in the nozzlesthe Steam leaves the nozzle with a very high velocity. It can be observed that the velocity of the Steam leaving the moving blades is comparatively higher .The loss of energy due to this Higher exit velocity is called “Carry over loss” or “leaving loss”.This loss may amount to 3 to % of the nozzle velocity. The moving blades of impulse turbine are ‘constant flow area profile type blades'. Therefore The pressure remains constant during the flow of steam through the moving bladesof impulse Turbine.

Reaction turbine



Inthistypeofturbine,thereisagradualpressuredropandtakesplacecontinuously over the fixed and moving blades. The function of the fixed blades is that they alter the direction of the steam as well as allow it expand to a larger velocity. As the steam passes over the moving blades its kinetic energy is absorbed by them. Instead of a set of nozzles, steam is admitted for whole of the circumference and therefore there is all round admission. In passing through the first row of fixed blades, the steam undergoes a small drop in pressure and its velocity is increased. It then enters the first row of moving blades and it suffers a change in direction and therefore momentum. This gives impulse to the blades. But the moving blades are of aerofoil type and hence there is also a pressure drop in the moving blades.

The reaction turbines which are used these days are really impulse-reaction turbines. Pure reaction turbines are not in general use. The expansion of steam and heatdropoccurbothinfixedandmovingblades.Thevelocityofsteaminthistypeofturbinesiscomparativelylow,themaximumbeingaboutequaltobladevelocity.This type of turbine very successful lin practice. Itis also called "Parson's Reaction Turbine".

Difference between Impulse and Reaction turbines

S. No.	Particulars	Impulse turbine	Reaction turbine
1.	*Pressure drop*	Only in nozzles and not in moving blades.	In fixed blades (nozzles) as well as in moving blades.
2.	*Area of blade channels*	Constant.	Varying (converging type).
3.	*Blades*	Profile type.	Aerofoil type.
4.	*Admission of steam*	Not all round or complete.	All round or complete.
5.	*Nozzles / fixed blades*	Diaphram contains the nozzle.	Fixed blades similar to moving blades attached to the casing serve as nozzles and guide the steam.
6.	*Power*	Not much power can be developed.	Much power can be developed.
7.	*Space*	Requires less space for same power.	Requires more space for same power.
8.	*Efficiency*	Low.	High.
9.	*Suitability*	Suitable for small power requirements.	Suitable for medium and higher power requirements.
10.	*Blade manufacture*	Not difficult.	Difficult.

Methods of reducing rotor speed

Incaseofsimpleimpulseturbine,thesteamisexpandedfromtheboilerpressure to the condenser pressure in one stage only. Hence the speed of the rotorbecomes very high for practical purposes. In order to make the rotor speed practicablecompounding of steam turbine is done. Compounding is the method of reducing rotorspeed by adding stages to a simple impulse turbine without affecting the turbine workoutput.Therotor speedcanbe reduced by thefollowing methods.

(i) Velocity compounding

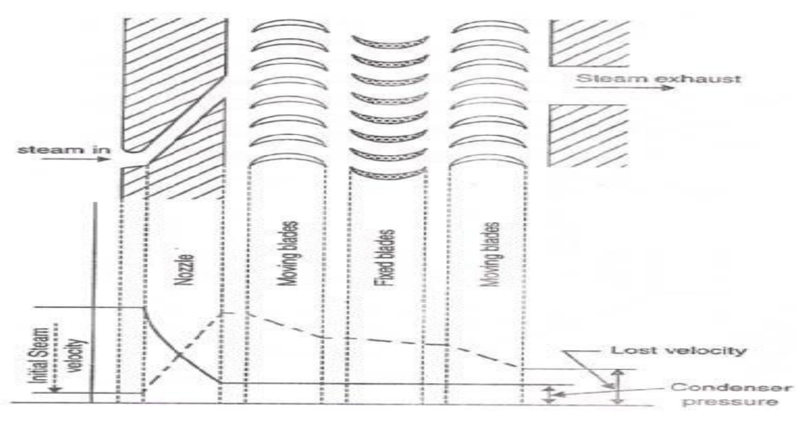
(ii) Pressure compounding

(iii) Pressure-Velocity compounding

(iv) Reaction turbine

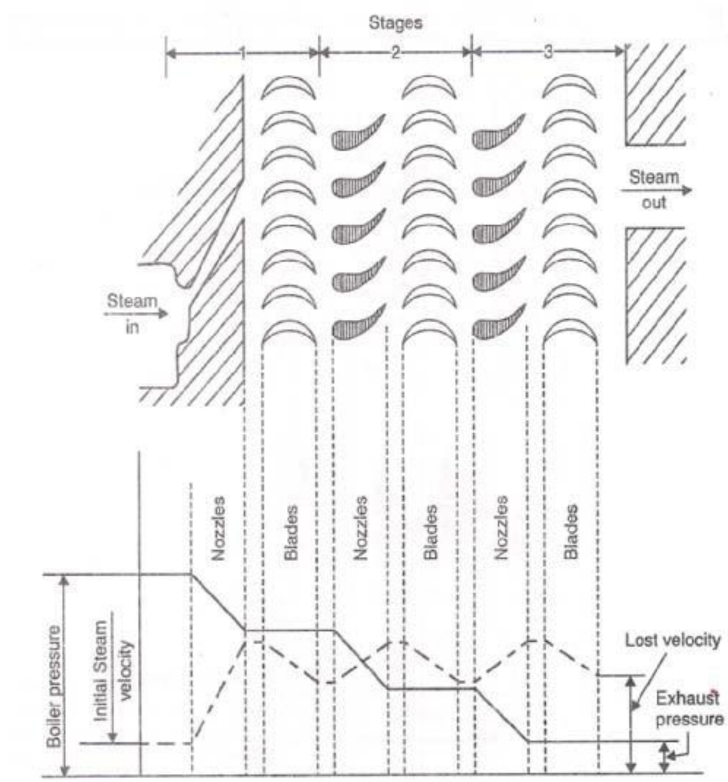
Velocity Compounding

Steamisexpandedthroughastationarynozzlefromtheboilerorinletpressureto condenser pressure. So, the pressure in the nozzle drops, the kinetic energy of thesteamincreasesduetoincreaseinvelocity.Aportionofthisavailableenergyisabsorbed by a row of moving blades. The steam (whose velocity has decreased while moving over the moving blades) then flows through the second row of blades which are fixed. The function of these fixed blades is to redirect the steam flow without altering its velocity to the following next row moving blades where again work is done on them and steam leaves the turbine with a low velocity. Fig shows a cut away section of such stage and changes in pressure and velocity as the steam passes through the nozzle, fixed and moving blades. Though this method has the advantage that the initial cost is low due to lesser number of stages yet its efficiency is low.



Pressure Compounding

Fig shows rings of fixed blades incorporated between the rings of moving blades. The steam at boiler pressure enters the first set of nozzles and expands partially. The kinetic energy of the steam thus obtained is absorbed by the moving blades. The steam then expands partially in the second set of nozzles where its pressure again falls and thevelocityincreases;thekineticenergysoobtainedisabsorbedbythesecondringofmoving blades (stage-2). This is repeated in stage-3 and steam finally leaves the turbine at low velocity and pressure. The number of stages depends on the number of rows of nozzles through which the steam must pass.
This method of compounding is used in Rateau and Zoelly turbine. This is most efficient turbine since the speed ratio remains constant but it is expensive owing to a large number of stages



Pressure-Velocity Compounding

Thismethodofcompoundingisthecombinationofpressureandvelocitycompounding. The total drop in steam pressure is divided into stages and the velocity obtained in each stage is also compounded. The rings of nozzles are fixed at the beginning of each stage and pressure remains constant during each stage. The changes in pressure and velocity are shown. This method of compounding is used in Curtis and Moore turbine.