What is Turbine? What Are Main Types of Turbines?

Turbine is a device which convert kinetic energy of fluid into mechanical energy.

The fluid may be either water or gas or steam according to the availability. It is mainly used in power plant industries to generate electric power. It can be categorized into three types.

The first on is known as hydraulic turbine, second one is gas turbine and the last one is steam turbine.

Hydraulic turbine is an hydraulic machines which convert hydraulic energy of water into mechanical energy. It installed at dam or near any large water reservoir.

Gas turbine uses compressed air or other gases to rotate the turbine and convert kinetic energy of gases into mechanical energy.

The last one is steam turbine in which first water is converted into high pressure super heated steam, which is further used to drive turbine.

What is turbine?

A hydraulic machine which converts hydraulic energy into mechanical energy is known as turbine.

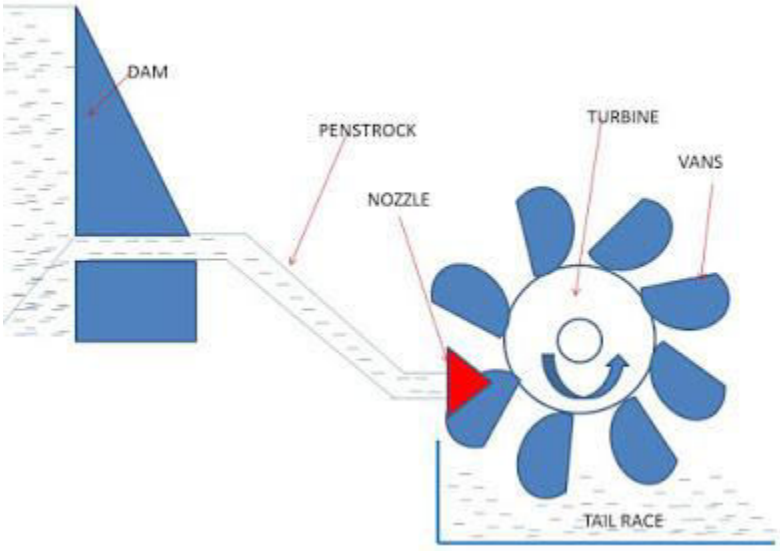
Turbine is a device which converts kinetic energy of water, air, gas or steam into mechanical energy which is further used to rotate generator shaft.

Simply turbine is a rotor which has vanes at the peripheral and connected at the end of an electromagnet or well known generator shaft which causes to rotate it and generate electric power.

We know that turbine is mostly used in hydroelectric power plants. As shown in diagram a dam is constructed across a river to store water. There is an elevation difference between turbine and dam.

Turbine and dam is connected by a large diameter pipe called penstock which carries pressurize water from the storage reservoir to turbine. The turbine is connected to an electromagnet.

When water strikes the turbine blades, it makes rotate the turbine hence electric generator which produces electric power. Turbine has different types of vanes fitted on rotter. The water is carried to tail race after worked on the turbine.



Turbine can be classified in various ways like according to direction of fluid, head at the inlet of turbine, types of fluid etc. These are

According to the type of energy at inlet:

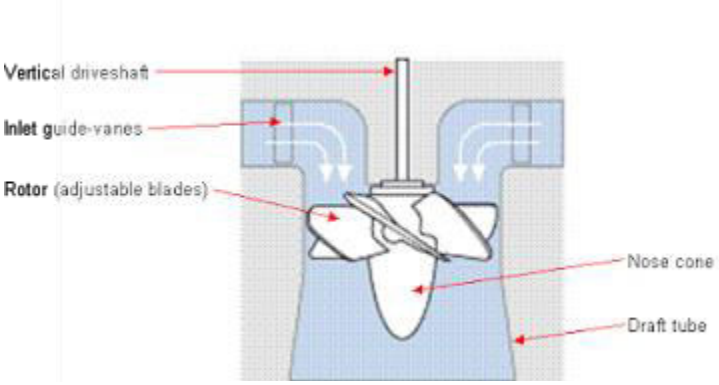
1. Impulse turbine:

If a turbine uses only impulse energy of fluid, it is known as impulse turbine. The impulse energy means it uses only kinetic energy of fluid. In this type of turbine, first whole pressure energy or head converted into kinetic energy and this kinetic energy used to rotate turbine. The water uses only its kinetic energy and the pressure of water remains constant at inlet and exit of it.

2. Reaction turbine:

If the water pressure at inlet and exit of turbine is different or the water use sits kinetic energy as well as pressure energy to rotate the turbine, is known as reaction turbine. When the water under pressure flows through the turbine, some of its pressure energy converts into kinetic energy which rotate the turbine.

Example: Francis Turbine



Kaplan Turbine (Reaction Turbine)

According to the direction of flow through runner:

1. Tangential flow turbine:

If the water flows along the tangent of the runner, the turbine is known as tangential flow turbine. Pelton wheel turbine is the example of tangential flow turbine.

2. Radial flow turbine:

If the water flows in the radial direction through the runner, the turbine is called radial flow turbine. If the water flows from outward to inward, radially, the turbine is known as inward radial flow turbine and if oppose the turbine is known as outward radial flow turbine.

3. Axial flow turbine:

If the water flows along the direction parallel to the axis of the runner, the turbine is known as axial flow turbine. Kaplan Turbine is the example of axial flow turbine.

4. Mixed flow turbine:

If the water flows through the runner in the radial direction but leaves in the direction parallel to the axis of rotation of the runner, the turbine is called mixed flow turbine. Francis is the example of mixed flow turbine.

According to head at the inlet of turbine:

1. High head turbine
2. Medium head turbine
3. Low head turbine

According to specific speed of turbine:

1. Low specific speed turbine
2. Medium specific speed turbine
3. High specific speed turbine

List the factors/criteria to choose a turbine.

Or

How to decide whether Kalpan, Francis or a pelton type tupe turbine would be used in a hydro project?

Ans. The selection of turbines depend on the following considerations.

1. Operating Head— Pelton turbine - Greater than 400 m

Francis turbine - 50-400 m

Kaplan turbine - Less than 50 m

2. Specific speed-Turbine having high specific speed is selected. High speed means a smaller size of the turbine. Francis turbines run at higher speeds (50—250) than those of pelton wheels (8—50), Kaplan turbine have the greatest specific speed (250—1000).

3. Cavitation- Cavitation occurs when the pressure at the runner outlet equals vapour pressure. Francis turbines can not be used for very high heads because of cavitation. Pelton turbines are free from cavitation because the pressure at runner outlet is the atmospheric.

4. Performance characteristics—Turbines should be selected in such a way that their efficiencies do not fall appreciably when operating under part load. Francis turbines operate efficiently between half and full load. Kaplan turbines are more efficient at low heads.

5. Overall cost—The plant should be designed for the minimum cost as cost is the prime consideration in designing a plant

6. Number of units—It is better to go in for a larger unit as far as possible, but there must be at least two units at any particular site so that one unit is always available.

List the advantages of Kaplan Turbine over Francis Turbine. **Ans.** Advantages of Kaplan turbine over Francis turbine

(i) Runner vanes are adjustable in Kaplan turbine while in Francis turbine run vanes are not adjustable.

(ii) There is less resistance offered as the number of vanes are fewer in Kaplan turbine (in) Specific speed range 250-850 m Kaplan turbine In Francis turbine specific speed range is 5o—250.

Differentiate between Francis and Kaplan turbine.

Ans.

Francis turbine	Kaplan turbine
1. Radially inward, mixed flow.	Purely axial flow turbine.
2. Position of shaft can be horizontal or vertical.	Only vertical shaft disposition.
3. Runner vanes are not adjustable.	Runner vanes are adjustable.
4. Large no. of vanes, (16–24) blades.	Small no. of vanes, (3–8) blades.
5. Medium head, medium flow.	Low head, large volume flow.
6. Specific speed from 50–250.	Specific speed from 250–850.

List the unit quantities as applied to turbo-machines.

Ans. (i) Unit power (ii) Unit speed (iii) Unit discharge.

Unit Power-The powered developed by a turbine working under a head of 1 meter, is known as unit power:

$$P_u = P/H^{3/2}$$

P =Power developed,

H =Head of water

Unit Speed-The speed of turbine, working under a head of 1 meter, is known as unit speed

$$N_u = N/\sqrt{H}$$

N = speed of turbine,

H = Head of water

Unit Discharge-The discharge of a turbine, working under a head of 1 meter, is known as unit discharge.

$$Q_v = Q/\sqrt{H}$$

Q = Discharge,

H_2 = Head of water

FMM - UNIT - IV - TURBINES

Hydraulic Machines:

These m/c are defined as those machines which convert either hydraulic energy into mechanical energy or mechanical energy into hydraulic energy.

Hydraulic energy $\rightleftharpoons$ Mechanical energy.

Turbines:

The hydraulic machines, which convert the hydraulic energy into mechanical energy.

Types: 1. pelton turbines 2. Francis turbines
3. Kaplan turbine.

Classification:

(1.) According to the type of energy at inlet
   (a) Impulse turbine (b) Reaction turbine
(2) According to the direction of flow through runner
   (a) Tangential flow turbine (b) Radial flow turbine
   (c) Axial flow turbine (d) Mixed flow turbine
(3) According to the head at the inlet of turbine
   (a) High head turbine (b) Medium head turbine
   (c) Low head turbine
(4) According to the Specific Speed of the turbine
   (a) Low Specific Speed turbine (b) Medium Specific Speed turbine
   (c) High Specific Speed turbine

Minor losses. Flow through pipes in series and in parallel Hydraulic and energy gradient.

- If at the inlet of the turbine, the energy available is only kinetic energy, the turbine is known as impulse turbine.
- As the water flows over the vanes, the pressure is atmospheric from inlet into outlet of the turbine.
- If at the inlet of the turbine, the water possesses kinetic energy as well as pressure energy, The turbine is known as Reaction turbine.
- When the water flows along the tangent of the runner the turbine is known as Tangential flow turbine.
- When the water flows in the radial direction through the runner, the turbine is called Radial flow turbine
- When the water flows from outwards to inward, radially, the turbine is known as inward radial flow turbine.
- When water flows radially from inwards to outwards the turbine is known as outward radial flow turbine.
- When the water flows through the runner along the direction parallel to the axis of rotation of the runner, the turbine is called axial flow turbine.
- When the water flows through the runner in the radial direction but leaves in the direction parallel to axis of rotation of the runner, the turbine is called mixed flow turbine