Learn about Turbines

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TURBINES

- The word **‘turbine’** was coined by Claude Bourdin in the early 19th century and is derived from the Latin word for 'whirling' or a 'vortex'.
- Water under pressure contains energy.
- Turbines convert this energy into rotating mechanical energy.
- Flowing water is directed onto the Blades of a turbine Runner, creating a force on the blades, thus transferring **kinetic energy** from the water flow to the turbine.

Where are Turbines used

- Hydroelectric schemes use the kinetic energy of moving water to produce electricity. This water is put through a **turbine,** which in turn drives a generator that generates electricity.

Types of Hydro-Electric Schemes

- **Run of the river:** Turbine and generator are located at the dam or along its side – e.g. **Bhakhra Dam**.
- **Diversion**: The supply of water is taken from a dammed river or lake to a remote powerhouse containing the turbine and generator – e.g. **Slapper** (the dam is at Pandoh, the water flows through two tunnels & a channel to power house at Slapper) .
- **Pumped storage:** This scheme incorporates two reservoirs. At times of low demand, electricity is used to pump the water from lower to upper basin. This extra water is then released to create power at a time when demand is high – e.g. **Tehri Hydropower Complex** where Tehri dam forms the upper reservoir and **Koteshwar dam** serves as lower reservoir.

Types of Turbines

- Water wheel Turbine
- Impulse Turbine
- Kaplan Turbine
- Francis Turbine
- Pelton Turbine
- Cross flow Turbine

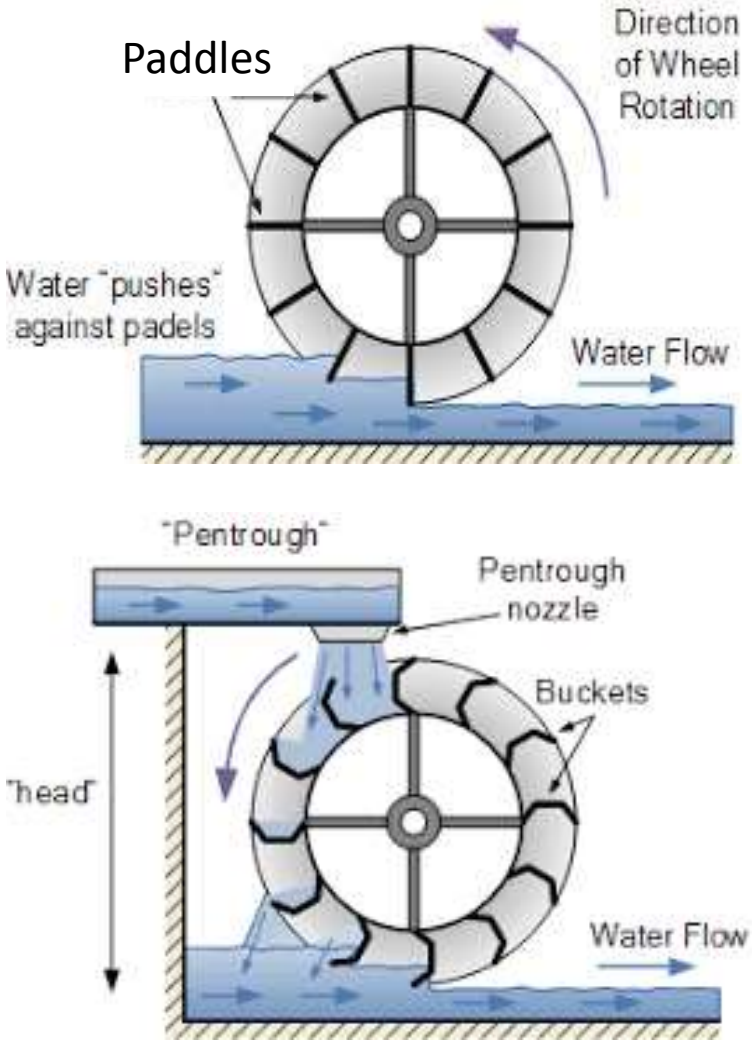
WATER WHEEL TURBINE

- Have you seen a water wheel in a field? These were very common till a few decades ago to water the fields.
- Animal power was used to drive a water wheel. These can also be driven by electricity.
- A water wheel is a hydro power system used for extracting power from a flow of water. A water wheel consists of a large wheel, with number of Blades or buckets arranged on the outside rim forming the driving surface.

Water wheel Turbine

two basic forms:

- Vertically mounted water wheel that is rotated by water striking paddles or blades at the bottom of the wheel called as **‘undershot type’.**
- In **‘overshot type’** falling water striking paddles, blades or buckets near the top of the wheel.
- Overshot wheels are more efficient. The wheel spins faster because gravity aids the falling water, pushing the wheel round at a higher speed.

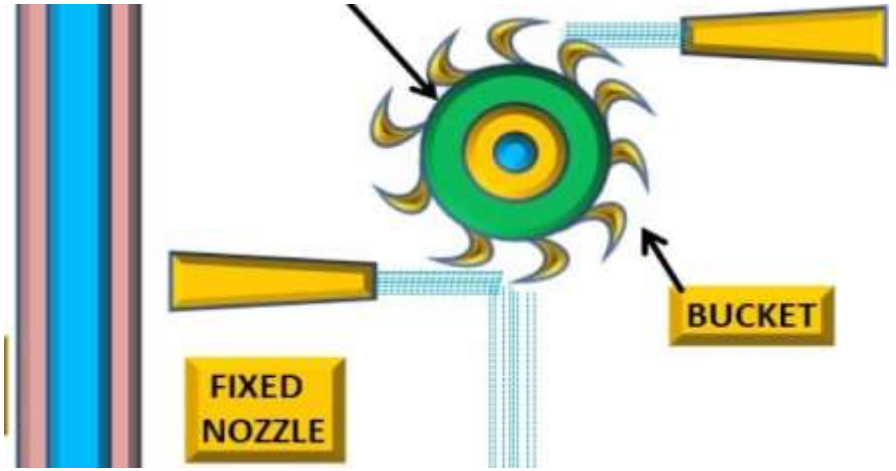


Applications of Water wheel Turbine

- water wheel was widely used crop irrigation, grinding grains, supply drinking water etc.
- These were probably the first method of creating mechanical energy that replaced humans and animals.

IMPULSE TURBINES

- Impulse turbine convert the kinetic energy of a jet of water to mechanical energy.
- The water's pressure (Potential energy) is converted to kinetic energy by a nozzle and focused on the turbine. The jet impinges on the turbine's curved blades.



The resulting change in momentum (impulse) causes a force on the turbine blades. Impulse turbines are most often used in high head applications.

KAPLAN TURBINE

Theory of operation

- It is a propeller-type water *turbine* with adjustable blades.
- Developed by Austrian professor Viktor *Kaplan (1913)* who combined automatically adjusted propeller blades with automatically adjusted wicket gates to achieve efficiency over a wide range of flow and water levels.
- The inlet is a scroll shaped tube that wraps around the turbine's wicket gate. Water is directed tangentially, through the Wicket Gate and spirals onto a propeller runner, causing it to spin.

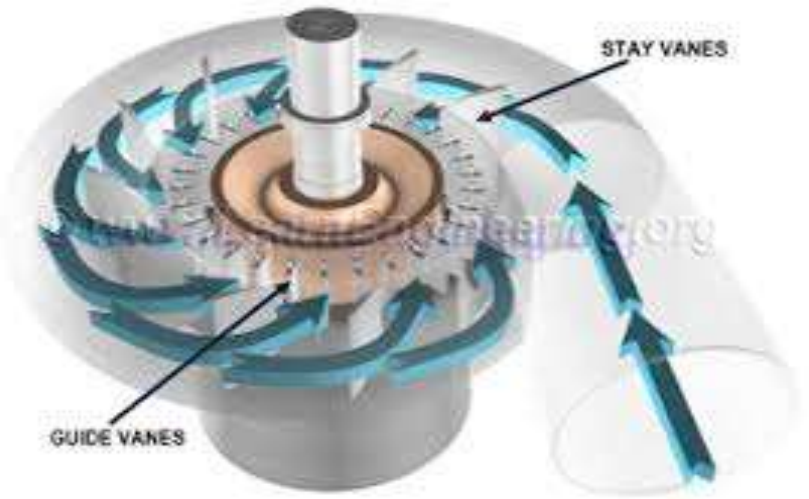
Applications-Kaplan turbine

- Kaplan turbines are widely used in high flow, low head range (2m to 40m). Kaplan turbines can produce as large as 400 megawatts.
- Kaplan turbines have been used in the power houses under UBDC project in Punjab.

FRANCIS TURBINE

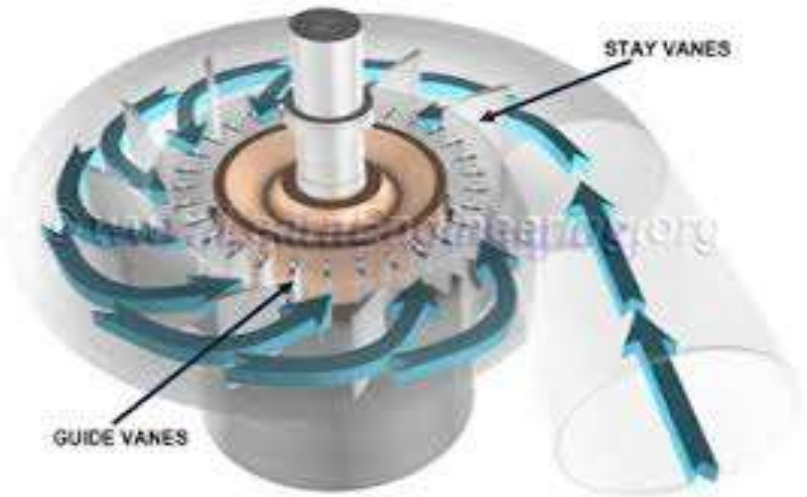
Theory of operation

- A Francis turbine has a runner with fixed vanes, usually nine or more. Guide vanes direct the water tangentially to the runner.
- The water enters the turbine in a radial direction with respect to the shaft, and is discharged in an axial direction. A casement is needed to contain the water flow.



Applications- FRANCIS TURBINE

- These turbines are used for low to medium head (10 m to 350 m) and can produce as large as 800 megawatts.
- Francis turbines have been used at **Ranjit Sagar Dam project (Pb.), Shanan Power house (HP.)** etc.



PELTON TURBINES

Theory of operation

The Pelton wheel turbine is a tangential flow impulse turbine. Where water flows along the tangent to the path of the runner. Nozzles direct forceful streams of water against a series of spoon-shaped buckets mounted around the edge of a wheel.

PELTON TURBINES

Theory of operation…

Each bucket reverses the flow of water, leaving it with diminished energy. The resulting impulse spins the turbine. The buckets are mounted in pairs, to keep the forces on the wheel balanced, as well as to ensure smooth, efficient momentum transfer of the fluid jet to the wheel.

Applications- PELTON TURBINES

- The Pelton turbines are used for medium to high head (50m to 1300m), low flow sites and can produce as large as 200 megawatts.

The Pelton water turbine was developed by Lester Pelton in 1880.

CROSSFLOW TURBINE

Theory of operation

- The Crossflow turbine is a hydropower system similar in appearance to an over-shot water wheel.
- Unlike the water wheel, however, it uses a nozzle and blades instead of buckets.

CROSSFLOW TURBINE

Theory of operation

- The “middle” of the Crossflow turbine is left open and the blades forming the walls of the bucket are angled.
- The water flowing into the top of the turbine not only spins the wheel by its weight but as it flows past the blades and into middle of the turbine, its direction changes.

Applications- CROSSFLOW TURBINE

The Crossflow turbines are used for low head (3m to 250m), high flow sites. It has lower efficiency than other turbine designs but enjoys a niche market for low cost installations.

The Crossflow water turbine was developed by Donat Banki in 1919

Thanks