LECTURE NOTES

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HYDRAULIC MACHINES AND INDUSTRIAL FLUID POWER

What Is Impulse Turbine ?

An impulse turbine is a type of steam turbine or hydraulic turbine that operates based on the principle of impulse. It is designed to convert the kinetic energy of a high-velocity fluid jet into mechanical work. This type of turbine is commonly used in hydroelectric power plants and certain types of steam power plants.

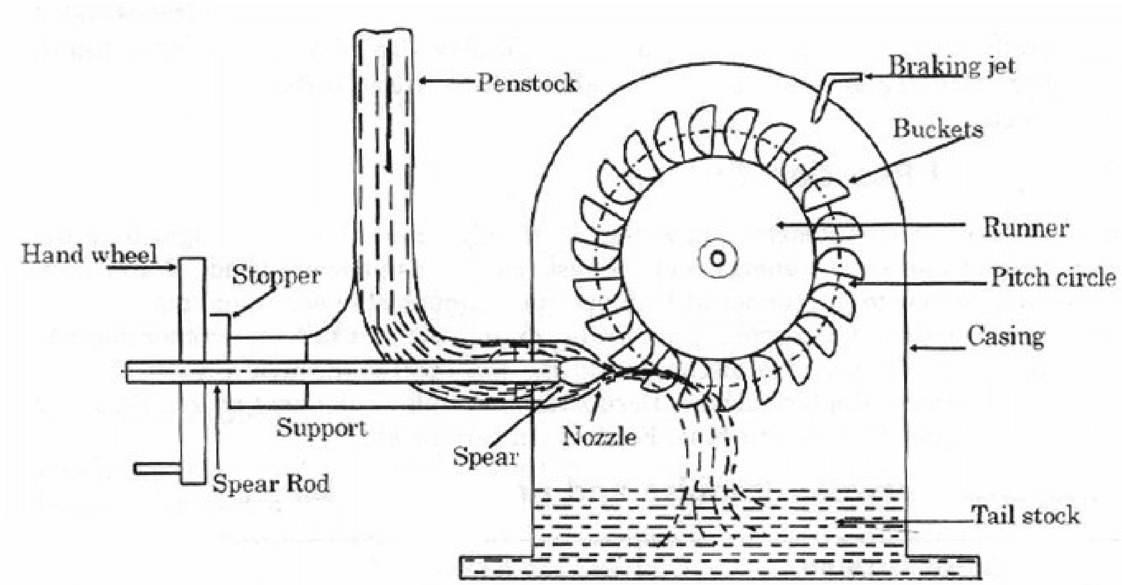
The working principle of an impulse turbine involves the conversion of the fluid's kinetic energy into rotational motion. It consists of a set of stationary nozzles or blades called guide vanes or nozzles and a set of moving blades known as impulse or rotor blades. The fluid, either steam or water, is directed through the guide vanes, which accelerate the fluid to a high velocity. The high-velocity fluid then strikes the impulse blades, causing them to rotate.

The key feature of an impulse turbine is that the pressure drop occurs entirely in the nozzles or guide vanes, and the moving blades only experience a highvelocity fluid jet. This design allows for a simplified turbine construction and higher efficiency compared to reaction turbines, which have both pressure drop and velocity change in the moving blades.

The rotational motion produced by the impulse blades can be used to drive a generator or any other machinery connected to the turbine. The efficiency of an impulse turbine depends on factors such as the fluid velocity, blade design, and overall turbine construction. Engineers carefully optimize these parameters to achieve maximum power output and efficiency for a given application.

In summary, an impulse turbine is a type of turbine that converts the kinetic energy of a high-velocity fluid jet into mechanical work through a set of stationary nozzles and moving blades. It is commonly used in hydroelectric and steam power plants to generate electricity or drive machinery.

Impulse Turbine Parts



The impulse turbine comprises several essential components that collaborate synergistically to facilitate the conversion of the kinetic energy of a high-velocity fluid jet into mechanical work. These components include the runner, buckets, nozzle, spear, casing, penstock, and potentially a braking jet.

The runner, as a fundamental part of the turbine, serves as the rotatable element that houses the carefully designed buckets or blades. These buckets, meticulously crafted curved surfaces, are securely affixed to the runner and play a pivotal role in effectively capturing the energy of the fluid jet and transforming it into rotational motion.

On the other hand, the nozzle, a stationary component, assumes the responsibility of directing and regulating the fluid flow onto the buckets. Its primary function involves accelerating the fluid to a significant velocity before it impinges upon the buckets, thus optimizing the efficiency of energy transfer.

To ensure the stability and precision of the fluid flow, a spear, commonly a small rod or pin, is typically positioned at the center of the nozzle. This spear aids in stabilizing and guiding the fluid jet, enabling it to strike the buckets with accuracy and consistency.

The casing, encompassing the turbine, assumes a critical role in providing structural support while maintaining the desired flow path of the fluid. Within the casing, various components, including the nozzles, buckets, and other internal parts of the turbine, are securely housed, ensuring proper alignment and optimal functionality.

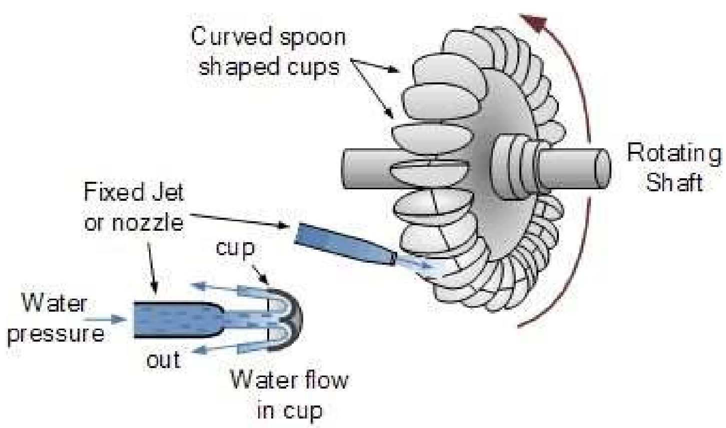
Furthermore, the penstock, functioning as a conduit, facilitates the delivery of high-pressure fluid to the turbine. Acting as a channel or pipe, it effectively transports the fluid from its source, be it a dam or a steam generator, to the turbine's nozzles where the energy conversion occurs.

In certain impulse turbines, an additional component known as a braking jet may be incorporated. This braking jet typically assumes the form of an extra nozzle and serves the purpose of directing a high-velocity fluid stream against the runner. By doing so, it introduces resistance, enabling control over the rotational speed of the turbine as necessary.

Collectively, these components seamlessly integrate to enable the efficient conversion of fluid energy into mechanical work within the impulse turbine. Through meticulous design optimization and meticulous calibration of these constituent parts, engineers strive to maximize turbine performance, ultimately achieving the desired power output and operational effectiveness.

Working Principle Of Impulse Turbine

The impulse turbine operates based on Newton's second law of motion, which states that the rate of change of momentum of an object is directly proportional to the force applied. In simpler terms, force is equal to the product of mass and acceleration (F = m * a).



In the case of an impulse turbine, the working principle revolves around two main factors: the mass of the flowing water or fluid and the change in velocity of the flow as it enters the turbine and exits after impact.

When water or fluid flows into the turbine, it possesses both mass and velocity. The nozzles or guide vanes of the turbine accelerate the fluid, converting its pressure energy into kinetic energy. This increase in velocity leads to a change in momentum of the fluid.

As the high-velocity fluid jet strikes the moving blades or buckets of the turbine, there is an impulse force exerted on the blades. According to Newton's second law, this force is directly proportional to the change in momentum experienced by the fluid.

The change in momentum is a result of the difference in velocity of the fluid before and after impact with the blades. By transferring its momentum to the rotating blades, the fluid experiences a change in velocity, and the blades start to rotate.

The force exerted by the fluid on the blades causes the rotor to spin, and this rotational motion can be utilized to generate electricity or perform mechanical work.

Therefore, the working principle of an impulse turbine is based on the concept of imparting a change in momentum to the fluid by accelerating it and then transferring that momentum to the rotating blades, resulting in the generation of rotational motion and the conversion of fluid energy into mechanical work.

How Does Impulse Turbine Works

The working principle of an impulse turbine involves the conversion of the kinetic energy of a high-velocity fluid jet into mechanical work. Here's a step-bystep explanation of how an impulse turbine works:

1. Fluid Acceleration: The process begins with the fluid, such as water or steam, entering the turbine through stationary nozzles or guide vanes. These nozzles or guide vanes are designed to control the flow and accelerate the fluid to a high velocity. The pressure energy of the fluid is converted into kinetic energy during this stage.
2. High-Velocity Jet: Once the fluid passes through the nozzles or guide vanes, it emerges as a high-velocity jet. The high-velocity fluid jet then enters the region where the moving blades or buckets of the turbine are located.
3. Impulse Transfer: As the high-velocity fluid jet strikes the moving blades or buckets, it transfers its momentum to the turbine's rotor. The impact of the fluid on the blades causes

them to change their direction, resulting in a change in momentum. According to Newton's third law of motion, the change in momentum of the fluid produces an equal and opposite reaction, causing the rotor and the blades to rotate.

4. Rotational Motion: The rotational motion of the blades and rotor is driven by the impulse transfer from the high-velocity fluid jet. The rotating blades are connected to a central shaft, which transfers the rotational energy to the generator or the machinery being powered by the turbine.
5. Fluid Exhaust: After the fluid imparts its momentum to the blades, it exits the turbine and is typically discharged into a lower-pressure environment, such as a tailrace in a hydroelectric power plant or an exhaust system in a steam power plant. The fluid's pressure and velocity are reduced, and it is then either reused or discharged from the system.
6. Energy Conversion: The rotational motion of the turbine's rotor is converted into mechanical work, which can be used to generate electricity through an attached generator or drive other machinery connected to the turbine.

In summary, an impulse turbine works by accelerating a fluid to a high velocity through nozzles or guide vanes. The high-velocity fluid jet impacts the moving blades, transferring its momentum and causing the rotor to rotate. The rotational motion is then utilized to generate power or drive machinery. The conversion of fluid energy into mechanical work is the fundamental principle behind the operation of an impulse turbine.

Types Of Impulse Turbine

There are several types of impulse turbines, each with its own unique design and characteristics. Here are some of the common types of impulse turbines:

1. Pelton Turbine: The Pelton turbine is one of the most widely used impulse turbines in hydroelectric power plants. It consists of a set of spoon-shaped buckets or cups mounted on the circumference of a rotating wheel, known as the runner. High-pressure water jets are directed onto the cups, causing the water to be deflected and creating a high-velocity jet. The jet strikes the curved surfaces of the cups, transferring its momentum to the runner and causing it to rotate.

2. Turgo Turbine: The Turgo turbine is a variation of the Pelton turbine and is often used for medium head applications. It features a runner with double-cupped buckets that are more open and have a slightly different shape compared to the Pelton turbine. This design allows for greater water flow through the turbine and increased power output. The Turgo turbine is known for its high efficiency and suitability for moderate head and higher flow rate conditions.
3. Crossflow Turbine: Also known as Banki-Michell or Ossberger turbines, crossflow turbines are commonly used in low-head hydroelectric power plants. They have a vertical axis and utilize the flow of water across a set of fixed guide vanes and moving blades to generate power. The water flows tangentially over the guide vanes, creating a swirling motion that strikes the blades, causing them to rotate. Crossflow turbines are compact, easy to install, and can operate efficiently at low flow rates.
4. Multiple-Jet Turbine: The multiple-jet turbine, as the name suggests, uses multiple jets of fluid to drive the turbine. It consists of multiple nozzles that direct the fluid onto the turbine's blades. This design allows for a distributed and balanced flow of fluid, resulting in improved efficiency. Multiple-jet turbines are commonly used in applications where a large flow rate of fluid is available, such as in high-capacity hydroelectric power plants.

5. Hollow Jet Turbine: The hollow jet turbine is a specialized type of impulse turbine designed to extract energy from low-velocity, high-volume flows of water. It features a hollow jet nozzle that allows the water to flow through the center of the turbine, rather than striking the blades directly. The water passing through the turbine creates a suction effect that draws in additional water, increasing the overall flow rate and power generation capability.

   These are just a few examples of the types of impulse turbines. Each type has its own unique design features and is suited for specific operating conditions, such as varying head, flow rate, and fluid properties. The selection of the appropriate impulse turbine type depends on factors such as the available resource, site conditions, power requirements, and efficiency considerations.

Application Of Impulse Turbine

Impulse turbines have various applications in both hydroelectric and steam power plants. Here are some common applications of impulse turbines:

1. Hydroelectric Power Generation: Impulse turbines are widely used in hydroelectric power plants where they convert the kinetic energy of flowing water into mechanical energy. The turbines are placed in the path of highvelocity water streams, such as those found in dams or rivers, and the force of the water striking the turbine's blades causes them to rotate. This rotational motion is then used to generate electricity through connected generators.
2. Steam Power Plants: Impulse turbines are also used in certain types of steam power plants. In these plants, high-pressure steam is directed through nozzles or guide vanes, which accelerate the steam to a high velocity. The high-velocity steam then strikes the impulse blades of the turbine, causing them to rotate. The rotational energy is used to drive generators and produce electricity.
3. Marine Propulsion: Impulse turbines can be employed in marine propulsion systems, particularly in high-speed vessels such as hydrofoil boats. By using a high-pressure water jet, impulse turbines convert the energy of the water flow into rotational motion, which propels the vessel forward. This application is commonly found in waterjet propulsion systems for fast boats, ferries, and military vessels.
4. Compressed Air Systems: Impulse turbines are also utilized in compressed air systems, where they convert the energy of high-pressure air into mechanical work. Compressed air is directed through the nozzles of the turbine, creating a high-velocity air jet that strikes the impulse blades, causing them to rotate. This rotational motion can be used to power machinery or drive air compressors.
5. Wind Power: While most wind turbines operate on the principle of lift or drag, there are also impulse turbines specifically designed for use in high-velocity wind environments. These turbines capture the kinetic energy of the wind by directing it through a nozzle or guide vanes, which accelerate the air flow. The highvelocity wind then strikes the impulse blades, generating rotational motion that drives an electrical generator.

These are just a few examples of the applications of impulse turbines. The versatility and efficiency of these turbines make them suitable for various industries where the conversion of fluid energy into mechanical work is required.

Advantages Of Impulse Turbine

Impulse turbines offer several advantages compared to other types of turbines. Here are some of the key advantages of impulse turbines:

1. High Efficiency: Impulse turbines are known for their high efficiency in converting the kinetic energy of fluid into mechanical work. Since the pressure drop occurs primarily in the nozzles or guide vanes, the moving blades experience a highvelocity fluid jet, resulting in minimal energy losses. This design allows impulse turbines to achieve high levels of efficiency, making them ideal for power generation applications.
2. Simplicity of Design: Impulse turbines have a relatively simple design compared to reaction turbines. They consist of a set of stationary nozzles or guide vanes and a set of moving blades. The absence of pressure drop in the moving blades simplifies the construction and maintenance of impulse turbines, reducing complexity and potential failure points.

3. Wide Operating Range: Impulse turbines have a wide operating range, meaning they can efficiently operate under varying flow rates and pressure conditions. They can adapt to different operating conditions without significant loss in performance, making them versatile for use in various applications.
4. Suitable for High-Speed Applications: Impulse turbines are well-suited for highspeed applications due to their ability to handle high-velocity fluid jets. They can effectively harness the energy of fast-moving fluids, such as high-velocity water streams or high-pressure steam, making them suitable for use in power plants or marine propulsion systems requiring high rotational speeds.
5. Robustness and Reliability: The simplicity of impulse turbine design contributes to their robustness and reliability. With fewer moving parts and a more straightforward construction, impulse turbines are less prone to mechanical failures and require less maintenance compared to more complex turbine designs. This reliability is especially important for continuous operation in power generation facilities.
6. Ability to Handle Particles and Debris: Impulse turbines are generally more tolerant of particles and debris in the fluid compared to some other turbine types. The high-velocity fluid jet in impulse turbines can handle small particles without significant damage or performance degradation, making them suitable for applications where the fluid may contain impurities.

Overall, the high efficiency, simplicity of design, wide operating range, suitability for high-speed applications, robustness, and ability to handle particles make impulse turbines advantageous for various industries. Their reliability and efficiency make them a preferred choice for power generation, hydroelectric plants, steam power plants, and other applications where the conversion of fluid energy into mechanical work is essential.

Disadvantages Of Impulse Turbine

While impulse turbines offer several advantages, they also have certain disadvantages to consider. Here are some of the key disadvantages of impulse turbines:

1. Limited Pressure Drop: One of the limitations of impulse turbines is that they can only utilize the kinetic energy of the fluid, as the pressure drop occurs primarily in the nozzles or guide vanes. This means that they are not able to efficiently harness the energy from the pressure of the fluid itself. As a result, impulse turbines may not be as suitable for applications where the pressure drop in the fluid is significant.
2. Higher Speed Requirements: Impulse turbines typically require high fluid velocities to operate effectively. This means that they may require a higher flow rate or pressure to achieve the desired rotational speed and power output. In certain applications where high fluid velocities are not readily available, impulse turbines may not be the most practical choice.
3. Limited Operating Range: While impulse turbines have a wide operating range compared to some other types of turbines, they still have certain limitations. They may not perform optimally under extreme variations in flow rates or pressure conditions. Impulse turbines are generally more efficient at specific operating conditions and may experience reduced efficiency outside of those ranges.
4. Potential for Erosion: The high-velocity fluid jet in impulse turbines can lead to erosion of the blades over time. The constant impact of the fluid on the blades can cause wear and tear, especially if the fluid contains abrasive particles. This erosion can gradually degrade the turbine's performance and efficiency, necessitating periodic maintenance and blade replacement.
5. Complexity of Nozzle Design: While impulse turbines have a simpler overall design compared to reaction turbines, the design and optimization of the nozzles or guide vanes can be complex. The shape, size, and arrangement of the nozzles greatly impact the turbine's efficiency and performance. Achieving optimal nozzle design may require detailed engineering analysis and testing.
6. Lower Starting Torque: Impulse turbines typically have lower starting torque compared to reaction turbines. This means that they may require external starting mechanisms or additional devices to bring them up to the desired operating speed. In applications where a high starting torque is essential, impulse turbines may not be the most suitable choice without supplementary systems.

It’s important to consider these disadvantages alongside the advantages when selecting a turbine for a specific application. The choice of turbine type should be based on the specific requirements, operating conditions, and trade-offs that best align with the intended purpose.

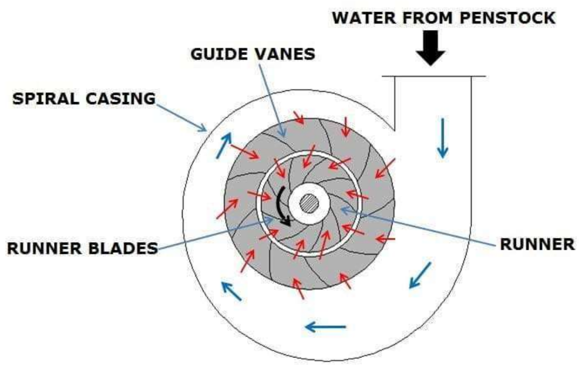
Difference Between Impulse And Reaction Turbine

Here’s a table outlining the key differences between impulse and reaction turbines:

Criteria	Impulse Turbine	Reaction Turbine
Working Principle	Utilizes high-velocity jets of fluid generate power	Harnesses the reaction force of fluid passing through the blades
Runner Design	Pelton wheel or similar design	Blades or buckets are fixed on the runne
Flow Path	Fluid passes through nozzles and strikes buckets	Fluid flows over blades or buckets and changes direction
Pressure Drop	Large pressure drop across nozzle e	Moderate pressure drop across the runns
Efficiency	Efficient for high head and low flo rate	Efficient for medium to high head and varying flow rate
Applications	Suitable for high head applications	Suitable for a wide range of head and flo rate applications
Example Turbine	Pelton tsurbine, Turgo turbine	Francis turbine, Kaplan turbine, Deriaz turbine, Tubular turbine

It’s important to note that while the table highlights some general differences between impulse and reaction turbines, there may be variations and specific characteristics within each type of turbine depending on design variations and specific applications.

What is Reaction Turbine?



REACTION TURBINE CONSTRUCTION

Reaction turbines are the type of turbine that formulates torque by countering the pressure or mass of a vapour or liquid. It utilizes the pressure as well as the momentum of the striding liquid to fluctuate.

The reaction turbines operate on the principle of Newton's third law of motion and the reaction is exact and distinct.

It is called a reaction turbine because the turbine is propelled by the reaction force occurring from the momentum of vapours through the convergence of the edge path.

The reaction turbines are normally used for zones with elevated flows and deeper heads and they are the most popular species of turbine consumed in the United States.

Distant from cross-flow turbines the reaction turbine is the only turbine to accomplish excellent strength production at deep peak water head and elevated speed, which is not profitable.

Reaction turbines are operated in wind energy mills to produce electricity. It is the abundantly widely wielded turbine for generating electricity in hydroelectric factories.

Now we will see construction in detail.

Reaction Turbine Parts or Construction:

The following parts of the Reaction turbine are following:

- Guide vane
- Draft tube

- Spiral casing
- Runner and
- Volute

#1. Guide Vane:

Guide Vanes have stabilized holes set up in turbines that assist direct liquid, vapour, or air around corners at absolute efficiency.

When the impellers gain or drop the discharge of a material through a procedure, the guide vane in the turbine makes certain that the equipment is passed evenly and as smoothly as apparent.

These are mended between two hoops in the aspect of a rotation.

The function of guide vanes is to allow water to reach the runner without impact.

#2. Draft Tube:

The draft tube is one of the significant components of a reaction turbine and pertains to runner entry to tag class.

The major processes of the draft tube are to authorize the establishment of a turbine above the bottom race category without failure of the head and to transmit an important portion of kinetic power reaching out of the carrier into stress power or pressure energy.

#3. Spiral Casing:

The Spiral casing is a valuable element of the reaction turbine which is used for the rightful measurement of the kinetic and potential energy of the liquid to accomplish the mandatory conclusion for reasonable execution of the runner in the turbine.

This conserves a continual speed straight through various entrances that have been given for the fluid to attain the blades because the cross-sectional region of the casing lessens notify them along the perimeter.

#4. Runner:

The runner is called the essence of the turbine. The runner is where liquid power is converted into the rotational force that propels the generator in the turbine.

Nevertheless of the carrier type, its pails or blades are credible for catching the most apparent energy from the liquid. Personal awareness of the layout or structure of the blade curves at the inlet and outlet is essential because these are important parameters involving energy generation.

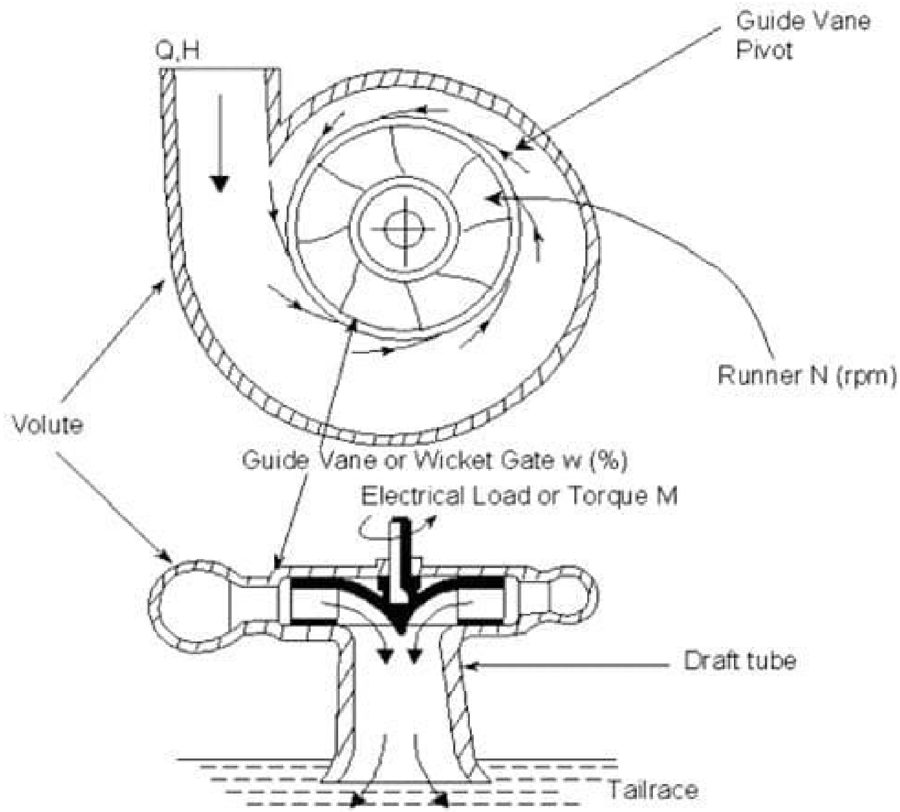
#5. Volute:

Volute is a spiral-shaped pump casing repeatedly utilized in centrifugal pumps.

The major purpose of a volute in a radial or mixed flow turbine is to strengthen the rotor with the ensemble progression at the desired intersection to optimize the execution.

The measurement of A/R rapidly impacts the progression angle diffusion at the rotor straight, having a substantial consequence on the turbine operation.

How does Reaction Turbine works?



The working principle of the reaction turbine is based on Newton third law of motion. The water enters into the spiral casing with high velocity and low heads.

It starts flowing through guide vanes into runner blades. The main function of guide vanes is to guides the flow of water to strike the blades of the runner at an actual angle to generate maximum power output.

During water flowing in the spiral casing, its pressure energy is being consistent all over the circumference of the casing, because the cross-sectional area is decreasing uniformly.

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Lecture Note
MECHANICAL ENGINEERING

Now there is a shaft that is attached with the casing, rotor, Gearbox and Generator.

A rotor contains a nozzle that releases water at high pressure.

When the water leaves the nozzle it experiences a return or reaction force that rotates the nozzle at a very high speed. And also a reaction force is generated by fluid moving on the runner blades. Because of the reaction force, the runner rotates.

The mechanical energy is converted into rotational energy and the rotor is attached to the gearbox and generator so here the rotational energy is converted into electrical energy and further it is connected to the transmission line.

And the water enters the draft tube and to the tailrace after moving over the runner blades.

The Water which is coming out after striking the runner blades has low pressure, so it is passed through a draft tube to recover its pressure as it reaches the tailrace. The draft tube has a uniformly increasing cross-sectional area.

But unfortunately, the pressure difference is too high to be recovered by a draft tube, so this results in the problem of cavitation and corrosion.

What is cavitation in Reaction Turbine?

When the water enters into the turbine we measure the pressure at that point and when it exits after striking the runner blades here also measure the pressure.

If there is a high-pressure difference, then due to this difference in pressure the air molecules which is having high-pressure enter into the casing in the form of bubbles.

This bubble keeps on exploding near the surface of the runner blades continuously causing a shock wave, and its defects at the runners surface. That is what we called cavitation.

And due to this cavitation process, the turbine efficiency is low and also in some cases it causes wear and tear if it is not fixed.

How to prevent cavitation from the Reaction turbine?

We can opt for a hard surface material like stainless steel to overcome cavitation or we can also go with surface Hardening of the runner blades, to prevent them from cavitation.

Different Types of Reaction Turbine:

Based on the direction of flow of liquid through the wheel the reaction turbine can be classified into the following kinds:

- Radial flow turbines
- Inward flow turbine
- Outward flow
- Axial flow turbines
- Kaplan Turbine
- Propeller turbine
- Mixed flow turbines
- Francis Turbine
- Gravity Turbine Bulb and
- Kinetic Turbine

Radial flow turbines:

The radial flow turbines are the turbines in which the flow of water is radial as in it is along with the radius of the rotation or wheel.

In a radial inpouring turbine, the progression reaches the nozzle blades in the radial orientation or the outbreak of a spin tangentially developing volute.

Described as an axial flow turbine, the radial flow turbine can operate at a somewhat elevated pressure rate (≈4) per phase with shorter progression ratios.

The flow arrives at the rotor blades in the radial orientation, is twisted in the rotor path and departures along the axis of the wheel. The radial flow turbines may be also subdivision into another two types:

- Inward flow turbine and

- Outward flow turbine

Inward flow Turbine:

In the inward flow turbines, the water reaches the wheel at the exterior boundary and then streams towards the centre of the wheel or inward.

In this turbine, the exterior diameter of the carrier or runner is equal to the inlet and the inner diameter is a duct. The runners in this turbine are enclosed by a guide mechanism.

The inward flow radial gas turbine has been utilized to leverage automotive turbochargers, development departments in vapour liquefaction, aeroplane secondary energy units, and cryogenic networks.

Outward flow turbine:

In the outward flow turbine, the water enters at the centre of the swirl and then streams outwards or towards the outer boundary of the wheel.

In this turbine, the internal diameter of the runner is the passage and the external diameter is a medium. The guide mechanism in this turbine is enclosed by a runner.

If the outward flow turbine velocity increases, the whirl manages to sprint as the turbine by itself can not adjust the speed.

Axial Flow Turbine:

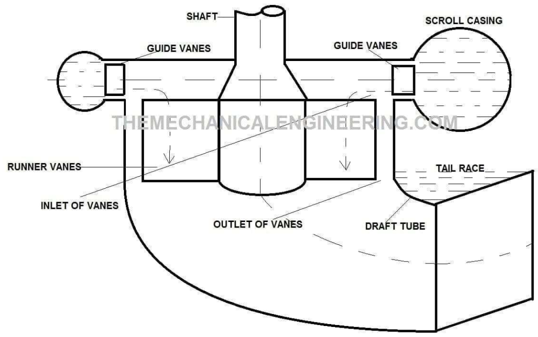
The axial flow turbine is a turbine in which the flow of the working liquid is similar to the shaft; it is the exact opposite of the radial turbines, where the liquid operates around a cylinder like a watermill.

It can be said that the axial flow turbines convert the flowing liquid into rotating mechanical energy.

The axial flow in this turbine is developed by impellers with inclined or tipped blades that create an acute angle with the plane of rotation. Axial flow is extremely valuable when powerful upright currents are expected.

Types of reaction turbines in an axial flow turbine: Kaplan and Propeller Turbine.

Kaplan Turbine:



Kaplan Turbine Parts

The Kaplan turbine is a propeller-type water turbine that contains flexible blades. It is named after the Austrian professor Viktor Kaplan who developed it in 1913, he combined the automatically modified propeller blades with automatically modified wicket gates to accomplish efficiency over a large range of flow and liquid levels.

This kind of turbine enables you to modify the blade curve or the impeller according to the needed energy. This permits the Kaplan turbine to labour according to the quantity alterations.

These turbines are widely used for electrical energy generation throughout the world. They surround the deepest head hydro sites and are particularly fitted for elevated flow circumstances.

Kaplan turbine builds tremendous growth to the small scale hydropower factories by producing high velocity of the shaft at very low head.

The Kaplan turbine is smaller in size. The efficiency of this turbine is very high as compared to the other types of hydraulic turbines. This turbine is very simple to construct and it needs a smaller area.

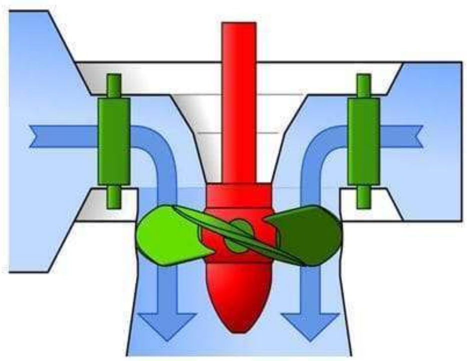
Kaplan Turbine Advantages and Disadvantages:

Advantages	Disadvantages
The Kaplan turbine can wor at a low head.	The Kaplan turbine has a problem with cavitation.
The number of blades in this turbine is less.	In this turbine, an elevated progression rate is required.

The Kaplan turbine requires These kinds of turbines are extremely costly to less area. construct, manufacture and establish.

It retains lexible runner vanes.

Propeller Turbine:



The propeller-type turbine is a type of turbine in which the flow is inward with a runner shaped propeller it can be seen in ships and submarines and it is provided with either remedied or elastic blades.

In the propeller turbine, the fluid progression is restrained by modifiable guide vanes which are also called wicket gates, the vanes stride the liquid into the runner to transmit the energy of the runner to the blades, the propeller turbine is usually assigned in hydraulic areas with elevated flow rates.

The major part of the runner is the propeller comprising the rotational intersection and blades to hold up the liquid capability and kinetic power to the cylinder connected to the turbine.

Propellers can be categorized by several procedures, such as the number of blades or blade tone.

The Fixed propeller-type turbines are commonly employed for huge units at deep heads, occurring in huge diameters and restricting rotational velocities.

As the name implies, the propeller-type turbine carrier or runner glances like the very enormous propeller of a boat or ship except that it fulfils the contrary goal.

Numerous types of propeller turbines accessible in the hydraulic energy initiatives are tube turbine, bulb turbine, strafe turbine and Kaplan turbine.

Propeller Turbine Advantages and Disadvantages: Advantages:

- Impeller turbines are normally wielded for appeals in minor heads that are not adequate for other companions such as Francis turbines.
- Impeller turbines with flexible blades or guide veins can maintain optimal hydraulic efficiency to suit progression situations.
- Compactness is one of the benefits of factions of impeller turbines, exceptionally bulb turbines.
- They expect formation with lower costs and limited area.

Disadvantages:

- Plugging the generator and rotor in specimens such as drips and Straflo can make it hard to permit various elements for expenditure.
- Cavitation and its outcomes are some of the warnings that propeller turbines are perceived to be.
- The opportunity of fluid leaking into the generator lodging can result in damage to the hydroelectric operation.
- Propeller turbines usually expect an enormous quantity of liquid cycle to regulate.

Mixed Flow Turbine:

A mixed-flow turbine is an internal flow, a reaction-type liquid turbine in which the carrier or runner vanes are so shaped that they occur acted on by the liquid strength both axially and radially.

A mixed-flow turbine can be glimpsed as a hybrid method between an axial direction and a radial turbine as it captures the factors of both.

Correlated to a radial turbine, this diminishes the flow direction curvature and efficiently reduces minor progression construction.

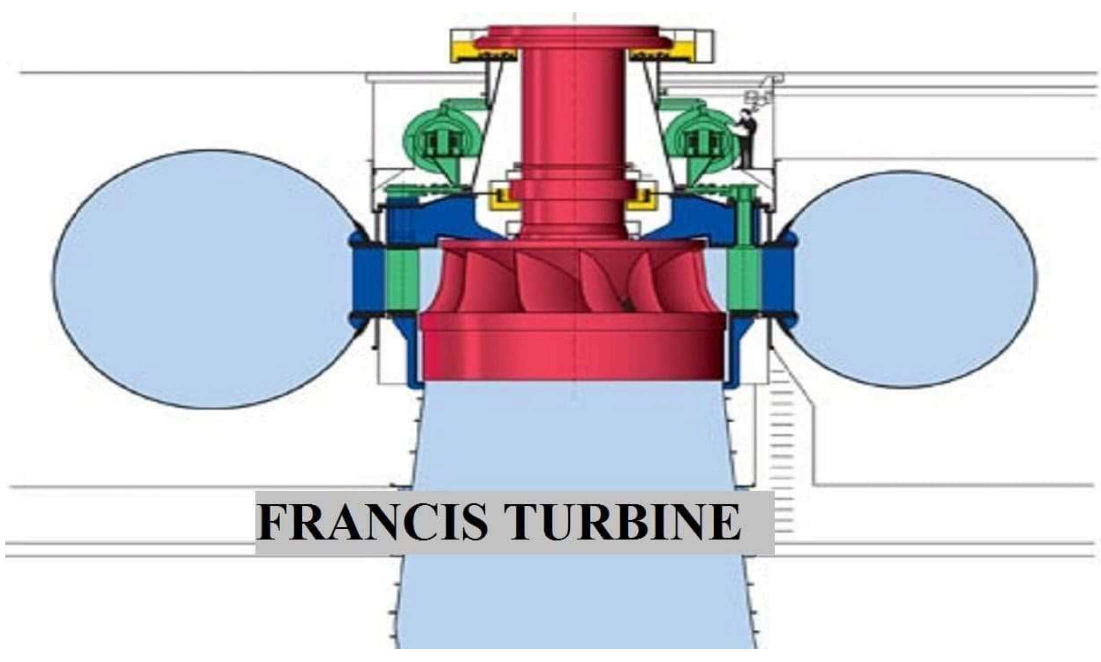
The mixed flow turbine was such an attractive and desirable technique that it is restfully adopted and used today, like in turbochargers of the modern car; the turbochargers operate the mixed flow air input procedure to maximize the abundance of air reaching the motor cylinders.

The more will be the air the more eruptions will arise in the engine container which can generate more power outcomes.

Francis Turbine is one of the types of Mixed flow turbine.

Francis Turbine:

Francis turbine can be defined as a mixture of both impulse turbine and reaction turbine in the Francis turbine where the blades fasten utilizing both outcome and impulse force of liquid streaming through them so they can generate electricity better efficiently.



Francis turbine is used for the production of abundant electricity often in medium or largescale hydropower locations. In the Francis turbine, the fluid enters these turbines radially implying that it enters the turbine perpendicular to the rotational axis.

Once entering the turbine, the water constantly streams inwards or towards the centre. Before the liquid retaining drift through the turbine, it departs axially and corresponds to the rotational axis.

The Francis turbines occurred in the initial hydraulic turbines that possessed a radial influx which was formulated by an American scientist James Francis.

Francis turbines are the vastly favoured hydraulic turbines. These turbines prevail as the most stable workhouse of hydroelectric power warehouses.

Francis turbine recharges approximately 60 per cent of the entire hydropower capability; this is mainly because it can operate efficiently under a large range of functioning conditions.

Francis Turbine Advantages and Disadvantages: Advantages:

- The Francis turbine is precise to regulate rightfully with inconsistent lengths or sizes.
- The difference in its efficiency is extremely short over the duration.
- The passageway of the Francis turbine is slight in comparison to the other kinds of turbines.
- This turbine has a lower expenditure cost in comparison to the other kinds of turbines.

Disadvantages:

- Francis turbines are constructed for a particular progression.
- It is not a reasonable choice to utilize in a cloak of substantial flow differences since the achievement lowers.
- It illustrates difficulties when enabling with sizes enormous than 800 m.
- This turbine has a cavitation situation.
- The access of filthy water with components can result in considerable difficulties to the turbine.

There are some other types of turbines:

Gravity Turbines:

These gravity reaction turbines transform gravity force into rotational force. The gravity turbine converts the kinetic power of the gravity force into electricity.

Gravity Turbine is a perpetual motion energy concept; This technique maintains the potential to deliver free energy to the public, which could have a vital effect globally.

Bulb Turbines:

This turbine is a kind of propeller turbine. In these types of reaction turbine joining, the generator is surrounded and plugged in a streamlined watertight steel habitat discovered in the tube centre.

The generator pushes with the assistance of an unstable angle propeller at the downside end of the valve.

Kinetic Turbine:

Kinetic energy turbines are further called free-flow turbines which generate electricity from the kinetic energy existing in streaming liquid relatively than the potential energy from the head.

The procedures can operate in rivers and man-made channels, tidal waters, or ocean breezes. Kinetic strategies do not employ huge civil labours because they can utilize actual configurations, such as bridges, tunnels and tailraces.

Reaction Turbine Advantages:

The following advantages of Reaction Turbine are:

- The recation turbine equires less space as compare to Impulse turbine.
- It uses an oil-free exhaust system.
- The size of this types of turbine is not big and the turbine is easy to construct.
- It has a high capability to use high temperature and high pressure.
- The hydraulic efficiency of reaction turbine is high.
- It has a high working speed.
- The reaction turbine blades have high efficiency.

Reaction Turbine Disadvantages:

The following disadvantages are:

- The major disadvantages of reaction turbine is cavitation.
- Thrust force generates here.
- It require high maintenance as compare to an impulse turbine.
- The maintenance cost is also high.
- It des not have symmetrical blades.

Reaction Turbine Application:

The reaction turbine is used in the Hydro Power Plant and also the wind power plant for the generation of electricity.