A MAJOR PROJECT REPORT

ON

“(water turbine)”

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF

DIPLOMA IN MECHANICAL ENGINEERING

SUBMITTED TO

GALGOTIAS UNIVERSITY ,UNIVERSITY POLYTECNIC

SUBMITTED BY

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Plotno.2 Secter17-A Yamuna Expressway Greater Noida Gautam Buddha Nagar Utter Pradesh, India session (2021-2022)

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CERTIFICATE

This is to certify that the project report entitled "Water Turbine"

Was successfully completed by student of sixth semester Diploma mechanical engineering).

SHADAB KHAN

In partial fulfill Ment of the requirements for the award of the Diploma mechanical engineering and submitted to The Department of mechanical engineering of Galgotias University university polytechnic work carried out during a period for the academic year 2021-22 as per curriculum.

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ACKNOWLEDGEMENT

This project is done as master project as part of course titled water turbine.

We are really thankful to our principal prof .MR.MOHITGAHARWAR, and the HOD (Mr Rashid Khan) Mechanical Engineering Department, GalgotiasUniversity,UniversityPolytechnicforhisinvaluableguidancean d assistance without which the accomplish ment of the task would have never been possible

We are also thankful to Ms.RAJBALA for giving this opportunity to explore in to there
a world and realize the interrelation without which a project can never progress. In our present project we have chosen the topic "water turbine We are also thankful tour present ,friends and all staff of Mechanical. Engineering Department for providing us relevantin formation and necessary clarifications ,and great support.

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ABSTRACT

The proposal aims at to giving a solution to the problem of low power output by designing a power generation system that maximizes power output by mounting the turbine on a D.C generator with a suitable coupling. This generator is then connected to the water pipe. The turbine is designed to generate electricity by converting kinetic energy from water flows to electric energy. The use of this technology proves sustainable as it works under minimum maintenance. In this proposal is included the conceptual approach, results ad conclusions arrived at validating the significance of conducting this research. In include but not limited to the advantage of the system as a solution to low power generation.

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INTRODUCTION

At the beginning of the new millennium, the world energy consumption increased rapidly with more than three quarter of this consumption mainly coming from the from the fossils fuel. Among the renewable sources of energy like the solar, biomass, hydroelectric and wind, hydroelectric power is rated very reliable as it is generated from most efficient means that is hydroelectric power plants that that produce electric energy.

Water plays play a critical role by they are used to turn the turbines. To do this, water is harness through collecting it in

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hydroelectric dam. It is then passed through a turbine through a penstock and then allowed out f the turbine in a tailrace. This turbine consists of a shaft that has some blades attached to it. These blades are rotated when water passes through it creating a rotational force.

Being the back of any hydroelectric power generation plant, the D.C generator converts mechanical energy to electrical energy. The electrical energy can then be transmitted and distributed. An electric generator does this by spinning a rotor that will in term turn the turbine. A typical rotor consists of a shaft with field windings. An excitation voltage is created when the rotor rotates creating current onto a stator. This current is magnetically induced while a stator is ring that is cylindrical in nature and is separated from the rotor by an air gap.

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Hydroelectric power generated varies depending on the level of technology used. With today's improved technology, it's possible to generate power from a micro generator by use of low flow and low head parameters. To demonstrate how this technology has revolutionize hydroelectric power generation, this proposal uses a small model designed by used of a 2 Lt water container that acts as a dam, the container is 300 mm tall, while a 1000 mm pipe with a valve and has an internal diameter of 5mm connects the container holding water to the turbine. The model has an electric generator connected.

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LITERATURE SURVEY

According to (Edwards, 2008), the system can produce approximately 400 watts at constant rate. This means 9.6 kilowatts can the produced per day. A example of this the hydropower generation system installed by Counter Lake Guest Ranch that used the low flow and head parameters. The system contains of a turbine with batteries, D.C generator, load controller and inverter. These are the main components of the system. As proposed in the system the system advantage is the ability to produce more power.

In his extensive research in this field, Bill Kelsey has come up with hydroelectric systems that are small in nature. In the system are turbines feed by unstated flow that is approximately 30 feet with water running through 275 feet and 4 inch diameter pipe. Kelsey system produces 3.6kW hours daily (Garman, 1986). It is worth noting that the efficiency of

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the system was enhanced by increasing the diameter of the PVC pipes as done by Kelsey. This doubles the output as the friction between the water and pipe is reduced. Kelsey didn’t however encounter problems with his systems. Use alternators with brushes didn’t work well as the brushes wore out.

Joseph Hartvigsen according to (Hartvigsen, 2008) managed to build his own micro hydroelectric system. The system has 96’ head and 6’’ diameter pipe. Burying of the pipe is essential to avoid freezing hence maintaining grade. Hartvigsen has its pipe buried 4’ down depending on the terrain. Increased power supply as negative effects as many batteries as destroyed through overcharging. This justifies the need for charge controller to control this. On average, the plant generates 800 watts at the power house.

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CONCEPTUAL DESIGN

For the project to be complete, the proposal has been designed as illustrated in the above diagram. This is basically designed in the above simple way as it also as an educational tool used to educate the general public. It should therefore be made easy and simple to understand. This will also enable the people to relate it to the real life experiences. To further justify this is a detailed description of proposed conceptual designed.

In the above proposed hydroelectric power, an experimental work is set a long side the project in the project site. The experiment is meant to serve as an educational display to educate the general public on how the project is intended to work. In the experiment, a 2lt container is used to hold the water. This acts as a dam used to harness water. The tank is 300 mm long. Though not drawn to scale, this height represents 30 feet on the actual dam that will be used to store the water.

A pipe 1000 mm long in the experiment acts as the 275 feet long PVC pipe that connects the water tank to the turbine. The pipe has a valve fitted on it that is used as a controller to control the amount of water to be released to the turbine. Pipe is approximately 5 mm in its diameter. This represents 0.3 m in actual project. The experimental work also contains a D.C generator fitted to the turbine. This motor converts mechanically energy to electrical energy.

HYDRO SYSTEM OVERVIEW

As intended in its design the purpose of the project is to provide energy that is renewable through use of water to produce electricity. The project will also act as an educational display to be used to inform the public on type of energy produced and how it's produced. Its effects on the environment will also be enlightened. There is a power output that is produce produced by the generator and is determine by the equation below:

$$Kw - hr = q\ (H - Hf)\ eT$$

Where q = the discharge of a stream in cubic feet for every second;

H =the gross heat, measured in feet;

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Hf = the heat lost in the tailrace and conduit system;

e= the station efficiency, expressed in form of an equation.

T = a period of time in hours;

As the data was collected, the obtained flow was nearly the base flow for the creek. This was found to be approximately 290 GMP. From this data, the lowest power was calculated to be around 400 W, which will allow for the adjustment of the generator and to determine the size of the nozzle and the pipe (Baker, 1991). From energy system s and design, it was founded that the maximum flow from the nozzle of the generator was around 428 GMP [8]. It was therefore, determined that the power from generated from the generator

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is 1.2 KW. However, this calculation was calculated using an efficiency of 50 percent for the generator.

In order for this design to be accomplished, there is a need to have a 4’’ supply from the generator to the powerhouse, where the generator will be put. The intake of the pipe need to be covered by the filter or a grate to make sure that no debris goes to the supply line (Baker, 1991). The pipe is also required to have a valve that shuts at the intake in order to allow for the generator or pipe maintenance. It is also preferred that the intake be supplied by some kind of a weir.

BATTERY SYSTEM

There are three batteries for this application in this project research: lead acid (Wet cell), gel cell, and absorbed class mat (AGM). There are some other several criteria that have to be considered when choosing the type of battery to be used for this application. The purpose of the battery is to produce the surge power required to operate the appliances (Garman, 1986). This battery could also be used to discharge a high percentage of their stored energy and also must be ready to recharge again to accomplish another cycle. There is another type of battery called ‘’Deep Cycle’’ battery which is specifically designed for this task. It is said that this battery will be kept in the powerhouse at the proposed site. The powerhouse might be poorly insulated and is not directly heated from any source.

GRID TIE SYSTEM

The grid tie system shares various major components of the off grid system. With this system, the inverter and the generator from the grid system are preferred (Garman, 1986). Since the grid tie exists, the battery bank is of no any importance. There are some many stipulations that need to be met by this water turbine before the installation of the system (Baker, 1991).

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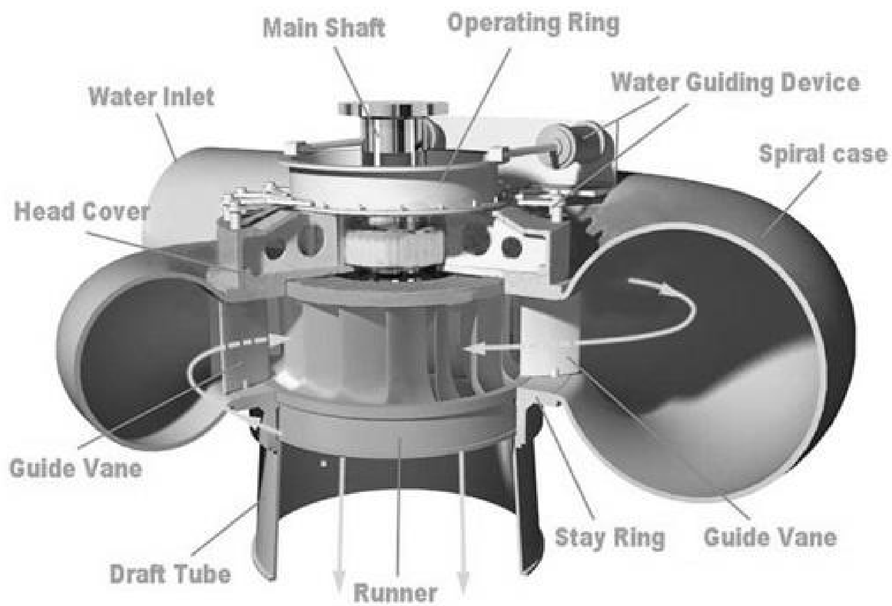
Construction

The most frequently used Francis water turbine is shown below. This can be designed with different components like the main shaft, operating ring, water guiding device, spiral case, guide vane, stay ring, runner, draft tube, headcover & fluid inlet. The construction of the water turbine is shown below.



Francis Water Turbine Construction

This is a combination of both reaction & impulse turbine, where the blades in this turbine turn with both impulse & reaction water supply force so that it generates electricity very efficiently. In hydropower stations, this type is most frequently used for electricity production within hydropower stations.

There are two turbines flow patterns based on working like radial flow & axial flow. An American civil engineer like James B. Francis came up with an idea by combining both turbines like impulse & reaction where water supplies radically into the turbine & axially exits.

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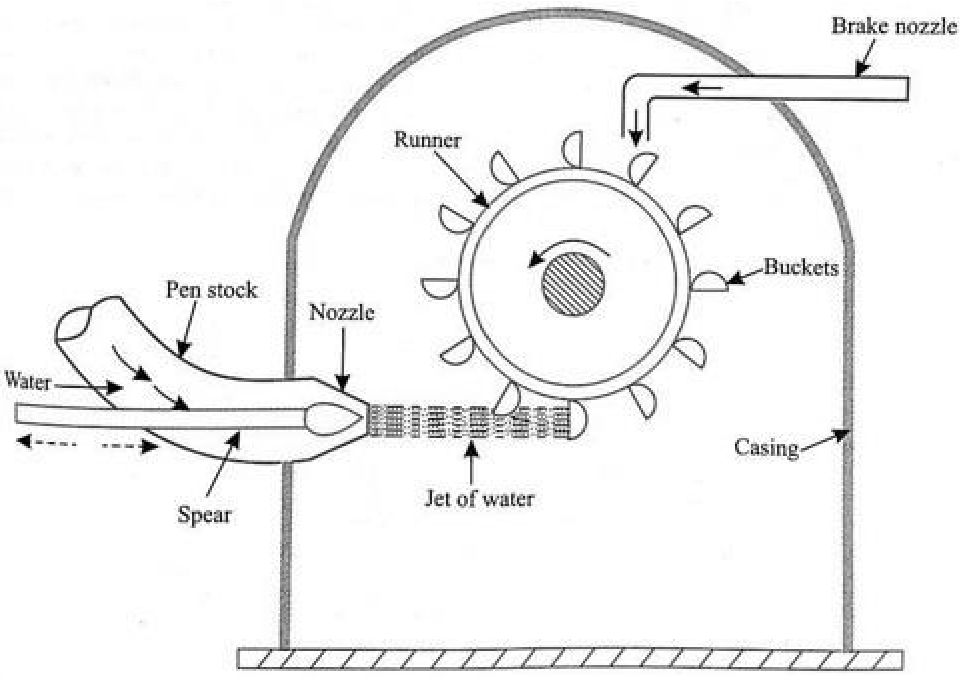

Brake nozzle
Runner
Buckets
Pen stock
Nozzle
Water
Casing
Jet of water
Spear

Water Turbine Working Principle

Turbines are fundamentally work based on Isaac Newton’s third law because this law states that for each action there is also an equivalent and reverse reaction. Generally, Turbines are fixed in position so once water supplies throughout it then there is a drop within force at the backside of every blade that pushes the turbine to revolve. For water or air, the working principle is similar, the medium will move faster, the pressure is greater & the turbine spins will be faster.

WATER TURBINE INFORMATION

If you are lucky enough to have a water course across your property, such as a stream, river, or if you are lucky enough to own an old water mill, water turbines are an ideal solution for providing reliable long-term renewable energy.

Most sites vary considerably in flow between winter and summer, reflecting the differences in rainfall. It is important to make sure that the flow is sufficient to run the turbine, and if you wish extract maximum power from the water turbine site, it is often desirable to install two water turbines, switching in the second machine, when the water flow allows. Alternatively, a twin nozzle water turbine may be used, which incorporates a valve to isolate the second nozzle when insufficient flow is available to run both nozzles.

High Head Water Turbines are 10 metres head of water and over
Medium Head Water Turbines are 3 – 15 metres head of water
Low Head Water Turbines are 1.8 – 3 metres head of water

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WE SUPPLY VARIOUS WATER TURBINES FROM 300W

Suneco can usually provide a turbine which will allow you to generate a significant proportion on your electricity needs. Even a modest flow of water may be capable of providing all of your electricity and heating needs, or alternatively, you can sell the excess energy back to the National Grid at attractive rates. Suneco water turbines have an output of 220v AC, and have a built in control regulator which maintains a constant electrical load on the turbine, regardless of power consumption – this provide frequency stability and avoids voltage going too high when there is no power drawn from the turbine. We sell a range of turbines including kaplan (for low head), crossflow and turgo (for high head). In fact, with suitable modifications to jet size, it is possible to utilize the Suneco turgo water turbines at very high head, making it a viable alternative to the pelton turbine. We have a range of turbines, loosely divided into 'high', 'medium' and 'low' head categories.

Click here to view our turbine range
Click here to get more info on high head water turbines

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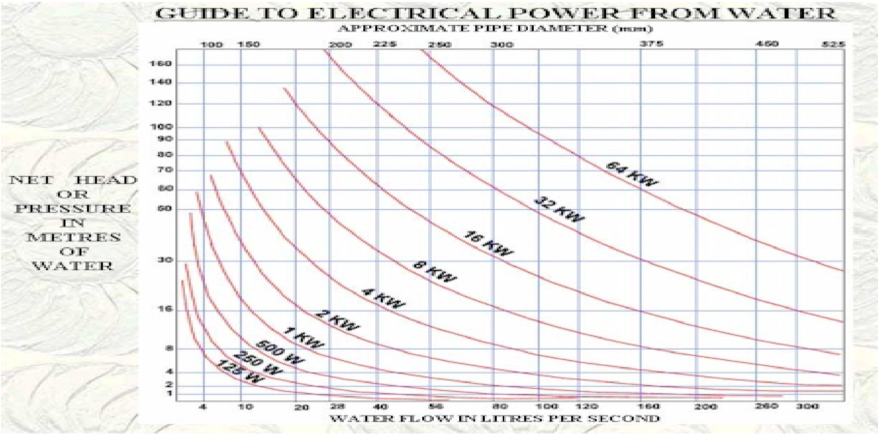
GUIDE TO ELECTRICAL POWER FROM WATER
APPROXIMATE PIPE DIAMETER (mm)
100 150 200 225 250 300 375 450 525
NET HEAD OR PRESSURE IN METRES OF WATER
160 140 120 100 90 80 70 60 50 30 16 8 4 2 1
64 KW
32 KW
16 KW
8 KW
4 KW
2 KW
1 KW
500 W
250 W
125 W
4 10 20 28 40 56 80 100 120 160 200 260 300
WATER FLOW IN LITRES PER SECOND

You can easily calculate the available power for a water turbine site using the following equation: Power (watts) = Head (m) x Flow (litres/sec) x 9.81 (gravitational constant 'g') A typical water to wire efficiency is around 70%, so you should multiply the result by 0.7 to get the actual amount of electricity that you can expect from the site. Most sites vary considerably in flow between winter and summer, reflecting the differences in rainfall. It is important to make sure that the flow is sufficient to run the turbine, and if you wish extract maximum power from the water turbine site, it is often desirable to install two turbines, switching in the second machine, when the water flow allows. Alternatively a twin nozzle machine may be used, which incorporates a valve to isolate the second nozzle when insufficient flow is available to run both nozzles. By reducing the jet diameter on our water turbines, it is possible to operate them with heads of over 100m.

Our water turbines are lightweight, and small in physical size, and yet able to supply high quality electricity, regulated in terms of frequency and voltage by their own internal voltage stabilisation circuitry. They are based on 'Turgo' runners, which provide an ideal alternative for the Pelton wheel at lower heads. The medium head turbines, for example, incorporate a 'dump load' ballast heating element in the draught tube, which uses water-cooling to ensure that the load on the turbine remains constant. The turbine may be operated for years with minimal maintenance, although it is necessary to apply grease to the bearings on your water turbine using the grease cap a couple of times a month, to ensure a long life.

500W turbine operating at a 110m head site (with custom 8mm jet)

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Please visit our other Hydro web pages for further information on estimating your Hydro potential, feasibility studies, abstraction licensing, system design and installation. maintenance.

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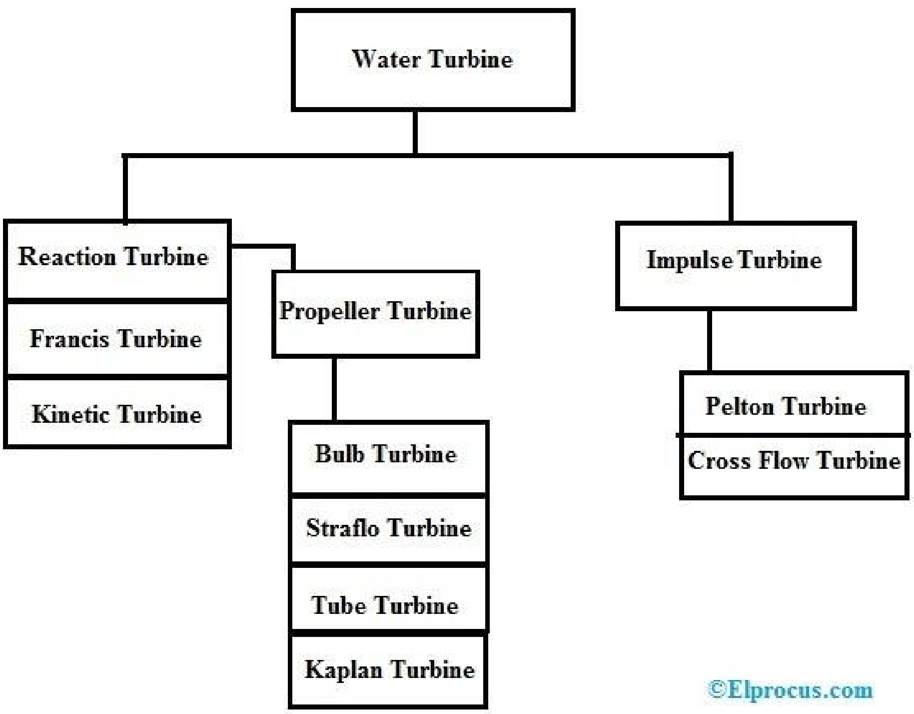
Water Turbine Types

The working of the turbine mainly depends on different factors like height of “head”, water flow, deepness to set the turbine, efficiency, cost, etc.

There are two main types of hydropower turbines: reaction and impulse.



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REACTION TURBINE

This turbine generates power once both the forces are combined like moving water and pressure. A runner is directly located within the water stream so that water flows on the turbine blades instead of hitting every blade separately. Generally, these turbines are mostly used in the United States due to their lower head & higher water flow. The most frequently used reaction turbines are Francis & Propeller. Kinetic turbines are also reaction turbines.

PROPELLER TURBINE

Generally, a propeller turbine includes a runner with a minimum of 3 to a maximum of 6 blades. This is an inward flow reaction type turbine with a propeller-shaped runner, used in submarines & ships. This runner can be designed with either adjustable or fixed blades. In this turbine, the flow of water can be changed through wicket gates or variable guide vanes which move the water into the runner for transferring its energy toward the blades. Generally, this turbine is used in hydraulic sites through high flow rates.

The main components used in the runner are wicket gates, a draft tube & a scroll case. There are different kinds of propeller turbines like bulbs, tubes, Straflo & Kaplan.

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BULB TURBINE

This is a reaction turbine, used for very low heads. As the name suggests, the components of this turbine and the generator are located in a bulb. This turbine includes different blades based on the water flow and head. As compared to the Kaplan turbine, this turbine includes higher flow capacity & full-load efficiency. The construction cost of this turbine is low.

STRAFLO

These are axial turbines where the generator is placed at the outside of the water channel and is connected to the edge of the runner. These turbines reduce the requirement of the bulb by placing the generator outside of the water channel.

TUBE TURBINE

The power range of this turbine ranges from 20 kW to 700 kW where the generator and the turbine are located on a similar shaft including common seals & bearings. The configuration of a tube turbine generator is used where there is a penstock feeding water toward the plant.

Generally, a closing device is a butterfly valve where is opened normally through a hydraulic power pack & blocked through dead weight. A flexible connection is necessary between the turbine and valve to allow fitting & elimination of the unit.

Here, the power plant design can be simplified by selecting an installation angle among horizontal & vertical. The requirement of space for this turbine unit is small & no separate installation beds are necessary.

KAPLAN TURBINE

The propeller-type is a Kaplan turbine that includes adjustable blades. This turbine was developed by an Austrian professor namely "Viktor Kaplan" in the year 1913. He combined the propeller blades with wicket gates which are automatically adjusted to get efficiency on a wide range of water flow & levels.

These turbines are at present used widely worldwide in low-head & high-flow power production. The head of this turbine mainly ranges from 33 to 230 ft whereas its output mainly ranges from 5 to 200 MW.

FRANCIS TURBINE

The first modern hydropower turbine is the Francis turbine, invented by an Engineer namely 'James Francis' in the year 1849. This turbine includes a runner through fixed blades where the flow of water around the runner can cause the blades to rotate. The components used beside the runner are a draft tube, scroll case & wicket gates.

These turbines are mainly used in medium to high head situations and used for low heads also. This turbine performs very well in both the orientations like vertical & horizontal.

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KINETIC TURBINE

These turbines are also known as free-flow turbines, used for generating electricity from the KE (kinetic energy) within the water flow instead of the potential energy (PE) from the head of the turbine. These turbines work in tidal waters, rivers, man-made channels & ocean currents because kinetic systems naturally use water streams and they do not need water diversion throughout riverbeds, pipes, and man-made channels. Kinetic systems do not need large civil works as they can utilize existing structures like tailraces, channels & bridges.

IMPULSE TURBINE

Generally, this type of turbine uses the speed of the water for rotating the runner & releases atmospheric force. A water stream strikes every bucket on the runner. The water flows out the base of the turbine after striking the runner without suction on the base of the turbine.

Generally, an impulse turbine is used for low flow and high speed-based applications. The impulse turbines are classified into two types like Pelton & crossflow.

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PELTON TURBINE

Pelton turbine was invented in the year 1870 by American inventor namely “Lester Allan Pelton”. Generally, these turbines are used for extremely high heads & low flows. Draft tubes are not required for an impulse turbine because the runner should be located above the maximum tailwater to permit operation at atmospheric pressure.

This turbine includes a minimum of one or several free jets which discharges water into an aerated gap & intrudes on the runner buckets.

CROSS - FLOW TIRBINE

The cross-flow turbine was invented by an Austrian engineer namely “Anthony Michelle” in the year 1900. Later, some improvisations on this design have done by a Hungarian engineer like Donát Bánki & a German engineer like Fritz Ossberger. This turbine is available in drum shape with a rectangular-shaped nozzle directed next to bent vanes on a cylindrically model runner. It looks like a squirrel cage blower.

This turbine allows the flow of water throughout the blades two times. For the first time, water supplies from the external side of the blades to the inside. After that, the water supplies from the inside back out.
At the beginning of the turbine, a guide vane directs the flow of water into a restricted part of the runner. This turbine was designed to hold a huge water supply & lower heads than the

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Pelton turbine can handle.

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Design Overview

Turbine is a rotary engine that converts the energy of a moving stream of water, steam or gas into mechanical energy. The basic element in a turbine is a wheel or rotor with paddles, blades or buckets arranged on its circumference in such a way that the moving fluid exerts a tangential force that turns the wheel and imparts energy to it.

Structure and Features of Turbines

1) Horizontal Axis Pelton turbine

In this turbine, the free jet from the nozzle strikes double-cupped buckets, which are coupled with the runner. The turned jets over the buckets exert a balanced force that rotates the turbine shaft. There are two types of Pelton turbines, one nozzle type and two-nozzle type. Structure of two-nozzle type Pelton turbine. One nozzle type turbine is applied to high head and low discharge. Twonozzle turbine is used with relatively large discharge. In general, two-nozzle type is widely used. The nozzle is needle

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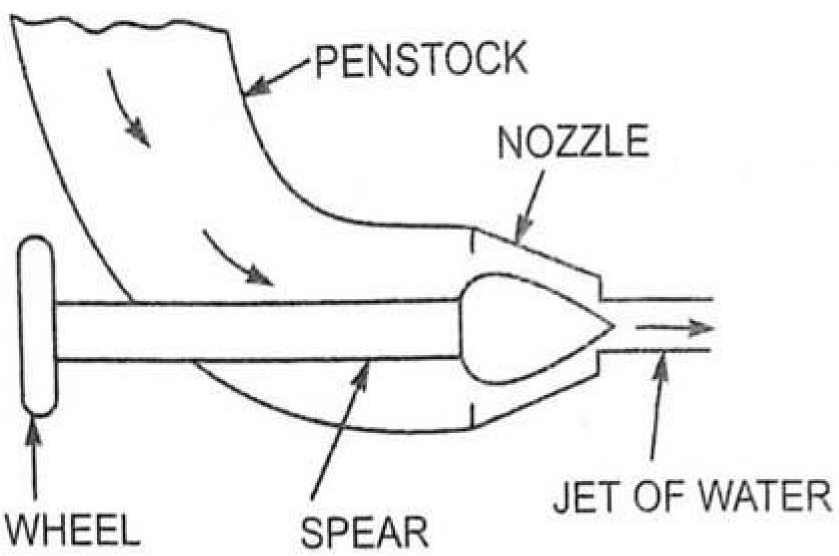
valve type. Discharge of the water jet can be adjusted by Moving the needle valve. The efficiency depends on discharge. For one nozzle Pelton turbine, efficiency Change is about 2-3 % against discharge change of around 40% from needle Full-open valve. Thus, it is possible to have high efficiency operation up to Around 20% of maximum discharge for two-nozzle turbines. The ns value of Pelton turbine is given for single nozzle. When the effective head is H m, maximum power output is P kW, and the speed Of rotation is N min-1, the specific speed of a two-nozzle Pelton turbine is given

PENSTOCK NOZZLE



A deflector is attached between the top of nozzle and the buckets that enables Adjustment of the speed of rotation and sudden intercept of water jet flows into The runner. The runner of a Pelton turbine needs be positioned high enough so that the Runner does not touch the surface of the discharged water. The height between The bottom of the nozzle and the surface of the discharged water is the head loss. The structure, however, is rather simple. The turbine is suitable for middle and Small hydro since pressure rise and speed rise at load rejection can be controlled With low value by the use of deflector.

2) High Specific Speed Impulse Turbine

It is known as Turgo Impulse turbine, which is applied for high specific speed Range of 65~55 mkW as an impulse turbine and so it is applicable to relatively Large discharge against head compared to Pelton turbine. As for its structure, it has one runner and one to two nozzles, and is similar to a Pelton turbine.

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However, the water jet action to the runner is quite different. The structure of Turgo impulse turbine with the runner and Nozzle inside a casing. Water jet from the Nozzles strikes the runner at an angle of 20o -25o. At the top of the inlet of Horizontal vanes each of three or four runner blades. The water jet is Discharged toward about the same direction of the shaft from the outlet side and Opposite to the inlet direction.

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Generator

There are two types of generators for hydropower's, synchronous and induction.

Synchronous generators are widely used and generate three-phase alternating current with low-voltage terminal voltage for small capacity, but in case of more than 1,000 kVA capacity, 11,000 V voltage might be applicable.

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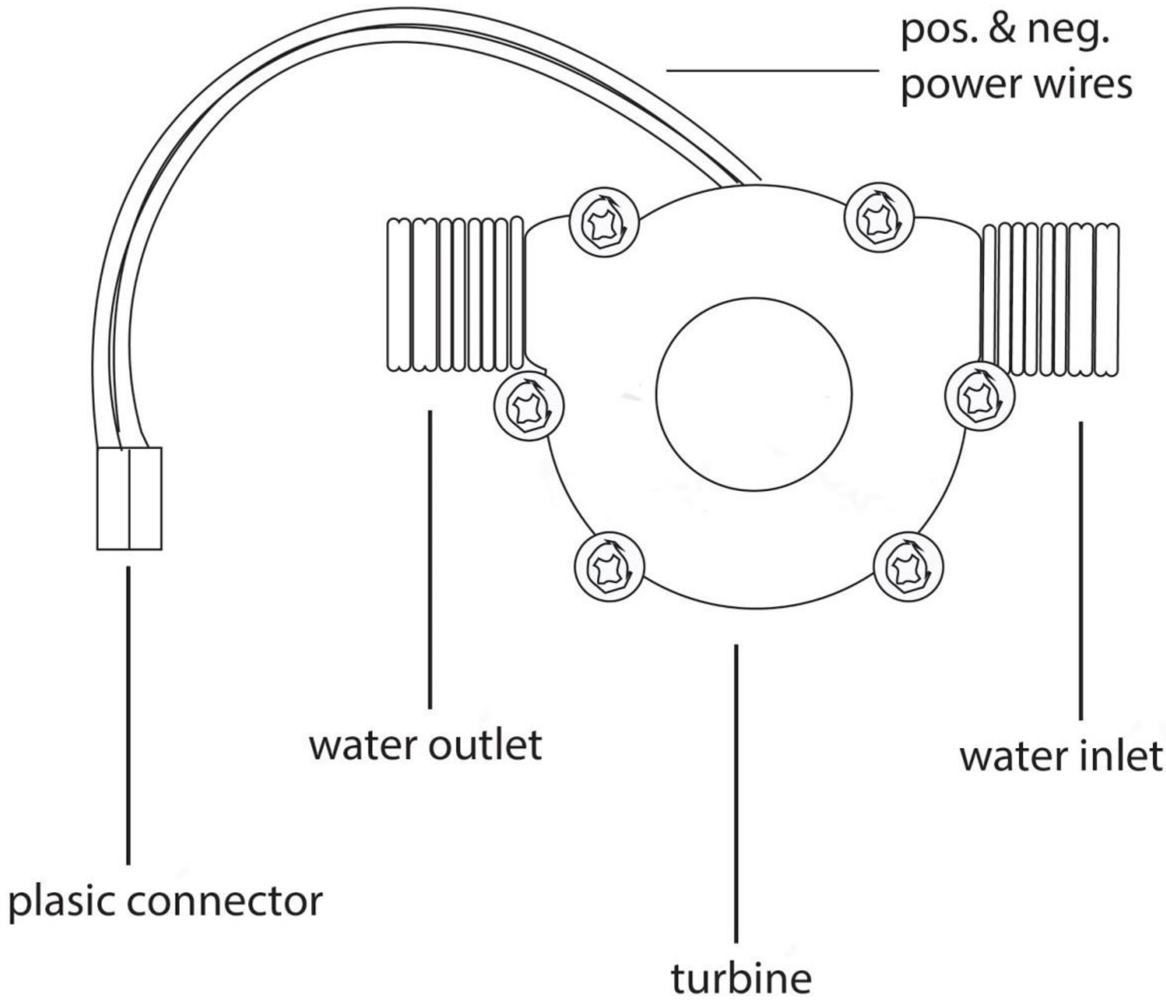
Water Turbine Generator



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(1) Synchronous Generator

This generator type induces a voltage in armature coils by rotating magnetic poles. There are several types of exciter system such as Separate Excitation type, Static Excitation type, and

Alternate Current Excitation Brushless type.

Brushless type generators are often employed in small hydro plants because they are easy to maintain.

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Induction Generator

Induction generators are a rotating structure composed of a primary winding and Secondary winding, electricity is generated through electromagnetic induction Between the windings. It is applied to powerhouse less than 1,000 kW connected to power grid in parallel. Generator structure cam be simple and low cost by applying a squirrel cage type Secondary winding.

Generally, this type of generator cannot generate

Independently. Operation must be established by supplying an excitation current To the primary winding from other power source. In addition, the generator Causes such a rush current as is corresponding to several times in the rated Current when it is connected to the power system on null voltage.

However, it tends to be applied to small hydro because of low cost, simple Maintenance, and easy operation and control. Induction motors are applied to Generators at low cost. In this case, it should be noted that the induction motor Is not able to withstand the over speed condition.

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Advantages

The advantages of a water turbine include the following.

These are Renewable.

- Emission Free.
- Consistent.
- Changeable.
- It can create small lakes.
- Lands can be developed very fast.
- Hydropower gives several benefits like irrigation support, flood control & clean drinking water.
- Hydropower is inexpensive.
- It provides inexpensive electricity & strength eventually as

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compared to other energy sources.

The disadvantages of a water turbine include the following.

- Effects on fishes in the water
- Plant locations are limited
- The initial cost is high
- Methane & carbon emissions

Flood Risk

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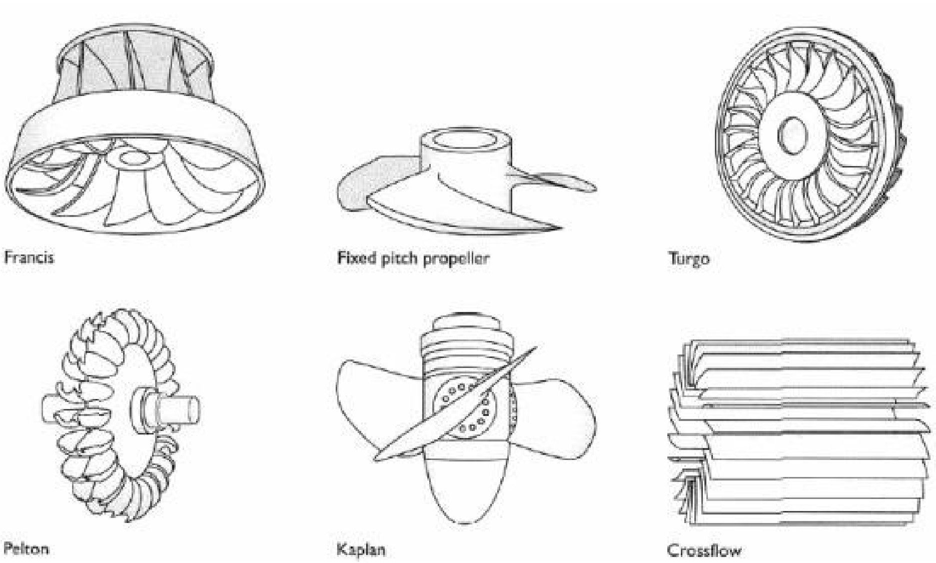
Applications

The applications of a water turbine include the following.

These are widely used for industries to electrical grids. These turbines are mostly used for generating electric power.These turbines are available in dams for generating electric power using the potential energy of water.The most widely used Francis turbine is used within hydropower plants for producing electricity. A mixedflow type turbine is used in irrigation for pumping water from the ground. It is a very efficient type of turbine as compared to others.



ENVIRONMENTAL IMPACT

Water turbines are generally considered a clean power producer, as the turbine causes essentially no change to the water. They use a renewable energy source and are designed to operate for decades. They produce significant amounts of the world's electrical supply.

Historically there have also been negative consequences, mostly associated with the dams normally required for power production. Dams alter the natural ecology of rivers, potentially killing fish, stopping migrations, and disrupting peoples' livelihoods. For example, Native American tribes in the Pacific Northwest had livelihoods built around salmon fishing, but aggressive dam-building destroyed their way of life. Dams also cause less obvious, but potentially serious consequences, including increased evaporation of water (especially in arid regions), buildup behind the dam, and changes to water temperature and

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flow patterns. In the United States, it is now illegal to block the migration of fish, for example the white sturgeon in North America, so fish ladders must be provided by dam builders

CONCLUSION

As mentioned in the above findings, this design is seen as the most cost-effective and very efficient hydroelectric power generation system (Garman, 1986). The system is good as it uses low flow and head parameters as well as the duct technologies that make it more efficient and effective. The actual project can produce up to 4000 watts as illustrated in the experimental work on model performance testing using the low flow and head parameters (Baker, 1991). Due to the availability of the educational display in the project, the public can be informed on how power can be generated using this hydroelectric generation system.

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