# DESIGN AND FABRICATION OF HYDRO POWER PLANT

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***Abstract-The world's hydroelectric potential needs to be considered in the new energy mix, with planned projects taking into consideration social and environmental impacts, so that necessary mitigation and compensation measures can be taken. Hydro development should go hand in hand with further research and development in the other renewable options such as solar and wind power. In this paper, we are going to show the various opportunities in remote and isolated areas of North east India wherever the areas are not connected to national grid. The design of a prototype of a hydro turbine has been discussed in this work. The hydro turbine will be boon to such kind of areas where there are natural resources of falling water from some height particularly in the hilly areas and also the areas which are not connected to the national grid.***

***Keywords: Hydro Power Plant, Turbine, Hydroelectric Power, Prototype.***

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## I. INTRODUCTION

We all know that electricity is one of the most important discoveries in human race and it has become the most widely used source of energy to be used in almost every aspect in generating power. Power is a basic part of nature and it is one of our most widely used forms of energy. We get power, which is a secondary energy source, from the conversions other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources..

Different Types of Electricity Generating Power Plant

- Steam power plants
- Geothermal power plants
- Gas power plants
- Nuclear power plants
- Wind power plants
- Hydro power plants

Energy sources are valuable for their abilities to generate electricity, heating and other necessities of Industrial & Commercial life and modern home requirements. While conventional forms of energy, which includes fossil fuels and nuclear energy, have supplied most of the world's electric power for the past century, a recent focus on climate change and energy independence has raised interest in unconventional forms of energy, many of which emits less carbon and is renewable. Our project topic is based on the use of hydro power energy to convert it as electric energy so as to use it for various commercial, industrial and home requirements. Besides electricity can be produced by various ways like using Coal Power (Thermal electric power), Nuclear Power, Wind Power, Solar Power etc.

### *HYDRO POWER PLANT HISTORY*

It's a form of energy … a renewable resource. Hydropower provides about 96 percent of the renewable energy in the United States. Other renewable resources include geothermal, wave power, tidal power, wind power, and solar power. Hydroelectric power plants do not use up resources to create electricity nor do they pollute the air, land, or water, as other power plants may. Hydroelectric power has played an important part in the development of this Nation's electric power industry. Both small and large hydroelectric power developments were instrumental in the early expansion of the electric power industry**.** Hydroelectric power comes from flowing water, winter and spring runoff from mountain streams and clear lakes. Water, when it is falling by the force of gravity, can be used to turn turbines and generators that produce electricity.

Hydroelectric power is important to our Nation. Growing populations and modern technologies require vast amounts of electricity for creating, building, and expanding. In the 1920's, hydroelectric plants supplied as much as 40 percent of the electric energy produced. Although the amount of energy produced by this means has steadily increased, the amount produced by other types of power plants has increased at a faster rate and hydroelectric power presently supplies about 10 percent of the electrical generating capacity of the United States. Hydropower is an essential contributor in the national power grid because of its ability to respond quickly to rapidly varying loads or system disturbances, which base load plants with steam systems powered by combustion or nuclear processes cannot accommodate. Reclamation's 58 power plants throughout the Western United States produce an average of 42 billion kWh (kilowatt-hours) per year, enough to meet the residential needs of more than 14 million people. This is the electrical energy equivalent of about 72 million barrels of oil. Hydroelectric power plants are the most efficient means of producing electric energy. The efficiency of today's hydroelectric plant is about 90 percent. Hydroelectric plants do not create air pollution, the fuel--falling water is not consumed, projects have long lives relative to other forms of energy generation, and hydroelectric generators respond quickly to changing system conditions. These favourable characteristics continue to make hydroelectric projects attractive sources of electric power.

### *DESIGN OF PELTON WHEEL TURBINE*

The Pelton Turbine has a circular disk mounted on the rotating shaft or rotor. This circular disk has cup shaped blades, called as buckets, placed at equal spacing around its circumference. Nozzles are arranged around the wheel such that the water jet emerging from a nozzle is tangential to the circumference of the wheel of Pelton Turbine.

***WORKING PRINCIPLE OF PELTON TURBINE***

The high speed water jets emerging from the nozzles strike the buckets at splitters, placed at the middle of a bucket, from where jets are divided into two equal streams. These streams flow along the inner curve of the bucket and leave it in the direction opposite to that of incoming jet.The high speed water jets running the Pelton Wheel Turbine are obtained by expanding the high pressure water through nozzles to the atmospheric pressure. The high pressure water can be obtained from any water body situated at some height or streams of water flowing down the hills.The change in momentum (direction as well as speed) of water stream produces an impulse on the blades of the wheel of Pelton Turbine. This impulse generates the torque and rotate the shaft of Pelton Turbine the impulse received by the blades should be maximum possible. That is obtained when the water stream is deflected in the direction opposite to which it strikes the buckets and with the same speed relative to the buckets.

***GENERTING POWER***

In nature, energy cannot be created or destroyed, but its form can change. In generating electricity, no new energy is created. Actually one form of energy is converted to another form.To generate electricity, water must be in motion. This is kinetic (moving) energy. When flowing water turns blades in a turbine, the form is changed to mechanical (machine) energy. The turbine turns the generator rotor which then converts this mechanical energy into energy form electricity. Since water is the initial source of energy, we call this hydroelectric power or hydropower for short.At facilities called hydroelectric power plants, hydropower is generated. Some power plants are located on rivers, streams, and canals, but for a reliable water supply, dams are needed. Dams store water for later release for such purposes as irrigation, domestic and industrial use, and power generation. The reservoir acts much like a battery, storing water to be released as needed to generate power.The dam creates a head or height from which water flows. A pipe (penstock) carries the water from the reservoir to the turbine. The fast moving water pushes the turbine blades, something like a pinwheel in the wind. The waters force on the turbine blades turns the rotor, the moving part of the electric generator. When coils of wire on the rotor sweep past the generator's stationary coil (stator), electricity is produced.

This concept was discovered by Michael Faraday in 1831 when he found that electricity could be generated by rotating magnets within copper coils. When the water has completed its task, it flows on unchanged to serve other needs.

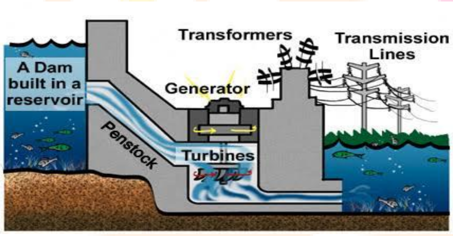


**Figure.1.1.Hydro Power Plant**

## II. LITERATURE REVIEW

***DESIGN AND FABRICATION OF A WORKING PROTOTYPE OF A HYDRO TURBINE***

**Frankly Kumar Kaila 1, Debajit Kumar Sandilya[2]** ,The world's hydroelectric potential needs to be considered in the new energy mix, with planned projects taking into consideration social and environmental impacts, so that necessary mitigation and compensation measures can be taken. Hydro development should go hand in hand with further research and development in the other renewable options such as solar and wind power. In this paper, we are going to show the various opportunities in remote and isolated areas of North east India wherever the areas are not connected.

***COSTING OF A SMALL HYDRO POWER PROJECT***

**Sachin Mishra, S. K. Singal and D. K. Khatod,** Hydropower, large and small, remains by far the most important of the renewable sources for electrical power generation worldwide, providing 19% of the planet's electricity. Small hydro is one of the cost-effective and environmentally benign energy technologies to be considered for rural electrification in less developed countries. The installation cost of the small hydropower project is mainly divided into two parts Civil works and electromechanical equipment. One of the most important elements on the recovery of a small hydro-power plant is the electromechanical equipment (turbine–alternator). The cost of the equipment means a high percentage of the total budget of the plant.

***HYDRO TURBINE RUNNER DESIGN AND MANUFACTURING***

**Fatma Ayancik, Umut Aradag, Ece Ozkaya, Kutay Celebioglu, Ozgur Unver, and Selin Aradag,**This research describes a methodology for the parametric design; computational fluid dynamics (CFD) aided analysis and manufacturing of a Francis type hydro turbine runner. A Francis type hydro turbine consists of five components which are volute, stay vanes, guide vanes, runner and draft tube. The hydraulic performance of the turbine depends on the shape of the components; especially on the shape of the runner blades. The design parameters for the other components are affected by the runner parameters directly. Runner geometry is more complex than the other parts of the turbine. Therefore; to obtain accurate results and meet hydraulic expectations, CFD analyses and advanced manufacturing tools are necessary for the design and manufacturing of the hydro turbine runner.

## III .METERIAL SELECTION

- Pelton wheel
- Nozzle
- Shaft
- Spur gear
- Ball bearing
- Frame (Mild steel )
- Dynamo (capacity 12v).

## IV. DESIGN CALCULATION

### *4.1DESIGN CALCULATION OF PELTON WHEEL*

Diameter of the Pelton wheel (D) =0.24m
Diameter of the Jet (coming from the nozzle) (d) =0.12m
Artificial head from pump = 7.4127m
Step1: velocity of jet at inlet, V1 = $CV(2gH)^{1/2}$
$=0.98(2*9.81*7.4127)^{1/2}$
= 11.81 m/s
Step2: velocity of wheel, U= $(2gH)^{1/2}$
$= (2*9.81*7.4127)^{1/2}$
=12.05m/s
Step3: RPM of the shaft, N= 60u/π D
= 60*12.059/3.1416*0.24
= 960 rpm
Step4: Jet ratio, m = D/d
= 0.24/0.12 =2
Step5: Number of buckets, Z =15+0.5*m
=15+0.52*2
=16.

## V. CAD MODEL

### *5.1 DEMENSION OF PELTON WHEEL*

Wheel diameter: 24cm
Width : 1.7cm
DEMENSION OF BUCKET
Bucket diameter: 6cm
Length : 7cm
Angle : 22.50

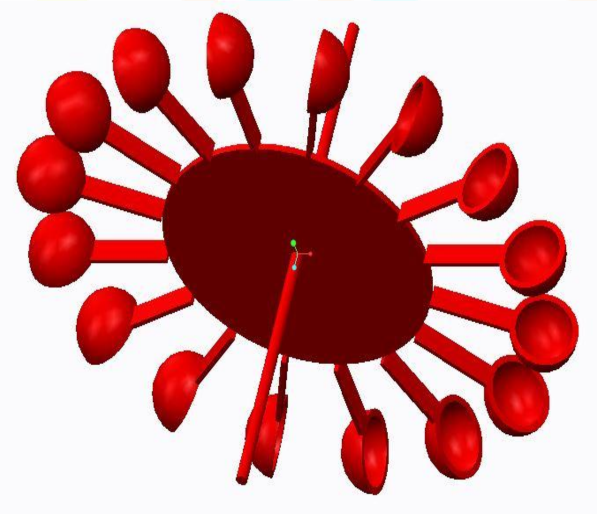

**Figure 5.1 Pelton Wheel**

## VI FABRICATION PROCESS

### *6.1FABRICATION OF THE PELTON WHEEL*

As we know that the shape of the bucket or runner is quite complex in construction and there are material and machine limitations to manufacture an exact form of Pelton bucket. So, in order to make an efficient bucket of the Pelton wheel which will do the same work as the scientifically proved diagram of the bucket, we had used some household ladle whose shape resembles to that of a bucket.

***STEPS***

- Taking width and 0.5 mm thickness, we had made a circle by hammering on an anvil so that all the 16 nos. of equidistant buckets could be placed. For this purpose, we measure the periphery of the circle and marked in 16 parts as we get from calculation.
- Width and 0.5mm thickness and joined it to the manufactured circled bar using arc welding process.
- Then we take the spoons or the ladle which are stainless steel and cut it at the middle leaving 5 cm from the main bucket by using a hacksaw. We also cut the upper portion of the bucket by using the grinding wheel so that water get passes outside as shown in the diagram.
- We then join the splitter made of thin sheet of mild steel by using special electrode made for arc welding operation required for joining stainless steel and mild steel named as Durochrome heterogeneous welding rods
- We take 2cm square rod of 5cm length and cut into 21 equal dimensioned pieces using power hacksaw and join it in the circular manufactured bar by using arc welding process as shown in the figure.
- We then take a hollow circular mild steel bar of inner dia 10 mm having a small amount of tolerance and fitted to the main centre of the circular framed turbine so that it can be fitted to the shaft.

**Figure 6.2. Pelton wheel**

### *6.2 DESIGN OF THE FRAME*

Design of the frame is of great importance as it has to be manufactured in order accordingly with the design and scale of the project. The frame should have the capacity to hold the whole project firmly so that it could not fall or break down during the running of water or running of the Pelton wheel during its live operation,

***STEPS***

- We start the fabrication part of the project from the construction of frame. As shown in the below given diagram we cut the L-shaped mild steel bars and square hollow rods into required dimension(in cm) by using a power hacksaw machine
- First we have joined the L-shaped bars into the specified dimension so that a robust base can be fabricated. For that process, we have joined and welded all the pre-cut steel bars of various dimensions by using arc welding process using E6013 type electrode
- After the construction of the main base, we then cut hollow square steel bars to be fitted vertically into the base. For this purpose also we have cut the bars and welded to the main base again by using arc welding method usingE6013typeweldingelectrode

### *6.3CONSTRUCTION OF NOZZLE*

Nozzles are used to provide the high velocity jet coming out of the pump to the Pelton wheel. We had made these different sizes of nozzles. The diameters of the nozzles are 1.5 cm.

***STEPS***

- For making converging nozzles we take two different sizes of cylindrical rods and cut it in machine into the desired sizes. Then both the rods are joined by using welding rods. The various operation regarding the construction of various sizes of the nozzles are shown in the picture given below: We have used different types of nozzles so that we can vary the jet velocity of the water jet so as to obtain different values of rpm of the rotating Pelton wheel.

### *6.4DESIGN OF SHAFT*

***STEPS***

- We now move onto the shaft part, for which we take a 10 mm diameter cylinder rod of 580 mm length. We use lathe machine to make the shaft as per required size and for this we use operation like turning, facing and finally we get the shaft as per required size 10mm for the pelton wheel part(shown in the figure)
- To fit the shaft in the base frame and connect it to the alternator we had use bearing housing of internal diameter 10 mm whole on the base. This bearing housing is used for the purpose of holding the main shaft to the frame rigidly. The bearing housing is held tightly with the main frame but using nuts and bolts of 10 mm dia and length 1.5 inch.
- To connect the alternator and the shaft, coupling is used. For coupling, one part of the shaft is threaded to join the alternator. We make a key slot on the shaft and the coupling part, which is done in the lathe and the shaper machine so that the rotator motion of the shaft is being transferred to the rotor shaft of the alternator. For threading part we use 14 mm screw pitch and gear arrangement is (30, 70, 50, 100) in the lathe machine. This threading is done for the purpose of joining the other part of the coupling with the rotor shaft of the alternator.

## VII. COMPLETE WORKING MODEL

**Figure: 6.1 Model Diagram**

## VIII. RESULT AND DISCUSSION

1. The design and fabricated model have given around 960 rpm when rotated with the help of a pump under the artificial head of 7.4m. This rpm can be further enhanced by using a higher head resulting in more discharge of water and more jet velocity.
2. The Pelton wheel may not rotate after a while or stop rotating if enough RPM is not generated as per the limitations of the Alternator due to partial excitation of the rotor. Partial excitation of the rotor inside the alternator generates opposition force to the rotating shaft. If we can overcome this force, then only current will be generated produced/generated in the alternator.
3. If there is manufacturing defect in the alignment of the Pelton wheel, then there will be vibrations to the Pelton wheel which may result in fewer rotations or zero rotations.
4. Special care should be given to the manufacture of the frame so that it could not fall down during operation.
5. The Pelton wheel, shaft and Alternator should be held tightly in the frame so that there must be lesser vibrations as much as possible.
6. The design of the nozzle should be such that it could discharge the required amount of water without any failure with a high velocity. This velocity of jet would generate the force on the Pelton wheel will lastly rote the conductor of the Alternator.
7. Care should be taken during the manufacturing process so that there should be no loss of materials which would result in more amount of investment.

## IX. CONCLUSION

As robust global economic expansion continues the question of where a growing world population will continue to get the electricity to drive the economic engine remains. While most of the new generation supply will come from thermal resources, conventional thinking on the development of new resources and supplies should provide greater emphasis on using sustainable, renewable resources. Hydroelectric power has an important role to play in the future, and provides considerable benefits to an integrated electric system. The world's remaining hydroelectric potential needs to be considered in the new energy mix, with planned projects taking into consideration social and environmental impacts, so that necessary mitigation and compensation measures can be taken. Clearly, the population affected by a project should enjoy a better quality of life as a result of the project. Hydro development should go hand in hand with further research and development in the field of other renewable options such as solar and wind power. Energy conservation measures should also be optimized and encouraged.

Any development involves change and some degree of compromise, and it is a question of assessing benefits and impacts at an early enough stage, and in adequate detail, with the full involvement of those people affected, so that the right balance can be achieved. Two billion people in developing countries have no reliable electricity supply, and especially in these countries for the foreseeable future, hydropower offers a renewable energy source on a realistic scale. Our project aims at designing and fabricating a similar type of project but the scale of the project may be lesser compared to the micro hydro power turbine due to limitations of the machines and availability of the materials

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