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A review of the design and experimental validation of the Polycarbonate Pelton turbine

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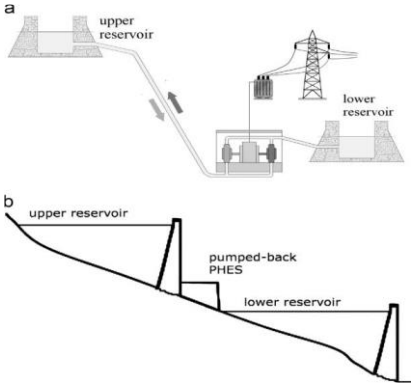
Abstract: **Day by day the demand for electricity is increasing due to increasing population and commercialization. Energy consumption is higher than its production by conventional method. Thus, hydroelectricity exists as one option to meet the growing demand for energy through an unconventional method. The performance of a water turbine is strongly influenced by the characteristics of the inertia of the water. Electricity is the most versatile and easiest to control form of energy. It is practically lossless and essentially non-polluting at the point of use.**

It can be generated clean using completely renewable methods such as wind, water and sunlight. Thus, taking into account the importance of generating electricity through renewable methods, a system is designed and built that will generate electricity using a Pelton wheel turbine. In a multi-storage building, water is supplied to different floors from the top of the building. Using the downward force of the water, the assembly containing the Pelton wheel turbine and alternator is connected and we use this to generate electricity.

Keywords: Pelton wheel turbine,Polycrbonate Pelton wheel turbine , Weight Reduction.

I. INTRODUCTION

In hydroelectric power, the gravitational force of water is used to drive a Pelton turbine, which is connected to an electric generator to produce electricity. Different types of turbines are used to generate hydropower. Among them, the Pelton turbine is used in places with medium to high gradient. Energy from running water has been used since time immemorial to meet some energy requirements. The oil embargo of 1972 sparked a search for alternative energy sources. Small hydropower, which has so far given way to the development of medium and large hydro projects, has attracted more attention than any other renewable energy source.



1.1 Principle of Hydro power plant

Basically, due to the versatility and convenience of electric power on the one hand and the cheapness and renewability of hydropower on the other, small hydropower plays a definite role in today's energy scene. The concept of generating electricity from water has been around for a long time and there are many large hydroelectric plants around the world. What is new to most people is the idea that the same concept will work on a smaller – and even individual – scale.

There are literally hundreds of thousands of micro-hydroelectric sites (up to 100 kW) around the world that could be developed for environmentally friendly renewable energy supplies.

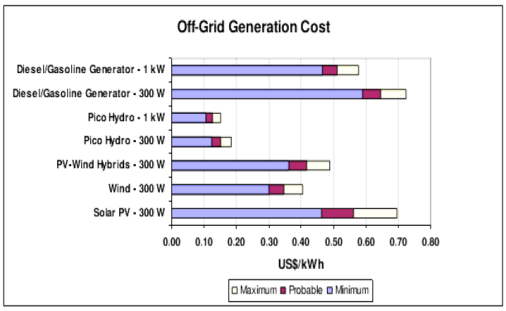
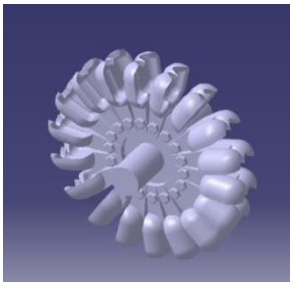


Fig no 1.2 Off-grid power generation cost

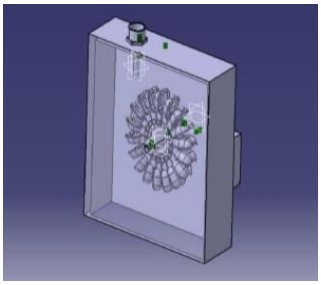
Hydropower is a non-polluting process that uses the high head of flowing water to generate electricity. Turbines are machines that generate water power. The force of the moving water turns specially designed vanes known as vanes or buckets, which in turn drive an attached shaft that goes into a centrifugal type generator. There are different types of turbines that can be selected for power generation based on the size of head available and some other conditions associated with the water. Hydropower plants are classified in various ways such as total head of water available in the reservoir, water storage capacity of the dam, power produced, total head of water in the reservoir, nature of electrical load of the plant. One of the most popular classifications of power plants is according to the amount of energy produced, and there are different versions according to different standard organizations and authors.

II DESIGN OF PELTON WHEEL TURBINE

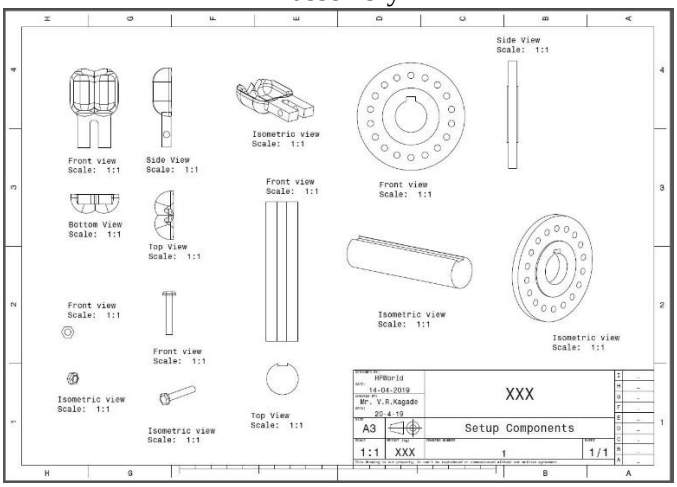
The Pelton wheel is designed taking into account the design parameters from the base research paper. The model designing is performed on CATIA V5 software



a). Pelton Wheel



b.)Pelton Wheel Turbine assembly



c.) Pelton wheel Components

Fig No. 2.1 Cad model and drafting of the Pelton wheel turbine

III. EXPERIMENTAL SETUP

Components of the experimental setup

3.1 Body

The body has all the components of the experimental setup assembled on it. It is manufactured from square tubes of MS material. The metal tubes are joined using nut and bolt arrangement which makes the transportation of the setup easier.

Fig. No. 3.1 Experimental setup

3.2 Turbine and casing

The turbine and casing are assembled separately and then it is attached to the experimental setup. The casing is manufactured from acrylic to reduce the overall weight of the setup. The transparent side is also made from acrylic material.

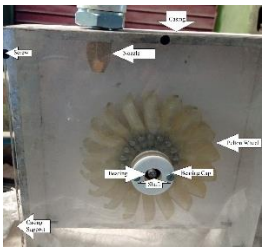


Fig No 3.2. Turbine and casing

3.3 Nozzle

The nozzle is made from brass material with a nozzle diameter of 6 mm. The length of the nozzle is 30 mm.

Fig No 3.3. Nozzle

3.4 Water Pump

The water pump is used to pump the water into the Pelton wheel turbine setup to give an impulse force to the Pelton wheel. The water pump used is of 2HP which is selected according to the pressure required from 15 m head.

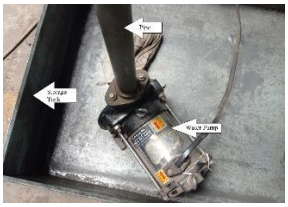


Fig No. 3.4. Water Pump

The water pump is of Kirloskar brothers Limited.It has rpm of 2840 at discharge of 4.0 LPH.

3.5 Water storage tank

The water storage tank is used to collect the water which is discharged from the Pelton wheel. This water is again used to run the Pelton turbine through water pump.

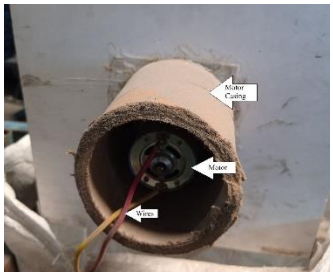


Fig. No. 3.5 Motor casing

3.6 Electricity Generator

The is mounted at the bask of the Pelton wheel shaft. This motor is used to convert mechanical energy into electrical energy.

Fig. No. 3.6 Motor

It is manufactured by Belfin with voltage of 12V for rpm of 4100 rpm. It has shaft diameter of 5mm

3.7 Tachometer

The tachometer is used to measure the rpm of the shaft of thePelton wheel turbine. This measured rpm is used to find the output power of the shaft theoretically.

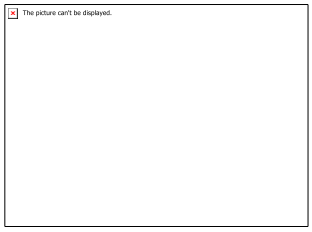


Fig. No. 2.7 Tachometer

The tachometer is made by Teclock which ranges from 0-10,000 rpm

3.8 Rotameter

Rotameter is used to measure the flowrate of the water flowing through the pipe. It ranges from 0 – 1200 LPH

Fig. No. 3.8 Rotameter

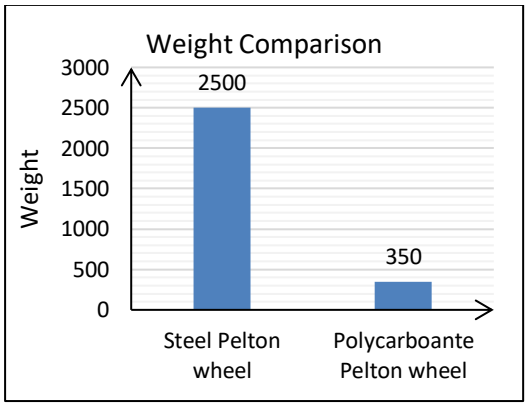
3.9 Digital multimeter

Digital multimeter is used to measure the current and voltage generated from the Pelton wheel turbine.

Fig. No. 3.9 Digital Multimeter

IV. EXPERIMENTAL RESULTS

Throughout experimentation is performed on the polycarbonate Pelton wheel.



4.1 Weight comparison

Fig No 4.1 shows, when the polycarbonate material was used for the development of the Pelton wheel turbine the power output increased with the reduction of weight in the Pelton wheel turbine.

Also, it is observed that the polycarbonate material when used for development of Pelton wheel the reduction of weight results in the increase in the power output.

Parameters	Measuring Unit	Experimental Output
RPM		2862
Torque	N-m	0.073
Flow rate	Liter/ sec	2.3
RPM		4850
Torque	N-m	0.11
Flow rate	Liter/ sec	3.6
RPM		3266
Torque	N-m	0.085
Flow rate	Liter/ sec	2.62
RPM		5228
Torque	N-m	0.13
Flow rate	Liter/ sec	4.2

Table no:- 4.1 Experimental Results

Table no 4.1 shows the experimental results obtained during experimentation. Here we understand that the results are linearly proportional to the discharge and rpm of the turbine shaft.

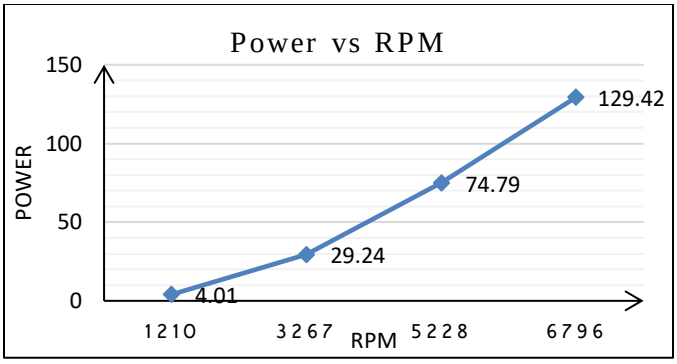


Fig no 4.2 Power vs RPM

The fig no 4.2 shows the relation of power with respect to rpm. And it shoes that as the power increases the rpm also increases linearly. Here the graph has two different slopes upto 3267 rpm the power has regular slope whereas after 3267 rpm the sope become steep

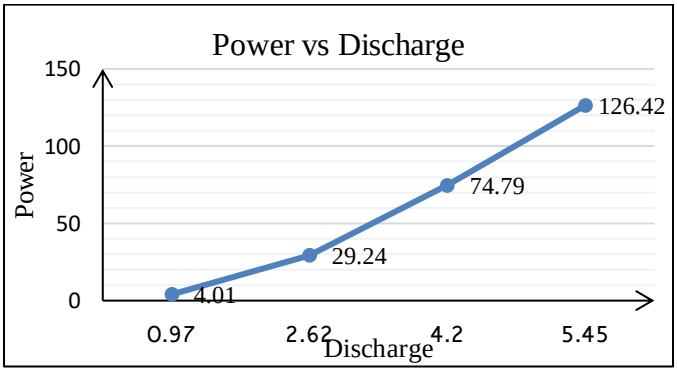


Fig no 4.3 Power vs Discharge

Fig no 4.3 shows the relation of power with respect to discharge. And it shows that as the discharge increases the power also increases

V. CONCLUSIONS

Earlier the prime reason of decrease in efficiency of Pelton wheel is due to use of metal. This reason has been eliminated by using polyurethane material. Thus, efficiency increases.

Also, in this work form design calculations the output power generated was 64W. So, the conventional alternator of 100W is selected.

By reducing the dimensions and using Pelton wheel compact size design has been made.

Using readily available water energy source, operational cost for generating electricity has been reduced.

The generation of electricity is from a type of hydro power plant. Thus, there is no pollution generation as it is clean source of energy.

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