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DESIGN AND PERFORMANCE OF MINI HYDRO ELECTRIC POWER PLANT

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ABSTRACT

Hydropower is an important renewable energy resource worldwide. Hydropower is sensitive to the state of environment, and climate change. Hydro electric power comes from flowing water – 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. Issues of degradation of the environment and climate change can negatively impact hydropower generation. A sustainable hydropower project is possible, but needs proper planning and careful system design to manage the challenges. Well-planned hydropower projects can contribute to supply sustainable energy. An up-to-date knowledge is necessary for energy planners, investors, and other stakeholders to make informed decisions concerning hydropower projects.

This work focuses on designing and functioning of Mini hydropower with the resource availability to work with environment and climate change. The basic components were designed and Mini Hydro Power plant is constructed to generate electric power by the flow of water. It works by the flow of water to run the turbine and the power generated to charge the battery. It requires initial investment, but has long life span with low operation and maintenance cost.

1.1 INTRODUCTION

In this era, concerns about environment and climate change management influence choices investors and international financing institutions make concerning energy projects. The word "environment" can be defined in many ways depending on the discipline; but it is broadly understood to refer to surroundings that interact with life on earth. The surroundings can be divided into nonliving and living components. The important point concerning environment is that it provides resources, such as energy, that support life on earth. Since energy is sourced and processed into a usable form from the environment, activities pertaining to its extraction, transportation, conversion, and utilisation impact the environmental system. The impacts are pronounced in thermal energy systems. For fossil fuel energy systems, it is also not possible to totally avoid emissions and environmental setbacks because of combustion. During the combustion process, energy is converted from chemical into heat and the gaseous products of combustion are ejected from the system at a higher temperature than the ambient (as dictated by Second Law of Thermodynamics). Some of the gaseous products of combustion are harmful to life and climate system, as will be discussed later in the paper.

The increase in global energy demand as a result of population and economic growth in developing countries coupled with huge demand from developed countries is well documented. According to the statistics from International Energy Agency (IEA), the documented values show that the total global primary energy supply in 2009 was 12,150 Mtoe up from 6,111 Mtoe in 1973, indicating an almost 100% increase. The global energy supply is still dominated by fossil fuel (coal, natural gas, and oil): fossil fuel contributes around 80% of the 2009 total mix as compared to about 87% in 1973. The contribution from other fuel sources is quite minimal. The mix from biofuels and waste (about 10%) is basically derived from biomass solid-fuel sources mainly for provision of domestic thermal energy requirements; a predominant source of energy in less developed regions of the world such as sub - Saharan Africa.

2.1 HYDRO POWER

Hydropower is one of the cheapest ways to generate electricity and is used by more than 60 countries worldwide, meeting half of their electricity demand. It also provides the added benefits of being a clean energy source, providing energy 'on demand' and creating thousands of jobs across the globe.

There are several types of hydropower facilities and they're all powered by the movement of flowing water. Turbines and generators are used to convert the water's kinetic energy into electricity, which is then fed into the electric grid to supply homes, businesses and industries.

A new technology called micro hydro is increasingly being used in remote areas to power homes and businesses. The technology makes it possible for small holdings to generate their own energy, independent from large hydropower plants. Micro hydro uses smaller water flows to run small generators that produce enough energy to power a home, or run on-site equipment.

Hydropower works by harnessing the energy that comes from the flow of water through a turbine connected to a generator, thus turning it into electricity. Most hydropower plants store water in a dam, which is controlled by a gate or valve to measure the amount of water that flows out. The greater the elevation of the dam, the more energy can be generated.

Just before the water flows over the dam, it gains potential energy, which is converted into kinetic energy as it flows downhill. The water is used to turn a turbine, which is connected to an electric generator that distributes the power to the end users.

3.1 METHODOLOGY

- Hydropower works by harnessing the energy that comes from the flow of water through a turbine connected to a generator, thus turning it into electricity.
- Most hydropower plants store water in a dam, which is controlled by a gate or valve to measure the amount of water that flows out.
- The greater the elevation of the dam, the more energy can be generated.
- Just before the water flows over the dam, it gains potential energy, which is converted into kinetic energy as it flows downhill.
- The water is used to turn a turbine, which is connected to an electric generator that distributes the power to the end users.

Fig 3.1 Construction of Mini Hydro Electric Power Plant

4.1 DESIGN AND CALCULATION

4.1.1 Specification

- **Power output and efficiency**

$P = \eta\ (Q\ \Delta p)$

$\eta = 45\%$

$\rho = 1020\ kg/m^3$

$\Delta h = 85m$

$Q_1 = Q_2$;p=5200w

$V_1 = V_2 * \Delta P$

$\Delta P = \rho * g * \Delta h$

$= 1020 \times 9.81 \times 85$

$\Delta p = 850{,}527$ pa

$Q = M/\rho$

$P = 0.45\ (12/1020\ \ X\ 850{,}527)$

$P = 4502$ w

Efficiency $\eta = P/Q\Delta P$

$=5200 / (12/1020\ X\ 850{,}527)$

$=52\%$

P = power output for measure in watt

η = efficiency of turbine

ρ = density of water

g = acceleration due to gravity

h = fall height

Q = discharge

A = cross sectional area of the channel

V = velocity

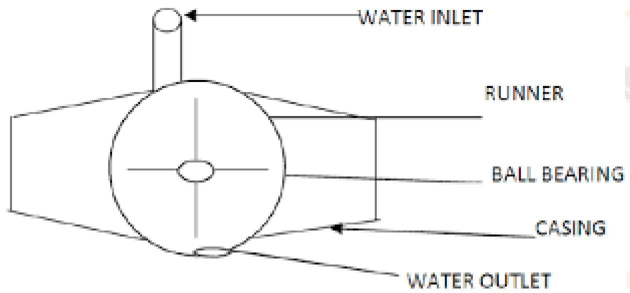

Fig 4.1 Inner view of Turbine

4.1.2 Output

Efficiency, $\eta = P/Q\Delta P$

$= 5200 / (12/1020\ X\ 850{,}527)$

$= 52\%$

5.1 COST ANALYSIS

The cost analysis for this project is done as follows. All the components along with the miscellaneous cost are included in the total cost of this mini hydroelectric power plant.

S. No.	Activity	Amount in Rs.
1	DC 12 V generator	1250
2	DC to Dc boost up module	1400
3	12 V battery,12 V LED bulb, 12 V fan, multimeter	2350
4	Turbine blade, Coupler joint rod, Switches	500
	Total	**5500**

6.1 RESULT AND DISCUSSION

The design, construction and installation of the mini hydro-electric power plant were carried out. After installation, the system was operated and the output voltage was measured using digital multimeter. The reading obtained was 20W to the battery. The output was again measured with a multimeter and was indicated. This output was applied to a 12W bulb which was blown immediately. It was again applied to a 12W fan and it was blown. It was observed that the output current was quite appreciable. This mini-hydroelectric power plant could power a load of up to 50W at the release of the water flow.

7.1 CONCLUSION

It is very possible that a generator can be powered by a water flow. It represents the power of water flow and the generator respectively. If this is done successfully and the turbine is built with high efficiency, this methodology can be further extended to generate more amount of electricity.

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