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A review and case study on Pico hydro power generation through water pipeline-A greener approach.

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Abstract **—Electrical demand nowadays has increased tremendously due to increased automation and implementation of advanced technologies. This increased demand calls for new and efficient methods of power generation. But undertaking a new power generation plant at a large scale is a hectic task in itself and requires large financial support. Demand for green energy production is arising all over the world. A lot of emphasis is laid in making the buildings green. A minimum amount of energy savings made contribute to saving the environment. In this study, an idea is studied and proposed to extract power from the high head water in the pipelines of a building. Pico hydroelectric power is both reliable and efficient form of clean source of renewable energy. Utilization of rather wasted hydro energy through water pipelines can be successfully extracted by such Pico hydro generation plants. Kinetic energy stored in domestic water pipeline that has the potential to generate electricity for energy storage. It generates electricity with no fuel cost and also low maintenance. We can also install a mechanical arrangement to generate electricity from the potential energy possessed by water storage tank from a water head of even 5m and above very easily. Hence, this paper give us opportunity to make a small scale hydro generation system using water from tank as an alternative electrical energy source for commercial and residential use.**

Keywords- Turbine, Generator, Shaft, Bearings, Converter, Battery Storage, Pelton , Francis, Kaplan, Inpipe, Head, Flow rate, Efficiency.

I. INTRODUCTION

There is need for developing systems applicable universally for reducing degradation of the environment and benefit the society. A large number of methods for managing and monitoring the environmental sustainability of regional systems have been proposed by the scientific community for more than a decade. Adding value, reducing cost, and improving the environment and inter-relation between economic development and environmental protection, leading to a need of an innovative evaluation method is essential. There is increasing energy demand across the world. Due to global warming, there is constraint on the use of conventional sources of energy. Pico hydro is the hydro electricity generation methods with the huge amount of electric output of five kilowatts. The recent development and innovations in Pico hydro technology have made it an easily available economic source of power even at remote places around the globe. It is a very versatile power source that could be used to generate AC electricity. Light bulb,television and other similar electronic devices can be easily operated by using the pico hydro power. The need of pico hydro electricity all around the world is that it allows electricity generation simply and at no fuel cost. The growing high demand in electrical energy is forcing man to search for different available energy resources. The instrument's used in pico hydro electricity generations specialized with its small and compact design, so that it could be installed in a small area very easily. The main advantage of this hydroelectric power generation is that it has a lower cost per kilowatt compared to that of solar or wind power. So pico hydro system is undoubtedly recommended in places with regular water flow.

Lu et al. (2015) presented a comparison study on two design optimization methods for green energy systems in buildings using single objective optimization employing genetic algorithm and a multi-objective optimization utilizing non-dominated sorting genetic algorithm. The work attempts to produce green energy with in a high building by utilizing the energy from the water flowing through the pipes from the overhead tank. The gravitational force is the driving force for energy of water. The motivation of the paper is to utilize this mini hydro energy and find the feasibility of extracting the energy using a pico hydro turbine. The energy of water in the overhead tank is the freely available energy. High head water in building pipes has high potential energy. This energy is converted to kinetic energy as the water flows down the pipe. The water looses considerable energy when it enters the tap. This energy is used for running a micro-impulse hydro turbine.

In some large skyscrapers and buildings even pressure reducing valves are utilized to reduce the pressure of pipe water which is nothing but wastage of the energy. In such cases the inline pico hydro plants can be used to reduce the pressure of water by extracting kinetic energy for the energy conversion process. In brief it can be said that utilization of such pico hydro plants in residential pipelines if undertaken by number of common people may lead to reduction of excess of demand pressure on the power suppliers.

II. NEED FOR PICO HYDRO PLANTS

Electricity is the all round and widely used form of energy. The global demand for electricity is continuously growing. Availability of useable energy in the form of electricity has gradually assumed an essential component of our daily lives. World trend shows that the demand for electrical energy in developing countries in particular normally grows at a rate faster than the rate at which generation can be augmented. The consequent ever-escalating difference between demand and supply of electricity therefore poses a challenge in technologically developing and advanced countries. As per survey report of 2014, 7.5 crore Indian households are without access to electricity. The per capita electricity consumption in rural household is found 8 units per month compared to 24 units in urban areas. This calls out for water generation through pipeline. For the case of this paper we are utilizing the water pipelines used to feed the residents of a building through overhead tanks. The ever increasing demand of electricity needs to be catered in one or the other way and hence power generation through water pipelines is a great way to help at some extent.

III APPROACH AND METHOD

A. Flow Rate and Pressure Head:

Generated power is proportional to the flow rate and pressure head of water. The higher the flow rate and pressure head of water are able to produce higher level of kinetic energy which will turn the runner blades of the turbine and state rotating. The generator shaft coupled to the turbine start to move and hence convert the kinetic energy to electrical energy.

Gross head is the vertical distance between the penstock and where the water leaves the turbine. Penstock is where the pipe takes water from the steam .In determining the head gross and net head to be considered net head is the gross head minus pressure losses due to friction and turbulence. Minimizing the length of the pipeline and turns in the pipeline can prevent some losses to pressure.

To measure the flow rate we have used the bucket method here. So to use the bucket method we first used a bucket of 1 litter and then we measure the time to fulfill the bucket in what amount of time by using our test pipe. By using this method we calculated the flow rate in Meteres/seconds. So we can find this by using equations also.

FIG

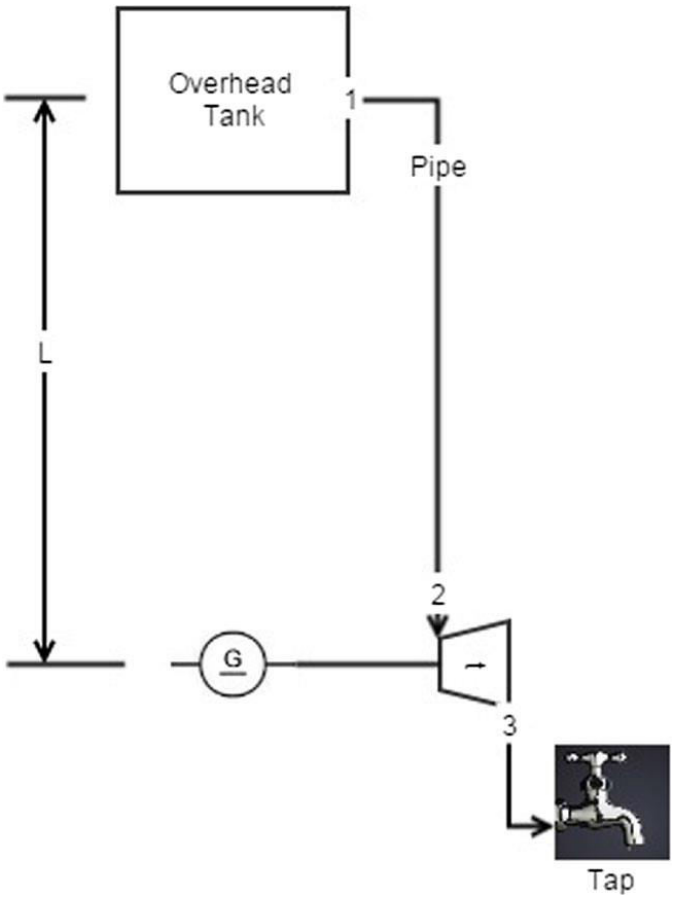

FIG: LINE DIAGRAM OF THE IDEA

B. Turbine and Generator design:

To design turbine we have measured flow rate, diameter of the pipe, velocity. There are two type of turbines i.e. first one is of Impulse type and the other one is of Reaction type. As we are having medium head and medium flow rate we have gone for the Pelton wheel turbine. In pipe lift based turbines can also be utilized but it requires so complex design. The design of turbine and casing is carried out in the CATIA designing and assembling software by skilled user. All the dimensions are chosen accurately according to a 3 inch pipeline. Even a single mistake in the dimensions can lead to misalignment of the turbine with respect to the pipeline.

Turbine:

The turbine as discussed above is a pelton wheel turbine due to high head of the water and medium water flow. The buckets are chosen with length, breadth and depth in the ratio of 2:5:4 respectively which is the most commonly used standard ratio. The number of buckets is kept to be 18. The actual designed turbine along with the design is shown below:

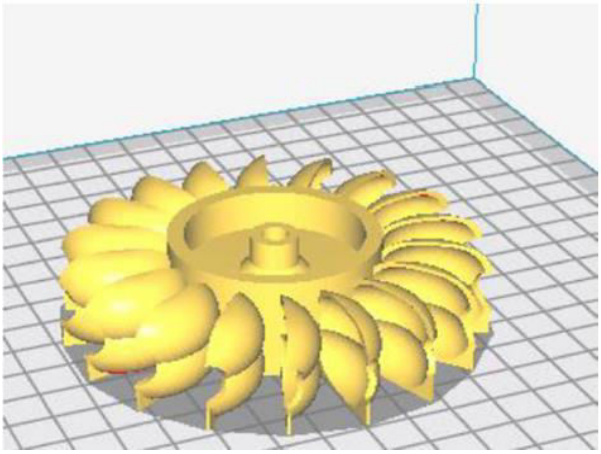

FIG : Turbine model designed in CATIA.

FIG : Actual turbine model

C. Generator design:
The generator is designed according to the speed of the shaft connected to it. The designed generator must have better efficiency to avoid any further losses. We used AC Generator.

D. Converter circuit:
The power developed is in ac form it can directly utilize through frequency changer by converting appropriate frequency. For purpose of storage rectifier is used to convert ac to dc. Converted dc power stored in battery.

IV.CONCLUSION

Water consumption for household can be utilized by putting pico hydro generator to produce electricity. Potential electricity can be generated by pico hydro generator. Pico hydro generator is developed using the concept in hydropower systems which are conventional type and pumped storage type. There are two main parts that need to be determined in this project which are the selection of generator and the size of turbine. In this project, permanent magnet generator is chosen and the turbine is designed in a small scale according to the turbine design in the market. After the prototype is completed, several tests were conducted which are turbine test, open circuit test and system test to determine the how much power can be generated. The prototype of Picro Hydro Generator has been built which consists of turbine and generator.

V .ACKNOWLEDGEMENTS

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