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Introducing Pico Hydro From Daily Used Water And Rain Water

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ABSTRACT
Demand for energy is increasing day by day because of increasing the population and industrialization. But, the over usage of electrical energy may cause power crisis. So, there is a need to develop the methods of optimal utilization which decreases the over usage of energy and try to work as positive catalyst in stable environment. This paper shows the possibility of tapping the wasted energy from daily used water and rain water. The wasted energy of daily used water and rain water can be converted into the electrical energy by hydro electric mechanism through several energy conversion processes. There is also obtained the electrical energy is in KW range, which is sufficient to lighten a garage of multi storeyed building or small needs of home. The generated electricity is stored in a battery for any future uses. As the increasing of daily used water and rain water on roof, the designed system will be effective to decrease the power crisis of Bangladesh to some extent.
Keywords - Potential energy, Daily used water and rain water, Hydroelectric mechanism, Energy conversion, Home uses.

I.   INTRODUCTION

Environment produces a large number of energy. If there is used that energy or convert the energy from the available source than it will be the cheapest and most attractive technology to make proper utilization of energy. As a perspective demand of power is greater than the generation power. The capability of present generation of Bangladesh in public sector is 4794MW (56%) only [1]. The per capita energy consumption in Bangladesh is one of the lowest (136KWh) in the world [2]. At present the generating station of Bangladesh produces electricity from Natural gas (67.21%), Furnace oil (22.55%), Diesel (5.52%), Hydro (2.58%) and Coil (2.35%) [3]. Bangladesh has not big reserve of coil and oil but a large number of natural gas. Most of the   economic activities of the countries are dependent on power as well as natural gas. So, the over using of natural gas can make emptiness of the reserve of natural gas. Already there existing such systems using renewable energy such as solar, wind etc. So, we have to think another system which produces energy from daily wasted energy. Water is a great source of energy and we use a large amount of water for our daily needs.This paper proposes a system which produces electricity from our daily using water and rain water. When using water and rain water are falling down by the pipe arrangement of a building,it has a potential energy. By using this potential energy we can rotate a turbine which converts potential energy to mechanical energy. A dynamo or DC generator is   connected by chain drive with the turbine which converts the mechanical energy to electrical energy. As the shaft of DC generator rotates, it produces electricity. This generated electricity is stored in a battery and is used to lighten the garage or daily needs.

II.   METHOLOGY

Pico hydro means generating up under 5 KW of electricity through hydroelectric power [4]. Electricity is a basic part of nature and it is widely used in our daily works. A large amount of energy is wasted when our daily used water and rain water is going towards the drains by pipe. In this system a turbine is fitted where the water is falling down. The potential energy of water can rotate the turbine and a gear which is connected with the turbine. This is the conversion of potential energy to mechanical energy. A chain drive is connected with the gears which rotate the gear of the dynamo shaft. When dynamo shaft is rotated with a certain rpm, the mechanical energy is converted to electrical energy. The gear ratio of turbine and dynamo shaft is 5:1. The conversion is proportional to the falling mass of the water and also the height of the pipe from the ground. The whole system can be shown on Fig. 1.

Fig. 1   Basic figure of the system

III. SYSTEM DESIGN

The whole system can be represented by a block diagram as shown on Fig.2. The potential energy of the water is captured by the turbine as rotational energy which is converted to the mechanical energy.This mechanical energy is converted to electrical energy by using dynamo. This energy is stored in a battery and used it for future home uses.
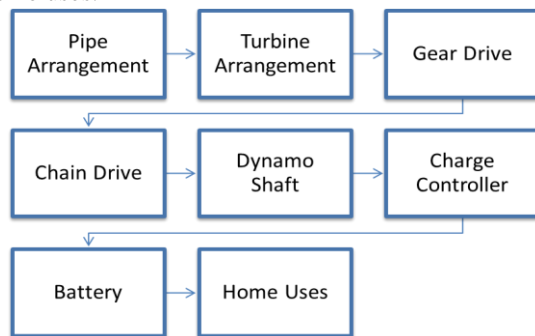
Fig. 2   Block diagram of the whole system

IV. CONSTRUCTION DETAIL

A. Pipe arrangement

In this system pipe arrangement is very important. The output pipes (without toilet pipe line) of a multi storeyed building is converted to a single pipe which is connected with the building horizontally. The height of the single pipe from turbine is between 1.5 to 2.0 meter. The diameter of the single pipe is increasing with the number of floor of the building. This can be written by,

$$X = N$$

Where, X is the diameter of the single pipe in inch and N is the number of floor of the building. The value of N is limited 2-8 and every 2-8 floor needs a single pipe and the length of the pipe is minimum 5 meter.

B. Turbine arrangement

The turbine of the system is placed where the water of the single pipe is falling down. The blade length of the turbine is equal to the diameter of the single pipe. The mass of the turbine is inversely proportional to the generating power. So, low mass turbine is suitable to generate power.

C. Gear

Gear is a rotating machine part having cut teeth which is connected with another toothed part to transmit torque and produced a mechanical advantage through a gear ratio 5:1.

D. Chain Drive

Chain drive is a media of transmitting mechanical power from one place to another. It is used to transmit to the wheels of a vehicle particularly rickshaw, bicycle etc. The gear and chain drive are shown on Fig. 3.

Fig. 3   Top view of gear and chain drive

E. Dynamo or DC generator

A dynamo or DC generator is a type of electrical generator which produces direct current with the use of a commutator. It converts mechanical rotation into a pulsating direct electric current through Faraday's low.

F. Battery

The generated electrical power is stored in the battery and can deliver to the load.

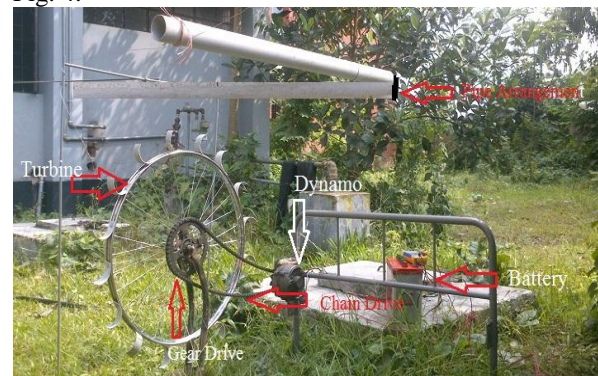All the equipment's that are used in this system and whole system in practically is shown on Fig. 4.

Fig. 4   Total system in practical view

V. EXPERIMENTAL DATA COLLECTION AND ANALYSIS

A. Data collection

The data collection of this paper can be representing by several steps.

➢ When only one faucet is opened,then 25 kg water per minute or 0.42 kg per second is falling down towards the turbine. The potential energy of falling water rotate the turbine and dynamo shaft also. So, a terminal voltage is produced and caused charging current to flow towards battery. So battery is charging with a terminal voltage. At that moment terminal voltage is 5.23V and charging current is 0.809 A.

➢ When two faucets are opened at a time then the terminal voltage is increased to 10.09 V and the charging current is 1.13 A.
➢ When three faucets are opened at a time then the dynamo produce maximum terminal voltage which is 11.90 V and a charging current 1.78 A.
➢ When four faucets are opened then the voltage is 12.39V and charging current 2.27 A. All the data of the above moments are given in Table I.

Table I.   Experimental data of pico hydro

Mass of water (Kg)	Maximum voltage (V)
25	5.23
50	10.09
75	11.90
100	12.39

The graph of Mass of water Vs. Terminal voltage is shown in Fig. 5.
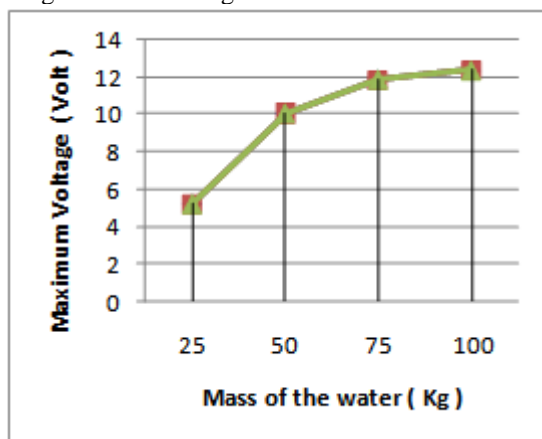
Fig. 5   Mass of water vs. Terminal voltage graph

B.   Data analysis
In this paper, the experimental data are taken from a five storeyed building and various numbers of faucets are opened.The variation of the output is shown on Fig. 4, where it is clear that the terminal voltage and the charging current is increasing proportionally with the mass of water.

i.   Theoretical Analysis [5]
Mass of water, M = 25 kg
Height of the pipe from ground, h = 2 meter
Mass of the Turbine, m = 4 kg
Radius of the turbine, r = 0.33 meter
No. of rotation per minute for turbine = N_1
No. of rotation per minute for dynamo shaft = N_2
Gear ratio N_1/ N_2 = 1/5
Now, potential energy E = M×g×h
            = 490 J

Now, Induced torque in turbine, τ = roller mass × (angular velocity) ^{2}× roller radius
= 4 × $(2\pi N_1/60)^2$× 0.33
Here, E = τ
So, N_1 = 184 rpm
And N2 = N = 920 rpm

Rating of the Dynamo used:
Rated Voltage V= 12V, RPM = 2000
Current capacity = 50 A
Internal generated voltage E_0 is obtained from using the equation,
E_A = $(N \times E_0)/N_0$ = 4.91 V
Armature Current, I_A = Load Ampere Hour (Ah)/60
= 50/60 = 0.833 A
Terminal voltage, V_T = $E_A - I_A R$= 5.478 V
Output Power = $V_T I_A$ = 5.71 watt
Now, total minite of a day = 1440 min
Considering useful minite in a day = 500 min
Power generated in 500 minite = 500 × 5.71 = 2855 watt.

ii.   Practical analysis [6]
As the water falling towards the turbine the output terminal voltage is increased with the increases of the mass of water. From this charging period generated power is calculated.The result is shown on Table II.

Table II.   Observation of data for fico hydro

Observation No.	Voltage (V)	Current (A)	Power (W)
01	5.23	0.809	4.231
02	10.09	1.13	11.401
03	11.90	1.78	21.182
04	12.39	2.27	28.125

It is seen that when the mass of falling water is 100 kg then the obtained power is 28.125 Watt. For a small time interval variation of voltage and current is displayed in Fig. 6.
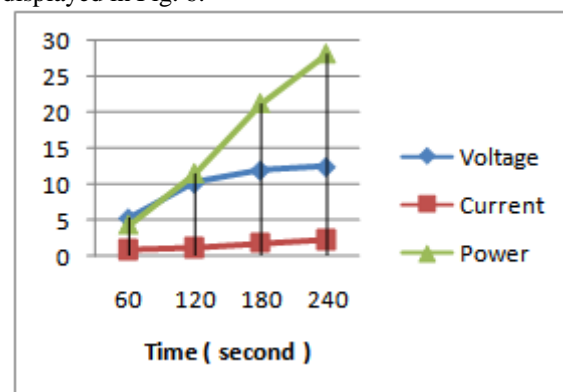
Fig. 6   Graph of the Pico Hydro Output

VI.   SCOPE OF THE SYSTEM
From the Table II it is clear that the output power is very effective.In world, each person uses

about 80-100 gallons of water per day[7]. If every home in the United States replaced existing faucets with another model, we could save nearly $1.2 billion annually [8].In Bangladesh the average monthly rainfall is 210 mm[9].So, it is said that the perfect uses of used water and rain water can help the power producing for small home uses and it will be beneficial to the country like Bangladesh to fulfill the future demand of electricity.

VII. CONCLUSION

This paper introduces a generation system for tapping energy from the daily used water and rain water. It produces electrical power proportional to mass of the falling water. This method is suitable to develop the country like Bangladesh by utilizing wasted energy of the daily used water. By utilizing this system, the future demands of electricity can be minimized to some extent.

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