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Design and fabrication of perpetual motion hydroelectric power Generator

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Abstract

Perpetual Motion Hydroelectric Generators is a system which generates electricity by using the potential energy of falling water under two circumstances, firstly for power generation and secondly for recirculation of water. These types of systems can be extremely useful in rural regions where there is a shortage of electricity as well as a limited supply of water. This paper describes the design and fabrication of a hydroelectric generator as well as a hydraulic ram pump. Emphasis is given to the calculation of power produced, discharge and the efficiency of the ram pump. The results obtained are validated with respect to standard fluid mechanics calculations.

Keywords: *Recirculation, Hydroelectric generator, Hydraulic ram, Power*

1. Introduction

Hydroelectric power (HEP) accounts for 97.9% of the total world renewable energy [1-4]. Currently, most of the sites for large HEP plants have been exploited. The shift is towards the small HEP plants [4,5]. Large hydro-electric plants are highly capital intensive, remotely located, have long gestation periods and impoundments are potential environmental hazards. Large untapped potential of energy in flowing streams, rivers slopes, canals falls, and irrigation and water supply dams can be

Exploited by small/mini hydro plant. This energy is available near rural load centres [11]. With the continuous growth of population the human use of natural water resources has increased steadily [6]. There is a growing concern over the liability of adequate water supply to meet the future needs of society [6-10]. The ideology behind this project is to achieve perpetual motion by minimizing any loss of energy and recirculating the falling water without the use of any external source of energy. A hydraulic ram pump is also known as a "Hydrum" [2]. It is a

completely automatic device [2-5] that uses the energy of flowing water such as a spring, stream or river to pump part of the water to a height above that of the source [11-14]. Various designs were tried and some of the main challenges [5] were the balancing of the weight of the turbine and the motor, high noise from the waste valve, accumulation of water in the turbine drum. This paper addresses the challenges faced and the methods undertaken to overcome it. A perpetual motion hydroelectric generator consists primarily of two parts namely: Hydroelectric Generator and a Hydraulic Ram. The hydroelectric generator further consists of a pelton wheel turbine and a permanent magnetic motor. A

hydram is a structurally simple unit consisting of two moving parts. These are the impulse valve (or waste valve) and the delivery valve (check valve). The system also consists of an air chamber and an air valve [15]. A perpetual motion machine of type one states that a machine continues to function perpetually without supplying any energy [14]. It is defined as " A perpetual motion machine (PMM) is a device based on mechanical, chemical, electric or other physical processes which, when started, will remain in operation forever and provide additional works as well [6].

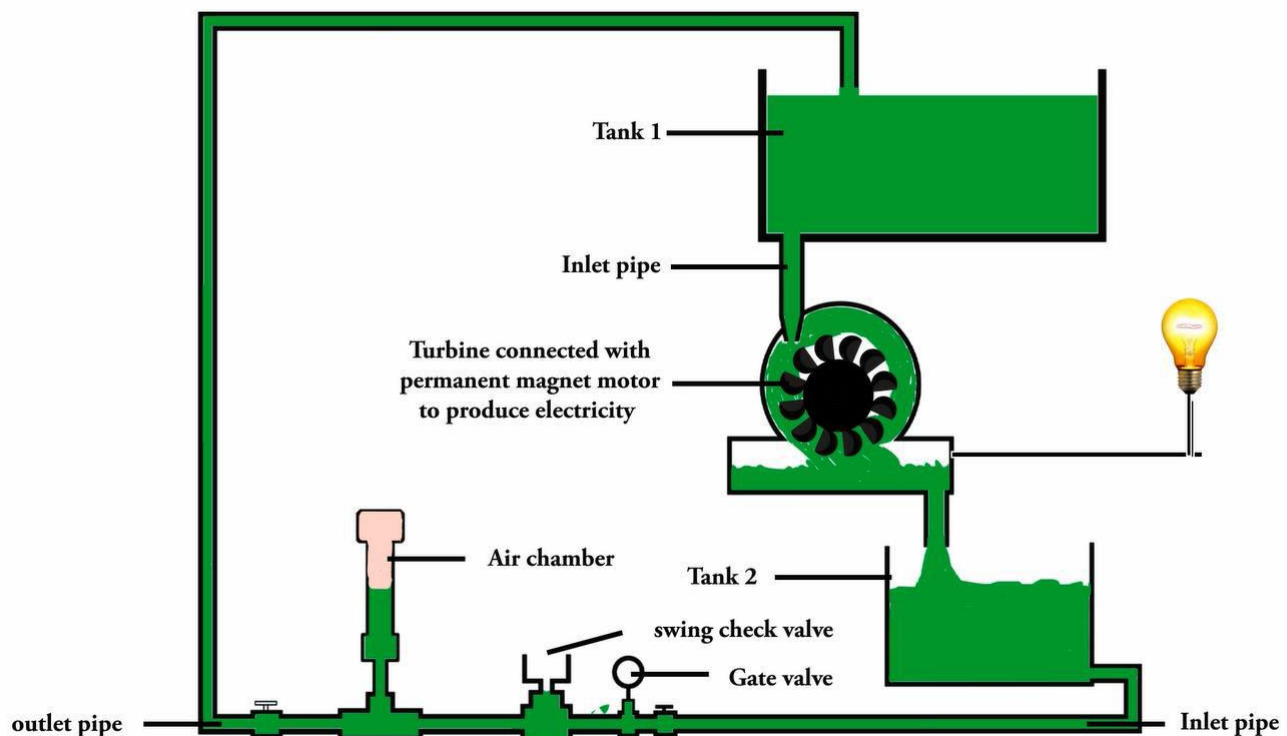


Fig.1. Representation of Perpetual Motion hydroelectric power generator

Figure 1 depicts a pictorial representation of the proposed perpetual motion machine (PMM). Water falling from tank 1, placed at a certain height falls onto a pelton wheel turbine which uses the potential energy of the falling water to rotate. This potential energy is converted into mechanical energy. A permanent magnetic motor is connected to the turbine by means of a primary shaft. The rotation of the turbine causes the shaft to rotate which in turn causes the rotor of the motor to rotate. This action of the shaft and rotor leads to the production of electricity. To get an accelerated velocity of the falling water from the primary tank, a nozzle is used which is placed into the inlet pipe.

The effect of the nozzle not only gives an accelerated velocity but also provides a direction for the flowing water. The permanent magnetic motor can be connected to a bulb, battery or general household appliances which need to be run. The water which rotates the turbine is then directed towards a secondary tank (tank 2). From the secondary tank, the water is used by the hydraulic ram pump, which pumps it back to the primary tank (tank 1), thus producing a continuous cycle in which the water begins from tank 1 and ends up back to tank 1. This paper deals with the combination of a hydraulic ram pump and hydroelectric generator [6] to produce a perpetual motion machine (PMM).

Theoretical power is calculated with the consideration of the entire set

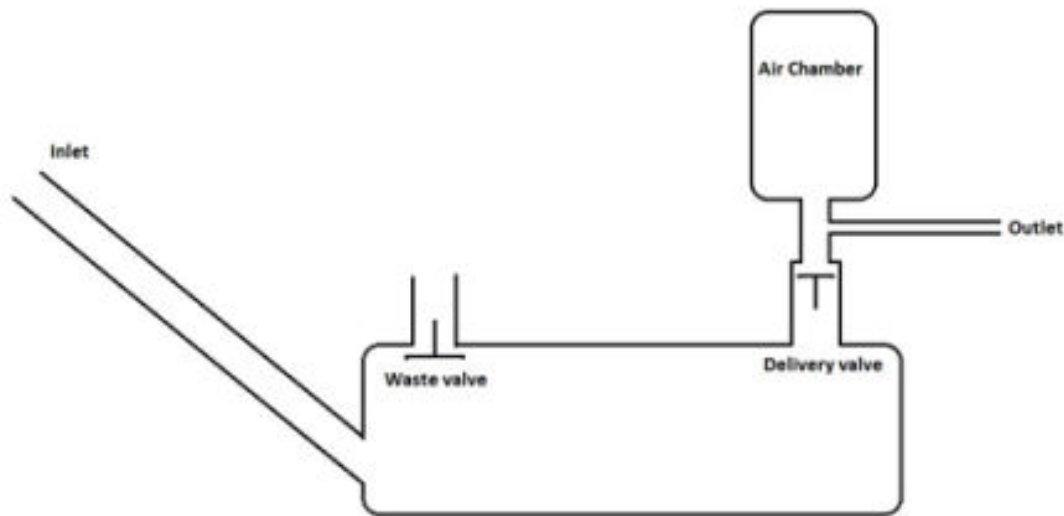


Fig.2. Construction of Hydraulic Ram Pump [4,5]

up [6], as well as individual calculations of each of the systems. Figure 2 shows the basic construction of a hydraulic ram pump. The force of the moving water gives the power it needs which uses the momentum of the relatively large amount of moving water to pump a relatively small amount of water uphill [9]. The pump has a valve that allows the water to flow through the pipe and build up speed [5]. Once it reaches its maximum speed, the high velocity water causes the valve to shut suddenly. Due to this the flowing water develops a great deal of pressure in the pump [5]. This causes the second valve to open. High pressure water flows through the second valve to the delivery pipe which has an air chamber to allow the delivery pipe to capture as much high pressure water as possible during the impulse [2, 5]. The pressure in the pump falls, the first valve re-opens to allow water to flow and build up momentum again [5]. This cycle continues until the velocity of the flowing water changes or until the water supply stops.

2. Related Study

C.A Nwosu and Madueme were able to construct a micro hydropower plant using a hydraulic ram pump. The technique used for power generation was pumped hydro storage method. The flow rate of the water is set at an optimal rate. This is achieved using a flow regulator. The amount of energy produced depends on the flow rate and the head. S.U Patel discusses about the use of cross flow turbine in

micro hydro power plants. Explains about the importance of turbine design in order to reduce losses. Selection of turbine should be dependent on factors like number of power generating units, rotational speed and low cost. O.D Thappar has successfully made a table that lists the turbine that can be used for a suitable head

also discusses about the possibility of advancement in ultra-low head hydropower system and encourages the development of small hydropower systems. R.N Mbiu – performance testing of hydraulic ram pump. Did a detailed study on problems encountered during construction of hydrams which includes factors such as waste valve weights, pumping pressure and corresponding head.

3. Methodology

Figure 3 shows the methodology followed for the design and fabrication of a perpetual motion hydroelectric power generator. The methodology begins with the definition of the problem, which is the objective. Literature survey includes all the present research that has been done on this particular topic or on individual components. Subsequently designs of both the hydram as well as the pelton wheel are key parameters of the plan. Based on the designs, fabrication and procurement of materials is done as per the specific requirement. The entire prototype is assembled once the individual components have been fabricated. Various tests are conducted according

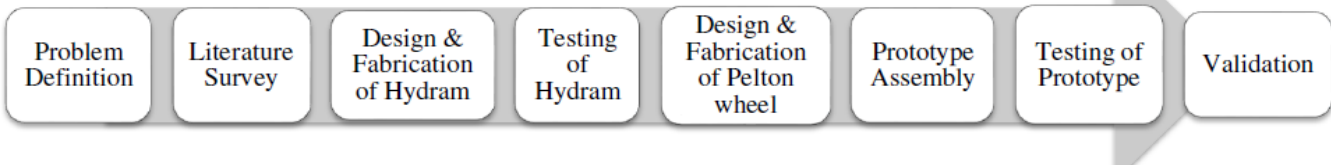


Fig.3. Methodology in Design and Fabrication of Perpetual Motion Hydroelectric Power Generator

to various parameters to obtain the best possible result. The last phase of the methodology is the validation of the obtained results with those that have been already been conducted previously. Hydropower is a non-polluting, non-renewable source of energy [7]. It makes use of water falling from heights to spin a turbine which produces electricity. This is done by the conversion of kinetic and potential energy of water into useful energy [7]. The vital factors to be considered while calculating the power are mainly the flow and head. The relation between power, head and flow is shown in the equation below [7].

$$P = Q1 \times H1 \times \rho \times g \quad (1)$$

9.81 is a constant, it is the product of density of water and acceleration due to gravity (g). Velocity of the falling water is given by

$$V1 = \sqrt{2gH1} \quad (2)$$

Flow rate through the pipe (Flow in the pipeline)

$$Q1 = V1 \times A1 \quad (3)$$

The energy required to make ram lift water to a higher elevation comes from water falling downhill due to gravity. As in all other water powered devices, but unlike a water wheel or turbine, the ram uses the inertia of moving part rather than water pressure and operates in a cycle

based on the following sequences [15]. Since a hydram makes use of sudden stoppage of flow in a pipe to create a high pressure surge, the volumetric discharge from the drive pipe is given by:

$$Q = \pi r^2 L n / 60 \quad (4)$$

Due to the gravity effect the fluid flows inside the pipe with a velocity which is given by the equation (5).

$$Vd = Q / Ad \quad (5)$$

The nature of flow (Laminar, transitional or turbulent) is determined by using a dimensionless number which is calculated by using equation (6).

$$Re = Vd d / \nu \quad (6)$$

Equation (7) represents a mathematical relationship given by Blasius to determine frictional factor f with the use of dimensionless number.

$$f = 0.316 / Re^{0.25} \quad (7)$$

Darcy-Wersbach equation which is shown in equation (8) used to evaluate the loss in the head for fluid flow in pipes.

$$\text{Head Loss} = fL/d * (Vd^2/2) \quad (8)$$

Fluid which is present accelerates enough to close the waste valve; this is due to the drag and the pressure in the water which equals water valve weight. Equation (9) represents the drag force.

$$fd = Cd Av_p (VT/2) \quad (9)$$

Equation (10) represents the force that accelerates the fluid which is given by:

$$Fw = \rho AL (dv/dt) \quad (10)$$

The exit pressure which is much greater than that of the inlet at a point is given by the equation (11).

$$Pw = Fw / A \quad (11)$$

Equation (12) represents the power developed by the hydraulic ram.

$$P = \rho g Qh \quad (12)$$

Equation (13) represents the hydraulic pump efficiency.

$$\eta = Qh / (Q + Qw)H \quad (13)$$

Calculation of the fall and Elevation is given by the equation (14)

$$Q' = vol h / H * \eta \quad (14)$$

4. Working and Construction

Figure 4 shows the various components required in the construction of a perpetual motion hydroelectric power generator. Water which is stored in the primary tank (tank 1) is made to fall onto a pelton wheel turbine through a 1" high pressure PVC pipe by opening a 1" ball valve. The

Flowing water hits the cups of the turbine thereby converting its potential energy into mechanical energy. This causes the turbine to rotate, which is connected to the permanent magnetic motor by means of a primary shaft. Rotation of the turbine leads to the rotation of the shaft which causes the rotor of the motor to rotate. This action of the rotor along with the stator produces electricity by the

principle of electromagnetic induction. The falling water then gets collected into a secondary tank (tank 2) by a tank connector placed between the turbine housing and the secondary tank. The water is then made to flow through a gate valve and a T-joint where a swing check valve has been placed in the downward direction. The high velocity water causes the valve to slam shut, thus forcing the water to flow through a second swing check valve placed in the forward direction. The water then flows to another T-joint to which a 4" PVC pipe with an end cap is placed, which has been fitted with

closed cell foam up to half of its total length. The water begins to accumulate in the air chamber and the foam present within it helps in building up the pressure. This causes the air within the chamber to get compressed, and after a certain limit the now compressed air pushes back onto the water thereby forcing it to move back down and out of the air chamber. The pressurized water then causes the second swing check valve to close shut thus allowing the water only one direction that is through a 2" – 1" reducer. The water is then sent through a 1" gate valve and into the outlet pipe which delivers the water back to the primary tank (tank 1).

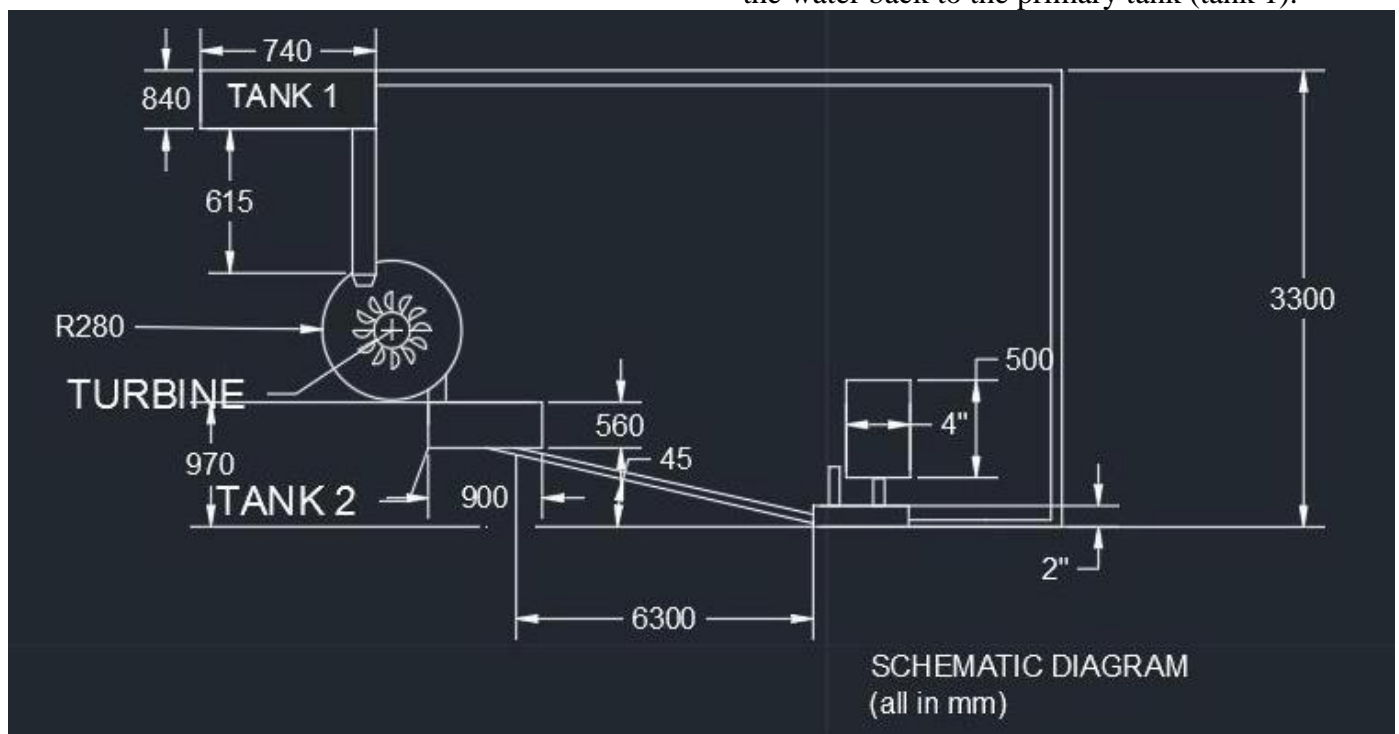


Fig.4. Schematic Diagram of Perpetual Motion Hydroelectric Power Generator

Figure 5 shows a fully constructed experimental prototype. The prototype consists of a mild steel frame of height 3 meters and width 1.8 meters, which houses a horizontal water tank (tank 1) of capacity 100 gallons, a turbine generator set and a horizontal tank of capacity 60 gallons. Tank 1 is placed at a height of 3 meters from the base of the frame. The turbine generator set is placed at a height of 2.14 meters from the base. The turbine disc is made up of nylon sheet and the cups of the turbine are made of stainless steel. The turbine housing is made of hard plastic. The permanent magnetic

motor consists of 42 coils and 46 turns of copper wire. The turbine housing is connected to the secondary tank (tank 2) by a 3" tank connector. Tank 2 is placed at a height of 0.97 meters from the base. From tank 2, a 2" drive pipe of length 6.3 meters is connected to the inlet of the hydraulic ram. Majority parts of the hydraulic ram are made up of galvanized iron except for the valves (swing check and gate) which are made up of brass. outlet pipe used is a 4 meter long high pressure transparent pipe which is connected into the primary tank (tank 1).



Fig.5. Fully Constructed Experimental Prototype

5. Validation

To perform calculations, various elements of both the systems have to be considered. Since the dimensions and standards adopted differ from those previously done, the output will differ greatly. The entire prototype has a total height of 3.3 meters and width of 2.2 meters. From experimentation it is determined that flow rate of water from tank 1 was determined to be 3.5 litres/min which is directed to the turbine. The water flowing into the inlet of the hydraulic ram was determined to be 4 litres/min while the output

was determined to be 1.5litres/min. The remaining water is given off by the waste valve, which is again re-circulated back to tank 2. Table 1 and Figure 6 represent the variation in the outlet flow rate of the hydraulic ram pump when the height to which the water needs to be pumped changes, while the input flow rate remains constant. It can be inferred that when the when the output height increases the flow decreases and vice versa. Table 1 and Figure 6 represent the variation in the outlet flow rate of the hydraulic ram pump when the eight to which the water needs to be pumped changes, while the input flow rate remains constant.

Table.1. Output flow rate with Change in height with respect to Inlet flow rate

Input Q(litres/min)	Output Q (litres/min)	Height (m)
4	2	2.5
4	1.6	3
4	1.5	3.3
4	1.42	3.5
4	1.25	4

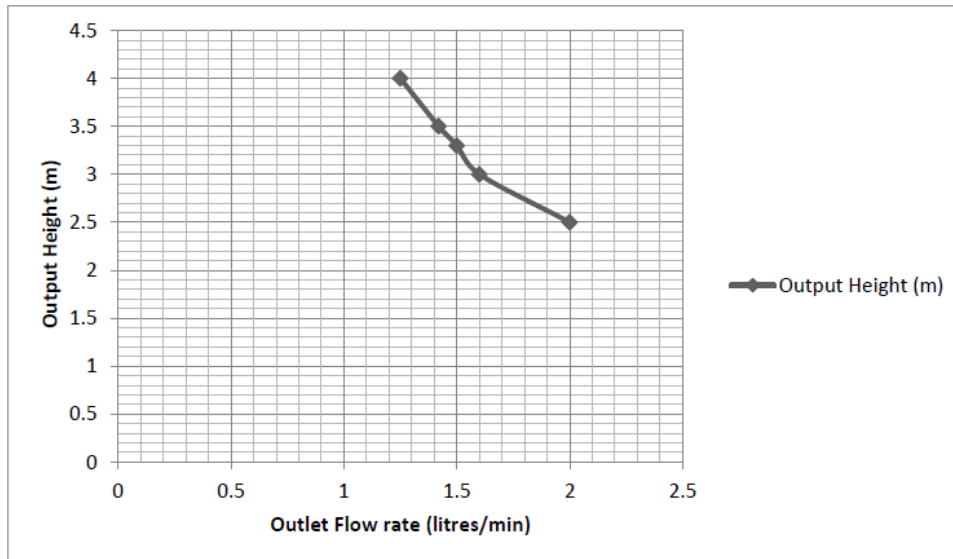


Fig.6. Variation of Outlet flow rate with Change in Height

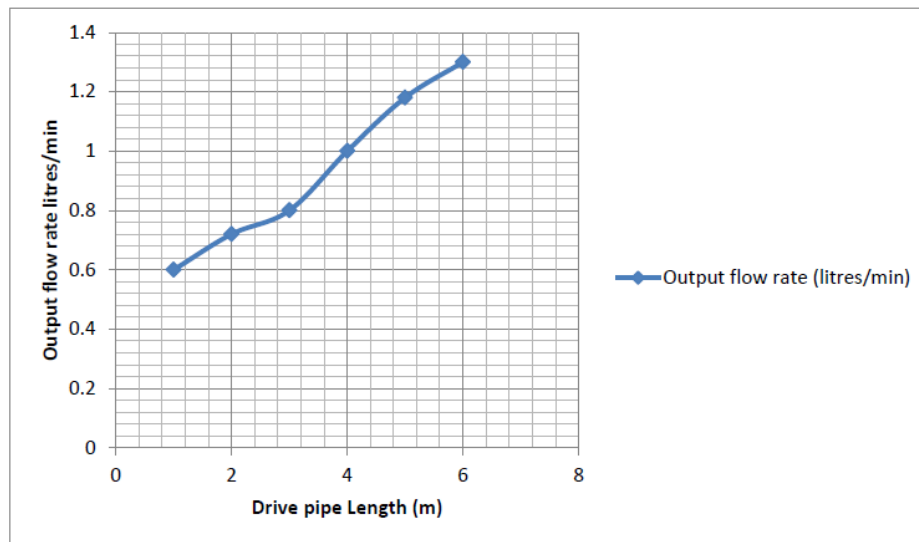


Fig.7. Output flow rate (litres/min) vs. Drive pipe length (m)

It can be inferred that when the when the output height increases the flow decreases and vice Table 2 and 3, figure 7 represent the output flow rate with respect to changing drive pipe length. It can be inferred that, when the drive pipe length increases the output flow rate also increases and vice versa given that the velocity of the water to the inlet of the hydraulic ram remains constant. By using equation (14), the output flow rate can be calculated by varying the fall and elevation and using a standard efficiency of 60% [3].versa.

Table.2.Output Flow Rate with respect to Drive Pipe Length

Drive Pipe Length (m)	Output Rate (lpm)
1	0.6
2	0.72
3	0.8
4	1
5	1.18
6	1,3

Table.3. Determination of Output Flow Rate

Sl. No	Fall Height (m)	Flow of water (litre/min)	Efficiency (%)	Elevation (m)	Output Flow rate (litre/min)
1	0.92	4	60	3.3	0.66

Conclusion

Hydropower is the most widely used type of renewable energy source used for the generation of electricity on small scale as well as large scale basis. The generation of electricity from hydroelectric power plants produces no greenhouse gases, toxic waste and particulate matter. Needless to say, that there is tremendous potential for growth of small hydro sector in our country. The need of the hour for small hydro sector is a disruption of the status quo, which should foster investments and help to develop sustainable business for entrepreneurs/investors/stake holders. Further, to build a more conducive and inclusive ecosystem for small hydro power to flourish, government backing is vital. Small hydro sector should, in fact, be natural allies for governments to partner with, as their primary goal is to deliver clean and sustainable energy with minimum to negligible effects on available natural and renewable resources. The future looks bright, progressive and with the continued support of the government, the small hydro sector is poised to grow. The production of sustainable energy without polluting the environment is one of the most significant results that have been achieved. The end result of power output is 150 watts which can be used to run the basic necessities in a household where power is not easily available. The significance of recirculation was such that without refilling the water, it can run for a long amount of time in turn providing electricity for a longer time to a household in rural areas.

Nomenclature

P = Power Generated (kW)

V1 = Velocity of water in nozzle pipe (m/s)

H1 = Gross Head (m)

e = Efficiency of plant (%)

g = Acceleration due to gravity (m/s²)

Q1 = Flow rate through nozzle pipe (m³/s)

A1 = Area of nozzle pipe (m²)

Q = Discharge (litres/min)

h = Supply head (m)

H = Delivery Head (m)

d = Pipe diameter (m)

L = Pipe Length (m)

Vd = Velocity of fluid (m/s)

Ad = Area of pipe (m²)

v = Kinematic Viscosity (m²/s)

Re = Reynolds number

f = Friction factor

fd = Drag force (N)

Cd = Coefficient of discharge

Av = Area of waste valve (m²)

VT = Velocity at the T section (m/s)

dv/dt = Change in velocity with respect to time (m/s²)

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