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A Review on Free Hydropower Energy Generation System by using Hydraulic Ram Pump

Eknath L. Manjarekar[1], Hrishikesh L. Mahadik[2], Shubham S. Sangelkar[3], Dipesh D. Kudav[4], Shreyash M. Adarkar[5]

[1]Assistant Professor, Department of Mechanical Engineering, Sspm's College of Engineering, Kankavli, Maharashtra
[2-5]UG Students, Department of Mechanical Engineering, Sspm's College of Engineering, Kankavli, Maharashtra

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Abstract - *Abstract—The paper gives total information of hydropower plant, which is operated by using a hydraulic ram pump and also it is a better solution for remote areas where their transmission is not yet reached. The ram pump is used to increase the head of falling water by lifting the water from low head to high head. The ram pump makes the process of power generation continuous and works a long time with less maintenance. As this system doesn't require an external source of energy it makes some free energy available for existing hydropower plants. The hydraulic ram pump works with falling water and a water hammer effect. This hydropower plant system can be used in remote areas which require less power requirement and components can be easily manufactured as like ram pump. Though the installation cost is high, the running cost is low. The paper also shows the design and performance of the hydraulic ram pump.*

Key Words: Hydropower, Ram Pump, Hydroelectric Power Plant

1. INTRODUCTION

We are living in a world where sustainable energy sources and renewable energy sources are required for economic development, for human welfare, and the environmental balance of our society. [1,2] Hydropower is the best renewable source of energy among all other renewable sources of energy and it is an economical, nonpolluting, and eco-friendly electro power generating system. By taking the advantage of falling water due to gravity electricity is being produced. Hydropower generates the energy of around 24% of the world's total energy. Hydro-electric power is more consistent than the solar power generation system as it produces electric power in day & night time also unlike solar power which can produce only in the day time. [3] The electric power developed by small water-falls, tributaries, and rivers in micro-hydro power generation systems are capable of producing an output power up to 5-6 KW, enough to supply a rural community village which has small electricity consumption. This system does not consume any fossil fuels hence, the hydropower generation system does not contribute to the depletion of fossil fuels also in pollution[2]. The hydropower plant works on the principle in which the potential energy of water in the reservoir is converted into kinetic energy which is further converted into electrical energy with the help turbine, generator, etc. some of the major component HPP are Dam or reservoir, penstock, turbine, generator , prime mover. [1] as shown in figure1

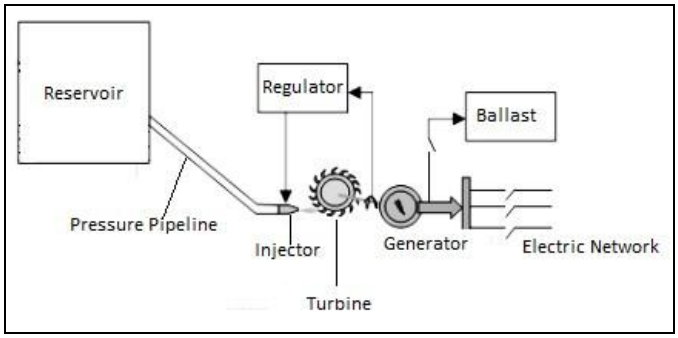

Fig-1: representation of a hydroelectric power plant[10]

Some micro-hydroelectric power generation plants are reversible, in that water is used again for power generation, pumped from the lower reservoir to the upper reservoir by using electricity when demand is low[1]. Whenever a demand is high reversible pumped hydro storage consumes external energy so the efficiency of hydropower plants decreases as the input energy is increasing[9]. To overcome this problem, we have to go for alternative energy resources in which energy is generated naturally like solar energy, wind energy, etc. The hydraulic ram pump is working on the kinetic energy of falling water and can be used as a small hydropower plant to pump the water at the desired elevation[10]. Ram pump has only two moving parts waste valve and delivery valve, pressure chamber, delivery, and supply pipe as shown in Figure 2 This pump uses the water hammer effect so that enough pressure created to lift some amount of input water to a desirable height which is higher the source of water. This pump has an attraction that it doesn't consume any external energy and work continuously if there is a continuous flow of water. [5]

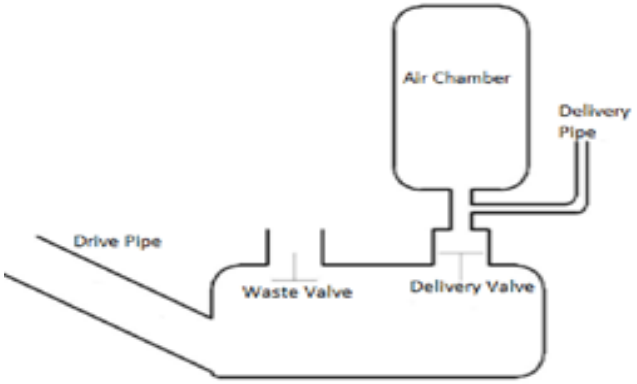

Fig-2: representation of a ram pump[11]

2. COMPONENTS USED IN FREE HYDROPOWER GENERATION SYSTEM AND WORKING

2.1 Components Used In Hydropower Generation System

a) Dam: The rainwater is stored in the dam also it supplies the water to the turbine for the generation of power.

b) Penstock: It guides the water from the storage reservoir to the turbine.

c) Turbine: It uses the kinetic energy of water to cause rotary motion and it gives the rotary motion to the prime mover.

d) Generator: A generator is used to produce electricity. Normally high speed 4 pole synchronous generator is used for micro hydropower plants.

e) Storage tank: the water after power generation collected in the storage tank.

2.2 Construction and Working

2.2.1 Material for Construction of Ram Pump

The material that we can use is Unplasticized PVC because of its properties like noncorrosive, longlasting (50 years). Pipes are strong and light having specific gravity one-fifth of cast iron. Only care should be taken for the joints in transit condition as the soundness of material depends on its joint areas. [5] Table 1 shows the various parts which are involved in the construction of a hydraulic ram pump.

2.2.2 Working

a) Basic Principle of Hydroelectric Power Plant

Rainwater is stored in a dam or water reservoir. There is potential energy due to the height of the dam. When this water is allowed to fall on the turbine where the potential energy is directly converted into kinetic energy which further converted into mechanical energy with the help turbine now this mechanical energy is converted into the electrical energy by using a prime mover which is coupled to the generator, this is how the hydroelectric power plant works. [4] PE↔KE↔ME↔EE (Potential Energy↔ Kinetic Energy ↔Mechanical Energy ↔Electrical Energy).

Initially, Hydropower is generated by using the rainwater stored in the reservoir. The water in the reservoir is having the potential energy, when waterfall on the turbine due to the hydraulic action the kinetic energy cause the turbine to rotate, and this rotary motion is used to generate the electricity by using the generator. Hydroelectric power can be produced with the help of a generator by connecting the turbine shaft to the generator. The generator produces electricity using electromagnetic induction[4]. The water after generation of power is stored in a storage tank given to the hydraulic ram pump which lifts some amount of water at the hydraulic head of the dam or reservoir. [9]

Table -1: Part Used in Ram pump

Sr no.	Part name	Description	Quantity
1	Pressure chamber	UPVC pipe	1 piece 2.5inch
2	Reducer	UPVC pipe	2inch *1/2 inch
3	Tee joint	UPVC pipe	1 inch
4	Air vessel cap	UPVC pipe	2 inch
5	Non-return valve	Brass	2 pieces as 1 inch
6	PVC pipe cutter piece joint	UPVC pipe	As per the requirement of supply and delivery Usually 4 to 5 pieces
7	Nozzle for pipe connection	UPVC pipe	2 each size as per supply pipe Diameter
8	Supply tank	Plastic	30 liters
9	Delivery tank	Plastic	30litres

b) Working of Ram Pump

1) Water hammer effect

The water hammer effect is a process that increases the pressure of water in a pipe over a short period. If the velocity of the water in a pipe is high enough, a fast closure of the pipe will cause a water hammer effect as shown in Figure 3. The water flowing will be compressed to the valve which has been closed suddenly. Water has kinetic energy. By closing quickly the pipe, this kinetic energy will be transformed into pressure. [8,6]

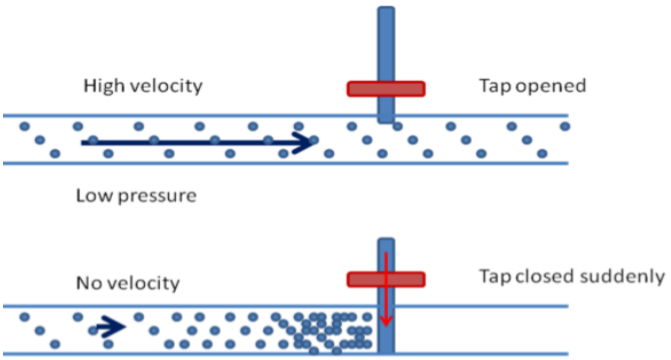

Fig. -3 Water hammer effect[8]

When the water stored in the reservoir at the delivery head allowed to flow through the drive pipe and then inlet of the hydraulic ram pump. When the velocity reaches the high value the waste valve or check valve closes. The inertia of water causes the flow in a forward direction towards the check valve and it opens the check valve. The force applied by the water cause compression of air in the pressure chamber and due to this air, the water is elevated by the delivery pipe for the desired use. The backflow of water is restricted by the check valve. At same time, pressure in drive pipe suddenly reduces to low due to this waste valve opens and water flow from source to ram pump beggining a new cycle. Average of 100-120 cycles per minute can be occur. Depending upon conditions such as head, flow, and the size of the ram. [4] The system is shown in figure.4

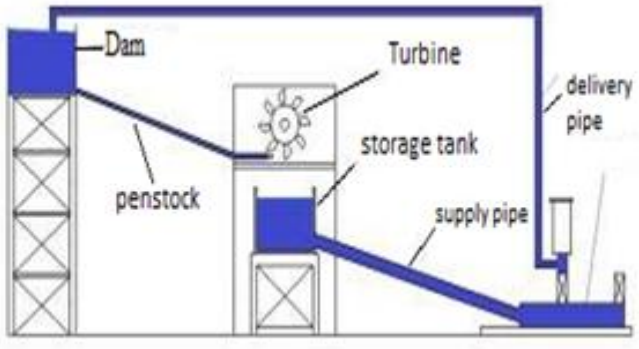

Fig -4: Name of the figure[9]

3. METHODOLOGY

3.1DESIGN FACTORS

The main factors are considered while designing the hydraulic ram pump:

- The difference in height between the water source and pump site (called vertical fall).
- The difference in the height between the pump site and the paint of storage or use (life).
- The quantity (Q) of flow available from the source. The length of the pipe from the source to the pump site (called the drains pipe).
- The quantity of water required.
- The length of pipe from the storage site (called the delivery pipe.[7]

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:

$$Q = \pi r^2 \frac{L}{60} \quad (1)$$

where, Q = volumetric flow rate through the pipe, r = pipe radius, L = pipe length and n = speed of revolution.

Also, the velocity of fluid flow in the driven pipe is given by

$$Vd = \frac{Q}{Ad} \quad (2)$$

where Vd = velocity of fluid flow and Ad = area of the pipe. To ascertain the nature of the flow (that is whether laminar or turbulent), it was necessary to determine the Reynolds number given by

$$Re = \frac{Vd}{\upsilon} \quad (3)$$

where, V = velocity of fluid flow, d = pipe diameter and υ = kinematic viscosity.

The friction factor f can be derived mathematically for laminar flow, but no simple mathematical relation for the variation off with Reynolds number is available of turbulent flow.

Furthermore, Nikuradse et al. found that the relative roughness of the pipe (the ratio of the size of the surface imperfection to the inside diameter of the pipe) affects the value off too.

For smooth pipes, Blasius suggested that for turbulent flow

$$f = \frac{0.316}{Re^{0.25}} \quad (4)$$

where, f = frictional factor of the pipe and Re is Reynolds number υ.

The Darcy–Weisbach formula is the basis of evaluating the loss in the head for fluid flow in pipes and conduits and is given by

$$f = \frac{L}{d}\left(\frac{V^2}{2g}\right) \quad (5)$$

where, g = acceleration due to gravity, L = length of the pipe, V= fluid velocity, and d = pipe diameter.

The velocity of fluid flow in the T–junction is given by

$$V_T = \frac{Q}{A_T} \quad (6)$$

where Q = is the volumetric fluid discharge and AT = pipe x-sectional area at T-junction.

Loss due to sudden enlargement at the T-junction is expressed as

$$H_{LT} = \frac{(V_d - V_T)^2}{2g} \quad (7)$$

Other losses of the head, as in pipe fittings are generally expressed as

$$H_L = K_T(\frac{V^2}{2g}) \quad (8)$$

Since the head (H) contributed to water acceleration in the driven pipe, this acceleration is given by

$$H - F_X \frac{L}{D}\left(\frac{V^2}{2g}\right) - \sum\left(K_X \frac{V^2}{2g}\right) = \left(\frac{L}{D}\right) x \frac{dv}{dt} \quad (9)$$

The value of K and f can be found from standard reference handbooks/textbooks. Eventually this flow will accelerates enough to begin to close the waste valve this occurs when the drag and pressure in the water equal the weight of the waste value. The drag force given by equation

$$fd = CdxAvx\rho x\frac{V_T}{2g} \quad (10)$$

The force that accelerates the fluid is given by

$$F = ma = \rho ALx\frac{dv}{dt} \quad (11)$$

The pressure at point is obtained by divided the force F in Equation (11) by the area A

$$P_3 = \frac{F}{A} \quad (12)$$

The power required can k calculated using this expression

$$P = \rho g Q_H \quad (13)$$

The efficiency of the hydram is given by

$$E = \frac{Qxh}{(Q + Q_w)xH} \quad (14)$$

4. ADVANTAGES

1. No fuel transportation cost.
2. No necessity of fuel & ash handling equipment.
3. No air pollution.
4. No external device is used for continuous process
5. It is a very neat & clean plant.
6. Operating & maintenance costs are very low.

5. DISADVANTAGES

1. Limitation to the selection of the size of HPP because of their requirements.
2. The initial cost is high but comparatively less with the existing system
3. Some standard losses occur during the flow of water like friction losses and head losses.
4. A proper cleaning arrangement of water is needed.

6. CONCLUSIONS

Saving of water and using renewable sources is necessary for rural areas, therefore hydroelectric plant with a hydraulic pump is the best design in such areas. Though installation cost is more, it is a one-time investment with less maintenance. The design is simple and easy. It could be tested in the region where the horizontal water streamflow has greater pressure and velocity. The current designed system produces hydroelectric energy from recirculated water by the ram pump. The recirculated water is used for power generation and the system acts as free energy or it behaves like perpetual motion.

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REFERENCES

[1]. Singh, K.V. ,Chauhan S. N. and Kushwaha D., 2015, Indian Institute of Technology Roorkee, ISST Journal of Mechanical Engineering, Vol. 6 No. 1, (January - June 2015), p.p. 59-62ISSN 0976-7371 © Intellectuals Society for SocioTechno Welfare.

[2]. Fortaleza N. B., Juan O. R.S, and Tolentino L.K.S. 2018, IoT-based Pico-Hydro Power Generation System using Pelton Turbine,Article in Journal of Telecommunication January 2018.

[3]. www.worldpumps.com, WORLD PUMPS July/August 2018Hydro-electric plant control K. Elissa, "Title of paper if known," unpublished.

[4]. [4] Jaupi O.,2017, Computer science: Application of technology/IoT in hydropower dams, 2017 UBT International Conference OCT 27-2017.

[5]. [5] Aniruddha Deo1, Atharva Pathak2, Santosh Khune3, Mamta Pawar4, Design Methodology for Hydraulic Ram Pump.

[6]. [6] C. A. Nwosu & T. C. Madueme,2013, Recycled Micro Hydropower Generation Using Hydraulic Ram Pump (Hydram).

[7]. [7] Shuaibu Ndache Mohammed,2007, Design and Construction of a Hydraulic Ram Pump

[8]. [8] Dominique Browne, DTU of Warwick University and their book "Hydraulic Hydraulic Ram Pumps – A guide to Hydraulic Ram Pump water supply systems".page 3-4

[9]. [9]Gaikwad.V.S1, Gholap.M.V2, Kadus.R.K3, Gaikwad.M.S4, Padekar.A.U.5 , Mali.P.K.6,2017, Recycled Hydro-power plant using hydraulic Ram Pump

[10]. [10] Sampath S S*, Chithirai Pon Selvan M**, Sawan Shetty* & Shahida Siddiqui.2015, determination of power inhydroelectric plant driven by hydram: a perpetual motion machine type 1.