Recycled Hydro-power plant using hydraulic Ram Pump

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Abstract

This project report is about designing a Recycled hydro electric power plant by using hydraulic ram pump to transfer tailrace water from turbine to water source which is situated at higher height, which used as supply water for electricity generation. This pump uses kinetic energy of flowing water for it's working means it doesn't require external energy sources.The hydraulic ram pump is believed to be the suitable and efficient application for the given conditions based on the calculations performed.

For the first step of designing, all the related problems are listed and understand. Then, the specifications, criteria and evaluation of the solutions are developed. This including choosing the most suitable operational working principals for the hydraulic ram pump (hydram), turbine generator, outline of the theoretical background behind the operation and its details calculations, which are being referred to the concept and theory entitles to Fluid Mechanics.

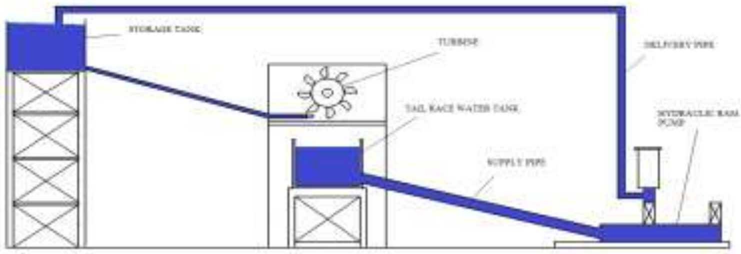
Key Words: *Hydraulic Ram pump, Recycled hydro-electric power plant, Pressure hammering effect etc.*

1.INTRODUCTION

Hydropower is not only renewable and sustainable energy source, but it's flexibility and storage capacity also makes it possible to improve grid stability and to support the deployment of other intermittent renewable energy sources such as wind and solar power. As a result, renewed interest in pumped hydro energy storage plants and a huge demand for rehabilitation of old small hydro power plants are emerging globally. By using hydram water can be lift at inlet source of turbine, so requirement of water for turbine generator for generating electricity is shared by recycled water. Due to this sharing, fresh water required for turbine is reduced. A hydraulic ram (also called Hydram) is a pump that uses energy from a falling quantity of water to pump some of it to an elevation much higher than the original level at the source. No other energy is required and as long as there is a continuous flow of falling water, the pump will work continuously and automatically. Provision of adequate domestic water supply for scattered rural populations is a major problem in many developing countries. Fuel and maintenance costs to operate conventional pumping systems are becoming prohibitive. The hydraulic ram pump (Hydram) is an alternative pumping device that is relatively simple technology that uses renewable energy, and is durable. The Hydram has only two moving parts and can be easily maintained.

1.1 RECYCLED HYDRO-POWER PLANT SYSTEM

Initially the water is stored in dam which is located on river. Here we consider dam as storage tank for running prototype of recycled hydro-power plant. Water from storage tank is transfer to turbine trough penstock. After water passing through turbine it release into river. But in our project, we collect this water into tail race water tank to recycle in to dam again. After collecting water, it passes to hydraulic ram pump by using supply pipe. Ram pump uses kinetic energy of flowing water to lifting it .Air chamber is important part in hydraulic ram pump. Air is compress due to water entering in it, which apply force on water to lifting it into dam.



1.2 Components used in recycled hydro-electric power plant are:

- Storage Dam: Concrete wall constructed across rivers for storing water from rainfall and provides that water to turbine for electricity generation
- Penstock: Guides water from dam to turbine.
- Turbine-Generator (mostly reverse type): Turbine runs due flow of water across it and in turn runs generator set for generating electricity.
- Tailrace storage: Stores water exited from turbine. Water from tailrace storage is lift up by convenient method to storage dam.
- Hydram: To lift water at elevated height

2. DESIGN

2.1Determination of Flow Rates of Water

The level of water in a tank and the size of a penstock pipe are paramount to the determination of the usable flow rate of the water through the penstock. The generic equation for determining the flow rate may be described as the product of the cross-sectional area A, of the orifice of the penstock multiplied by the average flow velocity v. Flow rate of water through the penstock depends on the differential height h, and the diameter of the orifice of the penstock D.

2.2 Net Head Measurement

The net head H is the difference between the gross head and the losses due to friction and turbulence in the penstock piping.

2.3 Turbine Selection

The choice of turbine depends mainly on the head and the design flow for the proposed micro hydropower installation.

2.4 Generator

As the heart of the micro electrical power system, generators convert the mechanical (rotational) energy produced by the turbine to electrical energy. A 4-pole synchronous generator of 1800-rpm is the most commonly used generators for micro hydro turbines.

The amount of hydraulic power available from a hydropower system is directly related to the flow rate, head and

$Ph = Q*H*g*\rho$

The electrical power is obtained as:

$Pe = Ph*\eta = Q*H*g*\rho*\eta$

where, Ph and Pe are the theoretical hydraulic and electrical power outputs respectively in W, Q is usable flow rate in m3/s, H is net head in m, g is gravitational constant (9.81m/s2), η is efficiency factor (turbine and generator, 0.5 – 0.7), and ρ is density of water (1.0 kg/m3).

Hydram (Hydraulic Ram Pump)

The automatic hydraulic ram is used for pumping water

Length of supply pipe

$$L_s = 2.5H$$

Delivery head of hydram

$$h=3H$$

Length of drive pipe

$$L=H$$

Length of supply pipe

$$\frac{L_S}{D_S}=150$$

Area of supply pipe

$$A=\frac{\pi}{4} * D_s^{\,2}$$

Velocity of water in supply pipe

$$V_s = C_v * \sqrt{2gH}$$

Quantity of water supply

$$Q=AV_s$$

Renold's number

$$R_e=\frac{\rho*V_S*D_S}{\mu}$$

Friction factor

$$f=\frac{0.07991}{R_e^{\,2}}$$

Head loss due friction

$$hf_s = \frac{f*L_S*V_S^{\,2}}{2gD_S}$$

Time for waste valve remains open

$$t_1 = \frac{L_S * V_S}{Hg}$$

Time for waste valve remain close

$$t_2 = \frac{L_S * V_S}{(h - H)g}$$

Total for complete one bit of valve

$$t = t_1 + t_2$$

Quantity of delivery water

$$q = \frac{\pi * {D_S}^2}{4} * \frac{V_S}{2} * \frac{t_2}{t}$$

Quantity of waste water through waste valve

$$Q_{wv} = \frac{\pi {D_S}^2}{4} * \frac{V_S}{2} * \frac{t_1}{t}$$

Theoretical pressure rise in hydram

$$P = V_s * \frac{C}{g}$$

D’Alembert efficiency

$$\eta_{D'Alembert} = \frac{q * h}{Q * H}$$

Rankine efficiency

$$\eta_{Rankine} = \frac{q(h - H_S)}{(Q_S - q)H_S}$$

Where,

L_s =Length of supply pipe

H=Head of supply

h=Delivery head of hydram

D_s=Diameter of supply pipe

A=Area of supply pipe

V_s= Velocity of water in supply pipe

C_v=coefficient of velocity

Q=Quantity of water supply

V_S=Velocity of water in supply pipe

R_e=Renold's number

ρ=Density of water

μ=Viscosity of water

f=Friction factor

hf_s=Head loss due friction

g=Acceleration due to gravity

t_1=Time for waste valve remains open

t_2=Time for waste valve remain close

$(h - H)$=Difference between supply and delivery head

t=Total for complete one bit of valve

q=Quantity of delivery water

Q_{wv}=Quantity of waste water through waste valve

$\eta_{D'Alembert}$=D'Alembert efficiency

$\eta\_Rankine$ =Rankine efficiency

3.conclusion

From present study it is conclude that performance of Hydraulic Ram Pump depends upon length of inlet and delivery pipes, diameters of pipes, inlet and delivery heads, flow rate available at source. The parameters are changes with change in site selected; also affect the size of pump required.

The study is centred towards the development of a hydraulic ram pump that would conveniently alleviate the problem of water supply from tailrace to the storage of hydro-power plant. Ideally, from obtained conditions of the supply and delivery heads and flows, stroke length and weight of the impulse valve, length to diameter ratio of the drive pipe, volume of the air chamber and size of the snifter valve, etc. we tried to come up with an design of a Hydram pump presented in this study.

REFERENCES

1) Nwosu, C. A. and Madueme, T. C., Recycled micro hydropower generation using hydraulic ram pump, International Journal of Research in Engineering & Technology (IMPACT: IJRET), 2013, Vol. 1, Issue 3, pp. 1-10.

2) Sampath, S. S.,Shetty,S., Pendanathu, A.M., and Chithirai P.S.,Estimation of Power and Efficiency of Hydraulic Ram Pump with Re-circulation System,International Journal of Computer-aided Mechanical Design and Implementation,2015, Vol.1, No. 1, pp.7-18.

3)Shuaibu,N.M.,Design and Construction of a Hydraulic Ram Pump,Leonardo Electronic Journal of Practices and Technologies ISSN 1583-1078, 2007, Issue 11, pp. 59-70.

4)Shende,P.B.,Choudhary,S.K. and Ninawe,A.P.,Analysis and Enhancement of Hydraulic Ram Pump using Computational Fluid Dynamics, International Journal for Innovative Research in Science & Technology (IJIRST), 2015, Vol. 2 , Issue 3,pp.12-19.

5)Pathak, A.,Deo,A.,Khune,S.,Mehroliya,S.andPawar,M.,Design of Hydraulic Ram Pump,International Journal for Innovative Research in Science & Technology (IJIRST),2016, Vol. 2, Issue 10.

6) YoungB. W., Generic design of ram pumps, Department of Civil Engineering, Papua New Guinea University of Technology, Lae, Papua New Guinea. Journal of Power and Energy, 1998, vol. 212, pp. 117-124.

7)http://www.landtohouse.com/rampump/

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