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Integration of conventional irrigation system in to hydropower system

Pawan*, Tarun Gupta** and Vinod Sehrawat**

**Research Scholar, Department of Mechanical Engineering,*
NGF College of Engineering and Technology Palwal, (HR), India
***Associate Professor, Department of Mechanical Engineering,*
NGF College of Engineering and Technology Palwal, (HR), India

(Corresponding author: Pawan)
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ABSTRACT: This paper is an approach to extend an idea to develop a mini and independent hydropower system of tube well on experimental setup. In India especially in north region like Haryana, Himachal, and Punjab are irrigated with Tube Well system. The mechanism is that the tube well produces high stream water jet having large amount of kinetic energy which can readily harnessed in to electric form of energy like electricity with the help of turbine. If this isreadily optimize one cangauge its sustainability by calculating effect on renewable mode, energy consumption, flow rate, water velocity, water pressure, torque, rpm generation , cost, application.Turbine with advance generator and transformer can harness waste kinetic energy in to electric form of energy which is used for further operation like lighting of bulbs etc.

Keywords: Micro hydraulic turbine, runner, turbine vanes and water speed.

I. INTRODUCTION

Harnessing of water power from land fill water, canals and rivers by various ways such as utilization of tidal power with construction of barrage across an acquirement and discharging water in a controlled manner with the help of turbine. Small dams accommodate water which may be used to provide big quantity of electricity. Tidal power is harnessed in different routes. Utilization of this technology are throughout the world, through various range of societies and cultures, Hydraulic power can be harnessed by various countries on a big as well as small scale. Harnessing of micro hydro power energy from flowing water due to gradient of height, for example harnessing energy of enough water from a local river which will be used in small factory or village. In last some decades developing countries are using micro hydro power because micro hydro systems have an important role to play in economic growth of remote rural areas. It is especially used in mountains. Micro hydro system can allow power for house hold use, factory and agricultural uses by power of mechanical or through the coupling of the turbine to a generator to produce electricity.

II. THE HYDRO POWER PRINCIPLES

Generating of power from water bets upon a compounding of head and flow. These two are necessary for generation of electricity. Diversion of water is done by pipe line, where it is directed downhill after than it goes on turbine. By coupling of turbine shaft and generator shaft produces electrical power, huge flow and huge head produces more electricity. Power produced by mechanical system as electricity will be less than water power because of friction between various parts of system. Pressure or head of water is generated by the gradient of height between the water intake and the turbine. Gradient can be expressed as vertical height (meter or feet) , or as pressure is measured by pound per square inch(psi). Total head creates pressure which will be available at the turbine during water flowing. It will be always be less than the water and the pipe. Diameter of the pipe line also has an effect on total head .A flow of water is based on water available, it can be represent volume per unit of time or gallons per minute (gpm), cubic per meter (m^3/s) or in terms of liter per minute. By designing of flow through nozzle is the maximum flow for which the hydro system is designed. It is generally less than of pipe, than the large flow of the stream (during the raining season) flow will be more than the minimum flow output and via media between potential electric output system costs. The theoretical power(P)gain from a given water head which is in exact proportion to the gradient and the amount of water available.

($Po = Q \times H \times 9.81$ (kW)

Where,

Po = Power at the generator terminal, in kilowatts (kW)

H = The gross head from the pipeline intake to the tail water in meters (m)

Q = Flow rate in pipeline, in cubic meters per second (m^3/s)

9.81 is a constant and is the product of the density of water and the acceleration due to gravity (g).

III. EXPERIMENTAL FIGURE

Fig. 1. Tube well in running condition.

A. Calculation of Tube Well

Size of tank = 200x155 cm^2

Rise of water during 10sec in the tank h = 8cm

Diameter of out coming water pipe = 4inch = 4 × 2.52=10.16cm

Water flow rate from tube well Q $=\frac{A\times h}{t}=\frac{200\times155\times8}{10}$ =24800cm^3/sec, where A is water filling tank area

Flow rate Q also = a×v where a is the cross section area of the pipe and v is the velocity of water

v = $\frac{Q}{a}=\frac{24800\times7\times4}{22\times10.16\times10.16}=305.777$ cm/sec = 3.05777m/sec

Classification of the Hydraulic Turbine on the basis of power generation-

Pico hydraulic turbine- 100W to 5kW

Micro hydraulic turbine 5kW to 100kW

Mini hydraulic turbine 100kW to 1MW

Small hydro turbine 1MW to 15 MW for grid use

Medium hydraulic turbine 15 MW to 100MW for grid use

Large hydraulic turbine above 100MW for large electricity grid use

B. Formalization of Mathematic Model

A hydro scheme requires water flow and a drop in height (head) to produce useful power. It is a power conversionsystem, absorbing power in the form of head and flow, and delivering power in the form of electricity.To measure the potential power and energy on a site the first step is to determine the flow rate and the head through which, the water falls. These two parameters are defined thus:

Flow rate (Q)is the quantity of water flowing past a point at a given time. Q is measured in cubic meter per second (m^3/s)

Head (H) is the vertical height from the level where the water enters the penstock at fore bay tank to thelevel of turbine centerline. The typical unit of measurement is meter (m).The power available from a micro-hydropower system is directly related to the flow rate, the head and the force ofgravity as expressed by the power equation as below:

$$P_{gross}=\rho_{water}\times Q\times g\times h_{gross}$$

Where

P_{gross} is the theoretical power produced (kW)

ρ_{water} is the density of water (kg/m^3)

Q is the flow rate in the penstock pipe (m^3/s)

g is the acceleration due to gravity (9.81m/s^2)

$h_{gross}$is the total vertical drop from intake to turbine (m)

No power conversion system delivers 100% useful power as some power is lost by the system itself in the form offriction, heating, noise etc. The efficiency of the system needs to be taken into account, since all the equipment usedto convert the power from one form to another do so at less than 100% efficiency. Figure 4 shows the power losses andefficiencies within a micro-hydro power system.

Where

Input power =wQHkw

w =9.81kN/m^3 (specific weight of water)

Q = Discharge in m^3/sec

H = Supply head (gauge pressure in Kg/cm^2 × 10) in meters

$$Q=\frac{C\times a_1\times a_2}{\sqrt{(a_1^2-a_2^2)}}\times\sqrt{(2gH_1)}$$

Where H_1 = Difference in pressure gauge of venturimeter × 10 in meter+ Vacuum head of draught tube if any mm of Hg × 13.6/1000 = meters

D_1 = Diameter of venturimeter = 100 mm

D_2 = throat Diameter of venturimeter = 65 mm

C = 0.962

a_1& a_2 =cross section area of venturimeter at inlet and throat.

Output power = $\frac{2\pi N(ReW)\times9.81}{60000}$ kW

Efficiency = $\frac{output}{Input}\times100$

Where N = Turbine speed in rpm

T = Torque in Kg-m

($R_{e\ effective}$ radius of the brake drum in meters.)

C. *Calculation of Experimental Setup*

Table 1: Shows Laboratory Testing on Model Influence on Turbine parameters.

For Table see annexure 1

Calculation for water flowrate and input power from the above table—

For sr.no.1 Water flow rate from venturi meter $Q=\frac{C\times a_1\times a_2}{\sqrt{(a_1^2-a_2^2)}}\times\sqrt{(2gH_1)}$

$=\frac{0.962\times78.5\times28.6}{\sqrt{(78.5^2-28.6^2)}}\times\sqrt{(2\times981\times0.4\times10\times100)}$

= 25818cm^3/sec

Water flow rate form liver valve at full opening =25818cm^3/sec

$V_1=\frac{Q}{a_1}=\frac{25818}{81}=318.74$cm/sec

Input power = WQHe kW

= $9.81\times25818\times10^{-6}\times2.5\times10=6.332$kW = 8.49hp

Output power= $\frac{2\pi N(ReW)\times9.81}{60000}kW$

$=\frac{2\pi1896(0.158\times14.5)\times9.81}{60000}$=4.152kW =5.5679hp

For sr.no.2 $Q = \frac{C \times a_1 \times a_2}{\sqrt{(a_1^2 - a_2^2)}} \times \sqrt{(2gH_1)} = \frac{0.962 \times 78.5 \times 28.6}{\sqrt{(78.5^2 - 28.6^2)}} \times \sqrt{(2 \times 981 \times 0.4 \times 10 \times 100)}$

= 25818cm^3/sec

Water flow rate form liver valve at 75^0 opening $= \frac{25818}{90} \times 75 =$ 21515cm/sec

$V_2 = \frac{Q}{a_1} = \frac{25818 \times 90}{81 \times 75}$ =382.49 cm/sec,where $a_1 = \frac{3.14}{4} 10.16^2 = 81cm^2$

Input power = wQH kW

= 9.81x 21515x10^{-6} x2.4x10 = 5.06549kW = 6.793hp

Output power $= \frac{2\pi \times 1877(0.158 \times 12.5) \times 9.81}{60000}$ =3.8065kW =5.10439hp

For sr.no.3 $Q = \frac{C \times a_1 \times a_2}{\sqrt{(a_1^2 - a_2^2)}} \times \sqrt{(2gH_1)}$

$= \frac{0.962 \times 78.5 \times 28.6}{\sqrt{(78.5^2 - 28.6^2)}} \times \sqrt{(2 \times 981 \times 0.4 \times 10 \times 100)}$

= 25818cm^3/sec

Water flow rate form liver valve at 60^0 opening $= \frac{25818}{90} \times 60 =$ 17212cm/sec

$V_3 = \frac{25818}{81x60} \times 90$ = 478.11cm/sec

Input power = wQH kW

= 9.81×31189.53×10^{-6} ×2.2×10 = 6.7048kW = 9.122hp

Output power $= \frac{2\pi \times 1728(0.158 \times 12.6) \times 9.81}{60000}$ =3.532kW = 4.7364hp

For sr.no.4 $Q = \frac{C \times a_1 \times a_2}{\sqrt{(a_1^2 - a_2^2)}} x \sqrt{(2gH_1)}$

$= \frac{0.962 \times 78.5 \times 28.6}{\sqrt{(78.5^2 - 28.6^2)}} \times \sqrt{(2 \times 981 \times 0.4 \times 10 \times 100)} =$ 25818cm^3/sec

Water flow rate form liver valve at 45^0 opening $= \frac{25818}{90} \times 45 =$ 12909cm/sec

$V_4 = \frac{25818}{81x45} \times 90$ = 637.48cm/sec

Input power = wQH kW

= 9.81×31189.53×10^{-6} ×2×10 = 5.522545kW = 7.5134hp

Output power $= \frac{2\pi \times 1536(0.158 \times 13) \times 9.81}{60000}$ =3.239kW =4.344hp

For sr.no.5 $Q = \frac{C x a_1 x a_2}{\sqrt{(a_1^2 - a_2^2)}} \times \sqrt{(2gH_1)} = \frac{0.962 \times 78.5 \times 28.6}{\sqrt{(78.5^2 - 28.6^2)}} \times \sqrt{(2 \times 981 \times 0.3 \times 10 \times 100)}$

= 22359.044cm^3/sec

Water flow rate form liver valve at 30^0 opening $= \frac{22359.044}{90} \times 30 =$ 7453.015cm/sec

$V_5 = \frac{22359.044}{81 \times 30} \times 90$ =828.11cm/sec

Input power = wQH kW

= 9.81×27010.925×10^{-6} ×1.6×10 = 5.522545kW = 7.5134hp

Output power $= \frac{2\pi \times 1054(0.158 \times 13.3) \times 9.81}{60000} =$ 2.274kW=3.049hp

IV. GAP IDENTIFICATION

It’s observed that there is no relevant study on forced water hydro power micro turbines which copulate with tube wells. There is no commercialization of forced water hydro power micro turbines in market.Study to develop an integrated forced water stream turbine is conversion of thought in to realistic irrespective of the optimization of micro hydro turbine system. So develop a micro hydro turbine which uses for harnesses water energy resources, which may benon-conventional energy resources.

Prove micro hydraulic turbine feasibility

Design of turbine base on the concept of water having flanged diffuser. Water turbine which work as high performance turbine which consider turbulence factor shows in Fig. 1.

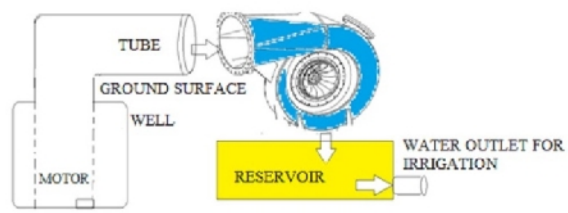
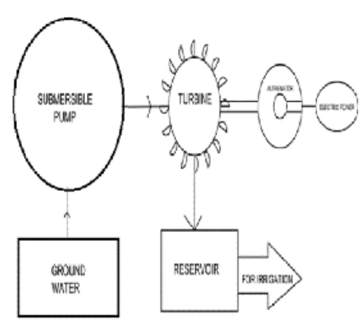


Fig. 2. Shows flow field boundaries.

A ring type plate called “brim”, to exit periphery of a short diffuser. The plate forms vortices behind it and generates a low pressure region. The water velocity is accelerated further near the entrance of the diffuser Fig.1 shows illustrate the mechanisms’ shrouded water turbine equipped with a brimmed diffuser came in to existence in this way.



Flow Diagram of Experimental setup

Fig. 3. Schematic diagram of energy conservation of tube well water.

V. EXPERIMENTAL SETUP

Fig. 4. Shows experimental setup of water pump with Francis turbine.

Brake Drum Dia. (D) = 0.3m
Rope Dia. (t) = 0.016m
Effective Radius of Brake drum $R_e = (D/2 + t) = 0.158$m
Weight of Rope and hanger = 1kg
Guide vane opening = 4.0
Brake drum net load W = (w1 actual weight + Weight of rope hanger) – (w2 spring balance error) in Kg

The experiment was carried out on a small scale model using a water turbine with rotor. The outlet water by using a 4 inch diameter pipe, which produce water flow rate equal to 25818cm^3/sec. This water flow rate is used for rotation of prime mover consist water velocity 318 cm/sec with runner speed 1890rpm. There is a little gap of velocity in between tube well water velocity and turbine water velocity. From the above calculation one can achieve the same power from tube well water when it will be connected with given turbine.

Cost of the Project

In this project the cost of different necessary components as complete turbine unit for micro hydro power, 5kW alternator, Bearings and installation cost will be considered

From the market survey, cost of micro hydro power alternator is Rs10000

Cost of Francis turbine runner with casing Rs is 75000Installation costRs 5000

Total cost =Rs 90000

VI. RESULT AND DISCUSSION

The experiment thus conducted in the lab shows the velocity of water at the rate 3.187m/s produces power 4.152kW. The same mechanism when used in a tube well shows the velocity at the rate 3.05m/s producing power to the tune of 4kW.

The proposed design is to recover part of the energy availableat the out let of the tube well impact on the performance of the turbine. Based on the initial set-up of the small scale model of the turbine, the water speed at the inlet of the turbine 3.05777 m/s. whereas the turbine surrounded with the enclosure recorded a rotational speed of 1500 rpm. The results show that the design of enclosure effectively increases the speed of the water turbine by 60.4%.

There was no difference on the motor current consumption and intake water velocity for all five test conditions. The outlet water is covered with a circular diverging draft tube. The result shows that the installation of a water turbine in these configurations will not affect the performance of the tube well and no additional load is added on the tube well.

VII. CONTROL AND MONITORING ASPECTS OF MICRO WATER TURBINE

(i) Rotational speed of the turbine.
(ii) The consistency of the electrical power output.
(iii) The acquisition and storage of electrical signals.
(iv) Centrifugal forces on the water.

VIII.OBJECTIVES OF MICRO WATER TURBINES

(i) Create clean energy generative system.
(ii) Analysis optimization of turbine.
(iii) Study differ parameters of hydraulic turbine.
(iv) To study out market potential of project.
(v) Analyze working of tube well and its water flow.
(vi) Study and analysis how should turbine connected.
(vii) Study how hydraulic turbine industry works.

CONCLUSION

(i) This retrofit micro hydraulic turbine system capable to harness energy from all non-conventional sources of hydraulic energy.
(ii) The hydraulic energy market has grown because of the environmental advantages of harnessing a clean and inexhaustible energy source and because of the economic incentives supplied by several governments.
(iii) This system has very high market potential.
(iv) It is retrofit-able to the existing tube wells and other unnatural hydraulic resources globally.
(v) With the help of micro hydraulic turbine we can harnesses lot of energy and electricity reduce overburden from fossils fuels

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