DESIGN AND DEVELOPMENT OF PICO HYDRO POWER SYSTEM BY IRRIGATION WATER

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Abstract - The energy demand day by day hastily increases with growth of population and their energy demands in India. Due to deficiency of power generation, most of the rural areas are suffering from electricity throughout the day for their household appliances. In this paper describes the design and development of pico-hydro generation system using irrigation water supply in farm. Water flow from the bottom of well through irrigation pipes has high potential with kinetic energy this will help in generate electricity, which will be helpful in household appliances in rural areas. Hence, this project is conducted to develop a low cost and small scale hydro generation system using irrigation water and generated power can be utilized to household appliances in rural areas.

***Key Words*: Pico Hydro system, Renewable Energy, Irrigation water, Small turbine, Energy storage.**

1. INTRODUCTION

Hydro Electric Power is the source of electricity in India. Hydro Technologies are associated with zero air emissions with electricity production are considered as "Green Energy" among nuclear, thermal, solar, wind, geothermal and tidal energy. Hydro Power generation contributes 83% of the renewable energy source (RES) [1]. Pico hydro is hydro power with a maximum electrical output of five kilowatts (5kW).

The size benefits for small scale hydro power system in terms of cost and simplicity from different approaches in the design, planning and installation which are compared to larger hydro power. Recent innovations are done in pico-hydro technology have made it an economic source of power even in some of the world's poorest and most inaccessible places. It is also a adaptable power source and generated electricity can be enabling to standard electrical appliances. Like Common examples of devices are tubelights, bulbs, radio and televisions etc [2].

This paper discusses about water is fetching with the help of water pump from river, well through irrigation pipe. During this project analysis has been done with different shape of reducers (T Shape, Y Shape & Straight) with a pressure of round 80 psi. This is fallen on rotating the turbine to produce electricity with the help of dynamo.

2. PICO HYDRO SYSTEM PLANNING

The proposed Pico Hydro System was fabricated at VPM's MPCOE, Velneshwar, and Ratnagiri. It consists of a pelton turbine model and a dynamo. The experiments were performed at palshet, Ratnagiri by utilizing irrigation water.

2.1. TURBINE

There are many number of different hydroelectric turbine designs, but they all incorporate the simple principle of converting the potential energy stored in water into mechanical energy by using a portion of it to rotate a paddle-wheel or propeller-type runner on the turbine. The materials used in this project for turbine explained below.

A. ACP Sheet

To connect the turbine vanes two circular sheets are used. The material used for making of circular sheet has used acrylic material in first phase of design of turbine. When water strikes on turbine vanes the quantity of water and pressure (5 bar) that destroy the sheet. In second phase of turbine design we used by ACP material which can sustain the water to fulfill pressure

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B. Specification of ACP material

ACP stands for Aluminium Cover Plate. In ACP material elasticity is maintain by rubber foil which placed between the two aluminium sheets. The strength of material which maintain by aluminium plate, rubber foils cover by two aluminium sheet. When water strikes on turbine vanes elasticity given by rubber foil and strength is increase by aluminium cover. This material sustains the water pressure. In this project weight is the main factor as the point considering of moment of inertia. So reduction of circular sheet weight ACP material can be use. This project is continuously run under water so corrosion is also main aspect so material chosen is also important factor so we use ACP material which is corrosion free.

Fig -1: Complete designed Pelton type model

C. Selection of dimensions

The diameter of circular sheet is depend upon following two important factor

a. No of vanes

In this turbine 12 no. of vanes selected over all vanes with diameter vanes sheet diameter is 62cm and each vanes size which is 4 inches. The no of vanes is also depend on turbine speed. So for increasing the turbine vanes distance between the two vanes is reduces. So time for next vanes comes under water is reduces due to this speed increases. By increasing vanes diameter, then diameter of circular sheet increases so cost also increases. By increasing diameter of water wheel it vibrates their mean axis when it rotates at higher speed. So limited to 62cm diameter of circular sheet

Fig -2: ACP Composite Sheet

b. Gear mechanism

Selection of diameter of circular sheet is depends on gear box mechanism. As increasing gear ratio, speed is increases but big sprocket which coupled on water wheel shaft is also increases as small sprocket is made constant diameter. So selection of circular sheet by consider diameter of big sprocket. Diameter selection of circular sheet is 1.44 ratios with respect to big sprocket. If diameter of big sprocket is more than circular sheet (water wheel) then water wheel will not rotate. By considering these aspects it is selected up to 62cm diameter of circular sheet.

c. Angle of water strike

For proper selection of angle of water contact is important in rotation of water wheel. These vanes are placed between the two circular sheets at an angle of 30 degree to the shaft. Also all this angle curves 30 degree with respect to the shaft. When water strike on vanes it radially outward so water can easily out from the wheel and increase the speed of water wheel.

d. Selection of material

When water is strike water wheel is rotate and all the force which is acting on the water wheel shaft. For selection of material it is important to select the material which can sustain the force of rotation. We use iron material which can fulfill above consideration. For reduction of weight middle size of shaft we are choose 0.8cm diameter and two end of shaft chosen according to bearing inner diameter (30 mm) and 1200 mm length of shaft at 30 degree diameter.

Fig-3: Complete developed pico hydro power generation model with casing of turbine

This project is run on water which use for irrigation purpose. Water is inlet upper site and collected at the bottom with zero percent reduction of water this task is performing by casing. Water wheel is coated by thin iron material. The bottom shape of casing is choosing such that water is easily out by the outlet pipe. When water wheel is starting to rotate, then water is flying out in backward direction so distance between water wheel and casing is more than front side of casing. If we are select distance between backside casing and water wheel is less then water reverse strike on water wheel and reduce the speed of water wheel. So we are select 14cm distance between this two.

3. PHASES AND MODIFICATION

This project has done with many modifications until get close to the required RPM and Torque. All this modifications are distributed in following four phases:

First Phase

- In first phase proper frame work done on which 2 bearings are connected at two ends and at a centre of frame. The shaft fitted between the two bearing on shaft to circular sheet is placed at appropriated distance. Between two sheet 12 no. of curvature pipe are fitted at an angle of 30 degree with each other. One end of shaft is connected to chain drive.
- In this phase used acrylic material, when water strikes on turbine vanes around pressure about 5bar that smashed the sheet. In this phase acrylic material which can't sustained because of the water pressure and which will be fulfilled by Aluminum Cover Plate (ACP) material.
- With this ACP designed, when water strike on vanes got up to 410 rpm. Here the pipe used is straight.

Second phase

- In first phase water is out by 2 inch pipe with straightened structured and got 400rpm. With same amount of water by increasing pressure of water with reduced the size of pipe 2:1 ratio. By water striking area has been increased using T-shape structure and then got more rpm.
- The T-shape structure two outlet of water is strike on water wheel so it occupies more area of vanes and rpm is increased to 900 rpm. But using T-shape pressure is immensely reduced. In T-shape water pressure drops at the age of single pipe. Also at the elbow again water pressure is dropped.

Third phase

- In second phase got 900 rpm. In third phase designed double gear system. In that big sprocket is rotates the small sprocket which is coupled to the bicycle wheel. Wheel rotation is 6 times to the turbine rotation.
- Bicycle wheel which will rotate generator by converting 56 times the turbines speed. But a major drawback is requiring more water pressure, so this system fails.

Fourth phase

- From the above three phases found that water occupy only 10 cm and our design water wheel length is 58 cm and so other excess area act as a load.

Fig.4: First Phase turbine using Straight shape

- For increasing speed of water wheel it has been reduced the length of water wheel. So reduced the length of water wheel 33cm. Because of reduction of excess area get the speed 1500 rpm. Also find out the area where scope for incrementing speed can be done.
- Also find out the clarification by increasing diameter of big sprocket. Previously used 72 teeth sprocket and small sprocket of 12 teeth. the speed increases 6 times to the water wheel speed so we replace 72 teeth sprocket by 84 teeth. So for same amount of water wheel speed we can increase the speed 7 times to the water wheel speed.

Fig.5: Second phase turbine diagram using T- shape reducers

- By changing the sprocket speed increased near to 1600 rpm. Again sprocket has more weight so we have to reduce that weight by maintaining required mechanical strength. Finally speed comes near to 1800 rpm and by using Y shape reducer is used in fourth phase.

Fig.6: By reduction of area of turbine

4. RESULTS

The following table shows the incremental in speed with different shape of reducers and sprocket.

Table.1: Speed for different size reducers

Shape of pipe	Speed for 72 teeth	Speed for 84 teeth
Straight	400	466
T-shape	900	1050
Y-shape	1700	1988

Break Test

For the calculation of mechanical torque generated by water wheel is calculated by break test. This test is similar as the Drum test of induction motor and which is tabulated in table 3.

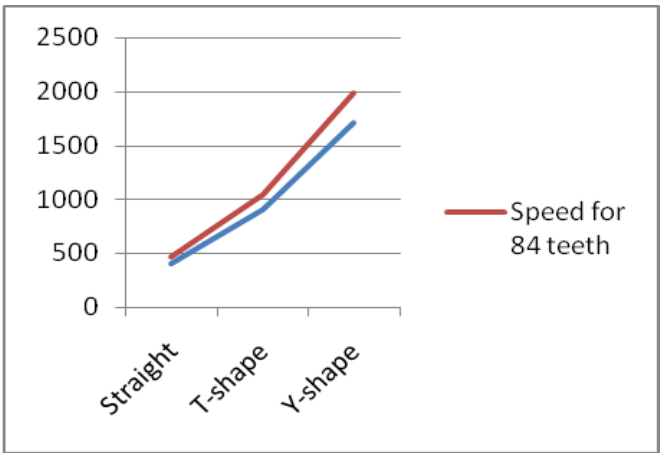

Fig.7: Speed vs. Different shape of reducers

Table 2: Power input to at different height

Condition	Water lifting in meter (m)	Input power taken (W)		Multiplying factor (8*power =W)
		W1	W2	
Normal	0	195	0	1560
Working	1.5	195	0	1560
Working	3	195	0	1560
Working	4	195	0	1560

Table.3: Observation table of break test

Sr No	W1 Kg	W2 kg	Speed (N) RPM	Torque (T) N-m
1	0	0	271	0
2	10	2	246	5.886
3	12	3.5	229	6.25

Calculated Torque

T= (W1-W2)*R*9.81
T= (10-2)*0.075*9.81
T=5.886 N-m

Mechanical input

Mechanical input power = g*Q*H

Where,

Q = Flow rate (litter/sec)
H = Supply head meter (meter)
g = Gravity (9.81)

Mechanical input power = g*Q*H
= 9.81*8*3
=234.65 watt

Calculated power output = g*Q*H*efficiency
= 9.81*8*2.99*50%
= 117.32 watt

Actual output given by dynamo = V*I
= 31.96*1.56
= 49.85 watt

Expected output = 2πNT/60
= (2*π*1323*0.84)/60
= 116.37 watt

Table.3: Observation table of load test at 72 and 84 teeth sprocket

Load (Bulb) 21W each	Sprocket in teeth	Voltage (V)	Current (Amp)	Power (Watt)	Speed (RPM)	Angular speed (rad/sec)	Torque (N-m)
1	72 teeth	19.76	2.30	45.448	936	98.01	0.46
2	72 teeth	26.3	1.82	47.866	1050	109.95	0.435
3	72 teeth	31.9	1.56	49.764	1170	122.52	0.4147
4	84 teeth	31.9	2.56	81.66	1323	138.58	0.58

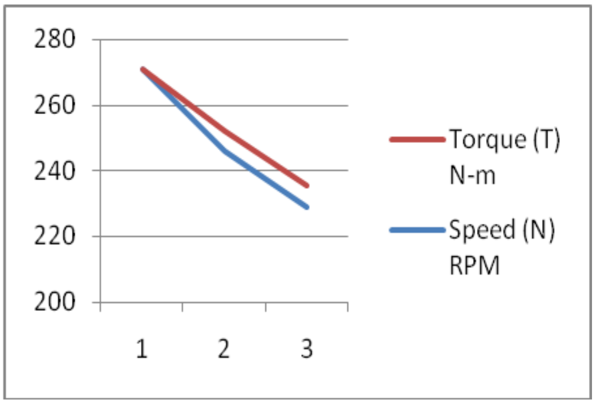

Fig.8: Graph between speed & torque

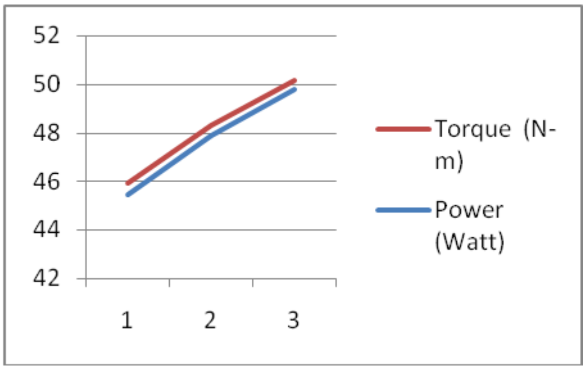

Fig.9: Graph between torque vs power

5. CONCLUSIONS

This project is carried out in four phases with certain limitation i.e. water pressure up to 80psi and at a height of 3m between vanes of turbine to the pipe. In this project we see that the current, voltage, torque, power, RPM, different types (72 and 84 teeth) of sprockets, different types of reducers in all four phases. In second phases using of T-shape reducer the speed increased up to 900rpm but pressure is immensely reduced. In third phase double gear system is used, but failed because of in deficient of water pressure. In fourth phase found that excessive area of vanes acts as load, so reduced the length of vanes up to 33cm to get required speed. The average power developed in the proposed system is 49.85 watt, current, voltage and RPM are 1.56 amp, 31.96 volts and 1170 RPM for 72 teeth sprocket. This system is efficiently capable of charging a 12 volt battery.

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