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Power Generation By Using Hydro-Electric Open Type Low Head Turbine With Minimum Flow Rate By Analytical Method

Ganesh Nangare[1]

Prof. S. D. Mahajan[2]

Abstract

Despite that researchers and equipment manufacturers have paid less attention to the emerging field of open type low-head power turbines, open type low head turbines can provide innovative, environmental friendly and cost-effective solutions for energy production. The challenge is to provide new turbine designs, which can be customized and applied to existing water systems, characterized by low-head and nearly constant flow rates .power generation capacity of Open type low head turbine is similar to the Micro-hydro turbine, generally it refers to power generation below 5 kW, prospects and potential uses of open type low head turbine schemes in remote locations built and tested a fixed. Geometry low head micro turbine suited up to a 1.5 m head and at about a 10-16 l/s flow rate, documenting good efficiencies. Use the velocity of water which is obtained by pump, and use that pumping water for power generation.

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***Index Terms*— Power Generation, Design, Turbine.**

1. Introduction

Most machines that make electricity need some form of mechanical energy to get things started. Mechanical energy spins the generator to make the electricity. In the case of hydroelectricity, the mechanical energy comes from large volumes of falling water. For more than 100 years, the simplest way to produce the volumes of falling water needed to make electricity has been to build a dam. A dam stops the natural flow of a river, building up a deep reservoir behind it. However, large dams and reservoirs are not always appropriate, especially in the more ecologically sensitive areas of the planet. For making small amounts of electricity without building a dam, the small-scale hydroelectric generator is often the best solution, especially where fast-fl owing water available. During farming process for the growth of plant there is need of water, to supply this water farmer need water pump .after pumping this water from pump station the water have velocity, the aim is that, the use velocity of water for power generation by using open type low head turbine. Findings of this research were quite in harmony with theoretical results which may be used for increasing the size of micro turbine along with a proportionate rise in generated power.

Depending upon the capacity the turbine is classified:

Size	Unit Size
Micro	Up to 100 KW
Mini	101–1000 kW
Small	1001–6000 kW

A. Experimental overview:

1) To Find out Numerical simulation.

2) To look forward for experimental set up

3) To Analyses of the system

4) Calculate stresses and feasibility

B. Measuring a stream:

1) Velocity of water

2) Force acting

3) Rotating Speed of rotor

4) Power Generation

2. General layout of a hydro-electric open type low head turbine:

Fig .1.0 shows a general layout of a hydro-electric open type low head turbine which consist of

1) A well which store the large amount of water.
2) Pipes which carry the water under pressure from pump station to the turbines.
3) Turbines having semi-circular types of vanes fitted to the wheels.
4) Tail race, which is a channel which carries water away from turbine and use this water for the growth of crop.

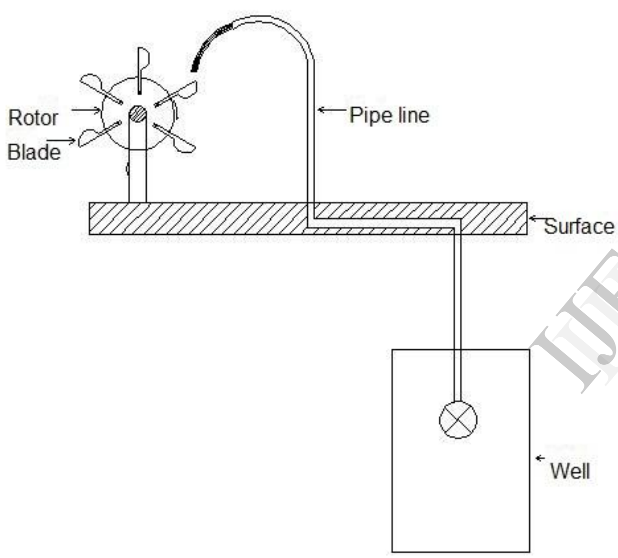

Fig .1.0 General layout of a hydro-electric open type low head turbine

3 .Design of prototype

Primary consideration for open type low head turbine design was that it should fit a limited space ranging from 1.5 to 3meter .Water falling on the turbine blade at distance of 1.5 meter

specifications:-

a. Perpendicular distance from shaft centre to force Exerting on blade = 230mm
b. Blade dimension = 100 x 100 mm²
c. Blade shape = semi circular
d .Number of blades = 09
e. Speed of turbine = 300 pm,600rpm,900rpm,1200rpm.

These dimensions were a result of required power generation and subsequently it was to be tested experimentally. Other design parameters included variable flow rates to provide different power values, out flow of one blade not to obstruct the other and availability of continuous value of torque at a certain rpm for same value of power generation. The calculated geometric dimensions were used to arrive at prototype design as shown in fig-2 which shows the design of individual blade, an exploded view of the rotor and blade assembly and final assembly of the complete turbine blade and rotor.

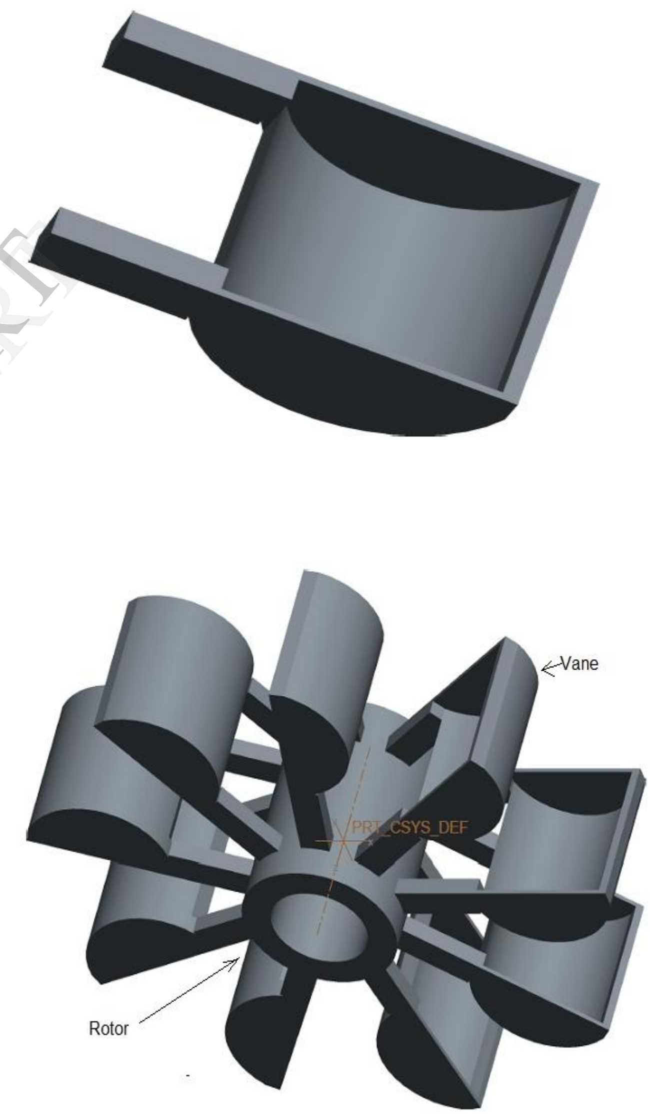

Fig .2.Blade and rotor assembly

A. Velocity diagram of blade

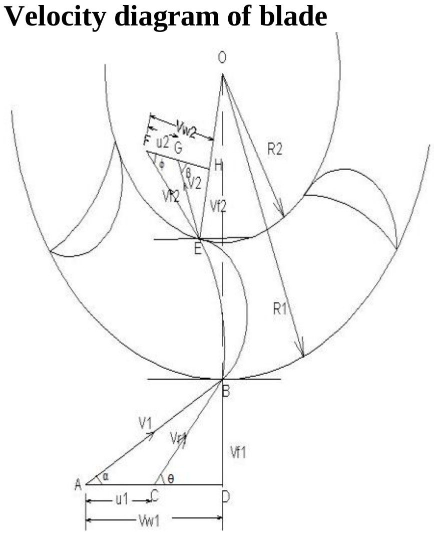

Fig.3.0 Series of radial curved vanes mounted on a wheel.

For radial curved vane, the radius of the vane at the inlet and outlet is different and hence the tangential velocities of the radial vane at the inlet and outlet will not be equal. Consider a series of radial curved vanes mounted on a wheel as shown in fig.3.The jet of water strikes the vanes and the wheel starts rotating at a constant angular speed.

Let, V1=Velocity of the jet at inlet.

u1=Velocity of the vane at inlet.

Vr1=Relative velocity of jet and vane at inlet.

α=Angle between the direction of the jet and direction of motion of the vane.

ϴ=Angle made by the relative velocity (Vr2) with the direction of motion at inlet also called vane angle at inlet.

Vw1 and Vf1=The components of the velocity of the jet V1,in the direction of motion and perpendicular to the direction of motion of the vane respectively.

Vw1=It is also known as velocity of whirl at inlet.

Vf1=It is also known as velocity of flow at inlet.

V2=Velocity of the jet, leaving the vane or velocity of jet at outlet of the vane.

u2=Velocity of the vane at outlet.

Vr2=Relative velocity of the jet with respect to the vane at outlet.

β=Angle made by the velocity V2 with the direction of motion of the vane at outlet.

ϕ=Angle made by the relative velocity Vr2 with the direction of motion of the vane at outlet and also called vane angle at outlet.

Vw2=It is also called the velocity of whirl at outlet.

Vf2=Velocity of flow at outlet.

after

Three phase monoblock pump having capacity 3 HP

From pump catalogue the flow rate of water at 11 meter head was 11.6 liter/second.

pipe diameter =65 mm

To find velocity of water

Q=AV

Where,

Q=Flow rate of water in m^3/Sec.

A=Cross section area of pipe in m^2.

V=Velocity of water in m/sec.

Velocity of water at outlet of pump V=3.49 m/sec

Discharge head .13m

from lawrence and brawnwoth(1906)noted that two kinds of flow occurs from the end of vertical pipes. With a small rise of water (up to .37d)above the end of the pipe, the flow acts like a circular weir. When the water rises more than 1.4d, jet flow occurs .as determined by sighting over the jet to obtain the maximum rise, the discharge is given by

$Q=5.01*d^{1.99}h^{.53}$

Where,

d=inside diameter of pipe having diameter .05m

h=Height of jet .

at 13 meter head discharge is

Q=9.69 liter/sec.

Velocity at the outlet of jet at the inlet V_1= 4.93 m/sec.

Then the velocity of wheel is given by

$u=\phi*(2gh)^{1/2}$

Here, ϕ=speed ratio

The value of speed ratio varies from 0.43 to 0.48.

u=2.33m/sec.

$ϴ=45^0$ vanes are symmetrical.

Vr1=Vr2 vane is smooth.

u1= ω* R1

u2= ω* R2

R1=Radius of wheel at inlet of vane.

R2= Radius of wheel at outlet of vane

Take R1=0.30 meter.

R2=0.20meter.

and N=300 rpm

After calculation at different speed we get theoretical power output without considering any losses.

Sr no	speed	u1	u2	Work	Power
	RPM	(m/sec)	(m/sec)	W.D/Sec	KW
1	300	9.423	6.232	423.41	0.4234
2	600	18.849	12.566	846.97	0.8469
3	900	28.272	18.848	1270.39	1.2703
4	1200	37.698	25.132	1643.94	1.6439

Table 1.0 Power-speed relation

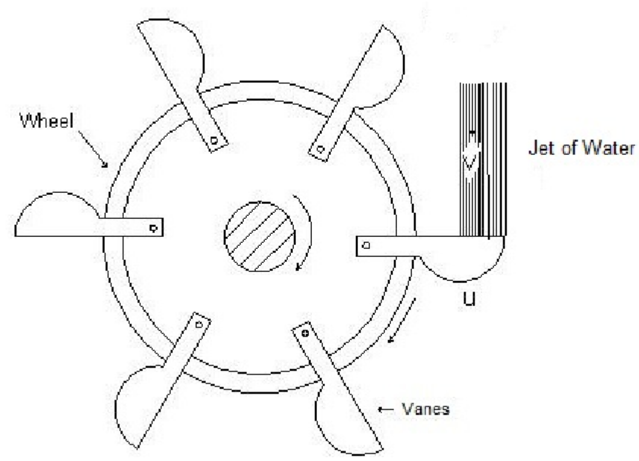

Fig.5.0 Velocity Profile on blade

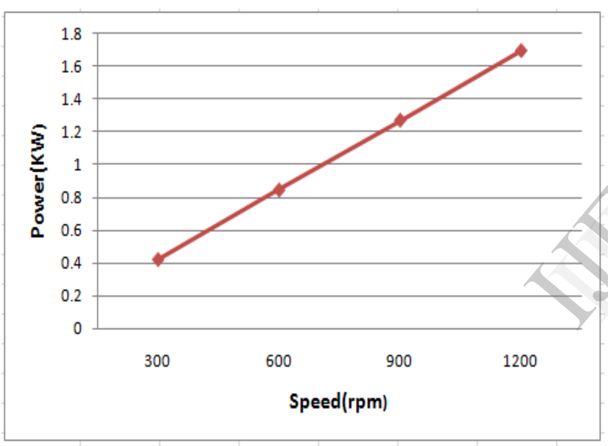

Fig.4.0 Power-speed relation

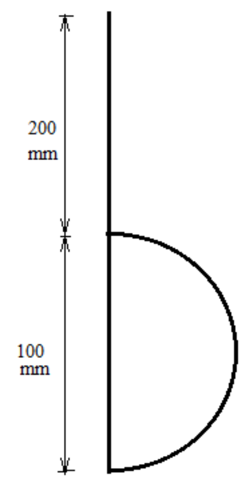

Fig.6.0 Blade Dimension

B. Design of Vanes

Shape of blade was made as a semi-circular bucket so that maximum flow rate of water may enter from the pipe and its thickness was based on strength to thickness ratio. Use of semicircular blade was expected to provide the following properties.

1) A semi-circular shape was expected to allow more flow of water to enter bucket as compared to one that could be striking a flat plate. This property was also established by past research.

Based on the above calculations, the total length of blade from shaft centre to tip of blade was estimated to 300mm and width of blade 100mm. Based on this data the approximately 9 blades were estimated for the required torque and power generation. Typical geometric specifications of a blade are shown in Fig.6.

4. Material Selection

For the current design, Aluminium 6061-T6 was chosen for the manufacturing of blade which had the following properties:-

a. Density 2.7g/cc

b. Ultimate Tensile Strength 310 MPa

c. Tensile Yield strength 276 MPa

d. Modulus of elasticity 68.9 GPa

e. Poisson Ratio 0.33

For the current design, 30C8 was chosen for the manufacturing of shaft which had the following properties:-

a. Density 7.86 g/cc

b. Ultimate Tensile Strength 500 MPa

c. Tensile Yield strength 400 MPa

d. Modulus of elasticity 210 GPa

e. % elongation 30

Model Preparation:

Ultimate design of the turbine was expected to have following parts:-

a. Pump

b. pipe line

c. Battery

d. Blade profile.

e. rotor

f. Bearings.

g. Shaft.

h. Generator.

The low head turbine assembly was manufactured as per design and an electric power generation system was installed on it for converting mechanical torque to electrical power. After manufacturing and assembly get the exact result .

5. Conclusion

Present research may be concluded by stating that such turbines could be used at regions where there is abundance of water storage and water which is pumped from there pumping station as per requirement for farming purpose. The analytical result analysis was important because carrying out all these efforts, if the project is found techno-economically on-viable, all the investments made will become a waste exercise. Therefore, in pre-feasibility stage assessment of cost and technical parameters should be worked out carefully so that only feasible projects are undertaken for detailed

investigations and implementation. From above calculation the project was analytical feasible for further experimental result analysis.

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