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CONSTRUCTION OF SMALL SCALE WATER FLOW TURBINE FOR RURAL AREA APPLICATION

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ABSTRACT

The objective of this research is to construct of small scale pilot plan flow turbine for rural area application in Myanmar. In Myanmar, there are many water resources. Water flow turbines are considered, designed and constructed based on rural area electricity requirement. All parts are available in local market and were installed in laboratory. The constructed flow turbine performed their functions correctly. This turbine can be applied over a water flow area and head range 3 m to 10 m in test running condition. This turbine can be constructed simply by people from rural area in our country with local materials. The small scale cross-flow turbine produces maximum power 4.8 w of under a head length of 10 m. This type of turbines is sample design, easy to maintain and low cost to construct.

Keywords: Flow turbine, blades, rural area, output power

Introduction

Abundant of stream, river and long coastal regions have in Myanmar. Therefore, run off river installation do not have any adverse effect on the local environment as large hydro. Small hydro plants maybe standalone system in isolated areas but could also be grid connected. The connection to the grid has the advantage of the easier control of the electrical system frequency of the electricity, but the disadvantage of being tripped off the system due to problems outside of the plant operator control [Andy Karsner (2008- May).].

Instead, a fraction of the water's stream is diverted downhill through a pipe to a small turbine that sits alongside the stream. The design and applications of hydraulic turbines has evolved over time. Functionally, there are several different types of hydraulic turbines, each of which operates under a characteristic set of operating conditions [Andy Karsner (2008- May).]. The flow water pushes directly to blade of turbine. The blade directly drives to shaft and turn to generator and produced electricity, so gear is not used in this turbine. This type of turbine includes in RE, which have many advantages and disadvantages. The initial cost of installation of renewable energy technologies is higher than the cost of the devices that use conventional energy sources. This pilot plan turbine is constructed for use in Phalan Township, Chin state.

Construction of flow turbine

This turbine was constructed as pilot plan to use in Chin mountain area. Flow turbine was constructed after studying of different papers and design calculations. Different fabrication and design were also taken into consideration to study their angles of attack and flow rate of water. The construction of flow turbine based on the flow water was pushed to the concave surface of blades for the efficient performance and electricity output from the alternator.

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Blade Construction

Different materials are brought in local for the setup of flow turbine. Iron sheet was cut and rolled for blades of flow turbine, it is cut into the size of 8 inches × 24 inches of area of 8 pieces of iron plane sheet. Its exact weight is 2.21 lb for each iron blade. Blades are arranged at the attach angle of 25 degrees. The space between the blades was 254 mm and total 8 blades were arranged. Size 2 cm diameter shaft with length 24 inches was taken and attached to both two alternators.

Frame Construction

Frame structure support rotor and alternator was fixed setup with shaft. Frame structure was important for definite place to provide the proper RPM of alternator. 2 inches width L shape iron bar was bought from the market for the frame of the whole setup. A channel of length 20 feet for 1 bar and 4 bars were used. The construction of frame is according to the dimension of 3ft×3ft×2.5 ft with 2 inches L shape iron bar. Frame after construction is bolted with to both ends with alternator was mounted on frame with arrangements.

Rotor Construction

Bicycle wheel was mainly used to attain maximum rotational speed by the drive of water flow and convert into the electrical energy, which was lighter than iron frame rotor and to minimize energy losses. The frictional force was reduced and increases the kinetic energy by using the mass and velocity of water to the blades surface for maximum output. Blades were put on the connecting bar between two bicycle wheels by the tight of screws. The pipe for two different diameters was used to control the proper movement and flow of water to the blades for the better RPM at the shaft. In this turbine have no transmission gear.

Generators

Alternator was used to convert from the mechanical energy into the electrical energy. The shaft output was carried which was direct drive to alternator with the turbine section. Shaft rotation provides the generation of electricity through the alternator. It was stand above from base 2 feet to the shaft height by the frame. Two alternators are connecting the ends of shaft and instantaneously rotate by drive of rotor. The electricity output and sent to storage battery.

All the manufacturing activities were carried out at science workshop except standard parts such as bolts and nuts etc., which were purchased from the market. The construction detail procedure photos are shown in Figures 2 to 9.

(a) Calculation of the water flow rate (Q)

The water flow rate was calculated by measuring river or stream flow velocity (V_F) and river cross-sectional area (A), $Q = V_F \times A$ (m^3/sec)

(b) Calculation of turbine power (Pt)

The electrical power of the turbine in Watt can be calculated as:

$P_t = Q \times Hn \times \rho \times g \times \eta_h$ (W)

Q - discharge [m^3/s] H_n - gross head [m] η_h - hydraulic efficiency [-]

ρ - water density [kg/m^3] g - gravitational acceleration [m/s^2]

(c) Number of blades:

The selection of optimum number of blades is very important in the design of Turbine Runner, fewer no of blades may cause incomplete utilization of water available to the turbine and excessive number of blades may cause the pulsating power and reducing the turbine efficiency. The following relation exists for the number of Blades in a Turbine runner: As circumference of rotor is $2\pi R$ = 2× π × 310 = 1946.8 mm

And blade spacing is S_{b} = 240.35 mm

So, no of blades will be $\frac{1946.8}{240.35}$ =8.099 ≈ 8 nos

(d) Blade spacing: Proper blade spacing allows the water to strike, on the blades for maximum thrust production, the blade spacing depends upon the number of blades used in the turbine runner. Blade spacing can be calculated as:

S =$[\pi * D - n(t)]/n$ S =$[3.14 \times 620 \times 10^{-3} - 8 \times 3 \times 10^{-3}]/8$

S = 240.35 mm

(e) Calculation of turbine efficiency (η_t)

The maximum turbine efficiency can be calculated as:

$$\eta = \frac{1}{2} \times C^2 \times (1+ \psi) \times \cos^2(\propto)$$

ψ - blade roughness coefficient (0.98) C - the nozzle roughness coefficient (0.98).

η - the hydraulic efficiency of turbine. $\propto$ - the attack angle of 20° to the runner.

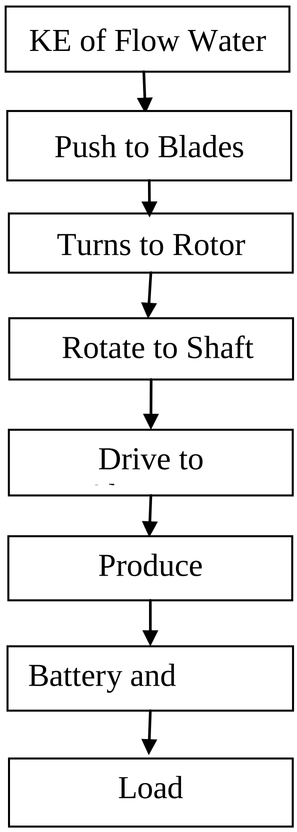

Figure 1 The working procedure of flow turbine

Photos for Construction of Flow Turbine

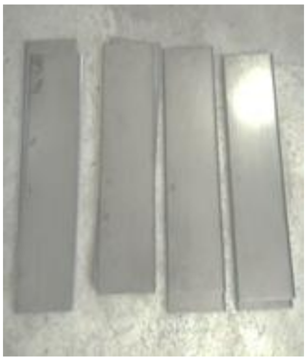

Figure 2 Iron sheet for lade

Figure 3 Mounted for frame

Figure 4 and 5 Setup of frame, rotor and iron bar

Figure 6 Installation of flow turbine and **Figure 7** Water flow turbine

The measurement and test of flow turbine

Figure 8 Test run of flow turbine by 2-inch pipe and 10 feet height.

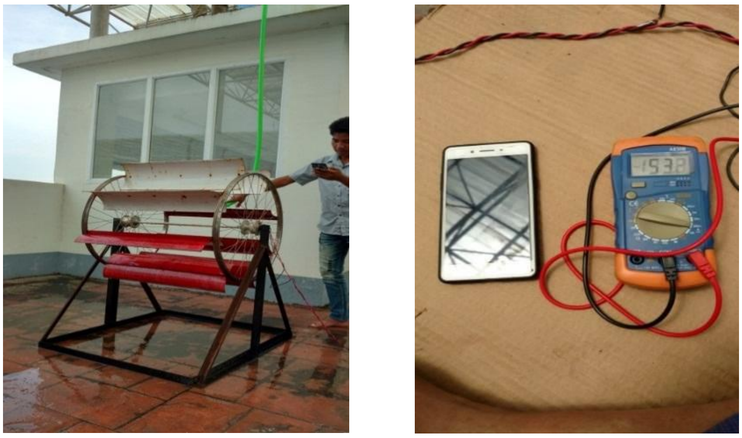

Figure 9 Test run of flow turbine by 1-inch pipe and 10 feet height

Results

The small scale flow turbine for rural area application was designed and constructed. It has (6) main categories; blades, dynamo, rotor, frame, shaft and charging controller. Blades, frame and charging controller was designed our self. The blade was carved by cutting and roller machine. Generator and rotor are bought from local market in Sawbwar Gyi kone, Mayangon Township. Other portions were made in science work shop Hlaing Township. The Results are shown in table and graph.

Table 1 Basic parameters of pilot plan flow turbine

Sr	Specifications		Measurements
1	**Blades**	Length	60 cm
		Thickness	0.4 cm
		Radius of curvature	12 cm
		Pitch angle	45°
		No. blade	8×24 inch
		Blade Attack Angle	25°
2	**Rotor**	Weight	8×7.68lb
		Diameter	65cm
		Inner	60 cm
		Outer	62 cm
		Weight	60 lb.
		Length	60cm
3	**Shaft**	Weight	2lb
		Length	60 cm
		Diameter	2 cm
4	**Flow rate**	Head length	3m to 10m
		RPM	150
		Volt	4.8 w

Table 2 Calculation of the water flow rate for 1 inch.

Sr	Diameter		Velocity of fluid (m/s)	flow rate (Q) ($\mu m^3/s$)
	inches	meter(m)		
1	1	0.0254	0.05	24.5312
2	1	0.0254	0.0833	40.8854
3	1	0.0254	0.1667	81.7708

Table 3 The input power of flow water for 1inch head and height of 3 m, 5 m, 10 m.

Sr	Diameter		Acceleration due to gravity (ms^{-2})	High (m)	flow rate (Q) ($\mu m^3/s$)	Density of fluid (kg/m^3)	input power of the turbine (watt)
	inches	meter (m)					
1	1	0.025	9.81	3	24.5312	1000	0.61
2	1	0.025	9.81	5	40.8854	1000	1.685
3	1	0.025	9.81	10	81.7708	1000	6.738

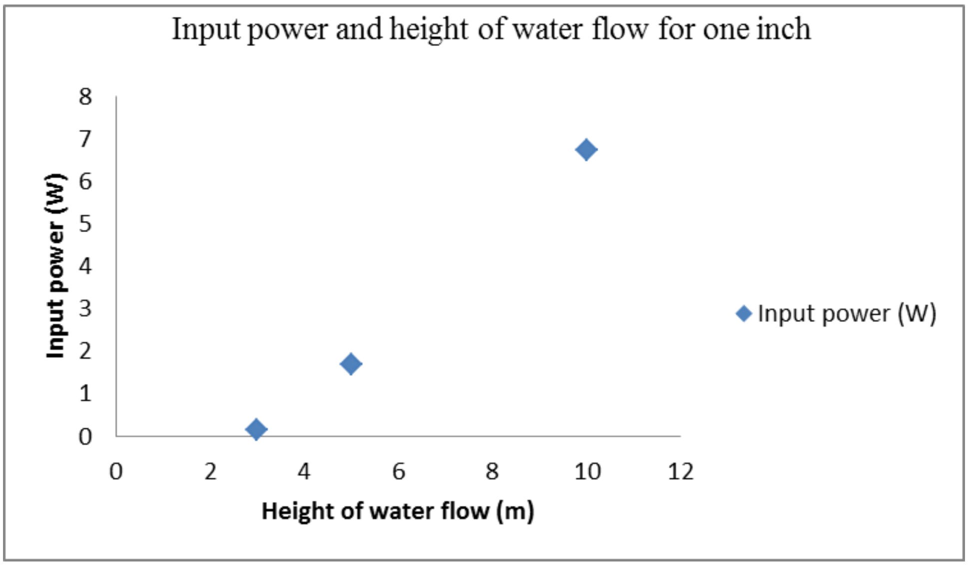

Figure 10 Input power depend on height of water flow with one-inch pipe

Table 4 Calculation of the water flow rate for 2 inch.

Sr	Diameter		Acceleration due to gravity (ms^{-2})	High (m)	flow rate (Q) ($\mu m^3/s$)	Density of fluid (kg/m^3)	input power of the turbine (watt)
	inches	meter (m)					
1	2	0.05	9.81	3	98.125	1000	2.426
2	2	0.05	9.81	5	163.5416	1000	6.738
3	2	0.05	9.81	10	327.0833	1000	26.953

Table 5 The input power of flow water for 2-inch head and height of 3m, 5m, 10m.

Sr	Diameter		Acceleration due to gravity (ms^{-2})	High (m)	flow rate (Q) ($\mu m^3/s$)	Density of fluid (kg/m^3)	input power of the turbine (watt)
	inches	meter (m)					
1	2	0.05	9.81	3	98.125	1000	2.426
2	2	0.05	9.81	5	163.5416	1000	6.738
3	2	0.05	9.81	10	327.0833	1000	26.953

Table 6 Experimental results for flow turbine for height of 3 m with 1 inch.

1	Volume	H (m)	Time (min)	Volt (V)	Current(I) (mA)	RPM	Power(P) (mW)
2	20 L	3	0.77	2.2 V	53	30	0.117
3	20 L	3	0.77	1.9 V	52	29	0.099
4	20 L	3	0.75	2.2 V	56	31	0.123
5	20 L	3	0.749	2.3 V	61	32	0.140
6	40 L	3	1:08	4.5 V	124	82	0.558
7	40 L	3	01:00	6 V	141	110	0.846

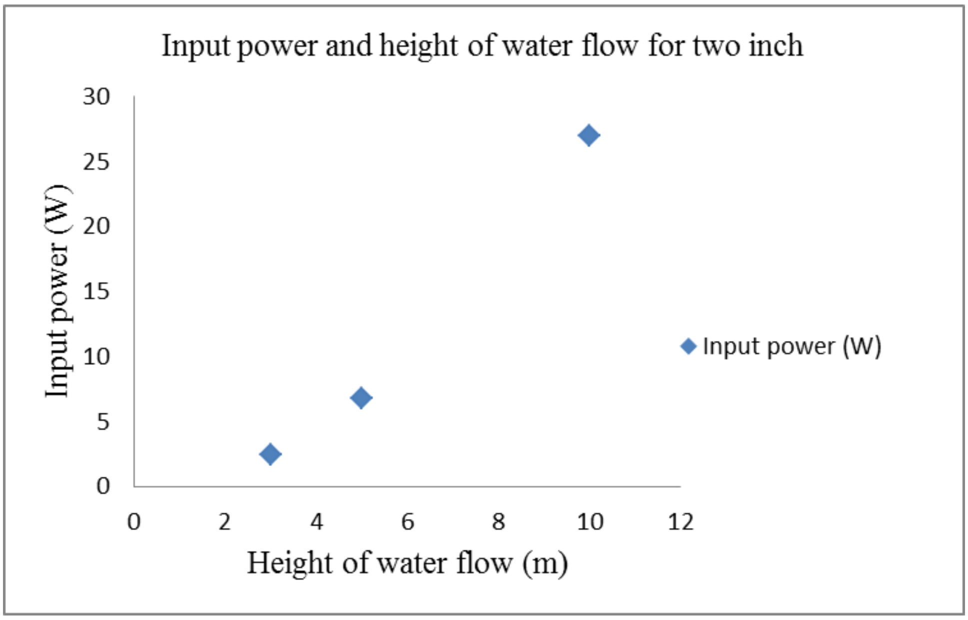

Figure 11 Input power depend on height of water flow with 2 inch pipe

Discussion

Design applied to the development of products, environments which has a user perspective and drives development based on your specific customer needs. Especially in mountainous areas where grid connection was connect to difficult and expensive. Other ways unreliable energy sources were required. Flow turbine was suitable device for this area. Flow turbines were few moving parts, compact systems and good efficiency. Flow turbines can operate continuously or on demand and be either grid connected or stand alone. Not like the big hydro plants that use dams and create giant lakes behind the dams, flown turbine plants only divert a fraction of the stream and they don't need a water storage pool. In rare cases where the site is close to grid lines, part of the produced power can be sold back to the utility, and the grid serves as backup for future plane. The flow turbine plant requires low maintenance.

Flow turbine systems produce no pollution. Flow turbine is made easily by local materials. This turbine can make themselves live in rural area peoples. Main disadvantage is required always flow stream nearby setup area. During the summer there will be less flow and therefore less power output. Advanced planning and research will be needed to ensure adequate energy requirement.

Conclusion

The flow turbine efficiency was depend upon the water flow rate, head length and blades factors. It can modify to output power 1 kW with same structure. As the power demand increases the size of the plant can be easily expandable. During the summer, there will be less flow and therefore less power output. This flow turbine is capable of producing up to 4.8 W output power at the head length of 10 m and flow rate of the performance test at selected site location by changing the water flow rate. The power output of this turbine is 0.85 watt with 110 RPM for 3 m height and 1-inch head. Advanced planning and research will be needed to adequate energy requirements. Thus, this turbine is suitable for rural area in Myanmar.

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