MODEL STUDY OF HYDRAULIC TURBINE IN PIPE

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Abstract- Electricity is the basic need of human beings. Per capita consumption of any country indicates in progressiveness. In India, the demand of electricity is as well as installed capacity is growing steadily. India has been facing power shortage during peak hour demand because electricity demand is grown at 10% per yearly. Still the research is going on to overcome the technical challenges associated with the development of small hydro power generation like selection of generator and turbine. In this paper the experimental study of different types of turbines and their blade configuration is carried out. The study has been carried out is totally an experiment. The result is totally based on experiments done on various floor of hostel building. Comparative efficiency of various types of turbines has been studied along with their respective heads applied, discharge, blades angle. This study is an initiation in India towards the utilization of water flow in closed pipe to generate electricity. In this paper the best anle of turbine blade is suggested.

I.Intoduction

Hydropower is a mature and cost-competitive renewable energy source that plays a strategic essential role in XXI century electricity mix, contributing to more than 16% of electricity generation worldwide (more than 3500TWh) and about 85% of global renewable electricity. In use in over 160 countries, hydropower capacity is on the rise, reaching 1.31 TW worldwide at the end of 2011against 369 GW of wind and 177 GW of photovoltaic at the end of 2014. Hydroelectricity presents several advantages over most other sources of electrical power, including a high level of reliability, proven technology, high efficiency (about 90% efficiency, water to wire), very low operating and maintenance costs, flexibility and large storage capacity. Furthermore, hydropower systems can help stabilizing fluctuations between demand and supply supporting the variability of other renewable energy sources such as wind power and photovoltaic electricity, whose production is growing considerably worldwide

In India, 85.6% electricity is generated from conventional sources of energy such as thermal, hydro, nuclear and gas power plants and rest 14.4% is generated by various renewable sources like wind, solar, small hydro, and biomass & waste materials. In renewable power generation, 61.3%, 18%, 10.9%, 9.6% and 0.3% are the share of wind, solar, biomass, small hydro and waste materials respectively. The small hydro power plant has 9.6% share in renewable power generation which is only 22% of the estimated small hydro potential available in India. Small hydro power plants (SHPP) are mostly suitable for providing reliable electricity to rural remote areas especially in remote mountainous regions. SHPP are generally of run off river type with no dam or water storage facilities. These plants are cost-effective and environmental friendly as compared to large hydro and suitable for rural electrification in developing countries.

Originallity of this idea is from already installed system in Portland,USA.The private company named Lucid pipes have carried out these project of installing turbines in pipes. Lucidpipe utilizes a unique, lift-based, vertical axis spherical turbine that fits inside of large diameter (24”-60”) water pipes. Water flows through the hydrodynamic turbine, generating power as the turbine spins. The hydrodynamic turbine has been carefully designed and labtested to maximize efficiency and power generation without interrupting the flow of water. As velocities increase, power production increases. Due to the lift-based design of LucidPipe, the system generates power across a very wide range of flow conditions, volumes and velocities. LucidPipe extracts very little head pressure per turbine, just 1–6 PSI (1-4 meters). This allows the modular LucidPipe system to be placed in series, while allowing for uninterrupted water flow. The turbine used and installed system of Lucid is shown in fig1.1.

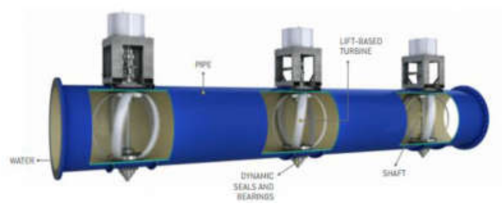


Figure1.1 System installed by Lucid company

II.TURBINES

The turbine is the root of hydro power system. We made different types of turbines using the acrylic sheet of thickness 2mm. We made ankle shaped turbines with an angle of 45, 60 and 90 degree shown in figure2.1. These turbines were made by cutting out the acrylic sheet into small pieces. The angles were made by molding them. Four fins were made for each turbine which was later assembled on the shaft using glue gun and soldering gun. The shaft was fitted into the dynamo. Then with the help of wires and soldering gun the LED was installed on the dynamo. The turbine was placed inside the pipe and the dynamo was placed above the pipe; this setup was fixed on the pipe with help of the glue gun. We made several setups like this to test it. Generators convert the mechanical (rotational) energy produced by the turbine to electrical energy. In this case the dynamo we used acts as a generator. As a sign that the electricity is generating we used one small red LED of rating 1.7Volts.

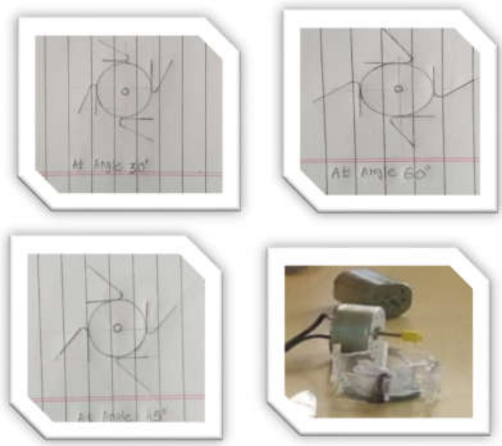


Figure 2.1 Turbine Blade Angles

III. CONDITIONS

As every experiments has their conditions similarly our experiment also have its own conditions

1. The on the tap which we performed is of 8mm diameter.

2. The plastic bottle we used as casing for the turbine blades have diameter 70mm.

3. We carried out experiment on our hostel building floor.

4. Material used for making blades is of acrylic sheet of thickness 2mm.

IV. PROCESS

We tested these setups on different head levels. To determine the energy produced by providing different discharges and heads. We calculated the discharge of the water by calculating the volume of water filled within a particular time period. We calculated the voltage and ampere with the help of voltmeter and ammeter. The voltage and ampere have given us the electricity generated with the turbine. We

had calculated these parameters with various different turbines which were created by us.
The tests were done in the hostel of the college. We had done the tests on 2nd and 1st floor of the hostel building. On each floor we had taken separate readings for the different angles of the turbine. The figure3.1 is shows the setup of our model and the time at which LED illuminated.

Figure3.1- Setup and LED illumination

On 1st floor of hostel building the static head was 6m and on 2nd floor of hostel building the static head was10m. 10 samples for each turbine at each floor for different discharge values were calculated corresponding to the current, volts, power generated.

V. OUTCOMES/RESULTS

The process mentioned above is carried out with certain conditions which are also mentioned previously. The results are given below according to the floors on which we had conducted the tests with particular angle of blade.

1. 2nd floor of hostel building(Head=6m)

30degree blade angle

Sr.no.	Discharge(cms/sec)	Current(mA)	Voltage(V)	Power Generated(mW)
1	0.1	10	1	10
2	0.11	11	1.1	12.1
3	0.13	12	1.3	15.6
4	0.15	15	1.4	21
5	0.16	17	1.5	25.5
6	0.17	18	1.7	30.6
7	0.18	20	1.9	38
8	0.19	22	2	44
9	0.19	25	2.1	52.5
10	0.20	27	2.3	62.1

Sr.no.	Discharge(cm3/sec)	Current(mA)	Voltage(V)	Power Generated(mW)
1	0.1	8	0.98	7.84
2	0.11	9	1.1	9.9
3	0.13	11	1.2	13.2
4	0.15	14	1.3	18.2
5	0.16	15	1.5	22.5
6	0.17	17	1.7	28.9
7	0.18	19	1.9	36.1
8	0.19	20	2	40
9	0.19	22	2.1	46.2
10	0.20	23	2.2	50.6

60degree blade angle

45degree angle

Sr.no.	Discharge(cm3/sec)	Current(mA)	Voltage(V)	Power Generated(mW)
1	0.1	12	2	24
2	0.11	14	2.2	30.8
3	0.13	16	2.4	38.4
4	0.15	17	2.5	42.5
5	0.16	18	3	54
6	0.17	20	3.3	66
7	0.18	22	3.5	77
8	0.19	25	3.9	97.5
9	0.19	27	4.2	113.4
10	0.20	32	4.5	144

2. 1st floor of hostel building (Head10m)

30degree blade angle

Sr.no.	Discharge(cm3/sec)	Current(mA)	Voltage(V)	Power Generated(mW)
1	0.1	14	1.4	19.6
2	0.11	15	1.6	24
3	0.13	18	1.8	32.4
4	0.15	22	2	44
5	0.16	25	2.2	55
6	0.18	30	2.4	72
7	0.2	32	2.6	83.2
8	0.23	35	2.7	94.5
9	0.24	42	2.8	117.6
10	0.25	45	3	135

60degree blade angle

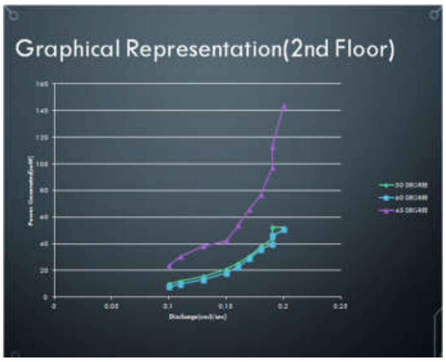
Sr.no.	Discharge(cm3/sec)	Current(mA)	Voltage(V)	Power Generated(mW)
1	0.1	9	1	9
2	0.11	11	1.2	13.2
3	0.13	13	1.3	16.9
4	0.15	15	1.4	21
5	0.16	18	1.6	28.8
6	0.18	20	1.8	36
7	0.2	23	2	46
8	0.23	27	2.2	59.4
9	0.24	32	2.3	73.6
10	0.25	35	2.5	87.5

45degree blade angle

Sr.no.	Discharge(cm3/sec)	Current(mA)	Voltage(V)	Power Generated(mW)
1	0.1	18	2	36
2	0.11	20	2.2	44
3	0.13	23	2.4	55.2
4	0.15	25	2.5	62.5
5	0.16	30	3	90
6	0.18	36	3.3	118.8
7	0.2	42	3.5	147
8	0.23	50	3.9	195
9	0.24	56	4.2	235.2
10	0.25	62	4.5	279

3.Graphical Representation

Figure5.1 for 2nd floor and 1st floor.



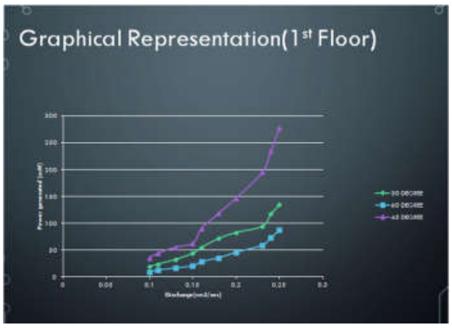


Figure5.1

VI. CONCLUSIONS

1. Minimum 72mW is required.

2. The top most floor(2nd floor) of hostel building maximum flow is of 200ml/sec generated power differentially for different blade angle.

3. The power generation for 45° is 144mW is the highest one. It is 130% of 30° and 180% of 60°.

4. The 1st floor of hostel building maximum flow is of 250ml/sec generated power differentially for different blade angle.

5. The power generation for 45° is 279mW is the highest one. It is 106% of 30° and 200% of 60°.

VII. FUTURE SCOPE

1. The variation in the material type may give the better result.

2. The experiment may be carried out by changing the blade design and angles.

3. The variation in the diameter of pipe may give different results.

4. The change in the head will definitely vary the results.

5. It will definitely help the students for the research work.

6.It proves to be initiation in small hydropower generation in closed pipes.

VIII. APPLICATIONS

1. It can be used in household pipe fitting.

2. It can be used in farms at the end of pump having high flow/discharge along with high head.

3. It is best suited at the place where available head is high but there is no further requirement of head.

4. The energy generated on small scale may be stored in batteries and may be use when needed.