Design and Development of Savonious low head Hydropower Turbine

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Abstract - The contribution of renewable energy in the global electricity production is 26.2% of which 15.8% is the share of hydropower (REN21, 2019). Hydropower is the largest contributor in renewable energy but has various negative impacts on biodiversity and now-a-days, society aims to produce energy in an efficient and sustainable manner. This is the reason that growth rate of large hydropower is reduced. But unlike solar and wind, hydro is 24X7 available, reliable and predictable source of energy and therefore instead of out-looking this source, it is better to utilize the water energy more effectively. Small hydropower has been evolved as a solution to the adverse impact of large hydropower on the
Environment. In small hydropower, energy can be harnessed by static and kinetic method. Energy is harnessed by creating water head in static method and using flow velocity in kinetic method. Now-a-days hydrokinetic technology is growing extensively and emerging as a promising technique which utilizes the flow velocity for the energy generation. In the present study, an attempt has been made to savonious hydrokinetic turbines with the aim to develop hydropower as low head turbines. The methodology of the study comprises of five steps involving data collection from the study area, turbine designing, numerical simulation followed by post processing and analysis of the results.

Keywords: *low head, hydrokinetic, savonious turbines, hydropower.*

1. INTRODUCTION

Almost throughout the year, consistent water currents are observed in rivers or canals in most of the parts of India. However, development towards the use of kinetic energy from river currents is not explored substantially in India.
Development of electricity from the water current of river may become one of the best renewable sources as it is predictable compared to wind or solar energy. Hence, there is a need for a simple hydro turbine which can take advantage of these naturally available sources. This type of run of the river
Hydro-electricity systems utilizes kinetic energy from rivers or canal water-flow, which does not require huge dams. Strong candidate for the utilization of these hydropower sources is Savonious turbine because of its simplicity in construction and better starting torque. It is made of two or more semicircular vanes (or blades) attached to a vertical shaft. It can be used as standalone plant at remote locations away from the power greed and nearer to the water current source. Savonious hydrokinetic turbine has the following advantages over wind turbines: It is simple in design and easy to manufacture. So, it is very easy to install in river or canal waters, because of which it is best suited for remote areas in developing countries like India. Unlike the wind turbine which needs to be
Installed at high elevation. Water current has a well-defined flow direction. This eliminates use of yaw control and reduces complexity. This improves reliability and reduces maintenance. Because of high power density of water, it has greater potential to extract power compared to wind turbine from a given size of the turbine and velocity of the fluid. Because of the above-mentioned advantages, Savonious turbine is suitable for the following applications: small scale standalone hydraulic turbine that can be used to generate electrical power for household applications, and for operating water pumps, charging batteries, powering telecommunications and several other low power applications.

2. Body of Paper

2.1. CONSTRUCTION

Component of Savonious Hydro-Kinetic Turbine use for power generation system is given below,

Sr. No	Components	Quantity
1	Ball bearings	2
2	Shaft	1
3	Washer	2
4	Nut and Bolt	20
5	Spur Gear	2
6	PVC Turbine blade	2
7	DC Motors	1
8	12V Storage Battery	1
9	Supporting frame	1

2.2 WORKING

Hydro power is energy from the water flow. It is renewable, inexhaustible and environmental pollution free. Hydro power is a natural phenomenon related to the movement of water masses caused. The Hydro power turbine captures the water kinetic energy in a rotor consisting of two blades mechanically coupled to an electrical generator. The turbine is mounted on a top of the frame to enhance the energy capture. In the proposed Savonious Hydro-Kinetic Turbine model, a charge controller is used to regulate the power generated by water turbine. It also simultaneously charges battery and gives power to the load. The controller has reverse current protection and short-circuits protection. A specifically chosen battery is used to store the generated power. In this present project we will make two blade type savonious turbine to test the performance of the Savonious Hydro-Kinetic Turbine.

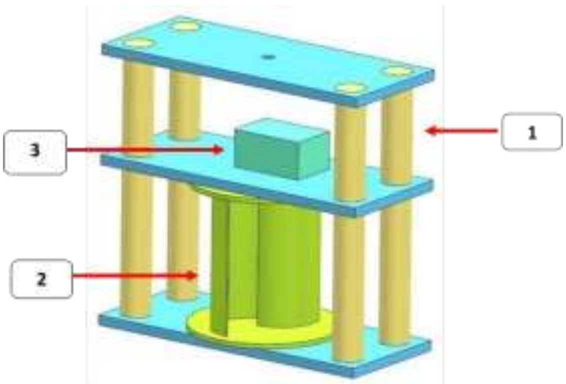

Fig.1. Proposed Model.

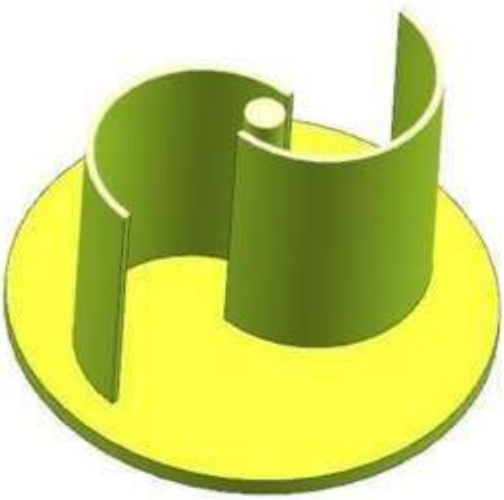

Fig.2 Cross Sectional View

3. Methodology

1) Literature survey on Savonious hydrokinetic turbine and river system in India.
2) Identify the different ways to harness the flow potential of small water bodies in India.
3) Design development and fabrication of Savonious hydrokinetic turbine.
4) Testing of hydrokinetic turbine in flowing water conditions.
5) Analysis of performance of the turbine with regards to power, efficiency and cost. Discussion and conclusion about results obtained.

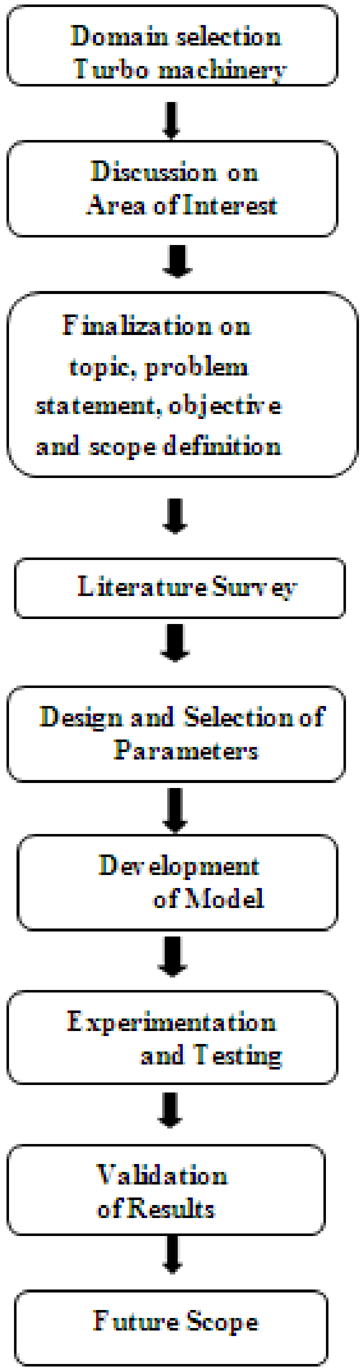

Fig.3. Work Planning.

4. LITERATURE SURVEY

1. Imron Hamzah, Ari Prasetyo, D. D. D. Prija Tjahjana, Syamsul Hadi, done the work on, Effect of Blades Number to Performance of Savonious Water Turbine in Water Pipe, according to his work, Savonious is usually known as a wind turbine that works efficiently at low wind speed. In this research, the Savonius turbine is proposed for a pico hydro

power plant that is installed straightly on the 3-inch vertical pipeline of rainwater and household waste. The Savonious water turbine was designed with blade curvature angle of 70º, the aspect ratio of 1, turbine diameter of 82 mm, and endplate ratio of 1,1. The experimental study investigated the effect of blades number to the performance of Savonious turbine on various volume flow rate of water. Savonious turbine with three blades number generated the highest coefficient of performance of 0.23 on tip speed ratio of 1.7 compared to turbines with the number of other blades. Rainwater and household waste at the high rise building which is commonly just wasted without first being used have a great potential as an energy source for a power plant. The water which flows only by gravitational force has a bigger momentum than air, so it has a higher capability to directly move a turbine connected to a generator. Another while application of the wind turbine as a water turbine becomes an interesting topic of research recently. For example, the Savonious turbine is commonly known as a Vertical Axis Wind Turbines (VAWT) which is recognized to be able to work efficiently in a low wind speed. Various methods have been conducted to raise the performance of Savonious turbine. Research which compared a 2-blade Savonious wind turbine with a semi cylindrical blade type from 3-blade Savonious wind turbine of the same blade type was conducted.

2. Ibrahim Mabrouki, Zied Driss, and Mohamed Salah Abid, done the work on, Performance Analysis of a Water Savonious Rotor: Effect of the Internal Overlap, according to his work, the water Savonious rotor is classified as a vertical axis water rotor like the Darrius, Gyro mill or H-rotor. The advancing blade with concave side facing the water flow would experience more drag force than the returning blade, thus forcing the rotor to rotate. In this work, they are interested on the study of the of the internal overlap effect of a water Savonious rotor. The experimental results is developed using a hydraulic test bench. The test bench consists on an intake, a control gate, a penstock, a canalization, a test section, an outflow and a pump. A detailed description of the global characteristics is presented such as power, dynamic torque, power and its coefficients. In this paper, they focalize our attention on the study of the overlap effect on the global characteristics of the water Savonious rotor. Particularly, they have studied the variation of the power, the dynamic torque, and its coefficients depending on the rotational and the specific speed. In this work, they confirm that the global characteristics of the Savonious rotor increases in the used test section with the increase of the overlap. In the future, they suggest the deflector addition to improve the rotors performance.

5. ADVANTAGES

The advantages covered by the propose system are listed as,

1) Overcoming disadvantages of standalone renewable electrical energy generation system.
2) Producing much more efficiency as renewable energy generation system.
3) Since, the system doesn't complexity of system testing and understanding became easy in terms of difficulties.
4) System maintains is remarkably reduced and becomes easy.
5) Wind as a renewable energy sources are utilized so, no waste production.
6) Producing clean, friendly to environment, renewable energy.
7) Once the system is designed and developed or manufactured, the installation of system is easy.
8) Within certain time period the installation cost gets covered.

6. APPLICAATION

Some of the applications for the purpose system are listed follow,

1) The system is used for domestic purpose.
2) Street lighting, Traffic signals.
3) Various monitoring systems.
4) Powering up for communication system.
5) Pump irrigation Systems.
6) As per requirement of electrical energy the system can be either designed or updated for higher energy requirement.
7) When AC mains supply is not available, the proposed system can be used as emergency system with only few changes.
8) So, it can be used for almost every electronic, mechanic, viz. system needing/ require electric energy to work on.

6. CONCLUSION

1. The Design and Development of a Savonious Low-Head Hydropower Turbine project successfully demonstrates that a vertical-axis Savonious turbine is a simple, reliable, and cost-effective solution for extracting energy from low-head and low-velocity water sources such as canals, small streams, irrigation channels, and wastewater outlets.

2. The developed turbine operates efficiently under minimal head conditions without the need for complex civil structures, making it particularly suitable for rural and decentralized power generation. The self-starting capability, ease of fabrication, and low maintenance requirements highlight its practicality compared to conventional turbines like Kaplan or Francis, which are unsuitable for very low head applications.

3. Experimental evaluation shows that optimized blade geometry, overlap ratio, and rotor diameter significantly influence torque and power output. Although the overall efficiency is lower than high-head turbines, the Savonious turbine compensates through robust performance, environmental friendliness, and adaptability to variable flow conditions. The system operates with negligible impact on aquatic life and does not obstruct natural water flow, supporting sustainable energy practices.

7. REFERENCES

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