Design and Development of Savonius Rotor Which Produce Electricity with Help of Water

RAJ DESAI [1], RAJ SHAH [2], ANSARI MAHFOOZ [3], VATSAL PATEL [4]
[1,2,3,4] *Dept. of Mechanical Engineering, Pacific School of Engineering, Sanki, Palsana, Surat*

Abstract- Waterotor is a device which converts the kinetic energy of flowing water into rotational mechanical energy and later on electrical energy. Waterotor are truly based on their design, configuration, etc. this prototype device can extract power from under water current viz. oceans, seas, canals. This device has found wide ranging of application that includes the handling of solid, liquid and viscous fluid without damaging the parts. This report is focused on the design, development and analysis of rotor. Designing of rotor blade is done by suitable software. The development of waterotor will carry out to influence the size of blade, blade angle, etc. new developed model imparts increases in efficiency and torque.

Indexed Terms - savonius rotor, water turbine, electricity, waterotor

I. INTRODUCTION

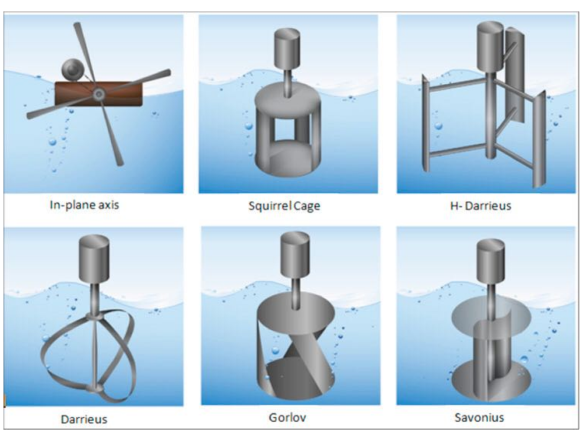
The developments of renewable energy especially wind energy become widely since 1973 due to the oil crisis issues. This view has been supported by Peter et al., (2008) who states that the oil price is forecasted to be raised in the future and thus water energy is an alternative energy sources. The water/wind turbine is a device that utilizes water/wind energy to generate mechanical or electrical power. there are two types of wind/water turbine: Horizontal Axis Wind/water Turbine (HAWT) and Vertical Axis Wind/water Turbine (VAWT). HAWT are most commonly known type of wind/water turbine and it operates parallel to the direction of the wind/water whereas VAWT rotor is operated perpendicular to the direction of wind/water. The two most common design principle of VAWT is Savonius type and Darrieus type. In satisfying demand of energy is reducing environmental impacts by the use of renewable energy resources are an important factor is to be continues. Decrease in cost and increase in efficiency it"s to be done for use of this source like solar, water resource and hydro power and also in practically eliminate the environment effects. For the implement it is require to large amount of capital and estate. Water rotors designed to rotate from Water energy typically are classified in two ways. Firstly bladed propeller type systems and secondly turbine type system that convert energy by the velocities higher than the speed of water to achieve mechanical or electrical power. For example, savonius turbine that converts the water flow speed directly into torque. The propeller type system through efficient, also require fast water speed and are costly and fragile usually it can operate a savonius rotor which works in very slow water speed and it is difficult to build and operate.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The design problem states that the team should do tests on counterfeit prototypes. So it is important to choose a potential energy site where we can test 5 the site. The selected site should be accessible, have a competent flow rate and the best flow characteristics. 1.7 SITE GENERATION On the basis of research, the flow of potential energy sources, it is necessary to select the site in which turbines will be located. A current operating speed of at least 2 m/s for efficient water generation and energy generation has been explored within multiple sources of new energy sources including Newfoundland and Labrador, which includes sea trends, recruitment currents and local rivers. 1.8 SITE SCORING PARAMETER DEFINITION To determine which site to go forward, sites were evaluated by a method known as site scoring. Site scoring is an extended screening system in which each site's analysis is based on the same criteria and then compared to it. Each site is scored in relation to each parameter, and each criterion or parameter is given importance or importance for the success of the project (11).The following are the site scoring parameters: Accessibility: Easy access to the site is essential because after the prototype has been fabricated, the team plans to test on the site. Flow Rate: The optimal flow for the marine current energy device was chosen to be more than 0.5 m/s. Flow Characteristic: Flow characteristic is an important factor because the flow direction affects the complexity of the current energy equipment. It is important to keep the design simple, thus, a proportional flow of more than double-directional or omni-directional flow is more favorable.

III. WRITE DOWN YOUR STUDIES AND FINDINGS

K. Sornes [1] in his paper have discussed various types of blade design. The axial flow turbine and cross-flow turbine being two most common small-scale concepts of the hydro-kinetic turbine. The axial concept has a rotational axis of the rotor which is parallel to the incoming water stream. The cross-flow concept, on the other hand, has a rotational axis of the rotor which is parallel to the water surface. The advantage of cross-flow turbines over axial flow turbine is that they can rotate un-directional even with bi-directional flow. Cross flow turbine can be divided into two groups, namely Vertical axis and In-plane axis. From which we are going to discuss namely six traditional types of blade design.



In the cross-flow turbine, the water passes through the turbine transversely, or across the turbine blade. It provides additional efficiency. Cross-flow turbines are often constructed as two turbines of different capacity that share the same shaft [1].

Which J. khan[2] has discussed about the in-plane axis in his research paper. In-plane axis is better known as floating water wheels. These are mainly drag based devices and inherently less efficient than their lift based counter parts. There is another problem with large amounts of physical access to such turbines. Darrieus turbine in-plane axis can also come under this category. But such systems are left common and suffer from bearing and power take off problems.

G. J. M. Darrieus [3] has presented two major types of Darrieus mechanisms. They differ on how they handle the centrifugal force imposed on the blade of the turbine, one is called Squirrel cage variant which consists of two disks at top and bottom with the airfoil running straight up and down between their rims. By this, the central power is controlled by the sturdy construction of the discs. The advantage of the turbine is to be able to progressively get into the rotation. the low Reynolds number is the disadvantages for it.

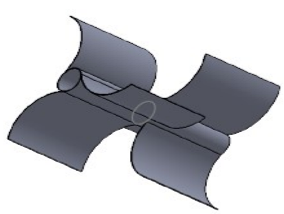
S. Roy et al [4] in his work have described H-darrieus turbine. H-Darrieus are a breed of vertical axis wind turbine designed by George Darrieus in 1920"s. They are capable of producing much power than the most typical wind turbine. H-Darrieus rotor is a lift type device having two or three blades designed as airfoils. The blades are attached vertically to the center shaft through support arms. The support to vertical axis helps rotor to maintain its shape. One major disadvantage of H-type Darrieus turbine is that since lift forces drive them that must be brought to a minimum speed before the forces generated as sufficient to propel the turbine. The initial torque coefficient is zero and at the lower signal Fig. 3 Squirrel cage Darrieus Fig. 4 H-Darrieus 8 ratio it is also negative. Therefore, a special motor is required to start the rotor, with the increase of height to diameter ratio, velocity magnitude difference from inlet up to rotor increases up to height to diameter ratio 1.0 and then decreases the loss of performance for a turbine with increases of height to diameter ratio. It can be concluded that velocity difference from inlet up to rotor is responsible for power stroke of blades during its clockwise direction. The Tip Speed Ratio of H-Darrieus turbine is high; hence, it rotates faster [5].

L. J. Hagen et al [6] in his research paper has summarized about Darries turbine. It was patented by Georger Jean Marie Darrieus, in 1931. Darrieus turbine is a vertical axis turbine. High rotating opened is achieved by the curvature of the blade. It is powered by the phenomenon of lift. There are major difficulties in making Darrieus turbine and making it self-starting. In Darrieus blade the airfoils are arranged to that they are symmetrical and also zero rigging angle. There is a problem in this turbine the angle of attack change of the turbine spins so that each blade generator max torque at two points in its cycle.

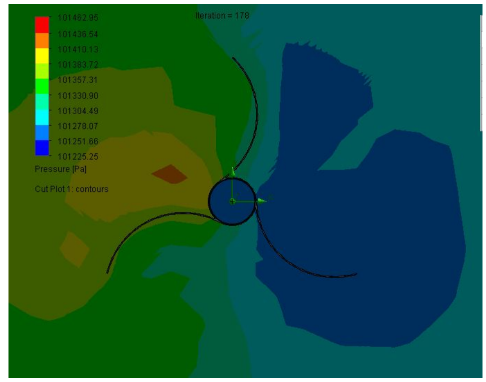
A. M. Gorlov [7] has patented information about Gorlov turbine also known as “cross flow helical turbine”. It is similar to Darrieus turbine. Gorlov reported from experimentally testing that maximum efficiency for Gorlov turbine is around 35%.

Dobreva et al [8] in his paper have briefed about Savonius turbine. It generates high torque at low speed. The maximum power coefficient is larger when rotation direction is water is clockwise for clearance ratio greater than 0.73.

In this paper, two kinds of simulation and analysis were done i.e. Computational Fluid Dynamics (CFD) Analysis and Structural Analysis by using Solid Works Flow Simulation and Solid Works Structural Simulation/Cosmo.



Savionous rotor



After the input data is ready, the model then is entering the meshing process. The meshing is viewed through a cut plot as shown in Figure. The fluid is experienced separation when it passes through the blade and this region is considered as high-gradient flow region. The mesh control is set to be finer in this region to obtain better solution accuracy.

IV. CONCLUSION

As an emerging renewable energy solution, comparative information on River Current Turbine systems is invaluable. This work attempts to summarize the state-of-the-art of hydrokinetic turbine technology. Advantages and disadvantages of various turbine rotor models have been discussed. From the survey, it is evident that the hybrids made for increasing the performance of traditional turbines can give better output as compared to traditional turbines. From the entire traditional the horizontal axis turbine has the maximum efficiency and vertical have the minimum efficiency. Waterotors (horizontal axis turbine) are truly based on their design, their configuration, etc. Large-scale waterotors requires high precision blades, high accuracy, which is difficult to manufacture. So designs of rotor blades are difficult and hence expensive.

REFERENCES

[1] K. Sornes “Small-scale Water Current Turbines for River Applications” ZERO-Zero Emission Resource Organization, pp.5-10, Jan 2010.

[2] J. Khan, “In-stream Hydrokinetic Turbines” Hydro volts institute Power. Tech. Labs, pp.004-012, 2006.

[3] G. J. M. Darrieus, “Turbine an axe de rotation transversal a la direction du courant, Brevet invention” pp.390-604, May 1926.

[4] S. Roy, A. Bisvas and R Gupta, “Computational Fluid Dynamics of a Twisted Airfoil Shape Two Bladed HDarrieus Turbine” International Journal of Energy and Environment, vol 1, Issue 6, pp.953-968, 2010.

[5] L. J. Hagen and M. Sharif, “Darrieus Turbine and Pump Performance for Low-Lift Irrigation Pumping” U.S. Department of Energy Federal Wind Energy Program, vol 1, pp.79-345, May 1982.

[6] M. Nakajima, S. Iio, and T. Ikeda, “Performance of Savonius rotor for environment friendly hydraulic turbine,” Journal of Fluid Science and Technology, vol. 3, no. 3, pp. 420–429, 2008.

[7] T. Ikeda, “Performance of double step Savonius rotor for environmentally friendly hydraulic turbine,” Journal of Fluid Science and Technology, vol. 3, no. 3, pp. 410–419, 2008.

[8] Stephen P. Santoro, “FLUID FLOW ENERGY CONCENTRATOR,” Santoro Wind Harvestor Inc., Rochester Hills, MI (US)