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Review Paper on Wind Turbine

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ABSTRACT

This paper presents advantageous concept of the present day situation, energy is a foremost necessity for human life. A wind turbine is a gadget which converts the kinetic energy of wind into mechanical energy. This mechanical energy can be used for many fields (such as grinding grain or pumping water) or for driving a generator that converts the mechanicalenergy into electricity that is supplied to the power grid users here we study of wind energy through the wind turbine mechanism. There is a must to cultivate non-conventional bases for power generation due to the purpose that our conventional sources of power are attainment scarcer by the day. This paper highlights on the knowledge that the kinetic energy receiving wasted while blades move can be used to produce power by using a special Windmills, wind pumps and sails to propel ships. Wind power as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation, and uses little. This engendered power can be used for general purpose uses like street lights, traffic signals etc. For obtaining the electricity through the wind turbine mechanism a prototype model is developed and studied. Finding from this research work is discussed in this paper.

Key words:-Wind Turbine

1.INTRODUCTION

If the effectiveness of a wind turbine is improved, then more power can be generated due to thispower wereduce the need for expensive power generators that cause atmospheric pollution. This would also decreasethe cost of power for the people. Power can be generated and stored by a wind turbine with no pollution. If the efficiency of the ordinary wind turbine is improved and widespread, the common people can cut back on their power costs immeasurably.

Ever since the Seventh Century people have been develop the wind turbine to generate electricity to make their lives easier. The whole concept of windmills is first originated in Persia. In the beginning people used the wind blades to irrigate farm land, crush grain and milling. This is probably where the word windmill came from.

Since the extremely use of windmills in Europe England and France during the Twelfth Century, some place such as the Netherlands have prospered from creating vast wind farms.

It is belief that windmills were not very reliable or energy efficient. Only half the sail rotation was utilized.Early 200 B.C. China used windmills to transport water and make grain they were usually slow and had a low tip speed ratio but were useful for transport.

Since its creation, man has regularly tried to develop the windmill. As a result, over the years, the number of blades on windmills has decrease. Most modern windmills have 4-6 blades while past windmills have had 8~12blades. Old modern of windmill was operate by hand, while present windmills can be automatically turned into the wind. The sail design and materials used to create them have also developed over the years.

There are various types of windmills, such as: the tower mill, Durries, sail windmill, sock mill, multi-blade, water pump, spring mill, savonius, cyclo-turbine, and the classic four-arm windmill. All of the above windmills have their advantages. Some windmills, like the sail windmill, are slow moving have a low speed ratio and are not very energy efficient compare to the cyclo-turbine. There have been many developments in the field of windmill over the years. Windmills have been capable of air breaks, to control speed in strong winds. Some vertical axis windmills have even been use with hinged blades to avoid the stresses at high wind speeds. Some windmills, like the cyclo-turbine, have been capable with a vane that senses wind direction and causes the rotor to rotate into the wind. Wind turbine generators have been capable with gearboxes to control [shaft] speeds. Wind turbines have also been capable with generators which convert shaft power into electrical power. But above all of these improvements in the field of windmill, the most important improvement to the windmill was made in 1745 when the fantail was invented. The fantail automatically rotates the sails into the wind.

2. LITERATURE SURVEY

The knowledge of availability of required components and their working is essential for implementation of the project. This chapter provides information about the wind mill theory and types which is important for designing of windmill.

Wind turbine aerodynamics must be designed for optimal output to exploit the wind energy. This problem remains both challenging and crucial. Much researches been conducted on Savonius rotors with two semi-cylindrical blades and S-shaped rotors with various flow parameters. Islam et al. [8] research of aerodynamic forces acting on a stationary S-shaped rotor and attempted to predict its dynamic performance. They measured the pressure distribution over the surfaces of the blades and found that flow separates over the front and back surfaces, and the point of separation depends on the rotor angle. They also found that the net torque becomes maximum at a rotor angle of $\alpha = 45°$ and negative while the rotor angleis between $\alpha = 135°$ and $\alpha = 165°$.

Diaz et al. [3] analyzed the pull and lift coefficients of a Savonius wind turbine to quantify the aerodynamic performance of the rotor. They found that maximum efficiency, in terms of power coefficient, occurs at a tip-speed ratio of $\lambda = 1$, and the drag coefficient decreases sharply when the tip-speed ratio increases or decreases from this value. They also found that the most important region of Savonius rotor operation occurs at a tip-speed ratio around $\lambda = 1$, wherethe lift coefficient remains as a constant 0.5. Sawada et al. [15] studied the mechanism of rotation of a Savonius rotor with two semi cylindrical blades and found that a rotor with gap ratio of 0.21 produces positive static torque at all angles. They also found that lift force contributes significantly to dynamic torque while therotor angle is between $\alpha = 240°$ and $\alpha = 330°$. Aldoss and Obedient [1] used the discrete vortex method to analyze the performance oftwo Savonius rotors running side-by-side at different separations. They compared their computational results on torque and power coefficients with their experimental results for verification.

Fujisawa and Goth [4] studied the aerodynamicdesign and performance of a Savonius rotor by calculating the pressure distributions on the blade surfaces at various rotor angles and tip-speed ratios. They found that the loaddelivered on the rotating rotor differs remarkably from those on the motionless rotor, especially on the convex side of the advancing blade, where a low pressure region is formed by the moving-wall effect of the blade. Torque and power performance, evaluated by integrating the load, were in close agreement with direct torque measurements.

Rahman et al. [11-13] experimentally studied aerodynamic characteristics, such as the torque and drag coefficients, of a three-bladed Savonius rotor model by measuring the pressuredifference between the convex and concave surfaces of each semi-cylindrical blade of the stationary rotor at different rotor angles and the variation of the separation point with theincrease of rotor angle. They used the static coefficients for dynamic prediction and comparedthe findings in terms of power coefficient for different tip-speed ratios with experimental resultsfor the two-bladed Savonius rotor.

Although the starting torque for Savonius rotors is high, it is not uniform at all rotorangles. The torque characteristics of an ordinary Savonius rotor have two problems. First, theyvary significantly at different rotor angles, causing the rotor to vibrate and consequently decrease its durability. Second, the torque at the rotor angle ranging from 135° to 165° and from 315° to345° is negative or very small, which hinders its use as a starter [6]. To decrease this torque variation and advance starting features, a new type of Savonius rotor was designed and fabricated by Hayshi et al. [7]. It had three stages, with a 120° bucket phase shift between adjacent stages. With this design, wind-tunnel tests showed that both static and dynamic torquevariations in one revolution were much smoother compared to an average one-stage rotor, whichgreatly improved the starting characteristics. They also calculate the torque characteristics of therotors with guide vanes and found that, on the average the guide vanes improved the torque coefficient in the low tip-speed ratio but decreased it in the high tip-speed ratio. They concluded that two- and three-stage conventional Savonius rotors could overcome the problem of negative torque. However, the maximum power coefficient decreases for this kind of design with morestages.To decrease the variation of static torque in conventional Savonius rotors with rotor angle ranging from 0° to 360°, Kamoji and Kedare[9] tested a helical rotor with a twist of 90°. They conducted experiments in an open-jet wind tunnel at gap ratios of 0.0, 0.05, and 0.08 to study theeffect of the overlap ratio and the Reynolds numbers on its performance to evaluate the statictorque, the dynamic torque, and the power coefficients. They compared its performance with andwithout a shaft between the different overlap ratios and end plate. A helical rotor without a shaftwas also compared with the performance of the conventional Savonius rotor. They found that allhelical rotors have a positive power coefficient of static torque for all rotor angles, but the rotorswith a shaft had a lower power coefficient than those without. The power coefficient of the rotorwithout a shaft with a zero overlap ratio was marginally less than the conventional Savoniusrotor. The rotor appeared to be sensitive to the Reynolds number, but this finding must be confirmed by rigorous experiments.McWilliam and Johnson [10] investigated various Savonius wind turbine models to observe the vortex formation and the effect of the scale of downstream wake using particle image velocimetery (PIV) in a close loop wind tunnel. In that experiment, they used standard Savonius design (diameter = 30.18 mm) with two semicircular blades overlapping. The design off these blades include deep blade design (diameter = 31.20 mm), shallow blade design (diameter = 28.04mm), outside J blade design (diameter = 32.97 mm) and inside J blade design (diameter =31.18 mm). They executed the experiment at a constant 3 m/s wind velocity. They observed thatvortex shedding from the following blade was common to all five designs they tested, which had an effect on the scale of the downstream wake of the rotor. They found that the forward curved blade was the critical area for external flow and the overlap ratio of Savonius wind turbine blades allows flow from the top blade to enter the bottom blade that reduces the negative pressure region behind the blades.

Saha et al. [14] fabricated a two-stage Savonius wind turbine by inserting valves on the concave side of the blades. They compared its performance with a conventional Savoniuswind turbine and found that with valves on a three-bladed turbine, the power coefficient was higher compared to a two-bladed turbine for both semi-circular and twisted blades. Without valves, airstrikes the blades and rotates them in a negative direction. They also varied the number of stages in a Savonius wind turbine and found that the power coefficient increase from a one-stage design to a two-stage design but decrease from a two-stage design to a three-stage design due to increased inertia. They tested twisted blades of one, two, and three-stages and found that threestagedesigns had a better power coefficient and the twisted-blade design showed better performance.

Gupta et al. [5] compared a three-bucket Savonius wind turbine with a three-bucket Savonius– Darrieus wind turbine. They found that the power coefficient of the combined turbines decreases as the overlap ratio increases. The maximum power coefficient of 51% was foundwhere there was no overlap. They claimed that the combined rotor without overlap, whichshowed 51% efficiency, was the highest efficiency of a Savonius wind turbine at any overlapcondition under these test conditions.

Altan et al. [2] did some experimental studies to improve the performance of theSavonius wind turbine using curtain. They placed curtain arrangement in front of the rotor in away that is capable of preventing the negative torque that affects the convex blade surface of theSavonius wind turbine.

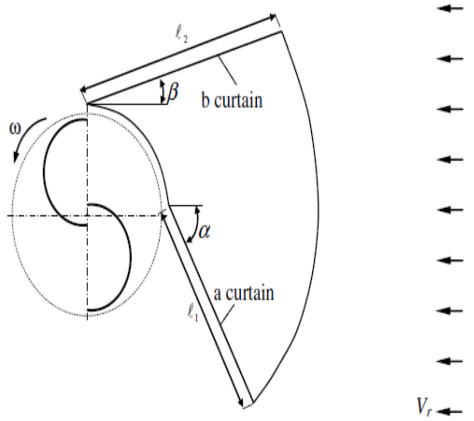

Figure2: Curtain positioning of Altan et al. experiment [3]

They performed the experiment with curtain and without curtain. They found that optimum curtain angle was α = 45° and ß = 45° where they achieved the highest powercoefficient. The numerical value for the power coefficient was 38% greater than the designwithout curtain. Other curtains also showed that the power coefficient can be improved by 16% compared to the design without curtains.

3. WORKING OF WINDMILL

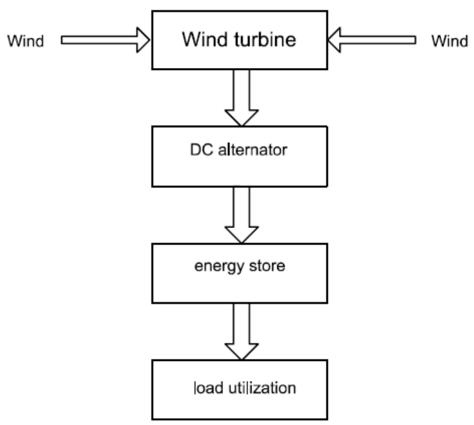

Fig- 3

The working of wind mill is very simple as the air comes in the structure, the working blades rotates which is connected to main rotor shaft by the supporting arms, the main rotor is coupled to a generator from where we can get the output.

The power in the wind turbine can be extracted by allowing it to blow past moving wings that exert torque on a rotor. The amount of power transferred is directly relative to the mass of the air, the area swept out by the rotor and the cube of the wind speed in wind turbine.

The air that travels through the swept area of a wind turbine varies with the wind speed and air density. As an example, on a cool 15°C (59°F) day at sea level, air density is about 1.22 kilograms per cubic meter (it gets less dense with higher humidity). An 8 m/s breeze blowing through a 100 meter diameter rotor would move about 76,000 kilograms of air per second through the swept area.

In wind turbine the kinetic energy ofa given mass varies with the square of its velocity. Because the mass flow wind increases linearly with the wind speed, the wind energy present to a wind turbine increases as the cube of the wind speed. The power of the example breeze above through the example rotor would be about 2.5 MW. As the wind turbine extracts energy from the air flow, the air is slowed down, which causes it to reach out and diverts it around the wind turbine to some extent.

At ground level wind velocity is low as compared to higher level, thus H.A.W.T are installed at higher level places. To contradict this concept, our project works on the principle of installing vertical axis savonius wind turbines at ground level itself where wind velocities are actually low but by mounting the wind turbine on moving locomotive, higher wind velocities can be achieved at ground level which makes the wind turbine to work in dynamic conditions instead of being stationary.

Thus the wind turbine is mounted on a locomotive and at various locomotive speeds gradually increasing wind velocities are obtained. Wind velocity increases on increase in locomotive speed. Using these wind velocities higher amount of mechanical power is generated which eventually goes on to generate more electrical power.

4.SCOPE FOR IMPROVEMENT

- Design of wind turbine can be studied and modified further for getting more than accurate power requirements.
- Effects of different materials of blades on speed of wind turbine is to be studied.
- Different shapes of wind turbine blades are needed to be studied to further enhance the power output.
- Use of Guide casing, guide blades and hinged doors can be done to provide direction to incoming wind on the blades and to protect the wind turbine rotor from any kind of external damage.

CONCLUSION

In conclusion, a wind turbine is a mechanism that converts the wind kinetic energy into electricity. The major working components of a wind turbine are: the gearbox, the rotor, the generator, protection system, the control, the tower and the foundation. Wind turbines are classified into two types of classes: horizontal axis wind turbine and vertical axis wind turbine. The advantage of a Vertical Axis Wind Turbine is that the wind can come from any direction; The disadvantage is the height limitations. The major benefit for a Horizontal Axis Wind Turbine is the high efficiency it has; The difficulty is the maintenance and restore at high altitude. Aerodynamically, the wind turns the rotor blades of the Horizontal Axis Wind Turbine because of the pressure gap between the top and the bottom of the airfoil. For the Vertical Axis Wind Turbine, it is the pull that acts on the blades and turns the rotor blades. Today, wind power is economically competitive compared to traditional energy because the cost of wind turbines is getting cheaper because of technology development. Wind energy is also a renewable and pollution free energy which can help us reduce the emissions of greenhouse gases. I believe that wind energy can become an important asset to solve climate change and global warming issues in the future.

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