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Design and Fabrication of Micro wind Turbine

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Abstract — **With recent surge in fossil fuel prices and demand for cleaner renewable energy sources, wind turbines have become an alternative technology for power generation. Greenhouse gases such as carbon dioxide (CO_2) emitted into the atmosphere contribute to the global climate change. This paper investigates the design of a Savonius type vertical axis wind turbine and its potential to generate power. A savonius wind turbine is designed and fabricated using the locally available materials. Then the actual power is measured at different wind speeds and finally the power coefficient is determined. The blade shape is taken as spiral involute .**

Keywords - **Savonius, power coefficient, spiral, involute.**

I. INTRODUCTION

Vertical-axis wind turbines have the main rotor shaft running vertically. Key advantages of this arrangement are that the generator and gearbox can be placed at the bottom, near the ground, so the tower doesn’t need to support it, and that the turbine doesn’t need to be pointed into the wind. Drawbacks are usually pulsating torque that can be produced during each revolution and drag created when the blade rotates into the wind. It is also difficult to mount vertical-axis turbines on towers, meaning they must operate in the often slower, more turbulent air flow near the ground, resulting in lower energy extraction efficiency. The main objective of this paper is design and fabricate a low wind speed involute spiral wind turbine and to find the power generated.

II. SAVONIOUS WIND TURBINE

A. Conventional Savonius Design

The Savonius turbine is one of the simplest turbines. Savonius wind rotor is one of the vertical axis wind turbines. It is simple in structure, has good starting characteristics, relatively low operating speeds, and an ability to capture wind from any direction. But it has a low aerodynamic efficiency[1]. Kamoji et al. [2] examined helical Savonius rotors in an open jet wind tunnel. From their results, the helical rotors with shaft have lower power coefficient than the helical rotors without shaft. Saha et al. [3] carried out a comparison between Savonius rotor with different geometries. They reported that, the optimum number of blades is two for the Savonius rotor whether it is single-, two- or three-stages. Twisted geometry of the blade profile has a good performance as compared to the semicircular blade geometry.

The differential drag causes the Savonius turbine to spin. Because they are drag-type devices, Savonius turbines extract much less of the wind's power than other similarly-sized lift-type turbines. Much of the swept area of a Savonius rotor may be near the ground, if it has a small mount without an extended post, making the overall energy extraction less effective due to the lower wind speeds found at lower heights. A savonius wind turbine used normally is shown below in Figure1.

Figure 1:View of Savonius rotor

A conventional Savonius wind rotor has blades formed from two half cylinders in rotation around a vertical axis with or without a gap in between[4]. The wind force is exerted on both the convex blade and concave blade as shown in Fig. 2.

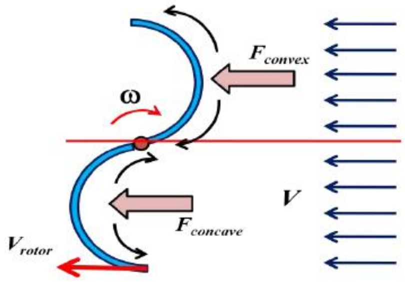

Figure 2: Direction of the torque affecting on the rotor blades by the wind force.

The savonius turbine works due to the difference in forces exerted on each blade.The half cylinder with concave side facing the wind will experience more drag force than the other cylinder, thus forcing the rotor to rotate. The differential drag causes the Savonius turbine to spin.

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B. Modified Blade design

The mast is connected to the supporting column. The three involute spiral wind turbine blades are connected to the turbine shaft with 120 degree dividing gap. Then this turbine shaft along with the blade attachment are connected to the top of the central mast bearing. Another end of the turbine shaft is connected to the supporting bearing of the turbine base plate. To the bottom of the turbine shaft, the driving rim is also connected. A small d.c generator is fitted to the one supporting column.

The wind flows over the spiral wind turbine blade. According to the wind speed, the wind turbine shaft rotates and at the same time the rim also starts rotating. A small d.c generator pulley rolls on the driving rim. Due to the friction, the generator power will be automatically produced.

Aluminium is a silvery white metal with a density about a third that of steel. Aluminium is a low price metal and has good reliability but low tensile strength. Aluminum alloy (T6) is used in the rotor construction[5] .

Figure 3: Involute spiral wind turbine blade model

The wind turbine base plate supports the wind turbine shaft and turbine columns.The material properties for the base plate is given below.

Material- Mild steel S45C
Density (kg/m^3) :7700-8030
Young's Modulus (GPa) :190-210
Tensile Strength (Mpa) : 569
Yield Strength (Mpa) : 343

The design details of the wind turbine is as follows .

Turbine Base plate
Base plate material : Mild steel
Plate thickness : 2.5mm
Inner circle diameter : 30mm
Outer circle diameter : 560mm

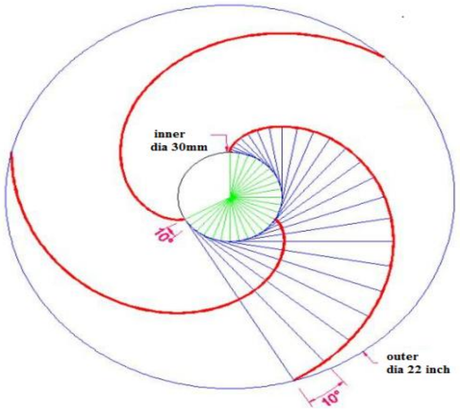

Figure 4: Turbine Base Plate

Turbine Blade
Material : A T-6 tempered aluminum.
Height : 786mm
Thickness : 1.5mm

Shaft
Material : Mild steel shaft.
Diameter : 19 mm.
Length : 890 mm

NBC Bearing
Inner Diameter : 19 mm
Outer Diameter : 50 mm

III. POWER EXTRACTED FROM THE WIND

The power that the rotor can extract from the wind P_w is less than the actual available from the wind power P_a . In order to calculate the performance of this wind machine, its configuration is essentially important.

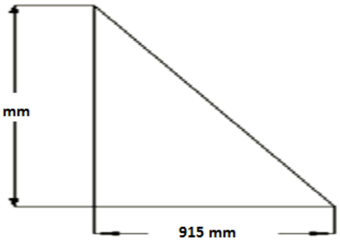

Figure 5: Rotor sheet area

$$\text{Area} = \frac{1}{2} \times b \times h$$

$$= \frac{1}{2} \times 0.915 \times 0.786$$

$$= 0.359\ \text{m}^2$$

The total power available in wind [6] at 4 m/s

$$P_a = 0.5 \times \text{Area} \times \text{Density} \times \text{Velocity}^3$$

$$P_a = 0.5 \times 0.359 \times 1.23 \times 4^3$$

$$P_a = 14.13 \text{ watts}$$

Practically, when the turbine is placed at 4 m/s inlet velocity and an outlet is 2m/s the power that can be extracted from the wind is found by the following methodology. The average wind speed through rotor area

$$V_{avg} = \frac{V_1 + V_2}{2}$$

where V_1,V_2 are the inlet and outlet wind speed in m/s

The mass of the airflow through the rotor area is given by

$$m = \rho A\left(\frac{V_1 + V_2}{2}\right)$$

$$\text{Kinetic energy} = m\frac{V^2}{2}$$

Therefore the power extracted,[7] P_W is given by

$$P_W = \frac{1}{4}\rho \times \left(V_1^2 - V_2^2\right) \times \left(V_1 + V_2\right) \times A$$

P_w = 7.94 watts

C_p [6] , the power coefficient is defined as the ratio of the power produced by the turbine to the power available in the wind.

$\boldsymbol{C_p} = P_w / P_a$

$\boldsymbol{C_p} = 0.56$

The figure 6 shows the relation between power obtained and the wind speed .The figure 7 shows the relation between rotor speed and voltage .

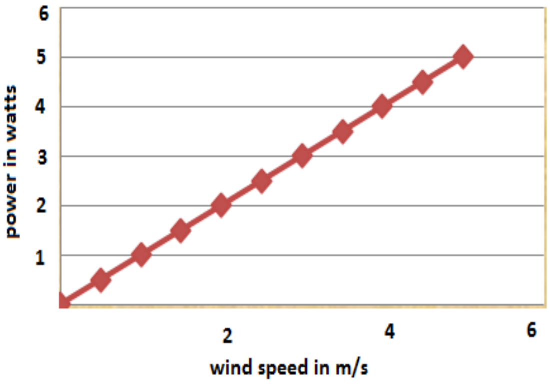

Figure 6: Power Vs wind speed

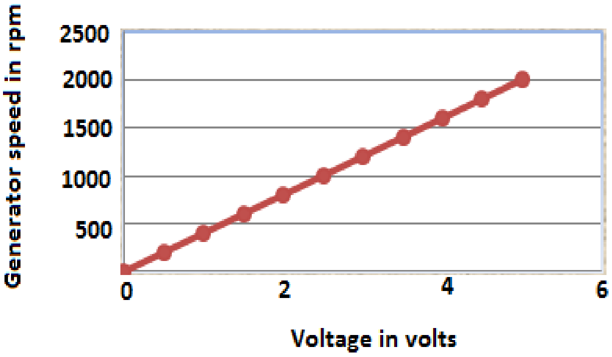

Figure 7: Generator rotor speed Vs voltage

IV. CONCLUSION

In this project, for the performance improvement of a vertical axis wind turbine, a different profile of the blades is analysed .For this model, the involute spiral blade system and the individual blade control system are applied respectively to improve its performance. By using the involute spiral method, the power output is improved about 30% comparing with other type blade.If more optimal involute spiral is used, more power would be generated, and other aerodynamic, structural and electrical variables could be considered for better power generation.

REFERENCES

[1] N.H.Mahmoud, A.A.El-Haroun, E.Wahba and M.H. Nasef, An experimental study on improvement of Savonius rotor performance, Alexandria Engineering Journal (2012) 51, 19–25

[2] M.A. Kamoji, S.B. Kedare and S.V. Prabhu, Performance tests on helical Savonius rotors, Renewable Energy (2008) 34, 521–529.

[3] U.K. Saha, S. Thotla and D. Maity, Optimum design configuration of Savonius rotor through wind tunnel experiments, Journal of Wind Engineering and Industrial Aerodynamics (2008) 96 , 1359–1375.

[4] Mohammed Hadi Ali, Experimental Comparison Study for Savonius Wind Turbine of Two & Three Blades At Low Wind Speed, International Journal of Modern Engineering Research (IJMER), Vol. 3, Issue. 5, Sep - Oct. 2013, pp-2978-2986.

[5] Norzanah Rosmin, Ahmad Safwan Jauhari, Aede Hatib Mustaamal, Faridah Husin and Mohammad Yusri Hassan, Experimental study for the single-stage and double-stage two-bladed Savonius micro-sized turbine for rain water harvesting (RWH) system, Energy Procedia(2015)68, 274 – 281.

[6] R. D. Maldonado, E. Huertab, J. E. Corona, O. Cehb, A. I. León-Castillo, M. P. Gómez-Acosta and E. Mendoza-Andrade, Design, simulation and construction of a Savonius wind rotor for subsidized houses in Mexico, Energy Procedia (2014) 57,691 – 697.

[7] Abdul kadir Ali, Steve Goldeb, Firoz Alama, and Hazim Moriaa, Experimental and Computational Study of a Micro Vertical Axis Wind Turbine, Procedia Engineering (2012) 49, 254 – 262.