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Research Paper on Modified Savonius Vertical Axis Wind Turbine

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Abstract- This paper presents the fabrication of Savonius vertical axis wind turbine to generate electrical energy from wind energy. Wind energy is the main source of renewable energy this resource widely used an alternative energy. This paper is focused increasing maximum efficiency by using savonius vertical axis wind turbine. In recent era, research and development activities in the field of renewable energy, especially wind and solar, have been considerably increased, due to the worldwide energy crisis and high global emission. The horizontal axis wind turbine cannot be used for household purpose. So, Savonius vertical axis wind turbine can be better option as it operate in low wind condition also. The choice for this model is to showcase its efficiency in varying wind conditions as compared to the traditional horizontal axis wind turbine and contribute to its steady growing popularity for the purpose of mass utilization in the near future as a reliable source of electricity generation. Apart from importing a few from outside, new designs were also developed one of the best is savonius vertical axis wind turbine give maximum output with low wind velocity at minimum cost. Wind power is sustainable and the production of electricity using wind energy is increasing day by day due to lack of availability of fossil fuels. The energy can be converted into electricity by using Savonius vertical axis wind turbines (VAWT).

Key Words: Renewable energy, VAWT, Savonius, HAWT, Household, permanent magnet DC motor Wind Power.

1. INTRODUCTION

The idea of this turbine was proposed by Sigurd Johannes Savonius in 1922 .but for many years it was not widely applied. However, recently its popularity has steadily grown. This results from the increasing significance of urbanized areas, which have specific demands. The Savonius rotor seems to satisfy these particular expectations. The Savonius rotor is widely considered to be a drag driven device. This indicates that the wind drag, acting on its blades, is the only driving force. However, it has been observed that at low angles of attack the lift force also contributes to the overall torque generation. Thus, it can be concluded that the Savonius rotor is not a solely drag driven machine but a combination of a drag-driven and lift-driven device. Such device have relatively high starting torques compared to lift device because of their higher solidity, but have relatively low tip-to-wind speeds and lower power outputs per given rotor size, weight and cost. The main virtue savonius vertical axis wind turbine is that it tends to rotate within a small range of velocity under all condition, so its rotational speed is closely proportional to wind speed. The savonius rotor works on a principle similar to that of the cup anemometer but is adopted to produce shaft power. They will react to wind from any direction therefore not need yawing equipment to turn the rotor into the wind. This type of turbine has become popular since it requires relatively low velocity wind for power generation. [3]

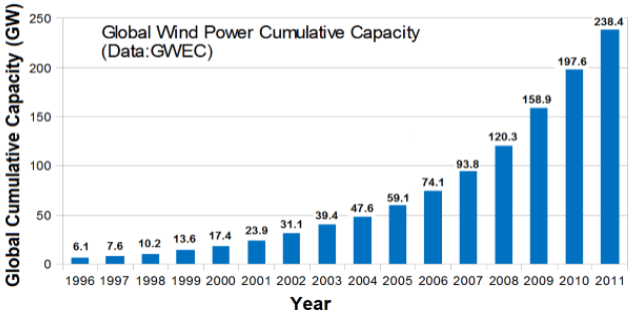
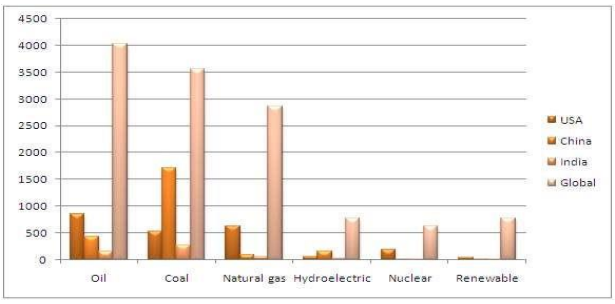


Fig.1. Global Graph treads in wind energy [2]

Day by day increase the utilization of wind energy as an alternative souse of other fossil fuel.

Fig.4. Graph showing energy consumption pattern in million tones oil equivalent [6]



2. LITERATURE REVIEW

Recent uncertainties in the world's energy market due to reduction of fossil fuel sources, global warming threats and increasing the price of fossil derivatives impose the need of harnessing the clean and renewable source of energy. In this context research in the field of wind energy is becoming particularly important hence the main reason of considering Savonius wind turbine is because of its

high starting torque at low wind velocity. Many modifications have been made on conventional Savonius wind turbine rotor blades; even though there is a problem of negative torque exists. In the present work experimental conventional savonius wind turbine is considered as a reference to validate the result. the static torque and analyze the pressure and velocity distributions are studied. The modification is done on conventional savonius rotor by introducing splitter. Splitter savonius wind turbine which is helpful for proper pressure and velocity distribution in rotor, thereby increasing the 5% improvement in power coefficient as compared with conventional Savonius wind turbine. In order to reduce the negative torque three different stationary guide vanes are analyzed in terms of velocity and pressure distribution with different velocity conditions and finally optimized Curved stationary guide vane selected for the splitter savonius rotor.[6]

3. COMPONENT OF SAVONIUS VERTICAL AXIS WIND TUBINE

3.1 Rotor

The rotor is only one of the main important components. For an effective utilization, all the components need to be properly designed and match with the rest of the component.

3.2 Bearings

Bearing is to reduce rotational friction and support radial and axial loads. Bearing is a machine element that constraints relative motion to only the desired motion, and reduce friction between moving parts.

3.3 Metal sheets

Metal sheets used for designing the blades. It is one of the fundamental forms used in metalworking, and can be cut and bent into a variety of different shapes.

3.4 Chain

Chain is the element joining a two wheel and transmits power between the driving to driven.

3.5 24V PMDC Motor

In electricity generation, an electric generator is a device that converts mechanical energy to electrical energy. The reverse conversion of electrical energy into mechanical energy is done by an electric motor, and motors and generators have many similarities.

3.6 Shaft

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one pan to another. The various members such as blade, pulleys and gears are mounted on it.

3.7 Sprocket wheel

This is power a transmission element it is also connected to shaft and it transmits power through chain drive.

4. BLADE SELECTION

Blade selection is one of the major steps in the design of a wind turbine. Blades convert kinetic energy from the wind into rotational energy in the turbine shaft. Vertical axis wind turbines are of generally two types- drag machines and lift machines. Drag machines move slower than the wind, have low efficiency and are self-starting, while in case of lift machines blade speeds are greater than the wind speed and are more favourable from an energy production view point but they are not self starting [3] To maximise power extraction, the use of cambered or angled blades is beneficial because such profiles will significantly increase the performance in the upwind where most of the power is produced. [4]

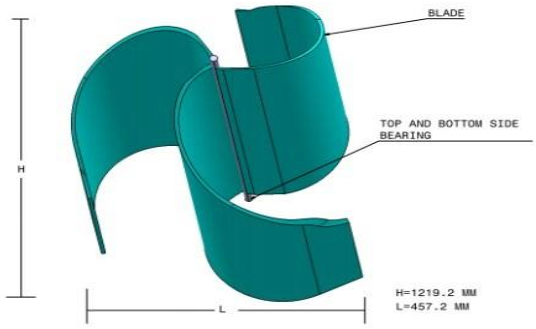


Fig.3 Final Blade Shape

3.1Parameters Consider While Designing VAWT

The Speed	-	Diameter
Start up Speed	-	Number of blades
Cut in Speed	-	Tip speed Ratio (TPR)
Voltage regulation	-	Taper
Battery Bank Voltage	-	Pitch and Twist
Inefficiency	-	Bearings
Blade Material	-	Aluminum

5. CONSTRUCTION

Firstly we consider the design of wind mill, after that we select the material required for wind mill. For fabrication of power mill, we seem 8 feet them we select Mild Steel square pipe for making the frame, and 4 x 2 feet aluminum blade the sheet cut in three pieces that is 4 feet height and 2 feet width of the one blade. There is a three blade are made of this aluminum sheet semi-circular in shape we used three blade for the operation of wind mill. These blades are arrange perpendicular to each other and welded to a shaft the shaft is 5 feet long with mounted two bearing one is top side and other is bottom side. The shaft and blade are connected with the help of nut and bolt to each other.After that we arrange the blade, shaft and bearing properly.This shaft is fitted in the two bearing. All these devices are fitted in the metal frame. The PMDC motor is also fitted on foundation. The sprocket wheel also connected to the

blade shaft. The rotation of PMDC motor and sprocket wheel is 1:3 ratios. The bearing is fixed on mild steel pipe. The MS pipe is fixed and not rotating. These wind mill fixed structure like table with help of ms square pipe welding.

6. WORKING OF SAVONIUS VAWT

A savonius vertical axis wind turbine has its axis perpendicular to the wind streamlines and vertical to the ground the savonius rotor operate lower tip speed ratios than lift-based. It consists of three-half-cylinder facing opposite direction in such a way as to have almost an S-shaped cross section. These three-semi circular blades are mounted on a vertical axis perpendicular to the wind direction with a gap at the axis between the three blades. To make a shaped they overlap to leave a wide space between the tree inner edges is near the central axis of the opposite half cylinder as shown in figure.

In the High velocity wind and middle part of the terrace will Strikes wind turbine blades and make a rotation in it The wind turbine blade will rotate at clockwise direction even when the wind move in any of the side of the terrace .because the arrangement of the wind turbine blades are in that manner. The vertical axis savonius wind mill the wind blade turbine is attached with the permanent magnet DC motor. One is in is at the bottom of the wind turbine blades. when the turbine blade rotate the attached PMDC motor will generate electricity in both way Thus, the mechanical energy is converted into electrical energy by using PMDC Motor and this produced power is stored in the battery and is utilize for street light, charging port for electric vehicle, traffic signals and many applications[2].

7. FIGURE

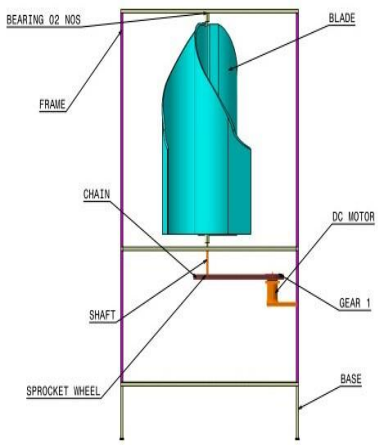


Fig.4. Model of savonius VAWT.

7. ADVANTAGES

1. Ability to operate in a wide range of wind conditions (turbulence level, wind speed)
2. Independence on wind direction, no additional control mechanisms are required.
3. Compact size.
4. Low noise emission.
5. Simple and cheap construction.
6. Electrical equipment can be placed at ground level.
7. High starting torque.

8. THEORETICAL CALCULATION OF CONVENTIONAL SAVONIUS WIND TURBINE

The electrical current produced by a wind turbine is quantified in terms of power, usually in units of watts. Equations have been developed for the purpose of predicting the amount of power a wind turbine will generate.

Swept area of the wind turbine (A) = (D x H)

Free wind power (P_{wind}) = $1/2\ \rho A s V^3$

$P_{rotor} = C_{p\ max} \times P_{wind}$

9. TABLE

Table1. Actual performance of Savonius rotor

Wind velocity 'V'(m/s)	Speed in (rpm)	Current in (Amp)	Voltage in (Volts)	Electrical Power in (Watt)
1.7	121	2.49	1.23	3.45
2.5	160	3.01	1.5	4.51
3.7	217	4.38	3.1	13.57
3.81	220	5.34	4.3	22.92
4.1	298	6.47□	5.30	35.88
4.65	316	6.12	5.77	35.31
4.9	324	6.183	5.83	36.4
5.27	363	6.10	5.79	35.49
5.45	348	6.12	5.77	35.31
5.5	365	6.37	5.98	38.11
6.1	385	9.035	7.2	63.42
6.3	393	8.11	5.69	58.06

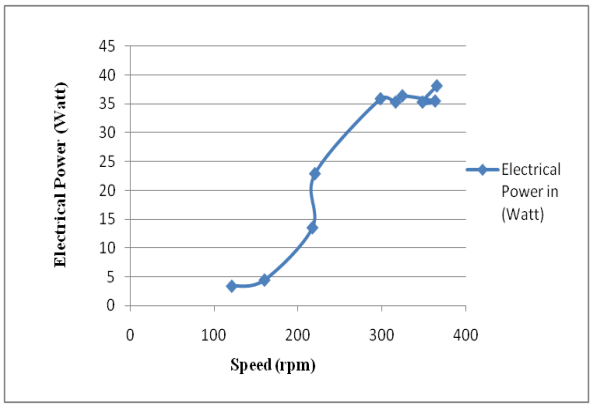
Acknowledgments

It gives me great honor and satisfaction in presenting this comprehensive research on "Fabrication of Savonius Vertical Axis Wind Turbine". I will always be thankful to my project guide Prof. K.R. Sontakke for his advice and guidance in this work and his tireless support in ensuring its completion. I would also like to express my thanks to Mechanical Engineering Department and the faculty members for their precious support.

10. CONCLUSIONS

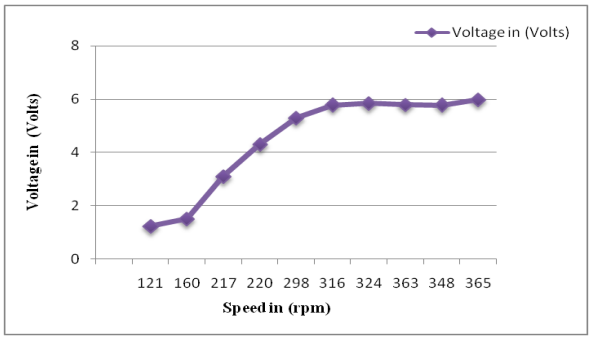
The wind energy generated by the moving blade can be utilized to generate electrical energy which can be stored in a battery and used for purposes like street lighting, Electric Car charging etc. This design concept is meant to be sustainable and environmentally friendly. In this way are concluded average power is 25.12 Watt. If these types of turbines can be installed on terrace, long high speed express highways like golden quadrilateral, a considerable amount of electrical energy can be generated, which can solve the issue of energy crisis to a large extend.

Appendix A



Graph: 1 Electrical Power Vs Speed

Appendix B



Graph: 2 Voltage Vs Speed

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