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Design And Fabrication Of Flapping Panel Vertical Axis Wind Turbine

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Abstract— **In a developing nation like India, electricity has become one of the most important basic needs nowadays. Coal and gasoline based power generation capacity stands at 71% in India, which contributes to a considerable part of air pollution. There are various renewable energy sources which are pollution free, one among them is the wind energy. So the main objective of the project is to facilitate pollution free power generation for individual purpose. In order to understand the problem and working, a flapping panel vertical axis wind turbine was designed. The advantage of using a vertical axis wind turbine over a horizontal axis wind turbine is that, the turbine need not be pointed towards the wind to be effective. The flapping panel wind turbine is designed using solidworks software and analysed using Ansys Fluent. By making use of the wind, the flapping panels attached to the shaft rotate and the rotor is connected to the permanent magnet electricity generator (PMG). The PMG converts the Kinetic energy of the rotor shaft into electrical energy. The PMG we have used has the capacity of producing maximum power at 1200rpm. On calculating theoretically, the power output is found to be 8W for the rotation of 76.39 rpm and for 1200rpm the power output is calculated to be 125W. The entire wind turbine setup is compact in size and can be easily mounted and erected.**

I. INTRODUCTION

A wind turbine converts the wind's kinetic energy into electrical energy. Wind turbines are manufactured in a wide range of vertical and horizontal axis. The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid. Arrays of turbines known as wind farms are becoming an increasingly important source of intermittent renewable energy and are used by many countries as part of a strategy to reduce their reliance on fossil fuels. One assessment claimed that as of 2009, wind had the "lowest relative greenhouse gas emissions, the least water consumption demands and the most favourable social impacts" compared to photovoltaic, hydro, geothermal, coal and gas.

A. LITERATURE REVIEW

1. Shivprakash Bhagwatrao Barve, through his research he found out that, High rotor efficiency is desirable for increased wind energy extraction and should be maximized within the limits of affordable production. Energy carried by moving air is expressed as a sum of its kinetic energy. The magnitude of energy harnessed is a function of the reduction in air speed over the turbine. 100% extraction would imply zero final velocity and therefore zero flow. The zero flow scenario cannot be achieved hence all the winds kinetic energy may not be utilised. This principle is widely accepted and indicates that wind turbine efficiency cannot exceed 59.3%. This parameter is commonly known as the power coefficient Cp, where max Cp = 0.593 referred to as the Betz limit. The Betz theory assumes constant linear velocity. Therefore, any rotational forces such as wake rotation, turbulence caused by drag or vortex shedding will further reduce the maximum efficiency.

2. Toms Komass, From his research he concluded that, Pitch System Using Matlab Tools, Institute of Agricultural Energetic In the course of this research the vertical axis wind turbine (VAWT) pitch system simulation model has been designed and verified using the MATLAB SIMULINK tool for blade aerodynamic force simulation. The research is based on the study of the Darrieus type VAWT blade force vector calculations, which provided the basis for building the mathematical model. It includes the mechanical model of the turbine blade force and torque simulation with and without the pitch control system. The main goal of the research achieved and the designed model was successfully verified by analytical results. The results show that the simulation is using correct pitch system calculations. It allows analysis of specific VAWT force vectors and torques. The calculations can also be used in transient process simulation for the real turbine with many blades over one rotor.

3. Robert E. Akins, Dale E. Berg, W. Tait Cyrus, From their research they found out the following, The measurements of aerodynamic torque on a vertical-axis wind turbine. Accelerometers mounted at the equator of the rotor and a torque meter mounted at the base of the rotor were used to compute the net aerodynamic torque acting on the rotor. Assumptions concerning blade- response symmetry were required to achieve blade torque as a function of rotor

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position on each half of a revolution for a two-bladed rotor. Results are presented for tip-speed ratios from 2.5 to 8.0 for two turbine rotational speeds. Evidence of dynamic stall is observed at low tip-speed ratios

4. M. Ragheb, his research was about Vertical axis wind turbine becomes unstable above certain height. The Largest horizontal wind turbines are capable of producing 6MW of power and stand just short of 100m tall, but if made any bigger they start to become less efficient. One reason is that the weight of the turbine blades becomes prohibitive. As they turned, this places the blades under enormous stress, because gravity compresses them as they rise and stretches them as they fall. Advantages of VAWT's are that they can catch the wind from all directions eliminating the need for the yaw mechanism. In addition, they can be built lower, so they are less visible and they can withstand much harsher environments.

5. Shraddha R Jogdhankar, S.D. Rahul Bhardwaj, he found out that In the recent era of rapidly developing technology the design of this vertical axis wind mill generator can be able to full fill certain amount of energy requirements generators can also replace the costly and less efficient solar panels. Having a nature of abundance unlike employment of resources in conventional methods satisfies the growing needs. Wind energy depends upon natural terrains which have wind potential, though these terrains are not found even in nature everywhere, but those which have, are the places that can be harnessed for high potential power generation. Taking into consideration the geographical attributes of our region, the vertical axis windmill will be efficient for power generation. The basic reason for using VAWT is that, it does not consider the wind direction and operates at low wind speed.

6. Prince safo, his approach was about the data collected on the wind energy technology all over the world suggest that the interest and demand for wind energy is increasing and that has also caused the technology to advance rapidly to a point where better ways of building and applying the technology has been uncovered. The technology was found to be good for the environment especially Africa because it will provide enough energy to satisfy the people cutting down trees for fuel and also because it has the best recycling among the other renewables energy. Wind energy technology was found to be the best for the Ghanaian environment in helping to solve their energy crisis.

7. Muthu Manokar.A, he concluded that the conviction that vertical axis wind energy conversion systems are practical and potentially very contributive to the production of clean renewable electricity from the wind even under less than ideal sitting conditions. Constructed used high-strength, low in more developed nations and settings or with very low tech local materials and local skills in less developed countries.

8. Marco Raciti Castelli, Stefano De Betta and Ernesto Benini, they researched and concluded that the Small Vertical Axis Wind Turbine Designed for the use of Industry purposes. The power produced by VWAT is 3.5 kW with the range of 6<=velocity<=20.

9. R. Bravo, S. Tulis, S. Ziada, In this paper, they reduced the Torque variation by increasing the Number of blades. The torque and Power Characteristics are compared. The aerofoil cross-section of Vertical Axis Wind Turbine is automated process. The change in the geometry, solidity of the Blade designs is very helpful to increase the efficiency of the VAWT. It covers an Analytical and Experimental investigation of torque ripple in the Darreius vertical axis wind turbine.

10. Javier Castillo, A low solidity wind turbine may present self-starting problems as rotor efficiency is poor at low tip speed ratios. Tip speed ratios are higher when the wind speed is low. Compact for same electricity generation, less noise, easy for installation and maintenance and reacts to wind from all directions materials must be less in weight, high strength. It provides nearly half the value of theoretical efficiency. For 4.5m/s winds, it provides nearly 48watt, for which the theoretical value is 70 watts.

II. PROBLEM DEFINITION

The power demand is increasing everyday due to the enormous growth in population. The majority of the power supply is produced through coal and thermal based power plants, which accounts for a considerable part of the pollution. Hence there were alternatives like the wind energy, solar energy, etc.., which are renewable and pollution free. But the cost of initial investment to harvest these renewable sources of energy is very high. So, it is not accessible to a average person.

Design Objectives

- The main aim is to generate pollution free electricity from renewable sources.
- To design a wind turbine, that does not depend on the direction of the wind.
- To generate electricity from slower and higher wind speeds.

MATERIALS

Mild steel

Mild steel, also known as plain-carbon steel and low-carbon steel, is now the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. It is iron containing a small percentage of carbon, strong and tough but not readily tempered. Mild steel contains approximately 0.05–0.25% carbon making it malleable and ductile. Mild steel has a

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relatively low tensile strength, but it is cheap and easy to form; surface hardness can be increased through carburizing.

Reinforced fiber

A polymer is generally manufactured by step-growth polymerization or addition polymerization. When combined with various agents to enhance or in any way alter the material properties of polymers, the result is referred to as a plastic. Composite plastics refers to those types of plastics that result from bonding two or more homogeneous materials with different material properties to derive a final product with certain desired material and mechanical properties. Fibre-reinforced plastics are a category of composite plastics that specifically use fibre materials to mechanically enhance the strength and elasticity of plastics. The original plastic material without fibre reinforcement is known as the matrix or binding agent. The matrix is a tough but relatively weak plastic that is reinforced by stronger stiffer reinforcing filaments or fibres. The extent that strength and elasticity are enhanced in a fibre-reinforced plastic depends on the mechanical properties of both the fibre and matrix, their volume relative to one another, and the fibre length and orientation within the matrix. Reinforcement of the matrix occurs by definition when the FRP material exhibits increased strength or elasticity relative to the strength and elasticity of the matrix alone.

III. COMPONENTS

Frame

It is a rigid body that supports the blades of the turbine.
Mild steel tubes- square
Cross section Base 500*20mm

Blade tip pin

It is fixed to the frame, that keeps the blades in place. Mild steel – 40mm

Blade

It is fitted to the blade tip pin.
Reinforced fiber - 450*200*3mm

Plummer block

It is fixed on the stand to support the shaft.
Internal dia Ø20mm and External dia Ø40mm
.

Shaft

It is a rotating machine element, which is used to transmit the torque.
One end of the shaft is connected to the permanent magnet generator.
Steel Ø43 mm and 500 mm length

Ball Bearing

It is used for holding rotating blades with help of bearing and other parts.
Dimension – Internal dia Ø12mm and external dia Ø24mm

Square plate is used to support the bearings in which the blades are inserted.
Dimension- 50*40mm

Nut

It is a hollow material where bolts are inserted. Mild steel Ø6 mm

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Bolt

It is moved inside nut. It has head, shank, thread portion.

Mild steel Ø10 mm

Stand

It is used to support the entire turbine setup.

Mild steel – 500mm height

Permanent magnet Generator

A permanent magnet synchronous generator is a generator where the excitation field is provided by a permanent magnet instead of a coil. The term synchronous refers here to the fact that the rotor and magnetic field rotate with the same speed, because the magnetic field is generated through a shaft mounted permanent magnet mechanism and current is induced into the stationary armature.

The phases are wound such that they are 120 degrees apart spatially on the stator, providing for a uniform force or torque on the generator rotor. The uniformity of the torque arises because the magnetic fields resulting from the induced currents in the three conductors of the armature winding combine spatially in such a way as to resemble the magnetic field of a single, rotating magnet. This stator magnetic field or "stator field" appears as a steady rotating field and spins at the same frequency as the rotor when the rotor contains a single dipole magnetic field. The two fields move in "synchronicity" and maintain a fixed position relative to each other as they spin.

PMG Rotor

• Is a field that induces voltage in the PMG stator.

• Poles are permanent magnets.

• Mounted on the shaft with the main rotor.

PMG Stator

• Is an armature that provides power to the regulator

• Induced by the PMG rotor.

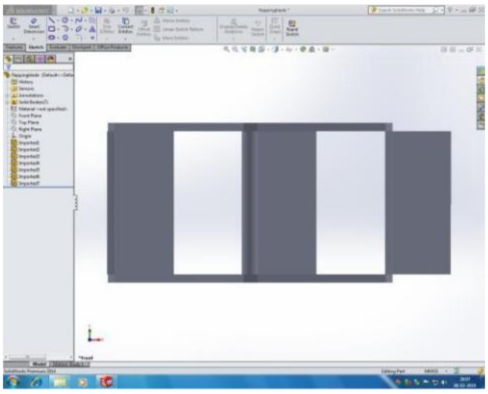
• Typically has random-wound coils in a laminated steel core.

• Various configurations: – Wound cores in a frame – Wound cores with no frame – Combined with the exciter stator in one frame

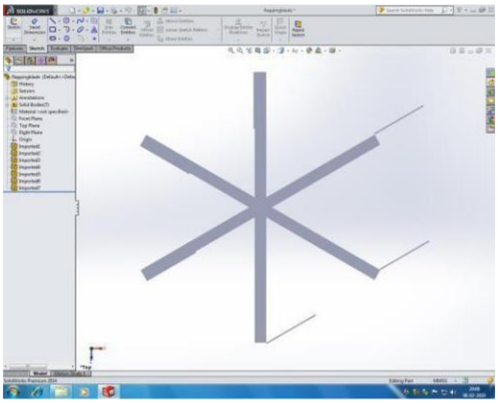
• Mounted on an end bracket (opposite side of prime mover).

IV. DESIGN AD MODELLING

Modelling software is used to show case the product in batter ways for understanding before the fabrication part is done.



Front View



Top view

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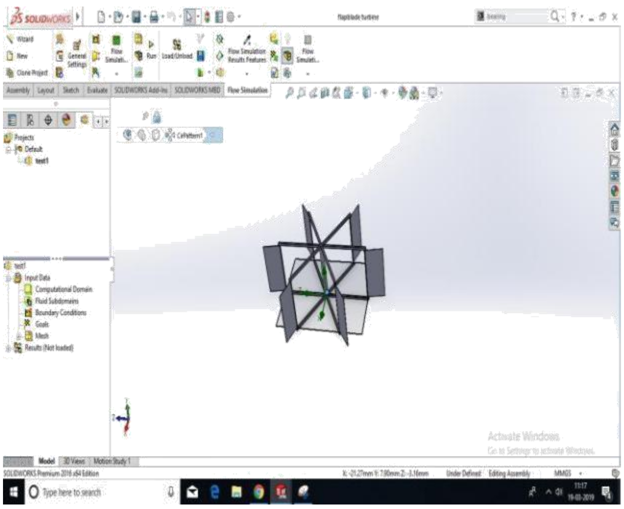

Isometric view

V. FABRICATION OF FLAPPING PANEL VAWT

Fabrication & working

The fabricating of the flapping panel wind turbine starts with the frame making, which is made up of rectangular mild steel rod with diameter 1m and length 0.5m. The mild steel used is a hollow rectangular plot which is made to cut as per the desired dimensions and the frame is fixed using welding technic. Once the frame is made the permanent magnet generator is fixed to the frame. Below the frame, the mounting stand is welded and attached. A shaft of 20mm diameter with length of 500mm is used to connect the turbine and permanent magnet generator. The pmg and the shaft are mounted to the stand using the plummer blocks. Then bearings are attached in the frame, which are used to hold the blade tip pins. Then finally the blades are attached to the blade tip pins which are attaches to the bearings. These bearings facilitate for easy flapping of the blades. The entire setup is attached and the shaft is connected to the pmg.

VI. RESULT AND DISCUSSION

The VAWT is made to work at normal conditions of wind at 4 m/s and it produces an actual power of 8W at 76 rpm The Final product images are as below.

VII. CONCLUSION

The unique characteristics of flapping panel turbine is that it starts rotating even at low speeds and independent to the direction of the wind which makes this VWAT a better turbine when compared to others and also with its power obtained at any cause of rotation makes it perfect one for power generation.

The flapping blades adapts to the direction of the wind direction, which makes the flapping action in accordance to the need and thus results in major advantage of rotation. The vertical blades Darrieus turbine has self-starting Capabilities both at low Reynolds numbers and to moderate values of the solidity. The blade pitch angle has a great influence on the self-starting behavior of the turbine, higher values of the blade pitch angle are favorable for a low speed wind starting

Hence through these techniques, the VAWT is made to work at normal conditions of wind at 4 m/s and it produces an actual power of 8W at 76 rpm. Showcases the turbine as safe & successful turbine.

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