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Experimental Analysis of Vertical Axis Wind Turbine

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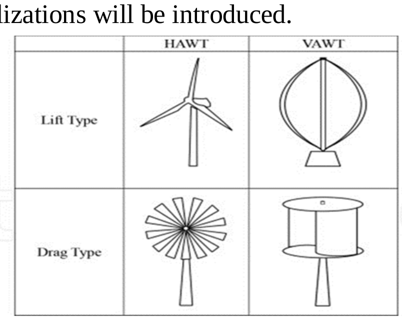
Abstract: The project focuses on Design, Fabrication and Testing of a VAWT (vertical Axis Wind Turbine) with Wind deflectors. The project is an ongoing research project and the phase we carried out was concerned in shifting the design from Darrieus type to Savonius type, which created the necessity of freshly designing all the parts, increasing the torque and rpm of the VAWT by implementing a deflector/guide vane system, make the whole structure portable meanwhile maintaining the project within a very low cost range. The said objectives can be are to be achieved by manipulating the knowledge of Design of Machine element, fluid dynamics, Energy Technology and CFD analyzing. A major concern was fashioning the design to enable the VAWT to operate with a maximum efficiency. Several parameters were analyzed with respect to wind speed to determine the best value for each parameter which would give the highest efficiency, thus ensuring the maximum ultimate performance of the VAWT. The parameters that were considered for analyzing are the number of blades the rotor should have, positioning of the blade (i.e. the distance from the shaft to blade and the angle the blade creates with the shaft), the shape of the deflector, and the angle of the deflector so as to generate the highest efficiency. Above parameters were analyzed using ANSYS/Fluent software package and the ultimate design was produced in accordance with the obtained results.

Keywords: Wind Turbine

I. INTRODUCTION

Wind turbine is a kind of rotating machinery. Although the horizontal axis wind turbine (HAWT) is the most popular wind turbine, the vertical axis wind turbine (VAWT) with the main advantages of smart design, novel structure, and wind direction independence receives more and more attention in small-scale wind power market. The straight-bladed VAWT (SB-VAWT) is one of the most researched and studied VAWTs. In this chapter, the historical development of the SB-VAWT will be briefly reviewed firstly. Then the aerodynamic models for the turbine design and performance analysis will be introduced. Finally, the types of traditional and new SB-VAWT and their characteristics and main utilizations will be introduced.



II. PROBLEM STATEMENT

A major hindrance in the growth of wind energy is fluctuation in the sources of wind. Highways appear to be a sufficient source of potential wind energy.An in-depth analysis of fluid flow due to traffic on highways must be performed to acquire boundary limits for the wind turbine design. The turbine must be able to store energy for use when there is low traffic, bumper to bumper or stop and go traffic The design must be sustainable and environmentally friendly.

The two primary types of conversion systems are the horizontal-axis wind turbine (HAWT) and the vertical-axis wind turbine (VAWT). HAWTs have been in practice for some time and are heavily favored over VAWTs for large-scale power generation; however, research of VAWTs has gained growing interest in recent years because of the opportunities available for small-scale and off-grid power generation which favors the use of vertical-axis turbines. The design and testing of 3D printed vertical-axis wind turbine models is presented in this work.

III. OBJECTIVES

VAWTs offer a number of advantages over traditional horizontal-axis wind turbines (HAWTs):

•Omni-directional VAWTs may not need to track the wind. This means they don't require a complex mechanism and motors to yaw the rotor and pitch the blades.

•Gearbox replacement and maintenance are simpler and more efficient, because the gearbox is accessible at ground level instead of requiring the operator work hundreds of feet in the air. Motor and gearbox failures generally are significant operation and maintenance considerations.

•Some designs can use screw pile foundations, which reduces the road transport of concrete and the carbon cost of installation. Screw piles can be fully recycled at end of life.

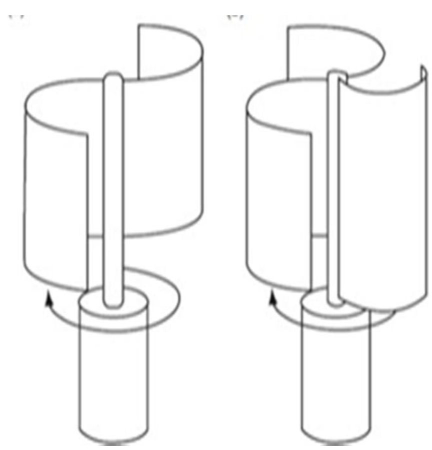
IV. IMPORTANCE OF THE PROJECT

Energy is a hot topic in the news today: increased consumption, increased cost, depleted natural resources, our dependence on foreign sources, and the impact on the environment and the danger of global warming. Something has to change.

Wind energy has great potential to lessen our dependence on traditional resources like oil, gas and coal and to do it without as much damage to the environment. Alternative energy sources, also called renewable resources, deliver power with minimal impact on the environment. These sources are typically more green/clean than traditional methods such as oil or coal. In addition, alternative resources are inexhaustible.These benefits, as well as data that suggest the drop-off of conventional oil drilling will overtake the output of new drilling by 2014, make renewable energy a viable source to pursue.

V. PRINCIPLE OF OPERATION

Savonius type Drag-based VAWT designs are referred to as Savonius type. The first Savonius turbine was developed in 1922 and was made up of semi-circle blades (MacPhee, David, and Beyene 2012). Conventional Savonius rotors with two and three blades are displayed Savonius rotors with (a) two blades and (b) three blades (MacPhee, David, and Beyenne, 2012) This type of turbines rotates due to a difference in drag caused by the shape and orientation of the blades. The blade moving with the wind experiences more drag than the blade moving against the wind due to the curvatures.



VI. METHODOLOGY

The operation way of a Giromill VAWT is not different from that of a common Darrieus turbine. The wind hits the blades and its velocity is split in lift and drag component. The resultant vector sum of these two components of the velocity makes the turbine rotate. The swept area of a Giromill wind tubine is given by the length of the blades multiplied for the rotor diameter. The aerodynamics of the Giromill is like the one of the common Darrieus turbine the wind force is splited in lift and drag force and it make the tubine rotate.

The VAWT-850 was the biggest H-rotor in Europe when it was built in UK in the 1989. It had a height of 45m and a rotor diameter of 38m. This turbine had a gearbox and an induction generator inside the top of the tower. It was installed at the Carmarthen test site during the 1990 and operated until the month of February of 1991, when one of the blades broke, due to an error in the manufacture of the fiberglass blades. In the 90's the German company Heidelberg Motor GmbH developed and built several 300 kW prototypes, with direct driven generators with large diameter.

VII. RESULTS

The following tables show the observations at various wind velocities and different rigging angles: At air velocity of 7m/s

Angle	RPM	Voltage	Current (mA)	power (P=V×I)
0	107	4.56	5.2	23.71
30	114	4.21	5	21.05
60	180	3.3	3.4	11.22
90	190	8.3	9.2	76.36

VIII. DESIGN OF MODEL

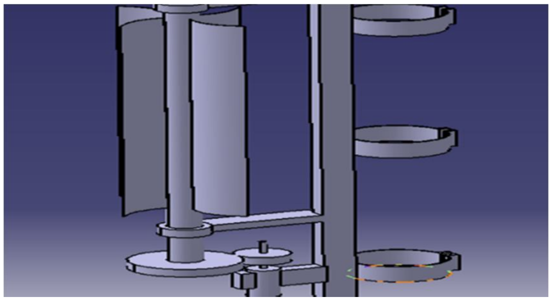


fig 8.1 Front view of VAWT

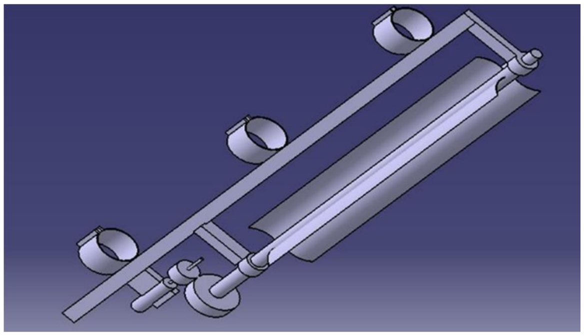


Fig 8.2 Side view of VAWT

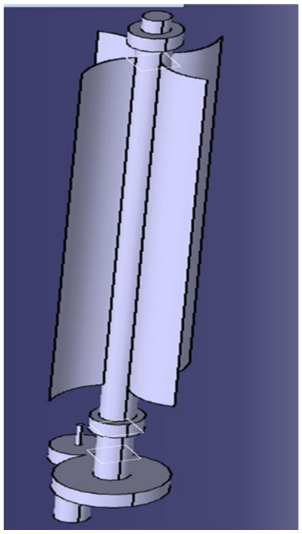


Fig 8.3 Blade Design

IX. CONCLUSION

1) *Performance:* The performance of VAWTs varied depending on various factors such as wind speed, turbine design, and blade configuration. The experimental results demonstrated that VAWTs can generate electricity efficiently in certain conditions, particularly in areas with turbulent or non-uniform wind flow.
2) *Start-up:* VAWTs have the advantage of being able to start generating power at lower wind speeds compared to horizontal axis wind turbines (HAWTs). This makes VAWTs suitable for locations with lower average wind speeds or inconsistent wind patterns.
3) *Scalability:* The experimental analysis revealed that VAWTs can be scaled to different sizes without significant loss in performance. This flexibility allows for the implementation of VAWTs in various applications, from small-scale residential use to large-scale wind farms.

X. FUTURE SCOPE

1) *Performance Optimization:* Further research can focus on optimizing the performance of VAWTs by improving their aerodynamic design and efficiency. Experimental analysis can help identify the most effective blade profiles, materials, and configurations to enhance power generation.
2) *Structural Enhancements:* Investigating new materials and designs to improve the structural integrity and reliability of VAWTs is another crucial aspect. Experimental studies can evaluate different materials' durability, fatigue resistance, and maintenance requirements, leading to more robust and cost-effective turbines.
3) *Noise Reduction:* Noise generated by VAWTs, especially at higher rotational speeds, is a significant concern. Future experiments can delve into noise reduction techniques, such as blade design modifications, innovative damping systems, and optimized yaw mechanisms, to minimize acoustic disturbances.

XI. SUMMARY

In this we have studied or analyzed that there are many ways to develop power from free energy. The world require more power the they grow and natural resources are going end one day , so world is trying to generate the power from free available energy.

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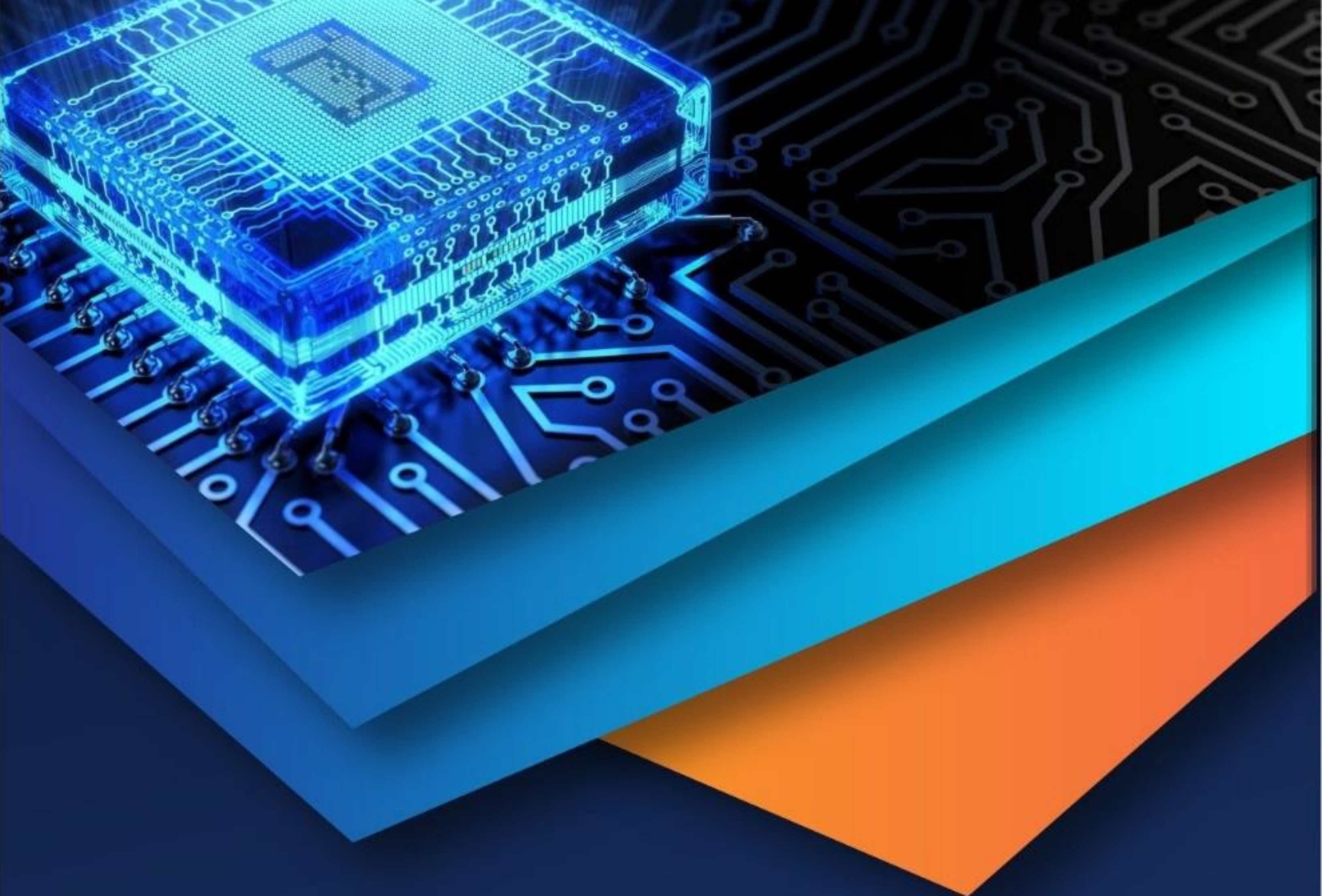

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