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Design and Review of Spiral Wind Turbine

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Abstract: *The present study emphases on "Generation of power using spiral wind turbine". The function of wind turbine is to convert wind energy into mechanical energy and then generator converts mechanical energy into electrical energy. The study specifically about the size and dimensional parameter that need to be considered while designing spiral wind turbine and also about making the turbine more energy efficient than conventional wind turbine, and to overcome all possible drawbacks of conventional turbine.*

Keywords: Archimedes Wind Turbine, Spiral Turbine, Tear Drop Shaped Wind Turbine, Wind Turbine Generator, Horizontal Axis Wind Turbine.

I. Introduction

Wind is a clean source of renewable energy that produces no air or water pollution. And since the wind is free, operational costs are nearly zero once a turbine is built. Besides, quality production and technology improvements, aim also to build turbines cheaper. Among all renewable resources, wind energy has been proven to be a relatively matured technology and has great potential in commercialization and the production of large quantities. The main application of wind power is generation of electricity from a power system network integrates transmission grids. There are principally two types of wind turbines Horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs), out of which HAWTs are commonly manufactured.

It works on simple principle of conversion of wind's kinetic energy into the mechanical energy followed by further converting it into electrical energy with the help of a generator. In case of horizontal axis wind turbines, the axis of rotation is horizontal with respect to the ground and approximately parallel to the wind stream. Spiral wind is a type wind turbine. Our design is a radical departure from conventional three bladed types. It has a teardrop shaped body with swept blades that makes it very stable in high and low winds. A generator is enclosed in its hollow interior. The unit is fully scalable from a small portable size to a 1 kilowatt or greater power range, and can easily be mounted on any roof or structure.

To solve energy supply issues and address climate change, reductions of Greenhouse Gas (GHG) emissions, biodiversity protection and development of renewable technologies, energy conservation, and efficiency improvements are becoming increasingly important. Among the renewable resources, wind energy is a relatively mature technology with enormous potential for commercialization and mass production. With the expansion of the power grid and the reduction of electricity remote areas, small-scale wind turbines are now being applied in several countries and in many fields, such as city road lighting, mobile communication base stations, offshore aquaculture, and sea water desalination.

II. Literature Review

A. Design, Fabrication and Analysis Of Fibonacci Spiral Horizontal Axis Wind Turbine [Yogesh Patil]

The present study is focused on the ever-advancing field of wind energy (HAWT). Objective is to design, fabricate a wind turbine with the help of Fibonacci spiral. The profile of the blades was conical helix. An attempt has been made to use such turbines in urban areas while reducing the installation height. 3D model of the blades was designed on solid works to study the static simulation. Study showed that such turbines can yield RPM at low wind speeds 5 m/s. Results showed that the modified spiral wind turbine is ideal for urban locations due to its property to withstand wind turbulence. The results showed that the minimum speed required to function the turbine is 5 m/sec. The maximum efficiency on theory basis was found to be 71.38 %. The turbines exhibit high response towards varying wind speed. The minimum speed of wind requires to rotate the blade is 5 m/sec. For optimum performance of the wind turbine the speed of the wind must lie in between 18 to 25 m/sec

B. Aerodynamic and Structural Evaluation of Horizontal Archimedes Spiral Wind Turbine [Arman Safdari and Kyung Chun Kim]

Aerodynamic characteristics of small-scale of Archimedes spiral wind turbine blade are presented in this paper. Numerical simulation for aerodynamic performance of the blade was carried out for different configuration of inlet velocity. Numerical approaches on the prediction of aerodynamic characteristics of the blade were performed by using XFlow which has been written based on lattice Boltzmann method. Wall-Adapting Local Eddy-viscosity (WALE) model has been applied as is has a good property near and far from solid body and wall for both laminar and turbulent flows. Particle Image Velocity (PIV) has been used to prove the obtained results of numerical simulation and investigate the aerodynamic physiognomies of the spiral wind turbine. In order to verify the numerical analysis velocity behavior around the blade are captured and compared with experimental results. The prediction of velocity outlines by using XFlow is in a good agreement with the trajectory and greatness of tip vortices engendered by the Archimedes spiral wind turbine blade from experimental results.

C. An Experimental Study on the Performance of Savonius Wind Turbines related with the Number of Blades [Frederikus Wenehenubuna, Andy Saputraa, Hadi Sutantoa.]

Wind energy is the most abundantly available clean form of renewable energy in the earth crust. Wind turbines produce electricity by using the power of wind to drive an electric generator. There are two kinds of wind turbines according to the axis of rotation to the ground, horizontal axis wind turbines (HAWT) and vertical axis wind turbines (VAWT). VAWTs include both a drag type configuration like Savonius wind turbine and a lift-type configuration like Darrius wind turbine. Savonius wind rotor has many advantages over others in that its construction is simpler and cheaper. It is independent of the wind direction and has a good starting torque at lower wind speeds. The experimental study conducted in this paper aims to investigate the effect of number of blades on the performance of the model of Savonius type wind turbine. The experiments used to compare 2, 3, and 4 blades wind turbines to show tip speed ratio, torque and power coefficient related with wind speed. A simulation using ANSYS 13.0 software will show pressure distribution of wind turbine. The results of study showed that number of blades influence the performance of wind turbine. Savonius model with three blades has the best performance at high tip speed ratio. The highest tip speed ratio is 0.555 for wind speed of 7 m/s.

D. Vertical Axis Wind Turbines: Current Technologies and Future Trends [J. Damota, I. Lamas 2, A. Couce, J. Rodríguez]

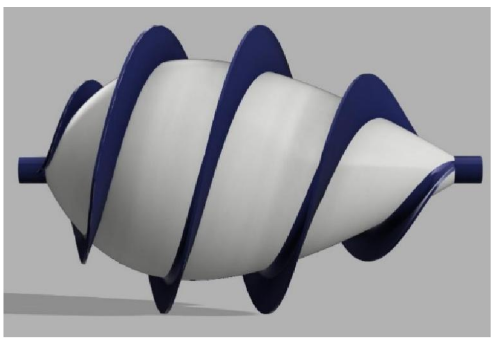
This paper, based on the pursuit of scientific articles published and recorded in the last five years (2010-2014) patents on VAWT technology, gives an image of the current situation of the treated technology. From data extracted we know: The different models that are working with different geometries, distinguishing between Savonius, Darrius, hybrid of both (D+S), models dedicated to Offshore technology and what can be applied generally (D&S) on both types of VAWT. The main countries that research and develop VAWT technology, globally and at European level and the number of dedicated studies and patents each. Multiple applications that can be given in fields such as building, industrial environment, social areas, civil engineering and other more. Future trends for VAWT, which can be seen in our environment, both rural and urban, as has already happened with other renewable technologies for electricity production, as HAWT and photovoltaic (PV), becoming part of the mix of renewable energy technology and business network of the future, thereby contributing to the reduction of CO_2 production and economic growth.

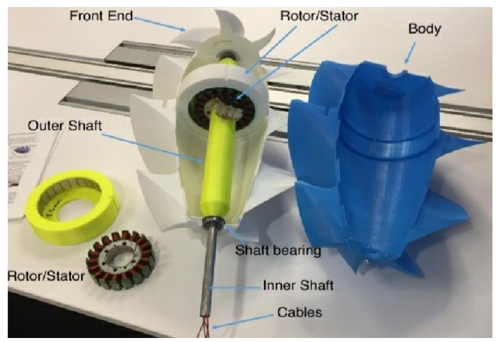
E. Analysis of Archimedes Spiral Wind Turbine Performance by Simulation and Field Test [Hyeonmu Jang 1, Dongmyeong Kim 1, Yechan Hwang 1, Insu Paek 1, Seungjoo Kim 2 and Joonho Baek 3]

In this study, the performance of an Archimedes spiral wind turbine is analyzed by simulation and validated by a field test. It is characterized as a horizontal-axis drag-type wind turbine. This type of wind turbine cannot be analyzed by the well-known Blade Element Momentum (BEM) theory or Double Stream Tube Method (DSTM) commonly used to analyze the performance of lift-type wind turbines. Therefore, the computational fluid dynamics (CFD) method was applied. From the simulation, the power coefficient, known as the mechanical efficiency of the rotor, the tip speed ratio was obtained. The maximum power coefficient, and the corresponding tip speed ratio were found to be 0.293 and 2.19, respectively.

III. Design and Construction Of Turbine

The present model consists of circular horizontal shaft mounted over a stand. This shaft having diameter equal to the inner diameter of Rotor/Stator which has copper windings and this Rotor/Stator is mounted over the shaft. The model has a tear drop like structure which is made up from fiberglass cloth covered with the plaster of resin typically a 2-part thermoset polyester, vinyl or epoxy which is basically a hardener and this hardener applied to the surface to make a tear drop like structure from glass. This fiber glass shell is mounted on shaft which will rotate with the help of roller bearing attached at the front end and back end of the shell. Inside this shell there are strong neodymium magnets which will help to produce electricity.



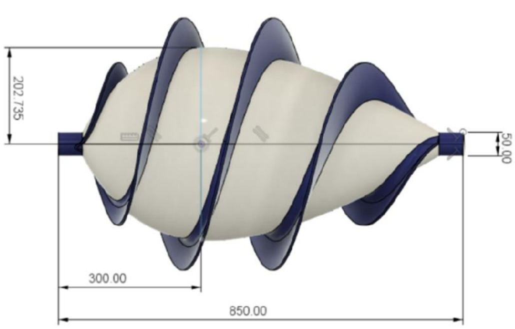


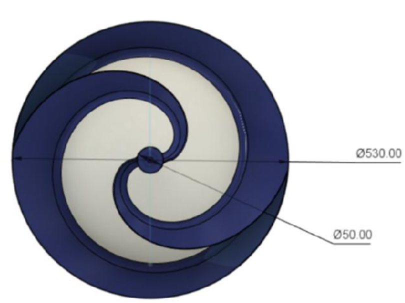
IV. Working

Electricity generation using spiral shape wind turbine works on principle of electromagnetic induction. Electricity generation with wind

A wind turbine turns wind energy into electricity using the aerodynamic force from the rotor blades, which work like an airplane wing or helicopter rotor blade. When wind flows across the blade, the air pressure on one side of the blade decreases. The difference in air pressure across the two sides of the blade creates both lift and drag. The force of the lift is stronger than the drag and this causes the shell to spin. The shell has strong neodymium magnets attached inside the shell. In this wind turbine whenever air flow strikes perpendicular to dome. It provides rotational motion to turbine. As this turbine rotates, it rotates electromagnet present inside of it. When electromagnet rotates, its magnetic lines of force crosses with copper winding. Since it is in closed circuit, current will flow through copper winding. This translation of aerodynamic force to rotation of a generator creates electricity.

Hence, electricity generated. This generated electricity measured by digital mustimeter (DMM) and power will store in battery.





V. Advantages

- Low cost
- No noise pollution.
- Lighter in weight.
- Easy to assemble.
- Higher energy efficiency.
- More easily installed compared to other wind turbine types
- Transportable from one location to another.
- Function in extreme weather, with variable winds and even mountain conditions.
- Permissible where taller structures are prohibited.
- Quieter to operate, so they don't disturb people in residential neighborhoods.

VI. Application

- It can install over the electric automobiles roof. And hence it charges the vehicles.
- It can install over the plants or industries.
- It is also useful in highway areas.
- Roof installation: spiral wind stable operation in turbulent conditions enables it to be roof mounted with fortified hardware similar to antenna mounts, no towers are necessary. It can be installed on a home, building, or business, with a good wind resource.
- Installation: Installation is quick, easy and can provide an alternative to fossil fuel powered generators.
- Negligible vibration: Spiral wind can generate power with negligible vibration as observed in wind tunnel tests at the city college of New York.
- No noise: Because there is negligible vibration there is no noise produced.
- Attractive design: Spiral wind aesthetic design adds to a home's image.

VII. Discussion

The attention towards horizontal and vertical wind turbines have gradually increased. How to improve the utilization rate of wind energy and solve the control problems and automatic start problems has become the focus of researchers. In order to improve the utilization of wind energy and solve the problem of automatic start up, some researchers have proposed new vertical axis wind turbine models, and some researchers have analyzed the aerodynamic performance of wind turbines to optimize the original wind turbine. Some researchers have also intensive on the difficulty of controlling vertical axis wind turbines.

By studying the power generation characteristics of the generator control system and improving the control method, the wind energy conversion efficiency is improved, and the generated electric energy is incorporated into the national power grid. This article draws on the essence of the above two ideas.

First, a new Nautilus isometric helical wind turbine structure is proposed. Then, by analyzing the aerodynamic performance, the blade number and blade size are improved. This article draws on the essence of the above two ideas. A new Nautilus isometric spiral wind turbine structure was proposed.

VIII. Future Scope

The future scope of the project involves designing and constructing a prototype of spiral wind turbine that would be economical environmental, reliable of the project such as building this wind turbine in large scale. By taking fund from Municipal corporation, it can install over the all-suitable areas such as near the seashore, at large grounds. This can be monitored through Supervisory control and data acquisition (SCADA) operators from remote place. The possible innovation includes using stronger, but lighter, eco-friendly material which drops the manufacturing cost as well provides more working efficiency. The addition of wind directional unit to detects wind direction and moving in same.

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