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Design and fabrication of aerodynamic wind turbine

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Abstract

The increasing demand for renewable energy sources has led to the development of efficient wind energy systems. This project focuses on the design and fabrication of an aerodynamic wind turbine optimized for maximum energy conversion efficiency. The turbine incorporates advanced blade profiles inspired by airfoil theory to enhance aerodynamic performance, reduce drag, and increase lift. Key considerations in the design include blade shape, angle of attack, tip speed ratio, and material selection. The fabricated prototype was tested under varying wind conditions, and the results indicated improved rotational speed and energy output compared to conventional designs. This project demonstrates the feasibility of using aerodynamic optimization techniques to improve the performance of small-scale wind turbines, contributing to sustainable and decentralized energy generation.

INTRODUCTION

As the current scenario demanding the electricity without any air pollution then we have to design a small aerodynamic wind turbine for generation of electricity at hill station areas.

These types of wind turbines are classified into two categories horizontal and vertical-axis categories. For horizontal-axis lift-type turbines, they operate under the same principle and shape as a large wind turbine, but Vertical-axis lift type wind turbines less efficient than their horizontal-axis counterparts.

Also, they generate less aerodynamic noise. Therefore, the demand for wind turbines has been increasing recently for street-lighting systems. For general horizontal axis lift type wind turbines, commercial analysis programs based on blade element momentum theory, are used to predict their performance.

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.

The simulation tool used for analysis was Ansys Fluent, and RANS equation- based analysis was performed. A number of studies have shown that the performance prediction of drag-type wind turbines, mostly vertical-axis wind turbines, are possible using CFD simulations . For a very limited number of cases however, experimental validation has been performed.

Fujisawa used commercial CFD codes to predict the power performance of a Savonius type vertical-axis wind turbine.

METHODOLOGY

The aerodynamic type of wind turbine blade can be examined by Computational fluid dynamics (CFD) which is one of the divisions in fluid mechanics. In Computational fluid dynamics is a division of fluid mechanics that uses numerical approaches and algorithms to solve and analyze problems that involve the fluid flows. Computers are used to execute the calculations and other parameter required to simulate the interaction of liquids and gases with surfaces defined through the boundary condition. CFD enables scientist and engineers to achieve numerical experiments, i.e. Computer simulations in a virtual flow laboratory. CFD is quicker and definitely inexpensive. A considerable reduction of time and expenses for solving the problems as compared to traditional approaches.

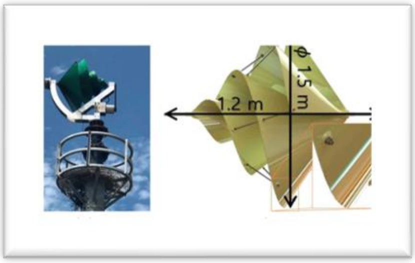
Computational Method CFD FLUENT consists of so various turbulence model in which Shear Stress Transport k-ω turbulence model has been used to the forecast the separation of flow which is two equation-based on the model. SST k-ω turbulence model uses the benefit of both k-ε and k-ω turbulence model where k is define the kinetic energy, ε is the rate of dissipation of the turbulent kinetic energy and ω is specific rate of dissipation.

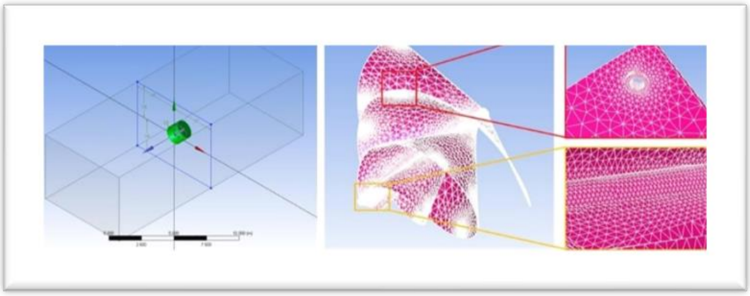
In order to build the computational domain and generate the mesh, the commercially accessible software —ANSYS Meshing tool|| is used to build a wind tunnel model and generate an amorphous mesh around the blade in the computational domain. As shown in the figure, a blade is placed inside of an imaginary wind tunnel with inlet and outlet conditions. Number of nodes on tunnel and rotor.

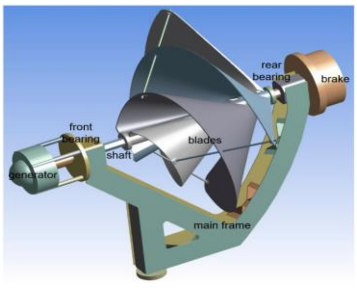
PART OF ASSEMBLY

1. Bearings
2. Generator
3. Bearing cup
4. Shaft
5. Turbine blades
6. Frame
7. Linkages

Below the parts of assembly are shown







WORKING

Wind turbines work on a basic simple principle that instead of using electricity to make wind—like a fan—wind turbines use wind to make electricity. In working Wind turns the propeller-like blades of a turbine around a rotor, which spins a generator, which creates electricity. Which are practically applicable in hill station places.

A wind turbine convert wind energy into electricity using the aerodynamic force from the rotor blades, which work like an airplane wing or helicopter rotor blade and other aerodynamic system. When wind flows across the blade, in the air pressure on one side of the blade decreases in that case. The difference in air pressure across the two sides of the blade creates both lift and drag practically. The force of the lift is to stronger than the drag and this causes the rotor to spin. The rotor connects to the generator, either directly or through a shaft and a series of gears (a gearbox) that speed up the rotation and allow for a physically smaller generator. This translation of aerodynamic force to rotation of a generator creates electricity And also provide less pollution.

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.

APPLICATION

1.It can install over the plants or industries.
2.It is also useful in highway areas.
3.Roof installation: spiral wind stable operation in turbulent conditions enables it to be roof mounted with fortified
4.Any juice making machine with the help of chain and gear used.
5.Negligible vibration: Spiral wind can generate power with negligible vibration as observed in wind tunnel tests
6.At the Height of buildings.
7.Attractive design: Spiral wind aesthetic design adds to a home's image.

ADVANTAGES

- No noise pollution.
- Lighter in weight.
- Easy to assemble.
- Higher efficiency.
- 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.

DISCUSSION

The attention towards horizontal and vertical wind turbines have gradually increased. How the process 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 Many researchers have analyzed the aerodynamic performance of wind turbines to optimize the original part of wind turbine. Many 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 is to draws on the essence of the above two ideas. First, a new type of wind turbine structure is proposed. Then, by analyzing the aerodynamic performance, the blade number and blade size are improved. This article has draws is on the essence of the above two ideas.