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A REVIEW OF OPTIMIZATION OF SMALL WIND TURBINE AT LOW SPEED

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ABSTRACT

Wind energy is an easily available renewable energy source. A turbine is a device that can convert wind energy into useful electrical energy. Wind energy is zero cost, affordable, reliable, and almost maintenance-free. That small wind turbine is applicable anywhere However, when sized properly and used at optimal working conditions, small-scale wind turbines could be a reliable energy source and produce low-cost valuable energy not only in rich countries but also in non-developing applications in locations that are far away from the main power in countries. Small-scale wind turbines are becoming a more area promising way to supply electricity in developing countries. The small-scale wind turbine blade has quite different aerodynamic behavior than their large-scale wind turbine. A small turbine can be installed for less energy requirement. Small wind turbines operating at low wind speeds regularly face the problem of less performance due to the profile of blades, angle of attack, twist angle, more drag of the blades. To overcome these problems we select airfoil shape blade which is NACA 4412 which have a good result at a low speed we are trying to modify it profile. Comparing performance of profile NACA 4412 and NACA 63415 at different twist angle and TSR with combination of blade profile by using Q-blade analysis software.

Keywords: NACA 4412, NACA 63415, Q-Blade, Small Wind Turbine-Blade, Angle Of Attack.

I. INTRODUCTION

Power has been extracted from or for hundreds of years, with historical designs made from wood, cloth and stone for the purpose of pumping water or grinding corn. Historical designs, especially large, heavy and inefficient ones, were replaced in the 1st century by the implementation of fossil fuel engines and nationally distributed energy networks. Learning more about aerodynamics and advances in materials, especially polymers, led to the return of wind energy in the late 20th century. Wind power equipment is now used to generate electricity and is commonly called wind turbines. The orientation of the shaft and rotational axis determines the first classification of the wind turbine. A turbine with a shaft mounted horizontally parallel to the ground is known as a horizontal axis wind turbine or (HAWT). A vertical axis wind turbine (VAWT) has its shaft normal to the ground.

II. LITERATURE REVIEW

[21]Peter J. Schubel * and Richard J. Crossley, Receive on wind turbine blade design: 23 April 2012; in revised form: 21 June 2012 / Accepted: 30 August 2012 / Published: 6 September 2012

A detailed review of the current state-of-art for wind turbine blade design is presented, including theoretical maximum efficiency, propulsion, practical efficiency, HAWT blade design, and blade loads. The review provides a complete picture of wind turbine blade design and shows the dominance of modern turbines in almost exclusive use of horizontal axis rotors. The aerodynamic design principles for a modern wind turbine blade are detailed, including blade plan shape/quantity, airfoil selection and optimal attack angles. A detailed review of design loads on wind turbine blades is offered, describing aerodynamic, gravitational, centrifugal, gyroscopic and operational conditions.

[20] N. Lakshmanan, S. Gomathinayagam*, P. Harikrishna, A. Abraham and S. Chitra Ganapathi review the basic wind speed map of India with long-term hourly wind data. Current science, vol. 96, no. 7, 10 april 2009 Long-term data on hourly wind speed from 70 meteorological centres of India Meteorological Department have been collected. The daily gust wind data have been processed for annual maximum wind speed (in kmph) for each site. Using the Gumbel probability paper approach the extreme value quantiles have been derived. A design basis wind speed for each site for a return period of 50 years has also been evaluated. The site specific changes

in the design wind speeds in the contemporary wind zone map for the design of buildings/ structures are highlighted and revision to the map is suggested.

[22] Design and optimization of a wind turbine by bharat koratagere srinivasa raju, the university of texas at Arlington, may 2011,page 13

The aerodynamic efficiency is lower on a two blade rotor compared to a three bladed rotor, rotational speed needs to be higher so as to achieve the same power as that of the three bladed rotors. The two and single bladed rotors need a special kind of arrangement that is hinged or teetering hub. Each time the rotor passes the tower and in order to avoid heavy shocks the rotor is to tilt away. Also the arrangement can have balance issues and in time the blades are bound to hit the tower during operation. The three bladed rotors are effective to use the yawing mechanism in them. Analysis of blades using wind tunnels would be possible for small scale rotors. But the increase in diameter has called for the use of computational fluid dynamic for fluid flow over blades and prediction of load.

III. METHODOLOGY

- Wind turbine working Principle
- Aerodynamic Principles of Wind Turbines
- Drag Design
- Lift Design
- Design Key Parameter
- Wind Speed
- Site Selection
- Location
- Height
- No of Blades & Blade Length
- Generators
- Towers
- Wind Turbine Blade Material

IV. OBJECTIVE

The aims to evaluate the aerodynamic performance of low speed fixed-pitch horizontal axis wind turbine blades through two and three dimensional computational analysis. and simulation done by Q BLADE software. The objectives of the project are to find best airfoil models of wind turbine blade comparing two different NACA4412 and NACA 63415 profile, so as

- To analyses the aerodynamics lift and drag coefficient.
- Analysis the best performance profile compare between NACA 4412 and NACA 63415.
- To analysis for power Output at different angle of attack.
- To predict wind turbine power output at low speeds.
- To analyze power at the tip speed ratio.
- To calculate pressure and velocity profile of blade by using Q Blade Analytical software

V. SOFTWARE

Q-Blade analysis software is open source wind turbine rotor blade calculation and design software. Q-Blade software allows us to define an air foil, compute its polar performance and directly integrates with the wind turbine rotor design and simulation. Q-Blade also gives deep insights into all the relevant rotor and blade variables with its post processing functionality. Software is very flexible and has user friendly interface for wind turbine rotor blade design.

- Air foil generator
- Blade design and optimization
- Defining BEM (Blade Element Momentum)
- Multi parameter rotor simulation
- Visualization of rotor blades

• Blade geometry export functionality

• Testing of aero elastic code. 6.6.3 Airfoil Design in Q-Blade

• For the design, NACA 4412 and NACA63415 airfoil is selected due to its surface pressure distribution characteristics.

• Airfoils are created using spline.

• Desired NACA airfoil can be imported using import function in Q-Blade.

• NACA airfoils geometries are inbuilt in the Q-blade software and additional airfoil data can be integrated by importing airfoil data file in '.dat' format.

• The scale and chamber of the airfoils can also be adjusted.

• NACA 4412 and NACA 63415 with less thickness are selected for the tip selection of the blade. Circular foils are also used at the tip of the blade so that the blade can be fixed in the hub.

VI. CONCLUSION

To achieve maximum efficiency of small wind turbine at low wind speed. We selected the standard air foil blade NACA 4412 and NACA 63415 for analysis. The parameter like angle of attack, twist angle .tip speed ratio (TSR) and chord length can affect the efficiencies of wind turbine. For the better result of small wind turbine we choose TSR 8 for analysis and changing twist angle and focus on changed angle of attack for high lift and drag coefficient the optimization small wind turbine blade at low wind speed. The demand for higher tip speeds reduces the width of the lower chord resulting in narrower blade profiles. This reduces the use of materials and can reduce production costs. For blades with tip speed ratios of 6 to 8 utilizing air foil sections with negligible drag and tip losses, Betz's momentum theory gives a good approximation input taken for design are length of blade 1 m, chord length at root 0.191 m , at tip 0.034m ,by using Q Blade analysis software.

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