REVIEW PAPER OF CFD ANALYSIS ON WIND TURBINE BLADE

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ABSTRACT

There are many research are performed on wind turbine all research are concentrated on blade profile in some research only 2d profile CFD simulation is done. This review paper aims at to move forward in this research on blade profile I have studied paper from 2001-2014 in which I have critically analyzed some paper. At last my work deals with 3d analysis of wind turbine with fluid and solid interference using NACA profile parameters on CFD and static structure analysis. The aim of this literature is angle of attack, wind blade material, twisting of blade airfoil, Vibration on blade and selection of Blade airfoil. 'Wind Power' When evaluating any change to the design of a wind turbine, it is critical that the designer evaluate the impact of the design change on the system cost and performance.

The wind turbine tower and the ground are not included in the flow model and a uniform wind speed profile is assumed at the entrance of the domain. To generate the volume mesh for the three blade rotor, the 120 degrees periodicity of the rotor is exploited by only meshing the volume around one blade. The remaining two blades are included in the computations through the use of periodic boundary conditions. The aerodynamics of HAWT are investigated using a commercial FEM and CFD code. The Specifications of an existing middle-sized turbine starting from the classical Blade Element Momentum (BEM) method is adopted for the design of the rotor. The active part of the blade is extended to the hub, following the design tendencies of modern wind turbines.

I. INTRODUCTION

The demand for the power around the world is continuously increasing very rapidly, as the stock of conventional sources of energy (i.e. fossil fuels) is limited and decreasing very fast and the earth's ecological balance is being damaged beyond its sustainable limit.

The development of any nation can be indicated by its per capita energy consumption. A developing country like India, with much lower per capita energy consumption as compared to that of developed nations, will have to look for better sustainable power to fulfill its higher

Energy requirements to cope up with higher and appreciable industrial production growth for future without degrading its environment balance. This limitation of traditional fossil fuels and the environmental aspects of

conventional power sectors have resulted in the realization that greater importance be given to the energy conservation, energy efficiency and non-conventional energy sources, i.e. renewable energy. Renewable energies such as wind and solar are growing faster than conventional energy.

Wind is an indirect source of solar energy. It is caused by the uneven heating of the earth by the sun and the resulting redistribution of air to equalize energy in the atmosphere moving air from areas of high pressure to areas of lower pressure. A 'wind turbine' converts the power in the wind into electricity, whereas 'windmill', converts the wind's power into mechanical power.

SrinivasG et al [1] has suggested that blades play an important role in converting wind energy into electrical energy. When the Wind attack to the blade, reaction force produce in form of lift and drag forces , this Forces are Calculated by Numerical method but because of complication and also it is a tedious work we can also go for another method , That is Computation Fluid Dynamics (CFD) method for getting desired results. CFD method is based on fluid mechanics, Its Function is to use blade air-profile and consider a 2 dimensional profile Choose by Design Foil Workshop for various chords (Abbott *et al* Report No.824) at different Angle of Attack of air and also in Different Reynold No.

Dr. Abdullateef A. Jadallaha et al [2] has give that the major point in wind turbine performance is Blade Element Method and Momentum theory Which gives some important parameter like tip speed Ratio, Pitch angle, Number of blade and wind speed. For low power wind turbine above parameter acts as a basis fundamental on blade design. The Optimization of wind turbine performance calculation based on Low wind speed to high wind speed by the changing of Pitch angle , angle of attack and tip speed Ratio.

Darshil U. Shah et al [3] has suggested that in low speed turbine, the blade designs have another parameter, which is a blade material in a manufacturing point of view. Light in weight and load Carrying capacity of material use to manufacturing of turbine blade. There are two type of material use to manufacturing of blade (1) Flax (Polyester) And (2) E-Glass (Fiber mass 45%) as reinforcement. Component weight of blade manufacture Flax Blade is light and to the greatest extent of loading condition. Recommend that Flax/Polyester is suitable for low power generating wind turbine blade.

Research on wind turbine is considerable increase day to day. Claudio Tavares Silva et al [4] has suggested that the another investigation field present in to a wind turbine that is Loewy's lifting deficiency Function (LDF), also called as Returning Wake Model, which is connecting to the Blade Element Momentum method (BEM). The Comparison of wind turbin between GH blade and BEM NE Blade in different wind speed.

In Design Of wind turbine, gearbox also a decisive component and some time it is failure in running condition. When shutdown condition coming into the wind turbine, load suddenly increase in the Gearbox teeth. The varying capacity in Gearbox is study by Y. Guo et al [5].

Armaghan Ahmad et al [6] has suggested that the wind turbine is model made on field area and tested with the practical condition, This process is a wastes of material and time . This process also can be performed on CAD-CAM modeling and Analysis software with using Mod-5B and NACA 4415 blade profile. CAD-CAM process is a visualization of actual practical condition. In this method, we can also understand aerodynamic condition and easy and fast to get result on this software.The profile of wind blade is NACA4415 is used to Test on CAD CAM Software and get the Result for 5 kW wind turbine.

Fei-Bin Hsiao et al [7] has suggested three different HAWT use at a different condition like Optimum Blade Shape, Optimum twist blade and Untwist blade, the HAWT blade geometry is a NACA 4418. The above this

condition is to be experimented in CFD software use a k-ω SST turbulence model. We get some result in experiment work, that the Optimum Blade (OPT) is more efficient to the untapped and optimum twist blade at a wide range of power coefficient of tip speed ratio which from 4.5 to 7 and untapered and untwist blade operates in lowest Cp value..

AdityaRachmanet al [8] has compare between Horizontal and vertical axis wind turbine with rounded shroud device, which is working as a diffuser at a flow of air inside to it. Flow of air into shroud, the horizontal axis wind turbine gives more performance as compare to vertical axis wind turbine. There is no contribution of shroud in vertical axis wind turbine

P. Santhana Kumar et al [9] has suggested that The Rotor distance about the axis is the point to give a effect in the performance of horizontal axis wind turbine. By CFD analysis and experimental analysis, Single rotor and counter rotor wind turbine with 2D and 3D model of the Airfoil of NACA 0012 and NACA 4415 is to be study with the Multi Reference Frame and comparison of the result, The Axis Distance increase to the rotor give more power and the performance of horizontal axis wind turbine increase at Counter rotor wind turbine with increase efficiency.

ParametPathike et al [10] has suggested that Low Wind Speed Area wind turbine blade design have a more complication than the Area of rotor Specified have a problem to design a hole wind turbine. Rotor diameter is less as compare to open field area, design and analysis of low wind turbine. Experimental data of Model FD2.7-500 which is provide by EL(2010), use for Blade profile of small wind turbine for low wind speed.

Ravi AnantKihoreet al [11] has suggested that Small wind turbine also be tested on other types of blade profile like NACA 0012, NACA 4412, NACA 4415, and NACA 23012 but after the testing of different type of profile blade it has found that NACA 4412 is suitable for low speed wind turbine.

Jang-Oh Moa et al [12] has suggested that Wind turbine performance is tested on NASA wind tunnel 24.4m x 36.6 m with 2 no. of blade and using a S809 Airfoil blade. The virtual simulation assumption and 3D blade model analysis on Ansys Fluent software. The simulation of wind turbine with large eddy and the equation use like Reynold-Average, Navier-Stokes and Direct Numerical Simulation. The flow analysis of air with Y-vorticity contour rang present in simulation result.

Dr. Eng. Ali H. Almukhtaret al [13] has suggested that Study of wind turbine is wide range of parameter but the operation on Airfoil with aerodynamic parameters has direct effect on the performance of wind turbine. The study of blade element theory and momentum theory has to give parameter about the lift and drag forces. Power efficiency of wind turbine is always fluctuated at Variable wind speed.

BuyungKosasih et al [14] has suggested that if the wind turbine is used at micro area. the performance of wind turbine increase with the round shroud. The micro wind turbine output with nozzle- diffuser shroud higher with increase the coefficient of power.

Tartibu L. K. et al [15] has give a parameter to design a blade, in which the Frequency of vibration to be concentrate on structure dynamic function. This function depends on material, design and size. Aerodynamic forces generates on wind turbine blade, vibration excite by natural frequency. The analysis on variable length of wind blade with rectangular cross section for simply way to discuss and overview on analysis . Natural frequency calculated by flap-wise and edge wise at different length. MATLAB and NX5 analysis tool use for modeling and finite element analysis, the fundament point is to be consider as density, stiffness, material and geometry.

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