CFD ANALYSIS FOR DIFFERENT BLADE PROFILES& ASPECT RATIO IN VERTICAL AXIS WIND TURBINE

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Abstract. Wind energy is one of the major forms of renewable energy resources found abundantly which is widely used as an alternative energy. The energy can be converted into electricity by using Vertical Axis Wind Turbine (VAWT) and Horizontal Axis Wind Turbine (HAWT). The vertical axis wind turbine is highly used for domestic applications where the volume of production is low and efficiency is optimal while the horizontal axis wind turbine is widely for larger volume of production requires huge investment and the efficiency is high. This paper is focused on design and CFD analysis of Flat, Savonius, Helical, Involute Blade Profiles of same cross section by varying the aspect ratio (height, diameter and different wind speeds) of different blade profiles and the best efficient blade profile is identified using CFD analysis. Once the turbine blade profiles were developed they were tested for parameters like torque generated, power output, speed, tip speed ratioand the result shows the best blade profile which can be used to extract more power with a low wind speed between 1- 6 m/s (varriable) by CFD analysis. The analysis is made with and without frictionand with friction as a factors.

Keywords: Computational Fluid Dynamics (CFD) Vertical Axis Wind Turbines (VAWT)

INTRODUCTION

In recent decades, the prospect of the depletion of fossil fuels has directed attention toward renewable energy sources. Among the renewable energy sources, onshore wind power is one of the most attractive because of its low cost of maintenance of installed systems. Although the concept of vertical axis wind turbines (VAWTs) was proposed by Darrieus [1] as early as 1931, the research and development in this area are still of interest and in progress nowadays. Among the several categories of wind generators,small wind turbines have gained more and more interest for their excellent adaptability to the urban environment in terms of visual impact and noise pollution.Being axisymmetric, they are omnidirectional turbines, which respond well to changes in wind direction. In order to determine the performance of the VAWT, analytical and numerical approaches, as well as experimental tests are generally used [2].The aerodynamic analysis of VAWTs is complicated due to their orientation to the oncoming wind. The VAWTs have a rotational axis perpendicular to the oncoming airflow. This accounts for aerodynamics that is more complicated as compared to a conventional HAWT. However, the configuration has an independence of wind direction. The main shortfalls of this are the high local angles of attack and the wake coming from the blades in the upwind part and axis. This disadvantage is more pronounced with VAWTs. The power output from the high speed lift VAWT can be appreciable.Understanding the aerodynamics of the pure drag type of VAWT will give important insight for improving the lift coefficient, and designing this turbine for better and more efficient harnessing of the wind power.

Lift Force

The lift force is one of the major force components exerted on an airfoil blade section inserted in amoving fluid. It acts normal to the fluid flow direction. This force is a consequence of the uneven pressure distribution between the upper and lower blade surfaces.

Drag force

The drag force acts in the direction of the fluid flowing. Drag occurs due to the viscous friction forces on the airfoil surfaces, and the unequal pressure on surfaces of the airfoil. Drag is a function of the relative wind velocity at the rotor surface, which is the difference between the wind speed and the speed of the surface[3]. This can be overcome by designing the leading and tailing edges of the blade by considering the aerodynamic flow of wind. The rotor of the savonius turbine produces high torque, and it can able to rotate in low wind speeds hence it does not need any starter mechanism for the initial rotation. The modelling and analysis process of rotor blade is done by the Computational Fluid Dynamics (CFD) [4].

Effect of aspect ratio

The aspect ratio of a geometrical shape is the ratio between its sizes in different dimensions. For example, the aspect ratio of a rectangle is the ratio of its longer side to its shortest side.

Conclusion

- There is no proper method and calculation procedure for finding the values
- The practically it should be tested for varying different parameters
- The common blade profiles used in the analysis are Flat, Savonius, Helical,

  Involutes Blade Profiles
- The design is very simple than HAWT with less complications

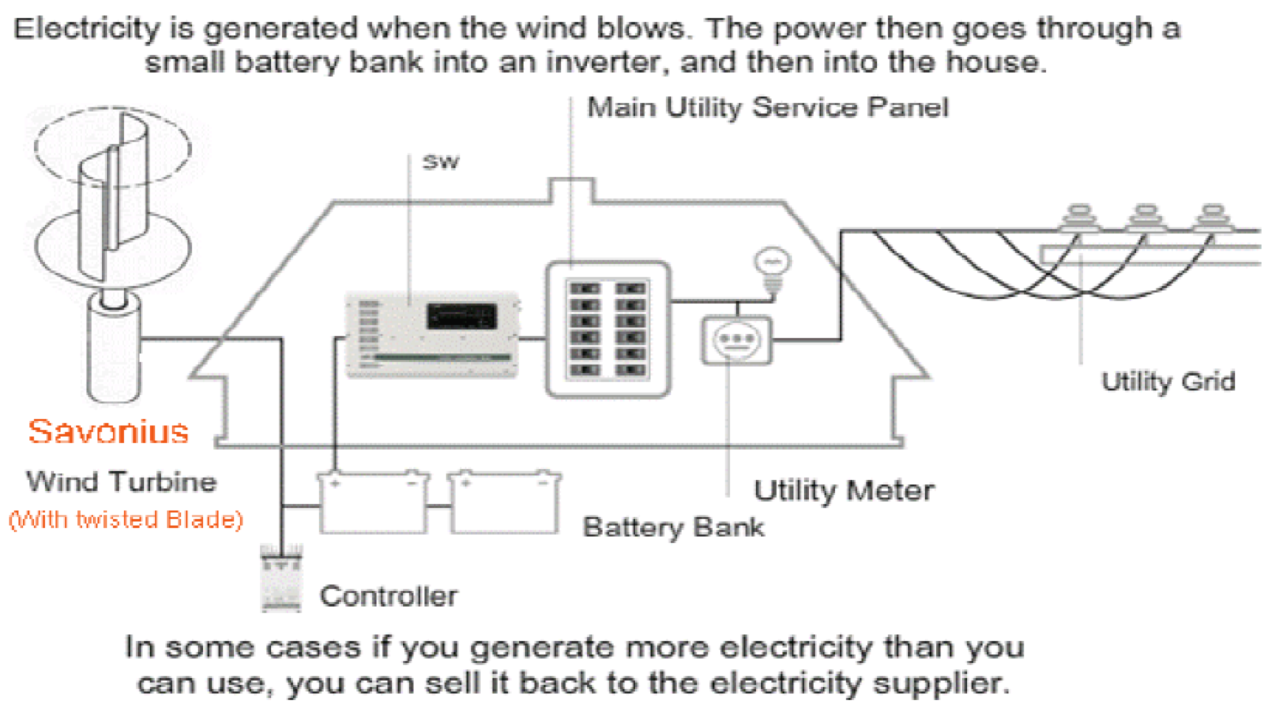

Fig. Residential Wind Turbine [4]

the turbine with the lowest AR will have the highest power coefficient and the lowest rotational velocity. In aerodynamics the aspect ratio of wing is the ratio between the lengths to its breadth. A high aspect ratio indicates long, narrow wings, whether a low aspect ratio indicates short, stubby wing. For most wings the length of the chord is not aconstant but varies along the wing, so the aspect ratio AR is defined as the square of the wingspan b divided by the area of the wing platform, which is equal to the length to breadth ratio for a constant chord wing. [5]

$AR = b^2/S$

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