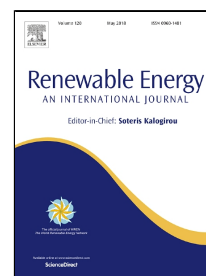


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Investigation on Aerodynamic Performance of Vertical Axis Wind Turbine with Different Series Airfoil Shapes

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Abstract: Numerical research for vertical axis wind turbine with different thicknesses or different cambers of airfoils was conducted in this paper. By comparing with experiment results, the simulation results were validated. Power coefficients at different tip speed ratios were calculated and compared with different types of airfoils: ① symmetrical airfoils with different thicknesses; ② symmetrical airfoils with same thicknesses and different thickness positions; ③ non-symmetrical airfoils with same thicknesses, same maximum thickness positions, same cambers but different maximum camber positions; ④ non-symmetrical airfoils with same thicknesses, same maximum thickness positions, same camber positions but different maximum cambers. It was found that power coefficients of VAWT show tendency at first increase and then decrease with the increase of tip speed ratio for symmetrical airfoils with same thicknesses and same positions of maximum thickness. Moreover, when the maximum thickness position moves from the leading edge to trailing edge, the power coefficients firstly increases and then decreases for symmetrical airfoils with same maximum thickness but different positions of maximum thickness. Besides, with the rise of areas enclosed by curves of surface pressure coefficients when the azimuthal position increases from 0° to 90°, there shows much larger work capability.

Keywords: vertical axis wind turbine; different airfoil shapes; wind energy; aerodynamic performance; CFD

1. Introduction

In recent years, due to the pollution, global warming and shortage of traditional fossil energy, the renewable energy resources have become increased significantly, such as biomass energy, solar energy, geothermal energy, hydroelectric energy, and wind energy, etc. Among these resources, wind energy becomes a research hotspot and hence extensive research efforts have been made to improve the technology of power generation through wind.

Wind turbine mainly can be divided into two types based on rotor structure and its position in airflow: horizontal axis wind turbines (HAWT) and vertical axis wind turbines (VAWT). HAWT is widely utilized for the commercial generation of electricity due to many years of research and development [1]. Compared with HAWT, VAWTs are omni-directional, accepting wind from any direction without any yawing mechanism [2]. Besides, VAWTs also have several well-known advantages: low noise, flexible and convenient, safe and reliable, nice appearance and simple maintenance. VAWTs can be used for distributed power supply fields such as public lighting in the urban central area, resident families, large outdoor advertising, telecommunication base station, oil field, highway entire journey supervisory system, cruise ships and villages, etc. VAWT is a good supplementary form of wind energy utilization and it has broad application prospects [3, 4]. How to improve the wind energy coefficient of VAWT has become a research hot point in academy [5, 6].

VAWTs can be classified into Darrieus wind turbine, Savonius rotor, combined Savonius and Darrieus rotor, two leaf semi rotary VAWT, Sistan type wind mill and Zephyr turbine [2]. Darrieus wind turbine was first designed in 1931 [7]. Among VAWTs, the Darrieus wind turbines show

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