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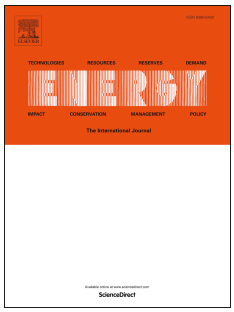

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Effect of Solidity on the Performance of Variable-Pitch Vertical Axis Wind Turbine

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Abstract

The Darrieus vertical axis wind turbine (VAWT) has been the subject of a large number of recent studies to improve self-starting capability and aerodynamic performance. This study presents a computational fluid dynamics simulation of the vertical axis wind turbine with fixed and variable pitch at different solidities. In order to introduce the best efficiency value of solidity for a variable-pitch vertical axis wind turbine, a computational modeling of two-dimensional transient flow around a VAWT at solidities between 0.2 to 0.8 and turbine with two, three and four blades is conducted. The numerical simulation models the flow field around a turbine rotor by solving the strong nonlinearity of URANS and SST k-ω turbulence model, utilizing the semi-empirical numerical model. To simulate the turbine in a variable pitch method, the user-defined function (UDF) code and the moving mesh method are used. The results show that variable pitch blades with high solidities are preferred when the initial self-starting torque is required. Moreover, the variable pitch blades are capable to produce more torque at high solidities. Therefore, the vortex interaction between upwind vortices and blades in downwind stream is decreased. The results verify that the power reduction of fixed pitch VAWT at high solidities could be solved by utilizing the variable pitch technique.

Keywords

Vertical axis wind turbine; Variable-Pitch; Solidity; 2D Numerical simulation, UDF

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