Abstract

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Computational Fluid Dynamics Study Of Dusty Air Flow Over Naca 63415 Airfoil For Wind Turbine Applications

Gulf and South African countries have enormous potential for wind energy. However, the emergence of sand storms in this region postulates performance and reliability challenges on wind turbines. This study investigates the effects of debris flow on wind turbine blade performance. In this paper, two-dimensional incompressible Navier-Stokes equations and the transition SST turbulence model are used to analyze the aerodynamic performance of NACA 63415 airfoil under clean and sandy conditions. The numerical simulation of the airfoil under clean surface condition is performed at Reynolds number 460×103, and the numerical results have a good consistency with the experimental data. The Discrete Phase Model has been used to investigate the role sand particles play in the aerodynamic performance degradation. The pressure and lift coefficients of the airfoil have been computed under different sand particles flow rates. The performance of the airfoil under different angle of attacks has been studied. Results showed that the blade lift coefficient can deteriorate by 28% in conditions relevant to the Gulf and South African countries sand storms. As a result, the numerical simulation method has been verified to be economically available for accurate estimation of the sand particles effect on the wind turbine blades.