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Sensitivity Analysis Optimization of a Horizontal Axis Wind Turbine from Its Aerodynamic Profiles

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Abstract : Due to the increasing environmental impact, the wind energy is getting strong. This research studied the relationship between the power produced by a horizontal axis wind turbine (HAWT) and the aerodynamic profiles used for its construction. The analysis is studied using the Computational Fluid Dynamic (CFD), presenting the parallel between the energy generated by a turbine designed with selected profiles and another one optimized. For the study, a selection process was carried out from profile NACA 6 digits recommended by the National Renewable Energy Laboratory (NREL) for the construction of this type of turbines. The selection was taken into account different characteristics of the wind (speed and density) and the profiles (aerodynamic coefficients Cl and Cd to different Reynolds and incidence angles). From the selected profiles, was carried out a sensitivity analysis optimization process between its geometry and the aerodynamic forces that are induced on it. The 3D model of the turbines was realized using the Blade Element Momentum method (BEM) and both profiles. The flow fields on the turbines were simulated, obtaining the forces induced on the blade, the torques produced and an increase of 3% in power due to the optimized profiles. Therefore, the results show that the sensitivity analysis optimization process can assist to increment the wind turbine power.

Keywords : blade element momentum, blade, fluid structure interaction, horizontal axis wind turbine, profile design
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