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OPTIMIZED DESIGN AND PERFORMANCE TESTING OF A 1.5 MW WIND TURBINE BLADE

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ABSTRACT

The costs of making WT blades are around1 5-20 percent of the production costs for wind turbines. The expenses of advances in the design of blades reflect the low total cost of the output of wind turbines. Profits from the better structural model, the use of suitable composite materials, and advanced production methods for blades and composite materials contribute to the need for numerical modeling and optimization methods. The design of the wind turbine is aimed at achieving optimum power output under different atmospheric conditions. Changing the blade shape is one of the methods used to adjust rigidity and stability, but can affect aerodynamic wind turbine performance. Another strategy for altering the physical and mechanical properties of wind turbines is to change the composite material used in the blade. The problem of deciding optimal blade shapes and the optimal composite material is a challenging one because the mathematical analysis of the aerodynamic load is complicated, and particular requirements and goal shave to be met. Thus, the design of wind turbine blades is a complex engineering challenge with many objectives. The aerodynamic performance of the turbine must be matched with the structural requirement. The problem also doesn't rely on a single geometric property but on the combination of aerofoils and various blade functions in addition to other parameters. This paper, therefore, aims to provide a method that can enable designers to deepen their understanding of the dynamics of the design space and to find a blade design that has a low energy cost. In this paper, S818, S825, and S826 series are used for designing wind turbine blades. These airfoils have many advantages interms of design level, off-design capacities, and structural properties to meet the inherent requirements of wind turbines. The initial design of a 1.5 MW composite wind turbine blade is first designed in this paper using the base airfoil. A multi-objective genetic algorithm has been used for the optimization of S818, S825, and S826 airfoils to achieve two goals – maximum lift and maximum elevation to drag ratio. It is shown that the multi-target genetic algorithm can yield superior airfoils in comparison with the original airfoils. Optimized airfoils are then used to develop a new wind turbine blade. The commercial computational fluid dynamics software has been used for measuring the flowfield and investigate the performance parameters. For the aerodynamic, structural design, and optimization of wind turbine blades, this study issignificant.

Keywords: Airfoil, Wind turbine blade, Computational fluid dynamics, Genetic algorithm Optimization