# Analysis of Aerodynamic Performance and Optimization Design Improvement for Horizontal —Axis Wind Turbine Blades

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**ABSTRACT**

The research mainly investigates the aerodynamics analysis methods and an optimization procedure for an upwind, horizontal-axis wind turbine blade, and applies the methodology to the improvement of aerodynamic performance of a turbine rotor previously presented by others, which has a tip-speed ratio of 4, rotor diameter of 6.3 m, three blades, and a rated power output of 25kW. This thesis uses NACA4412 as the original airfoil. Based on the blade element-momentum (BEM) theory, the blade is divided into five sections and a contracting tip section. The five airfoils for these sections are first optimized using a 2-D optimization procedure to find the best combination of parameters and attack angle so that Cl/Cd is optimized. The chord lengths and relative angles of these airfoils are then determined with the optimum rotor theory. A computer program is written to execute the BEM theory. Finally, the five 2-D airfoils are employed to construct a 3-D, three-bladed rotor. Three computational methods, including the BEM program, NREL aero-elasticity program, and Fluent software, are used to compute the power outputs and blade-related data for original NACA4412 blades, optimized NACA4412 blades, and the blades previously proposed by others. The research results show that the 3-D blades with added 2-D optimization procedure have remarkably less required mass than the blades with traditional optimization procedure at comparable power output. In addition, the optimization procedure has a great improvement in power output compared to that of the un-optimized blades previously proposed by other authors.

Keywords : Wind turbine blades optimization、blade elements momentum theory、optimum blade rotor theory、Power

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