Aerodynamic efficiency enhancement for asymmetric profiles

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Abstract. This paper presents a solution for enhancement of aerodynamic efficiency for asymmetric airfoils. In order to increase the lift and reduce the drag forces for a blade segment, a groove was created on its surface. There were carried out experiments consisting in the analysis of two asymmetric airfoil segments of the same type in the wind tunnel. One segment was designed with the groove and the other without it. The optimum location of the groove was determined by means of CFD analysis. Simulation results were compared to test results and the CFD analysis model was validated.

1 Introduction

Utilization of wind potential at small scale is hampered by reduced efficiency of low-power wind turbines. In this regard, more research has been carried out over the last decades. Proposed solutions to increase the performance of wind turbines are based on optimization of blade geometry, the use of special elements to increase aerodynamic effects, the use of composite materials based on carbon fiber etc. One method to increase the aerodynamic efficiency of the wind turbine rotors is to provide the blades with suction ports. This solution is presented in the work of one of the co-authors of this article [1]. Another interesting study on the control of the suction flow of a rectangular wing is presented in the paper [2].

Based on these studies, our team has done some research on increasing the aerodynamic efficiency of blades for low power wind turbines (1-10 kW). A wind turbine blade segment was analyzed with asymmetrical aerodynamic profile that was equipped with a groove on the surface. There were carried out experiments consisting of measurement of the lift and drag forces of the blade section in the wind tunnel for different angles of attack. In order to measure lift and drag forces for the grooveless blade section the adhesive tape was used to cover it.

In order to determine the optimum location of the groove on the airfoil section several CFD analyses were performed using ANSYS software. The blade section model was obtained via additive manufacturing technology using the 3D printer. The stages of the researches are presented further in more detail.

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