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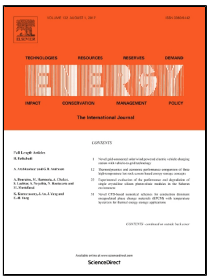

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Experimental investigations of boundary layer impact on the airfoil aerodynamic forces of Horizontal Axis Wind Turbine in turbulent inflows

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ABSTRACT

In order to check whether the developed airfoil UMY02-T01-26 can improve aerodynamic performance, a multiport device is used to investigate the pressure distribution acting on a single blade surface under inflow conditions. In this experiment, aerodynamic forces are discussed with different Reynolds numbers of $Re = 0.5 \times 10^5$, 1.0×10^5, 1.5×10^5 and 2.0×10^5. Furthermore, for the purpose of clarifing the impact of turbulence intensity, the aerodynamic forces characteristics of HAWT airfoil are estimated in the case of different turbulence intensities generated by static turbulence grids. According to the wind tunnel experimental analysis, it can be known that the blade boundary layer tape has no significant effects on the drag coefficient with or without turbulence grids. For the low turbulence intensity (without grid), the airfoil performance is improved when the boundary layer tape is attached near the leading edge. For the high turbulence intensity (with grid), in the case of the $Re = 0.5 \times 10^5$, the pressure coefficient presents a steady value from some back positions of $x/c = 0.20$, where the boundary layer tape is attached on the trailing edge position.

Keywords: Horizontal Axis Wind Turbine (HAWT), boundary layer, pressure measurement, turbulence intensity.

NOMENCLATURE

c	airfoil chord length [m]
C_L	lift coefficient
C_D	drag coefficient
C_p	pressure coefficient
d_e	effective mesh width [m]
F_D	drag force [N]
F_L	lift force [N]
M	mesh interval [m]
P	pressure of blade surface [pa]
p_i	pressure of measurement tap [pa]
p_0	static pressure [pa]
Re	Reynolds numbers
S_{Fe}	effective solidity factor
s_i	measurement taps distance [m]
TI	turbulence intensity
U_0	free stream wind velocity [m/s]
U_{ave}	average wind velocity [m/s]
W	resultant velocity to blade [m/s]
x	longitudinal coordinate [m]
y	lateral coordinate [m]
z	vertical coordinate [m]
α	angle of attack [°]

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