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1 Experimental investigations of boundary layer impact on the airfoil 2 aerodynamic forces of Horizontal Axis Wind Turbine in turbulent inflows

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5 ABSTRACT

In order to check whether the developed airfoil UMY02-T01-26 can improve aerodynamic performance, a 6 7 multiport device is used to investigate the pressure distribution acting on a single blade surface under inflow 8 conditions. In this experiment, aerodynamic forces are discussed with different Reynolds numbers of $Re = 0.5 \times$ 9 10^5 , 1.0×10^5 , 1.5×10^5 and 2.0×10^5 . Furthermore, for the puropose of clarifing the impact of turbulence 10 intensity, the aerodynamic forces characteristics of HAWT airfoil are estimated in the case of different turbulence 11 intensities generated by static turbulence grids. According to the wind tunnel experimental analysis, it can be 12 known that the blade boundary layer tape has no significant effects on the drag coefficient with or without 13 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 14 the $Re = 0.5 \times 10^5$, the pressure coefficient presents a steady value from some back positions of x/c = 0.20, where 15 16 the boundary layer tape is attached on the trailing edge position.

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

18 NOMENCLATURE

19	С	airfoil chord length [m]
20	C_L	lift coefficient
21	C_D	drag coefficient
25	C_{p}	pressure coefficient
26	$d_{\rm e}$	effective mesh width [m]
27	F_D	drag force [N]
28	F_L	lift force [N]
29	M	mesh interval [m]
30	Р	pressure of blade surface [pa]
31	p_{i}	pressure of measurement tap [pa]
32	p_0	static pressure [pa]
33	Re	Reynolds numbers
34	$S_{\rm Fe}$	effective solidity factor
35	Si	measurement taps distance [m]
36	TI	turbulence intensity
37	U_0	free stream wind velocity [m/s]
38	$U_{\rm ave}$	average wind velocity [m/s]
39	W	resultant velocity to blade [m/s]
40	x	longitudinal coordinate [m]
41	У	lateral coordinate [m]
42	Ζ	vertical coordinate [m]
43	α	angle of attack [°]

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