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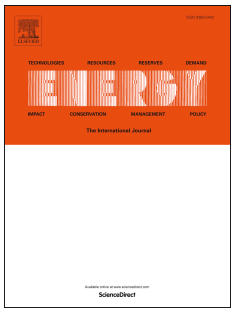

Performance evaluation of profile modifications on straight-bladed vertical axis wind turbine by energy and Spalart Allmaras models

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Performance evaluation of profile modifications on straight-bladed vertical axis wind turbine by energy and Spalart Allmaras models

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Abstract

In this paper, we investigated the effect of profile modifications on straight bladed VAWTs equipped with symmetrical aerofoil (NACA 4-digit series of NACA 0012, NACA 0015, NACA 0018, and NACA 0021). Aerofoil profile modifications being investigated, consists of only Gurney flap, only inward dimple and combination of both Gurney flap and dimple. In this work, we focused on the values of lift, aerofoil velocity and aerofoil forces as these are the vital parameters, which are used as the parameters to measure for power generated by the turbine by Energy and the Spalart Allmaras models. All the design modifications and simulation analysis have been done with the help of CFD by using ANSYS Fluent. The results of the modified profiles are compared in terms of lift coefficient (C_L), velocity (V) and blade force (F). These results are further validated with previous experimental results at same boundary conditions for to ensure the reliability of the analysis. The overall results show that NACA 0012 and NACA 0015 gives better performance in all three aspects of results (coefficient of lift, velocity, and force). Hence, present modifications are best suitable for increasing the performance of NACA 0012 and NACA 15 symmetrical aerofoil straight bladed VAWTs.

Keywords: Dimple, Gurney Flap, Energy Model, Spalart Allmaras model, ANSYS Fluent

Nomenclature

C	= Cord Length (m)	a	= axial interference factor
V	= True air speed or Wind Velocity (m/s)	ω	= angular velocity (Rpm)
p	= Pressure (Pa)	E	= Kinetic energy (Joule)
T	= Temperature (K)	F	= Force (N)
u	= tangential velocity (m/s)	W	= Work done
P	= Power (Watt)	η	= Efficiency
v_1	= wind speed upstream (m/s)	T	= Torque
v_3	= wind speed downstream (m/s)	F_L	= Lift force (N)
A	= Cross section area (m^2)	F_D	= Drag force (N)
r	= radius of rotor (m)	C_L	= Coefficient of lift
R_D	= radius of Dimple (m)	C_D	= Coefficient of Drag
L_G	= length of Gurney Flap (m)	C_P	= Coefficient of Power

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