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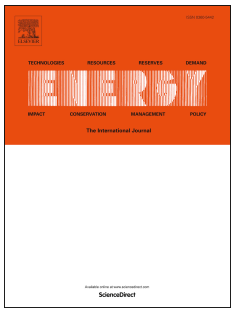

Detailed entropy generation analysis of a Wells turbine using the variation of the blade thickness

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Detailed Entropy Generation Analysis of a Wells Turbine using the Variation of the Blade Thickness

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Abstract

The inherent disadvantages, due to the narrow operational range and low efficiency of Wells turbine, are investigated based on aerodynamic and entropy generation analysis. To overcome these issues, the effects of blade thickness on the performance of a Wells turbine are discussed. In this study, two kinds of blade profiles are being investigated: the original design, a constant thickness blade (CTB) and the proposed design, a variable thickness blade (VTB). The computation is performed by solving the 3D steady incompressible Reynolds-averaged Navier-Stokes (RANS) equations with shear stress transport (SST) turbulence model in a non-inertial reference frame rotating with the turbine. The results show the interaction between tip leakage vortex (TLV) and suction surface of the blade is substantially reduced by using the VTB. The results reveal that entropy generation seems to give an advantageous effect of reducing the separation at the tip section of the VTB in the deep stall condition. At most, a 63.37 % increase in torque coefficient and 72.8 % increase in efficiency are achieved are achieved by the VTB in the deep stall condition. Moreover, a detail entropy generation and aerodynamic analysis show the main sources of losses are due to blade profile and secondary flows.

Keyword: Wells turbine; Wave energy; Variable thickness blade; Entropy generation analysis; Secondary flow

Nomenclature

T^*	Torque coefficient $(-)$	S_{gen}	Entropy generation rate $(\mathrm{W/m^3\ K})$
ΔP^*	Pressure drop coefficient $(-)$	$\overline{S_{gen}}$	Global entropy generation rate$(\mathrm{W/K})$
ΔP_0	Total pressure drop (Pa)	$\overline{S_{gen,P}}$	Global entropy generation rate due to the blade profile $(\mathrm{W/K})$