Abstract

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Numerical optimization of axial turbine with self-pitch-controlled blades used for wave energy conversion

Wells turbines are among the most practical wave energy converters despite their low aerodynamic efficiency and power produced. It is proposed to improve the performance of Wells turbines by optimizing the blade pitch angle. Optimization is implemented using a fully automated optimization algorithm. Two different airfoil geometries are numerically investigated: the standard NACA 0021 and an airfoil with an optimized profile. Numerical results show that each airfoil has its own optimum blade pitch angle. The present computational fluid dynamics optimization results show that the optimum blade pitch angle for NACA 0021 is +0.3° while that of the airfoil with an optimized profile equals +0.6°.The performance of the investigated airfoils is substantially improved by setting the blades at the optimum blade pitch angle. Both the turbine efficiency and tangential force coefficient are improved, especially at low flow rate and during turbine startup. Up to 4.3% average increase in turbine efficiency is achieved by optimizing the blade pitch angle. A slight improvement of the tangential force coefficient and decrease of the axial force coefficient are also obtained. A tangible increase of the stall-free operating range is also achieved by optimizing the blade pitch angle.