

A Vertical-Axis Unidirectional Rotor with Nested Blades for Wave Energy Conversion

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Abstract : In the present work, development of a new vertical-axis unidirectional wave rotor is reported. The wave rotor is a key component of a wave energy converter (WEC), which harvests energy from ocean waves. Differing from the huge majority of WEC designs that perform reciprocating motions (heaving up and down, swaying back and forth, etc.), our wave rotor performs unidirectional rotation about a vertical axis when directly exposed in waves. The unidirectional feature of the rotor makes the rotor respond well in a wide range of the wave frequency. The vertical axis arrangement of the rotor makes the rotor insensitive to the wave propagation direction. The rotor employs blades with a cross-section in an airfoil shape and a span curled into a semi-oval shape. Two sets of blades, with one nested inside the other, constitute the rotor. In waves, water particles perform an omnidirectional motion that constantly changes in both spatial and temporal domains. The blade nesting permits a compact rotor configuration that 'sees' a relatively uniform local flow in the spatial domain. The rotor was experimentally tested in simulated waves in a wave flume under various conditions. The testing results show a promising unidirectional rotor that is capable of extracting energy from waves at a capture width ratio of 0.08 to 0.15, depending on detailed wave conditions.

Keywords : unidirectional, vertical axis, wave energy converter, wave rotor

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