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Numerical Modelling and Simulation of a Bottom-hinged Flap type Oscillating Wave Surge Converter for Performance Optimisation

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Extracting energy from sea waves for power generation applications has become one of the leading research areas in the present time, due to the increasing demand for cleaner renewable energy sources. This paper presents a numerical modelling and simulation work towards performance optimisation of an Oscillating Wave Surge Converter (OWSC). Here, the specific objectives were to identify the optimum density and optimum thickness of a flap to be used in the OWSC for maximum power take off moment (Mpto) to increase the energy conversion efficiency of the OWSC. A series of Smooth Particle Hydrodynamics based 3-D numerical simulations were carried out using the DualSPHysics open-source simulation software. The model was validated using published experimental data on waves generated in a 18 m long and 4.58 m wide wave tank with a flap of 1.04 m wide, 0.48 m height and 0.12 m thick. After the successful validation of the numerical model based on the rotation angle of the flap, further set of numerical simulations were conducted to study the effect of density and the thickness of the flap, which are critical factors governing the performance of the OWSC. It was found that, when the flap density was increased from 250 kg/m^3, the average Mpto also increased and reached a peak value of 40.8 Nm at 750 kg/m^3 of flap density, which records a 18% increment of average Mpto and decreased again. Similarly, when the flap thickness increased from 0.01 m, average Mpto increased and reached to its peak of 40.2 Nm at 0.15 m of flap thicknesses which records a 12% increment of average Mpto and decreased again. Hence this study shows, choosing the optimum flap density and flap thickness is critical to improve performance of OWSCs, in order to effectively use them in next generation renewable energy applications.

Keywords: DualSPHysics, Hydrodynamics, Oscillating wave surge converter, Smoothed particle wave energy