

Primary Energy Conversion in a Direct Drive Turbine for Wave Power Generation

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Recent developments such as concern over global warming, depletion of fossil fuels and increase in energy demands by the increasing world population has eventually lead to mass production of electricity using renewable sources. Ocean contains energy in form of thermal energy and mechanical energy: thermal energy from solar radiation and mechanical energy from the waves and tides. The current paper looks at generating power using waves. The primary objective of the present study is to maximize the primary energy conversion (first stage conversion) of the base model by making some design changes. The model entire consisted of a numerical wave tank and the turbine section. The turbine section had three components; front guide nozzle, augmentation channel and the rear chamber. The augmentation channel further consisted of a front nozzle, rear nozzle and an internal fluid region representing the turbine housing. Different front guide nozzle configuration and rear chamber design were studied. As mentioned, a numerical wave tank was utilized to generate waves of desired properties and later the turbine section was integrated. The waves in the numerical wave tank were generated by a piston type wave maker which was located at the wave tank inlet. The inlet which was modeled as a plate wall which moved sinusoidally with the general function, $x=asin\omega t$. In addition to primary energy conversion, observation of flow characteristics, pressure and the velocity in the augmentation channel, rear chamber as well as the front guide nozzle are presented in the paper. The analysis was performed using the commercial code of the ANSYS-CFX. The base model recorded water power of 29.9 W. After making the changes, the best model obtained water power of 37.1 W which represents an increase of approximately 24% in water power and primary energy conversion.

Key words : primary energy conversion, numerical wave tank, augmentation channel, direct drive turbine, water power

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Performance Analysis of a savonius type direct drive turbine for wave energy conversion

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Although oscillating water column type wave energy devices are nearing the stage of commercial exploitation, there is still much to be learnt about many facets of their hydrodynamic performance. The techniques of Computational Fluid Dynamics (CFD) are applied to simulate a wave energy conversion device in free surface such as waves. This research uses the commercially available ANSYS CFX computational fluid dynamics flow solver to model a complete oscillating water column system with savonius turbine incorporated at the rear bottom of the OWC chamber in a three dimensional numerical wave tank. The purpose of the present study is to investigate the effect of an average wave condition on the performance and internal flow of a newly developed direct drive turbine (DDT) model for wave energy conversion numerically. The effects of blade angle and front lip shape on the hydrodynamic efficiency are investigated. The results indicated that the developed models are suitable to analyze the water flow characteristics both in the chamber and in the turbine. For the turbine, the numerical results of torque were compared for the all cases. The results of the testing have also illustrated that simple changes to the front wall aperture shape can provide marked improvements in the efficiency of energy capture for OWC type devices.

Key words : oscillating water column, numerical wave tank, savonius rotor, hydrodynamics, total efficiency
