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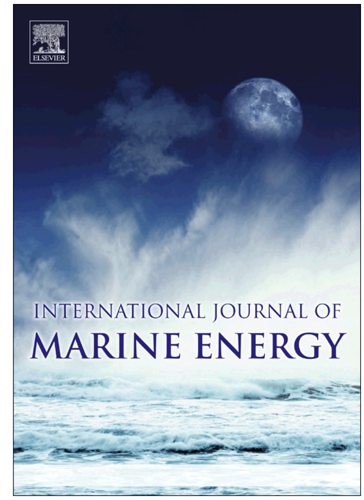

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Numerical Assessment of a Horizontal axis Marine Current Turbine Performance

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Abstract

Horizontal axis marine current turbine is a viable device which can harness kinetic energy from ocean currents. It is the closest concept to be commercialised among other marine turbines. Literature shows that computational fluid dynamics (CFD) models can accurately simulate turbine performance provided appropriate numerical techniques are employed. In this paper, the influence of different numerical approaches on the performance prediction of a two bladed turbine model was assessed by towing tank results from the USNA. Two turbulence models of k-ω SST and BSL EARSM as well as three boundary layer modelling techniques, including wall function, near wall region and transitional Gamma-Theta model, were compared. The effects of using steady state or transient solution methods by applying moving reference frame (MRF) and sliding mesh were investigated. Single blade simulation instead of whole turbine model was also evaluated together with the Reynold number effect. Although Transient solution with sliding mesh method offers a simulation closer to the real condition of turbine operation with accurate results, steady state MRF provides reasonable results while saving a significant computational time as well. Therefore, authors recommend utilising steady MRF simulation of whole turbine model using k-ω SST with wall-function model for performance prediction of horizontal axis marine current turbines in a balance between simulation time and results accuracy.

Keywords:

Horizontal axis turbine, Marine current energy, Performance evaluation, Computational Fluid Dynamics (CFD), Finite Volume Model

1. Introduction

The oceans offer a massive sustainable energy resource, including thermal and kinetic energy. Global tidal energy capacity is estimated to be in the order of 570 TWh/yr [1] well over twice electricity consumption of Australia in 2014 [2]. Horizontal-axis marine current turbines (HAMCTs) are a renewable energy technology, similar to wind turbines, that can convert the kinetic energy of currents to electricity [3]. Compared to other types of renewable energy, marine current power is highly predictable. Thus, it is advantageous to predict the hydrodynamic performance of these turbines in the early stage of the design process [4].

Marine current turbines are working on a similar basis as the wind turbines. Therefore, a lot can be learnt from wind turbine studies to develop performance prediction methods for

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