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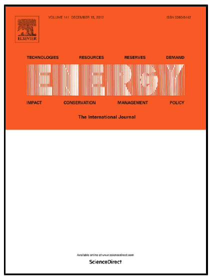

Performance of a horizontal axis marine current turbine– A comprehensive evaluation using experimental, numerical, and theoretical approaches

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Performance of a horizontal axis marine current turbine– A comprehensive evaluation using experimental, numerical, and theoretical approaches

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Abstract

This study provides a comprehensive assessment of a 2 bladed horizontal axis marine current turbine using experiments on two scale models, compared to both theoretical and numerical models and previous experiments in other facilities. The experiments were performed in a towing tank and a circulating water channel on rotors of 500 mm and 800 mm diameter. The effect of model scale was investigated together with facility bias. The impact of facility bias on the performance assessment was found to be induced from blockage and the presence of a shear flow velocity profile in the circulating water channel. A BEM model was modified to consider shear velocity profile in the performance calculations. No significant changes were seen in the BEM model results by inserting the shear flow in the code. In addition, the QBlade software was employed as a tool to investigate the effect of Reynolds number. It can provide the performance outcomes for a range in which the results are sensitive to Reynolds number. A RANS CFD model was provided which simulates the turbine in steady flow conditions. The theoretical, numerical and physical models were used to study the effect of scaling. The BEM and CFD model both had good agreement with the experimental results, which provides a strong platform for more detailed study on the HAMCT hydrodynamics.

Keywords:

Marine current turbine, scale model test, Towing tank, Circulating water channel, BEM theory, CFD modelling, Re/Scale effect

1. Introduction

In recent decades, due to increasing rate of fossil fuel exploitation, more studies are being performed to develop various renewable energy resources as sustainable alternatives. Oceans offer various resources of green energy, such as wave and current [1]. Horizontal axis marine current turbines (HAMCTs) are devices that can convert the kinetic energy of water currents to electricity, similar to what is usually seen in wind energy [2] [3]. Although researchers have been striving to enhance the technology of these devices for many years, there are not yet many commercialised HAMCTs around the world [4] [5].

Ensuring the optimum performance of a marine current turbine is essential in the design stage, including determining if the turbine is cost-effective and viable for a particular deployment site [6]. Selecting an appropriate and accurate method to characterise the hydrodynamics of a turbine is important. There are several different approaches available to study the performance of a full-scale turbine. The Blade Element Momentum (BEM) theory is a

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