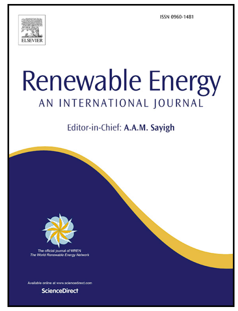

Validation of the actuator line method for simulating flow through a horizontal axis tidal stream turbine by comparison with measurements

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Validation of the actuator line method for simulating flow through a horizontal axis tidal stream turbine by comparison with measurements

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Abstract

The purpose of the present work is to evaluate the capability of the Actuator Line Method (ALM) to simulate flow through a horizontal axis tidal stream turbine. A numerical model combining the ALM with large eddy simulation technique is developed and applied to compute the flow past a laboratory-scale tidal stream turbine. The flow field is analysed in terms of streamwise mean velocity, turbulence intensity, turbulent kinetic energy and the decay rate of the maximum turbulent kinetic energy behind the turbine. It is found that the ALM performs well in predicting the mean flow and turbulence characteristics behind the turbine. The flow field predicted show a clear transition from an organised vorticity region near the turbine to a highly turbulent flow downstream. The location of this transition and the controlling parameters are discussed but further investigation, both numerical and experimental is required in order to clarify its effects on the flow structure and the performance of downstream turbines in tidal turbine arrays.

Keywords: Tidal stream turbine, Actuator line method, Large eddy simulation

1. INTRODUCTION

The interest in tidal stream energy worldwide is driven by three aspects of the resource: it is renewable, predictable (different from wave and wind), and amply available. Despite the considerable research effort in the past decade, the take-up, to date, of the technology remains slow. At the present time, the marine energy industry is lagging behind the wind energy industry. Many scientific and technological hurdles remain to be overcome before the identified potential of marine energy can be fulfilled. In studying Tidal Stream Turbines (TSTs) Computational Fluid Dynamics (CFD) has long played a key role either for better understanding the flow structure around TSTs or designing more efficient TST blades and accurately predicting their performance especially in TST arrays. Quantifying the complicated wake field of TST is identified as important for the design of both isolated TST and TST arrays.

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