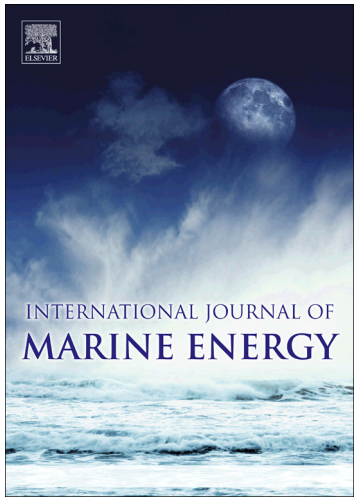

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Michael Shives, Curran Crawford

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Tuned Actuator Disk Approach for Predicting Tidal Turbine Performance with Wake Interaction

Michael Shives[1], Curran Crawford[2]

Dept. Mech. Eng., University of Victoria
PO Box 3055 STN CSC, Victoria, BC, Canada

Abstract

This article presents a practical method for predicting the power output of tidal farms with device wake interactions. The method uses Reynolds-averaged Navier-Stokes (RANS) simulations to predict turbine wakes and bathymetry effects. The power of each turbine depends on the local velocity, which is influenced by other turbine wakes. Therefore, the accuracy of power predictions depends heavily on proper wake modelling. This is a critical issue for the tidal power industry because best practice for predicting tidal farm energy yield has yet to be established, and wake interaction effects may drastically alter energy yield in a dense turbine farm.

This article introduces a methodology which accurately predicts power output while minimizing computational expense, named the *tuned actuator disk approach* (TADA). Rotors are resolved using 9–15 elements across their diameter, allowing for very fast simulations of multiple turbines. The model is tuned to match known thrust and power operational profiles for a set of calibration cases based either on experiments or a limited set of high-resolution simulations. In this study, TADA was used to model a tandem configuration of two scaled rotors in a flume tank, and gave accurate predictions of the rotor thrust, power and wake velocities. Predictions of thrust and power became independent of grid density with more than 15 elements spanning the rotor diameter, however errors associated with using 9 elements were limited to 3% for thrust and 6% for power. Once calibrated for a specific turbine and computational mesh, TADA can be used in full farm-scale simulations at reasonable computational expense, which is an important capability for predicting tidal farm energy yield.

Keywords: actuator disk, tidal, turbine farm, simulation

[1]mrshives@uvic.ca
[2]curranc@uvic.ca