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DEVELOPMENT AND VERIFICATION OF A COMPUTATIONAL FLUID DYNAMICS MODEL OF A HORIZONTAL-AXIS TIDAL CURRENT TURBINE

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ABSTRACT

This paper describes the development of a computational fluid dynamics (CFD) methodology to simulate the hydrodynamics of horizontal-axis tidal current turbines (HATTs). First, an HATT blade was designed using the blade element momentum method in conjunction with a genetic optimization algorithm. Several unstructured computational grids were generated using this blade geometry and steady CFD simulations were used to perform a grid resolution study. Transient simulations were then performed to determine the effect of time-dependent flow phenomena and the size of the computational timestep on the numerical solution. Qualitative measures of the CFD solutions were independent of the grid resolution. Conversely, quantitative comparisons of the results indicated that the use of coarse computational grids results in an under prediction of the hydrodynamic forces on the turbine blade in comparison to the forces predicted using more resolved grids. For the turbine operating conditions considered in this study, the effect of the computational timestep on the CFD solution was found to be minimal, and the results from steady and transient simulations were in good agreement. Additionally, the CFD results were compared to corresponding blade element momentum method calculations and reasonable agreement was shown. Nevertheless, we expect that for other turbine operating conditions, where the flow over the blade is separated, transient simulations will be required.

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