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Revolutionary geometries of mobile hydro-kinetic turbines for renewable energy applications

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An abundant source of renewable energy is feasible by harnessing the kinetic energy of moving water bodies using hydro-kinetic energy conversion devices. The knowledge of wind-turbine design, turbomachinery and fluid dynamic principles of incompressible flow can be applied to design traditional and novel geometries of hydro-kinetic turbines behind a waterborne vehicle. A preliminary design is created using the Blade Element Momentum Theory (BEMT) which includes the Prandtl's correction for blade hub and tip losses. The axial and angular induction factors are calculated iteratively taking into account the coefficient of lift and drag of specific airfoils for a certain angle of attack obtained from Xfoil. Although BEMT does not account for the tip vortices and radial flow induced by the rotation, it provides a good initial geometry. The blade geometry can then be parametrically modified using an in-house 3D blade geometry generator (3DBGB) and analyzed further using a 3D CFD analysis system. Different configurations such as unshrouded single row, unshrouded counter rotating and shrouded single row hydro-kinetic turbines are designed based on a suitable power requirement. The shrouded design uses a traditional axial turbomachinery approach, a low subsonic design using 1-D meanline axisymmetric analysis suite (T-AXI). Novel geometries with solidity varying spanwise are also designed to take advantage of the flow across the turbine. Structural analyses of these shapes are crucial. A high fidelity design and analysis system for hydro-kinetic turbines is demonstrated. The turbine blade designs presented here are believed to revolutionize the renewable energy harness technology.

Biography

Mark G Turner has done his PhD in Aerodynamics, Dept. of Aeronautics and Astronautics Massachusetts Institute of Technology, Cambridge, MA 1990. He is specialized in Computational Fluid Dynamics applied to Turbo machinery.

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