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Design, experimental analysis, and unsteady Reynolds-averaged Navier-Stokes simulation of laboratory-scale counter-rotating vertical-axis turbines in marine environment MINH DOAN, CLAUDRIO PADRICELLI[1], SHINNOSUKE OBI, Department of Mechanical Engineering, Keio University, YOSHITAKA TOTSUKA, Wind Energy Institute of Tokyo Inc. — We present the torque and power measurement of laboratory-scale counter-rotating vertical-axis hydrokinetic turbines, built around a magnetic hysteresis brake as the speed controller and a Hall-effect sensor as the rotational speed transducer. A couple of straight-three-bladed turbines were linked through a transmission of spur gears and timing pulleys and coupled to the electronic instrumentation via flexible shaft couplers. A total of 8 experiments in 2 configurations were conducted in the water channel facility (4-m long, 0.3-m wide, and 0.15-m deep). Power generation of the turbines (0.06-m rotor diameter) was measured and compared with that of single turbines of the same size. The wakes generated by these experiments were also measured by particle image velocimetry (PIV) and numerically simulated by unsteady Reynolds-averaged Navier-Stokes (URANS) simulation using OpenFOAM. Preliminary results from wake measurement indicated the mechanism of enhanced power production behind the counter-rotating configuration of vertical-axis turbines.

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