

WAKE DEVELOPMENT BEHIND A THREE BLADED MARINE HYDROKINETIC TURBINE IN A TURBULENT FREESTREAM

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Freestream turbulence (FST) is a flow condition of significant practical interest in the field of marine hydrokinetic energy harvesting. Recent studies[1, 2] have estimated the turbulence intensity levels at tidal energy sites to be approximately 12-13% in the stream-wise direction and 9-10% and 7-8% respectively in the transverse and vertical directions. In the current experimental work, we investigate the effects of controlled, elevated levels of FST on the wake characteristics of a three bladed, constant chord, zero twist hydrokinetic turbine with a radius of 0.14m (see figure 1a). All presented experiments are performed in a water tunnel facility 0.61m deep, 0.61m wide and 2.1m long. Elevated FST levels of 4% and 8% are generated using an active grid turbulence generator (see figure 1b) placed at the inlet to the water tunnel test section. Each experiment is repeated over a range of Tip Speed Ratios (TSR's) to capture the operating range of the turbine. Acoustic Doppler Velocimetry is used to characterize the flow in the wake of the turbine. Wake velocity deficit and wake recovery length are among the more crucial wake characteristics from a farm design standpoint as they dictate the optimum spacing between turbine units[3]. Velocity deficit across the rotor plane and the swirl number (used to predict wake recovery) are measured at various downstream locations for the different TSR's and elevated FST's. Additionally, the velocity fluctuations and turbulence spectra are also studied for each of the cases tested. The results obtained are compared to the case of a clean flow with an FST ~ 1% in order to correlate the intensity of turbulence to the wake formation and decay downstream of the turbine.

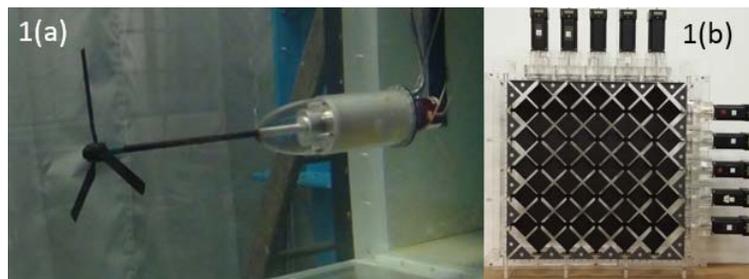


FIGURE 1(A). MARINE HYDROKINETIC TURBINE PROTOTYPE, (B) ACTIVE GRID

REFERENCES

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