TESTING A LAB-SCALE TIDAL STREAM TURBINE IN ELEVATED LEVELS OF HOMOGENEOUS TURBULENT INFLOW

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The high predictability of tidal flows across the globe makes it a dependable renewable energy resource for commercial generation of electric power. The major challenge to the large-scale utilization of the resource is the survivability of existing tidal energy converter technologies in the highly turbulent tidal environments. A thorough understanding of the effects of ambient turbulence on performance and wake characteristics of a tidal turbine is imperative to developing efficient and robust designs. In perspective of the extent of research concerning various aspects of the technology, impact of ambient turbulence on tidal turbines is a topic that has received limited attention[1]. The current experimental work aims to better the understanding of turbine performance and wake evolution in a turbulent flow environment, similar to actual tidal flows. All experiments reported were performed in the recirculating water tunnel facility at Lehigh University, equipped with a 10-shaft, active grid type turbulence generator at the inlet. The turbine model tested has a rotor diameter(D) of 0.28m, made of constant chord, no twist, SG6043 cross-section[2]. Two levels of homogenous ambient turbulence intensity, Ti=2.2% and 12.6% were tested in the experiments. From the data collected, elevated turbulence intensity was found to have a dramatic impact on the load fluctuations acting on the rotor; the standard deviation of rotor torque measured at Ti=12.6% was 4.5 times the corresponding value at Ti=2.2%. The angular momentum in the wake was observed to be considerably lower in the higher ambient turbulence. The drop-in swirl numbers at Ti=12.6% ranged between 12% at X/D=0.5 to 71% at X/D=4. The integral length scales in the near wake of the turbine were also explored; it was noted that the scales calculated immediately downstream of the rotor at Ti=12.6% were, on an average, 5 times the scales calculated at Ti=2.2% (see figure 1).

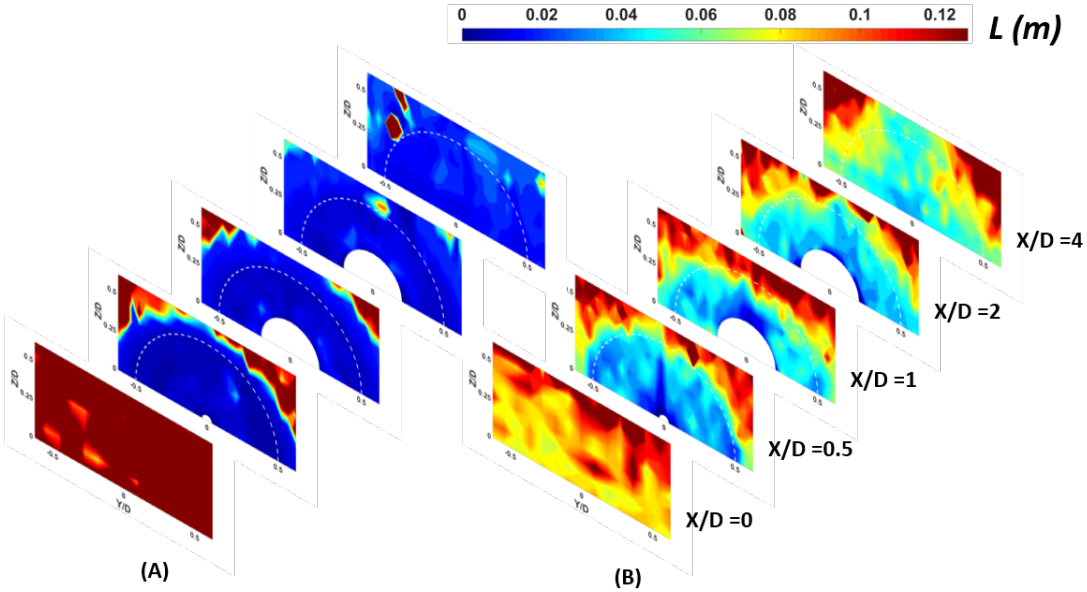

FIGURE 1. DOWNSTREAM EVOLUTION OF INTEGRAL LENGTH SCALES (A) TI = 2.2%, (B) TI = 12.6%

REFERENCES

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