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Phase Resolved Angular Velocity Control of Cross Flow Turbines

BENJAMIN STROM, STEVEN BRUNTON, BRIAN POLAGYE, Univ of Washington — Cross flow turbines have a number of operational advantages for the conversion of kinetic energy in marine or fluvial currents, but they are often less efficient than axial flow devices. Here a control scheme is presented in which the angular velocity of a cross flow turbine with two straight blades is prescribed as a function of azimuthal blade position, altering the time-varying effective angle of attack. Flume experiments conducted with a scale model turbine show approximately an 80% increase in turbine efficiency versus optimal constant angular velocity and constant resistive torque control schemes. Torque, drag, and lateral forces on one- and two-bladed turbines are analyzed and interpreted with bubble flow visualization to develop a simple model that describes the hydrodynamics responsible for the observed increase in mean efficiency. Challenges associated with implementing this control scheme on commercial-scale devices are discussed. If solutions are found, the performance increase presented here may impact the future development of cross flow turbines.

Benjamin Strom
Univ of Washington

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