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Cavitation inception criteria for hydrokinetic turbine blades
IVAYLO NEDYALKOV, MARTIN WOSNIK, University of New Hampshire — Cavitation can adversely affect the performance of hydrokinetic turbines, and cause noise, vibration and even erosion. In some cases, unstable operation can be caused by cavitation-induced flow instabilities. A theoretical model for cavitation inception criteria on the blades of hydrokinetic turbines was developed by deriving cavitation numbers using turbine momentum theory and Airy wave theory. The cavitation number on a turbine blade element is calculated as a function of tip speed ratio, axial and angular induction factors at the rotor - which depend on the turbine's operating condition - and location on the blade, blade rotation angle, free stream velocity, wave-induced pressure oscillation, wave-induced velocities, time-dependent turbine hub submergence, vapor pressure, and free stream turbulence. With cavitation maps for specific hydrofoil shapes, which exist for some basic foil shapes, or can be obtained from inexpensive experiments in a small high-speed water tunnel where velocity and pressure can be controlled independently, the physical cavitation inception limits σ_i and $(\sigma/2\alpha)_i$ can be determined. With this model, safe deployment depths and safe tip speed ratios for specific turbines installed at a given site can be predicted. The model is compared to the common cavitation inception scaling with lift coefficient or Reynolds number.

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