Energy Harvesting Performance of a Flapping Airfoil with Leading Edge Motion

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Abstract

Flapping foil energy harvesters have performance comparable to conventional rotating turbines while having additional advantages such as the versatility to accommodate geometric constraints such as shallow riverbeds, and reduced mechanical stresses during operation. This thesis focuses on how relative motion at the front section of the foil, or leading edge, impacts the performance of these energy harvesters. Wind tunnel testing for an experimental flapping foil device is conducted and force measurements are used to calculate a theoretical power output. It is found that leading edge motion that reduces the effective angle attack of the airfoil in the flow improves the theoretical energy harvesting performance. In addition a low order inviscid model is applied to the foil operation studied here to determine the ability of the model to reproduce the aerodynamic forces. It is found that, as formulated, the model is able to capture generic trends but fails to reproduce quantitative values. This thesis's finding are relevant for the design of flapping foil energy harvesters as well as other unsteady airfoil scenarios.

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