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Fluid-solid-electric couplings and efficiency of piezoelectric flags[1]
YIFAN XIA, SEBASTIEN MICHELIN, LadHyX - Ecole Polytechnique, OLIVIER DOARE, UME - ENSTA ParisTech — The spontaneous and self-sustained flapping of a flexible plate in an axial flow can be used for energy harvesting applications by placing piezoelectric patches on its surface, that periodically deform with the plate, generating an electrical current. These piezoelectric elements also introduce a feedback of the output circuit on the fluid-solid dynamics and may modify its flapping behavior. To better understand the dynamics of these piezoelectric flags, the resulting energy transfers and their harvesting efficiency, numerical simulations of the fluid-solid-electric problem were carried out using an explicit description of the energy harvesting mechanism and simple output circuits. In the case of purely resistive circuits, a tuning mechanism is identified between the circuit's time scale and the flapping frequency. When the circuit possesses its own dynamics (e.g. inductive/resonant circuits), a lock-in mechanism is observed that leads to an effective control of the flapping frequency by the output circuit over a large range of parameters and a significant increase in the energy harvesting performance of the device.

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