6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

MODELLING AND ANALYSIS OF FLOW-DRIVEN ENERGY HARVESTING DEVICES AND ASSOCIATED REDUCED-ORDER MODELS

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Keywords: *Piezoelectric energy harvesting, Monolithic FSI, Reduced order models*

A specific class of energy harvester devices for renewable energy resources allows conversion of ambient fluid flow energy to electrical energy via flow-induced vibrations of a piezo-ceramic composite structure positioned in the flow field. This energy converter technology simultaneously involves the interaction of a composite structure and a surrounding fluid, the electric charge accumulated in the piezo-ceramic material and a controlling electrical circuit. In order to predict the efficiency and operational properties of such future devices and to increase their robustness and performance, a mathematical and numerical model of the complex physical system is required to allow systematic computational investigation of the involved phenomena and coupling characteristics.

The presentation will discuss a monolithic modelling approach that allows simultaneous analysis of the harvester, which involves surface-coupled fluid-structure interaction, volume-coupled electro-mechanics and a controlling energy harvesting circuit. Based on a finite element discretisation of the weighted residual form of the governing equations, time- and frequency-domain analysis enables investigation of different types of structures (plate, shells) subject to exterior/interior flow with varying parameters, and attached electrical circuits with respect to the electrical power output generated. Consequently, options for parametric reduced-order modelling of flow-driven energy harvesters will be discussed.

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