Numerical investigation of flexible beams for electromagnetic energy harvesting under the wakes from upstream cylinder

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ABSTRACT

Over the recent years, wireless sensor networks (WSN) have gained increasing interest in structural health monitoring (SHM) due to the rapid advancements in wireless technologies and low-power electronics. The specialty of wireless systems is that they can monitor structures and machines continuously without the need of associated installation cost of wiring. However, powering WSN using the traditional limited-life batteries, which need regular replacement, can lead to huge maintenance cost, particularly for large network systems. Due to the continuous reduction in the power requirements of WSN, which is in many cases in the range of few milliwatts (mW), self-powering the sensors alternatively using small-scale energy harvesters have gained growing research attraction.

This paper investigates the potential of flexible beams for electromagnetic energy harvesting under the wakes from upstream cylinder numerically. A two–dimensional fully coupled fluid–structure interaction model has been presented, where the coupling between flow solver based on Vortex Particle Method and Finite Element based structural solver facilitates modeling the response of line-type flexible systems. The intention is to estimate the extracted energy outputs numerically from the response of the cantilever beams using an electromagnetic transducer for power conversion. A flexible beam under wake flows may experience large vibration amplitude when the frequency of the vortex shedding from upstream cylinder comes close to the resonance frequency of the system [1]. It is possible to target a particular wind speed for energy harvesting by varying the cylinder size, the free stream flow and/or the system frequency. In contrast to the instability phenomena based harvesters [2], where high wind speeds are required, the numerical simulations are performed here to model the power output from flexible cantilever beams under upstream wakes, particularly, for low wind speeds like 2-4 m/s. Satisfactory results are achieved; the modeled energy outputs in comparison with a reference harvester have shown the efficiency of the proposed harvester model.

REFERENCES

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