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A Simulation on a New Piezoelectricity Energy Harvesting Structure from Vortex Induced Vibration

Li Li*, Jinliang Wang, Zhanling Ge

College of Computer Science and Technology, Shenyang University of Chemical Technology
11# Economic Development District, 110142, Shenyang, China

Abstract: A new structure of energy harvesting is proposed. In the structure, the bimorph piezoelectric cantilever is inside the flexible circular tube, the circular tube stands in the fluid, the axial direction is perpendicular to the incoming flow direction, and the neutral plane of the cantilever beam in the cylinder is parallel to the flow direction. The cyclical vibration of the flexible tube caused by the flow-induced vibration drives the piezoelectric cantilever inside the tube to vibrate and generate electric energy. The effect of bluff body to the vibration of structure was investigated using FSI(fluid structure interaction) simulation. The results showed that the vibration of harvesting structure was more stable when a rigid cylinder was in front of the structure as a bluff body than a flexible cylinder. Then the simulation of three flexible tubes standing in a line and a rigid cylinder as a bluff body was performed, in order to find the optimal position for placing the flexible tube behind the bluff body. The simulation results showed that the second flexible tube behind the bluff body has an optimal and stable vibration response. Then the relationship between the fluid velocity and the vibration of structure was researched using the simulation method. The results showed the optimal vibration state occurred when the fluid velocity was 1.1m/s and the radius of the tubes was 10mm. Furthermore, piezoelectric coupling simulation and energy harvesting circuit simulation were carried out. The voltage distribution and the voltage with time were obtained. The voltage response was 85V, 9Hz AC when the harvesting structure was in optimal vibration state. Finally, the LTC3588 chip was used to simulate and experiment the energy harvesting circuit, and the simulation results were in good agreement with the experimental results.

Keywords: Energy harvesting; Piezoelectric material; Vortex-induced vibrations; FIS; Simulation; ADINA;