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Forced Vibration of Fluid Conveying Carbon Nanotubes Considering Thermal Effect and Nonlinear Foundations

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Abstract

Nonlinear and linear vibrations of fluid conveying carbon nanotubes considering thermal effects are studied. It is assumed that the nanotube conveying fluid flow has a general type of boundary conditions and is supported on a nonlinear Winkler-Pasternak foundation. The nonlocal Euler-Bernoulli beam theory is implemented to develop the governing differential equation of motion of the nanotube system. Furthermore, the surface effect is considered in the vibration modelling of the carbon nanotubes. The influence of the thermal effect combined with the applied longitudinal force on the vibration performance of the system is examined. The Galerkin procedure is employed to obtain the nonlinear ordinary differential equation and the multiple time-scales method is utilized to study the primary vibration resonance of the system. A parametric sensitivity analysis is carried out to reveal the influence of different parameters on the vibration primary resonance and linear natural frequency. The effects of temperature variation, boundary conditions, foundation coefficients and the fluid flow velocity on the primary resonance and natural frequency of the nanotube were investigated. The effect of temperature on the material properties of carbon nanotube is originally combined with the vibration model. Different types of Zigzag carbon nanotubes are considered and the effects of different parameters, namely, the fluid flow velocity and the temperature variations are compared.