Fluidelastic Instability and Fretting-Wear Characteristics of Steam Generator Helical Tubes Subjected to Single-Phase External Flow and Two-Phase Internal Flow

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Abstract

This study investigates the fluidelastic instability characteristics of steam generator (SG) helical type tubes and the safety assessment of the potential for fretting-wear damages caused by foreign object in operating nuclear power plants. The thermal-hydraulic conditions of both tube side and shell side flow fields are predicted by a general purpose computational fluid dynamics code employing the finite volume element modeling. To get the natural frequency, corresponding mode shape and participation factor, modal analyses are performed for helical type tubes with various conditions. Special emphases are on the effects of coil diameter and the number of turns on the modal and instability characteristics of tubes, which are expressed in terms of the natural frequency, corresponding mode shape and stability ratio. Also, the wear rate of helical type tube caused by foreign object is calculated using the Archard formula and the remaining life of the tube is predicted, and discussed in this study is the effect of the flow velocity and vibration of the tube on the remaining life of the tube. In addition, addressed is the effect of the external pressure on the vibration and fretting-wear characteristics of the tube.