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Fluidelastic Stability Analysis Using Unsteady Fluid Force Measurement of a Rotated Square Array Subjected to Two-phase Cross-flow

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The research findings presented in the literature confirmed that the rotated triangle array is inherently fluidelastically unstable in two-phase flow, especially in the transverse direction. On the other hand, recent work confirmed that the rotated square array is fluidelastically stable for all tested void fractions in two-phase flow, except for 97%. The quasi-steady analysis showed a significant reduction in damping for 97% void fraction compared to lower void fractions. The quasi-steady model, however, could not resolve the issue of the increase in tube bundle vibrations in the transverse direction for 97% void fraction. Hence, further analysis is required to deeply look into the array using the unsteady theory. In this work, the unsteady fluid forces were measure for a rotated square array with P/D=1.64. The advantage the unsteady theory has is taking into consideration the variation of the fluid force phase with reduced flow velocity. This is not encountered in the quasi-steady theory where the fluid force phase is always assumed to be constant. Unlike the quasi-static force measurements, the unsteady fluid dynamic force component and the vibration modes of the tubes are taken into account in the unsteady theory. The results of this work add a deeper understanding to the rotated square array dynamic behaviour. An array that showed a stable behaviour in two-phase flow. This study aimed in part to analyse the APR1400 steam generator tube bundle in single and two-phase cross-flow.

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