Scaling and Parametric Studies of Condensation Oscillation in an In-containment Refueling Water Storage Tank

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Abstract

The purpose of this paper is to study the condensation oscillation phenomena by steam-jetting into subcooled water through a sparger, implementing a scaling methodology and the similarity correlation between the test facility and model prototype. In addition, the results of this study can provide suitable guidelines for sparger design utilized in the IRWST for the Advanced Passive Reactor 1400 (APR1400). To corroborate the scaling methodology, various experimental tests were conducted. The scaling-related parameters experimentally considered were water temperatures, mass flux, discharge system volumes, tank sizes, source pressure, steam-jetting directions, and numbers of sparger discharge holes. To preserve the scaling similarity, the thickness of the minimum water volume created by the boundary layer that encloses the steam cavity was found to be equal to the maximum length of the steam cavity formed. Four key scaling parameters were identified and empirically correlated with the maximum amplitude of pressure oscillation. They are as follows: Volume of the steam cavity, flow restriction coefficient, discharge hole area, and density ratio of steam to water. Variations of the oscillation amplitude were small when steam-jetting directions were altered. The concept of a reduction factor was introduced for estimating the oscillation amplitude of the multi-hole sparger with test data from a single-hole sparger.