Off-take Experiment at T-junction of Vertical-up Branch on Horizontal Pipe

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Abstract

The off-take and the liquid entrainment on the air-water interface are experimentally investigated at the T-junction of vertical-up branch on the horizontal pipe. In case of the pressurizer manway opening after the loss of residual heat removal during a shutdown operation, the steam boiled from the core flows into the pressurizer via the surge line and is discharged through the manway, where the steam flow accompanies the coolant entrainment by the off-take below the inlet of surge line. This study has a focus on a shutdown operation. Test conditions are slightly over the atmospheric pressure and at room temperature. No water flow exists. An off-take is visually observed using the transparent pipes.

Scaling analysis is performed to scale down the test facility to the reference prototype, Korea standard nuclear power plant (UCN units 3 & 4). The horizontal leg and surge line geometries are scaled down as the horizontal pipe and the vertical-up branch pipe, respectively. Two different diameters of the branch pipe to have proper scaling methodologies are proposed for looking the diameter effect. The main pipe diameter (D) is 0.295m and the surge line diameters (d) are 0.05m and 0.07m. They have larger scales than those of related experimental studies. Experimental data is able to have the phenomenological similarity with the reference plant by the use of the large scale facility and by the scaling analysis.

With changes of an air flow and a water level, the onset of liquid entrainment (OLE) and the branch quality are investigated. The onset of slug transition (OST) in horizontal pipe is also observed and investigated for the relationship between the horizontal flow regime and the off-take phenomena. The scale effect of branch pipe exists in the OLE and the OST data. The branch quality is strongly affected by the flow regime in horizontal pipe. The stratified flow is more persistent up to larger air flow than the existing model. These experimental results will be bases of studies in phenomenological modeling and the proper scaling methodologies in the future works.