Experimental results of the SMART ECC injection performance with reduced scale of test facility

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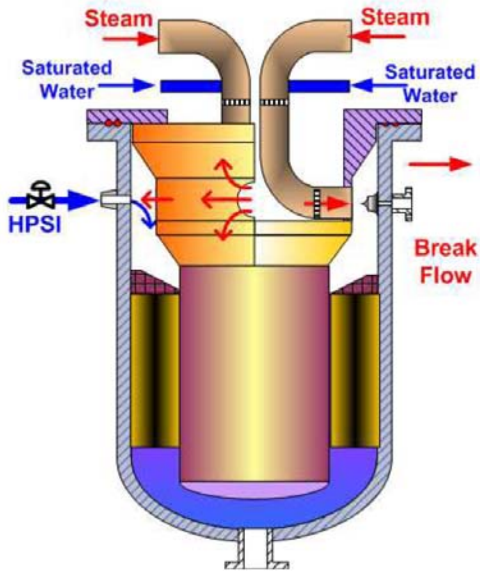
1. Introduction

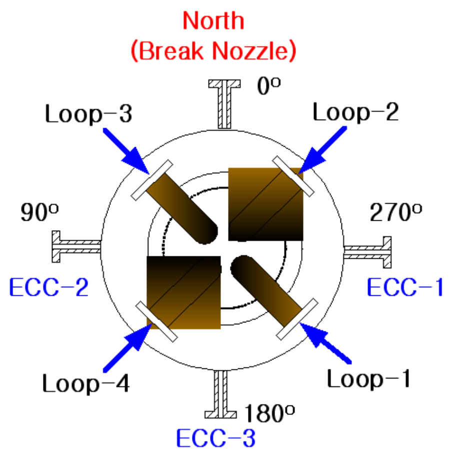
SMART pressurized water reactor type is different from the existing integral NSSS commercial pressurized water reactor system which is equipped with the main features. In addition, RCS piping is removed and the feature of the SBLOCA is a major design break accident. SWAT (SMART ECC Water Asymmetric Two-phase choking test facility) test facility is to simulate the 2 inch SBLOCA of the SMART using with reduced scale. The Test was performed to produce experimental data for the validation of the TASS/SMR-S thermal hydraulic analysis code, and to investigate the related thermal hydraulic phenomena in the down-comer region during the 2 inch SBLOCA of the safety inject line. The particular phenomena for the observation are ECC bypass and multi-dimensional flow characteristics to verify the effectiveness and performance of the safety injection system. In this paper, the corresponding steady state test conditions, including initial and boundary conditions along with major measuring parameters, and related experimental results were described.

2. Experimental apparatus and procedure

SWAT was designed by 1/5 scaling ratio using the modified linear scaling method. The design features of the SMART such that the elevation of RCP suction nozzles is the same with that of the ECC injection nozzles are maintained to reduce a distortion caused by the gravitational effect. SWAT consists of main test section, safe injection system saturated steam and saturated water supply system and recirculation water supply systems and break simulation system. In order to remove the uncertainty of the experiment, the pressurizer, stop cooling system, chemical, volume control system, SG system, the core region is excluded from the experiment simulated target. The main part of the test section is SG-side upper down-comer. The boundary conditions are saturated steam and water flow condition and drain flow rate to control the collapsed water level in the down-comer. As shown Fig. 1, the schematic diagram and the loop arrangement of main test section respectively were installed. The 4 saturated steam pipes and 4 saturated water pipes were connected to the upper in order to inject main test section. The safety injection pipe except break safety injection pipe was installed in 3 places. The thermocouples, pressure transmitters, vortex type flow meters were installed to measure temperature, pressure and flow. The experimental data measured by various instruments and so on separate PC's hard disks were respectively stored. Test I3 to extend the test drive condition was performed within the scope of the experimental operation of the device is available. In the vapor pressure of about 2.5MPa, this test was performed by controlled flow of saturated steam, saturated water and down-comer level.



(a) Schematic diagram of main test section



(b) Loop arrangement of main test section

Fig. 1. Schematics of test section and loop arrangement

3. Results and Discussion for Test I3

In test I3, collapsed average water level was maintained at 0.7m. Test was carried out adjusting the lower discharge flow rate increased the collapsed water level. Except discharge flow, break steam temperature and safety injection temperature in main test section, major variables were maintained constant value. The main purpose of the experiment, the collapsed water level tends to observe the ECC Bypass rate. With increasing collapsed water level, the ECC Bypass rate was expected to increase but correlation was not observed in both the Bypass rate of safety injection water and collapsed water level in experimental range (0.7 ~ 1.03 m). As seen in Figures 2 and 3, in the down stream the collapsed water level continuously increased with time. But the collapsed water level of water-steam separator during test I3 was maintained without change. It shows that there is no constant correlation between the collapsed water level of down-comer and the ECC bypass. Mass balance was evaluated for the wholesomeness of test data. Figure 4. shows the relationship of the conservation in injection flow and discharge flow.

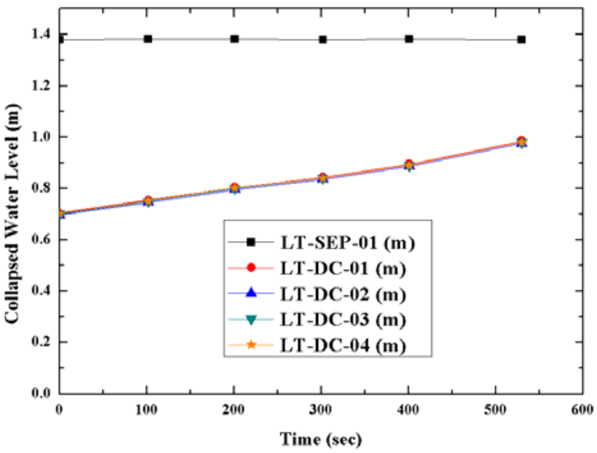


Fig. 2. The level changes of down-comer and separator.

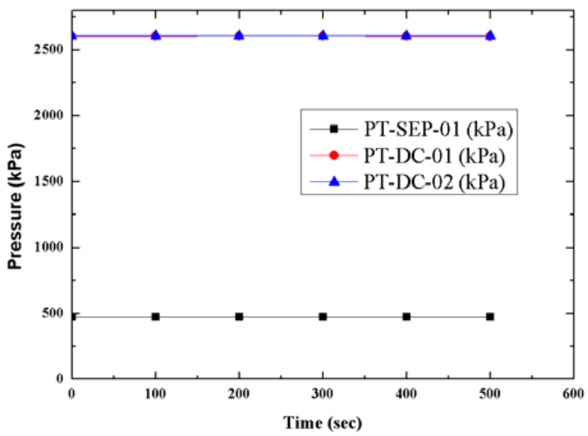


Fig. 3. The pressure changes of down-comer and separator.

Total injection mass sum is saturated steam, water and ECC flow rate. Total discharge mass sum is the discharged flow rate of the lower in the main test section, break flow rate and the liquid changes of down-comer and separator.

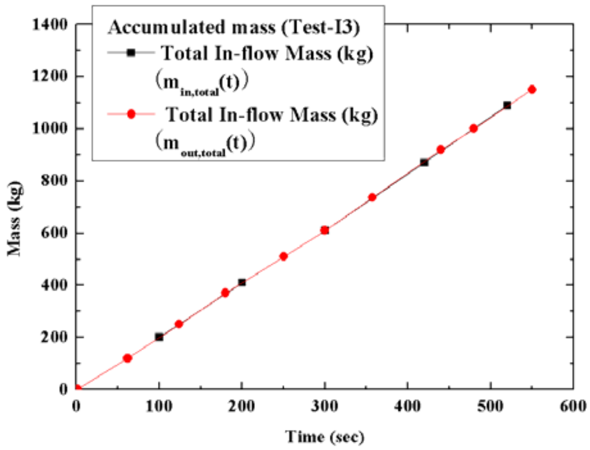


Fig. 4. The comparison of total in-flow and out-flow mass

3. Conclusions

This paper is to describe test results of the Test I3 simulating the 2 inch SBLOCA of the SMART using the SWAT test facility. TestI3 was carried out increasing the collapsed water level by pump suction height. The validity of the data produced by Test I3 determined by standard deviation and mass error. The major test data of Test I3. The data is considered with in acceptable level. Further test is scheduled by discussing SMART design validation team.

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