Preliminary Test of Jet Pool Scrubbing for Design of Experimental Vessel

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1. Introduction

Pool scrubbing is one of the effective way to prevent releasing of fission product, usually aerosol type, into environment during severe accident in nuclear power plant. Many researchers have studied the pool scrubbing phenomenon, and reliable analysis codes were developed, such as SPARC [1]. The codes usually have good agreement with experiments performed in low Weber number condition. However, it is questionable whether the reliability of the code results is also good in high Weber number region. In unit 2 of Fukushima accident, a large amount of fission product was removed with pool scrubbing in suppression pool, with pool scrubbing, and it is expected that Weber number during the pool scrubbing was higher than 10^6 [2]. In addition, in case of C-SGTR accident [3], jet pool scrubbing regime could be developed with operation of auxiliary feed water pump system. In the jet pool scrubbing condition, the efficiency of the pool scrubbing could be changed. There are few studies in the world on the jet pool scrubbing phenomenon [4]. Thus it is necessary to research on jet pool scrubbing phenomenon to increase safety of nuclear power plant.

2. Preliminary test

2.1 Test Facility

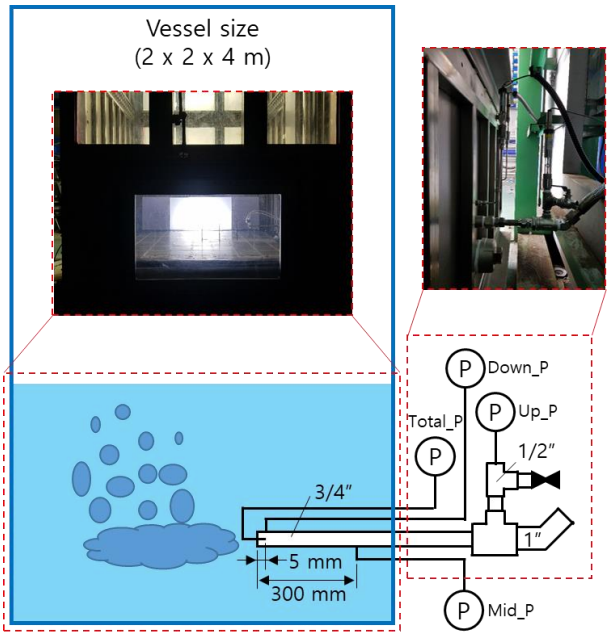

Figure 1 Schematics of preliminary test facility

To design the jet scrubbing experiment vessel, preliminary test was conducted to determine vessel volume, height and thermo-hydraulic test conditions. The test was performed with changing operating gas pressure. Preliminary test facility is shown in Fig. 1. It consists of vessel, nozzle, pressure transducers, and gas supply system. All signals from sensor was recorded using data acquisition system. Weber number, gas velocity at the nozzle exit, and gas flow rate were obtained by using the pressures data. In addition, gas jet length was measured with high speed camera (MIRO M110, AMETEK).

2.2 Thermo-hydraulic Results

The pressures data is indicated in Fig. 2. The test was performed in three different thermo-hydraulic conditions; A, B, and C, with changing upstream pressure. The test results are summarized in Table 1. Over than 10^7 of Weber number was recorded in all cases, and sonic velocity was expected in the case A.

2.3 Camera Measurements

Two kinds of camera was employed in the test, one is high speed camera for measuring bubbles and jet shape and the other one is video camera. Fig. 3 shows the jet shape with bubbles. Jet length was measured with camera and it was compared with correlation (equation (1) and (2)) from previous study [5]. The experimental results were shows good agreement with correlation and the results will be reflected for designing experimental vessel size.

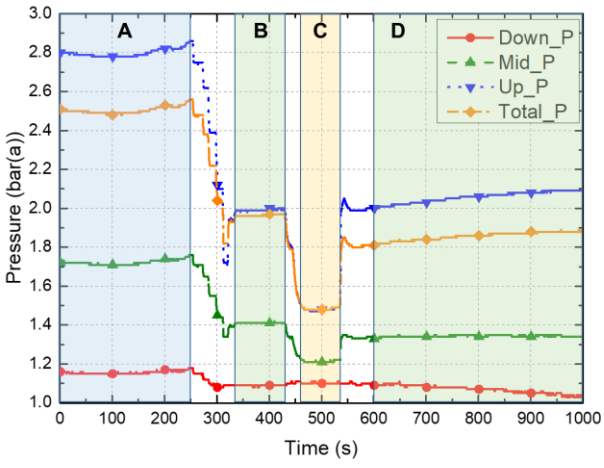

Figure 2 Pressure data

Table 1 Thermo-hydraulic test results

	A	B	C
Up_P	2.8 bar	2.0 bar	1.5 bar
We number	4.5×10^7	3.0×10^7	1.2×10^7
Gas flow rate	6000 lpm	4700 lpm	3100 lpm

Figure 3 Visualization of jet shape

$$Fr_g = \frac{\rho_g {u_0}^2}{(\rho_l - \rho_g) g D_0} \quad (1)$$

$$\frac{L_{jet}}{D_0} = 10.7 Fr^{0.46} \left(\frac{\rho_g}{\rho_l}\right)^{0.35} \quad (2)$$

3. Conclusions

Preliminary test has been conducted to determine the size of experimental vessel for studying jet pool scrubbing phenomenon. Weber number of 10^7 was observed in SGTR analysis [6] and it would be reflected in the preliminary test condition. Moreover, the vessel size was determined 1x1x2 m with considering the test results. In the future, various measurement equipment will be applied to the vessel for visualization of the jet flow and pool scrubbing phenomenon, such as optical probe, PIV, and PDA. Finally, aerosol decontamination model will be presented with aerosol removal model.

ACKNOWLEDGEMENT

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