Introduction to Steam Generator Tube Rupture Accident Test Facility

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1. Introduction

Under a severe accident, even if the integrity of the containment building is ensured, a radioactive material could be released to atmosphere bypassing the containment building due to the SGTR(Steam Generator Tube Rupture) accident [1]. Therefore, it is essential to perform experiment to evaluate risk and amount of fission product released into the atmosphere by SGTR accident. Under a SGTR accident, to evaluate risk assessment methods, the aerosol (and iodine) decontamination experiments should be performed, and the experiment results should be analyzed.

2. Test Facility

The test facility of SGTR accident consists of 3 main parts. 1) The test vessel including the steam generator tube, 2) the thermal hydraulic condition control system including the generator of steam, Air and N2, 3) the measurement and control part.

2.1 Test Vessel

SGTR Test Vessel was designed with inner diameter of 600mm, 8 mm thick, and 7 m high. The design pressure is 1.0 Mpa and the design temperature is 200℃ by scailing down the real steam generator in domestic operating plants. The length of tube installed in the SGTR test vessel is 5.789m, and its outer diameter is 19.05mm(3/4inch), and the number of tubes is 146(U-Tubes, two of them are the gas supply lines), and the pitch between the tubes is 25.4mm(1inch) (Fig. 1.)

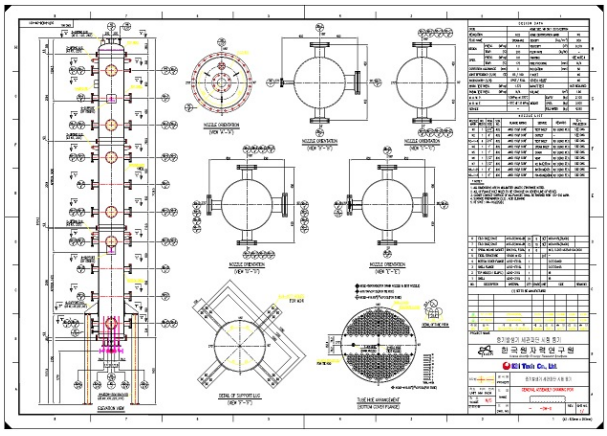

Fig. 1 Test vessel

2.2 Test loop

Gas supplying lines such as air, N2 and steam utilizes existing ARIEL facility. Aerosol generator and exhaust equipment were also shared with ARIEL facility [2]. Figure 2 shows the thermal hydraulic condition control system with test vessel. It consists of gas supplying line, cooling line, exhaust and drain line.

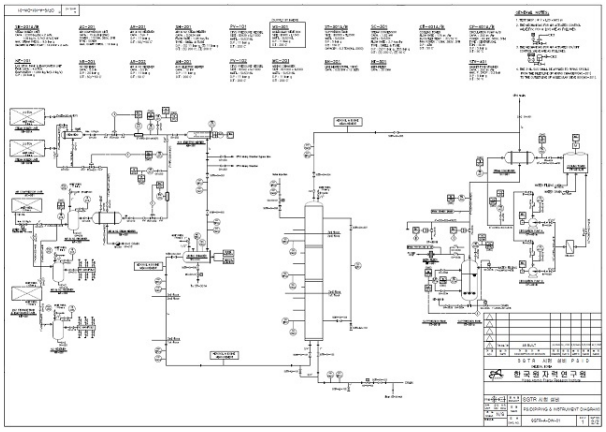

Fig. 2 test loop

2.3 Measurement and Control

In the SGTR accident experiment, the key measurement parameters are the concentration of aerosol/iodine at the important measurement points. And other key parameters are the thermal-hydraulic parameters such as temperature, pressure, flow-rate, etc. To measure the concentration of aerosol, the technic such as ELPI (electrical low pressure impactor, DEKATI) and filter mass measurement are used [3]. To measure the concentration of iodine, the technic such as ion-selective electrode (ISE) and volatile organic compound (VOC) measurement are used. The fluid and wall temperatures at each part of the facility were measured using thermocouples, the pressures were measured using a piezoelectric transducers, and the flow rate was measured with a voltex flow-meter. The aerosol/iodine measurement and generator systems were controlled remotely through the programmable logic controller (PLC). All the data signals were acquired and stored through NI Labview. Figure 3 shows the aerosol measurement system, and figure 4 shows the iodine measurement system.

Fig. 3 aerosol measurement device

Fig. 4 iodine measurement device

3. Test and result

After constructing the test facility, a single tube was installed and thermal-hydraulic test was performed as a preliminary test. Then experiments were conducted to determine the DF (Decontamination Factor) at the steam generator vessel and tubes.

3.1 Thermal-Hydraulic Test

The thermal-hydraulic test of the SGTR Test facility was carried out by injecting pressurized air to measure the pressure, temperature, flow rate, etc., which are the key thermal-hydraulic parameters in the test , The thermal-hydraulic test examine the steady-state behavior of the facility, and check the operation of the heaters and valves installed in the test facility. Table 1 shows the typical thermal-hydraulic condition.

Table 1. Thermal hydraulic condition

Test parameter	Setting Range	비고
Pressure	1~9 bar	Absolute
Temperature	25~200°C	
Water level	0~4 m	From bottom of test vessel
Air Flow Rate	0~1.0 kg/s	

3.2 DF measurement test in piping line

After the thermal hydraulic test, in order to obtain the fundamental reference data, a test for measuring the DF (decontamination factor) in the piping line carried out.

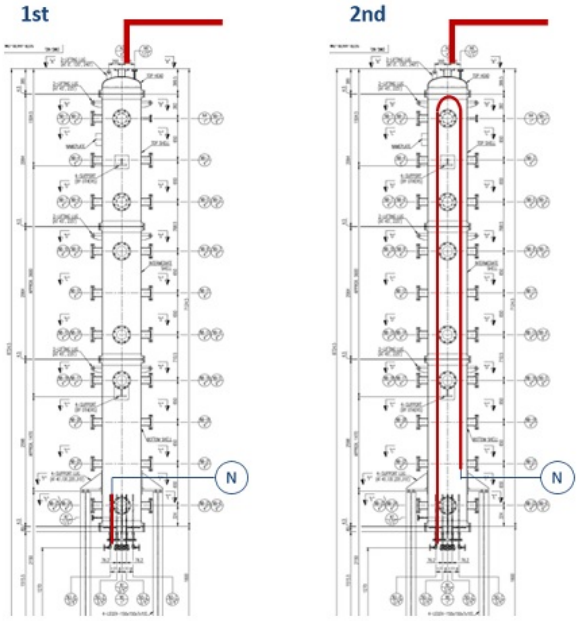

Fig. 5 DF measurement test in piping line

As show in Fig. 5, the DF measurement tests were performed on the single straight tube line and U-tube line. The test results are presented elsewhere.

Further experiments are planned for the short tube bundle, and U-tube bundle, and the required tubes are prepared.

4. Conclusions

By using the SGTR test facility constructed in this way, it is possible to obtain more practical and reliable data on the SGTR accident test. This data will be used for SGTR accident risk assessment and it is expected to be utilized in the development of the engineered safety features or the accident mitigating procedures for the SGTR accident.

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