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Performance Test of Solenoid Valves for Multi-Points Pressure Measurement

Youngjung Youn[a*], Dongjin Euh[a*], Incheol Chu[a], Tae-Soon Kwon[a]
[a]*Korea Atomic Energy Research Institute, P.O.Box 105, Yuseong, Daejeon, 305-600, Rep. of KOREA*
[*]*Corresponding author: yjyoun1@kaeri.re.kr*

1. Introduction

In order to investigate flow and pressure distribution of SMART reactor, SCOP facility are being designed with a 1/5 linear scale of prototype. The pressure and flow distribution are obtained with differential pressure transmitters. The measurement points to be utilized for the flow distribution are 210 points. Therefore, it is required to have an efficient way to get the hydraulic information with a limited number of instruments. Currently, solenoid valve networking that has a sequential operating logic is being considered with a 4~10 points per differential pressure transmitter. This study focuses on the design requirement for the pressure measuring system by simulation

2. Instrumentation of SCOP

2.1 SCOP Facility

In order to preserve the flow characteristics, the SMART design is linearly reduced with a scaling ratio of 1/5 in SCOP.

Although the reactor circulation pumps are working inside the reactor, the SCOP adapts external type of pumps with a preservation of flow geometry through the diffuser. The each of the four external loops has a pump, heater, heat exchanger and flow meter. The loop temperature is controlled at each loop by controlling the heater power or heat exchanger secondary flow rate. The system pressure is controlled by makeup tank which is installed at above the reactor simulator.

Core inlet flow distribution and outlet pressure distribution in order to supply boundary condition to estimate thermal margin of reactor will be simulated by 57 simulators which conserve the pressure drop of the fuel assemblies. The steam generator which is supposed to be inside of the reactor is exposed to the outside of the pressure boundary in order to draw the instrumentation line efficiently. The shell type of the SG primary side was simplified to the cylindrical shaped simulator with a pressure drop adjustment with an orifice inside. The tube inside SG secondary part was neglected in the SCOP facilities since SG secondary is not interested region.

2.2 Instrumentation

The loop flow rate, pressure and temperature would be measured by using vortex flow meters, smart type pressure transmitters and RTDs respectively.

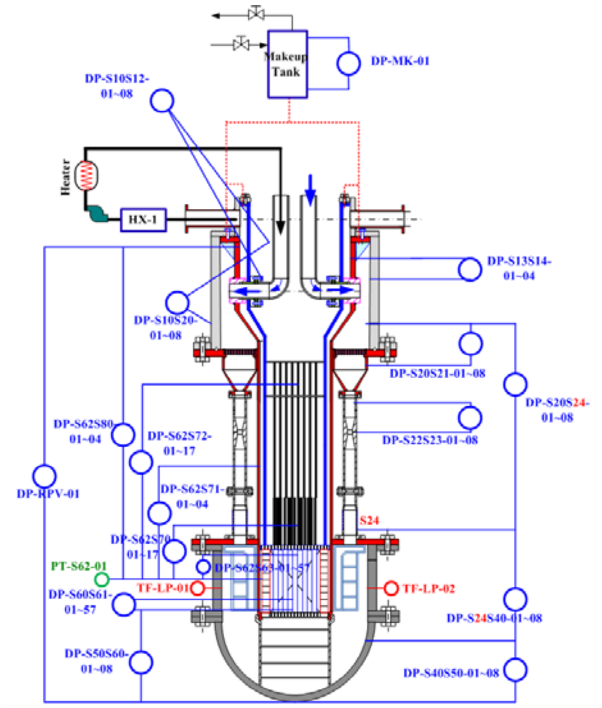

Fig. 1. Instrumentation of SCOP

The major measured parameters inside the reactor simulators are pressures or differential pressures.

The SCOP has total 210 points of pressure to be measured to obtain pressure and flow distribution inside the SMART reactor simulator as shown in Fig. 1. With respect of budget and install space, the usage of same number of pressure transmitters is difficult and impractical. The current design of SCOP adapts solenoid valve networking with multiple valves to a transmitter by using sequential operation. A concept of solenoid valve networking is shown in Fig. 2.

2.3 Solenoid Valve Test

To investigate the response time of the pressure transmitter and line size effect, a test loop was established with two differential pressure transmitters, pressure delivery tube and valves. The specifications of solenoid valve and DP transmitter are summarized in Table 1 and 2.

Based on configure of Fig. 3, lower pressure sides of the two transmitters are faced to air with the same pressure conditions. At the upstream of the higher sides of transmitters, solenoid valves are in close state. When the solenoid valves are activated, the transmitter has differential pressure due to the hydrostatic head induced from the water level inside the central tube.

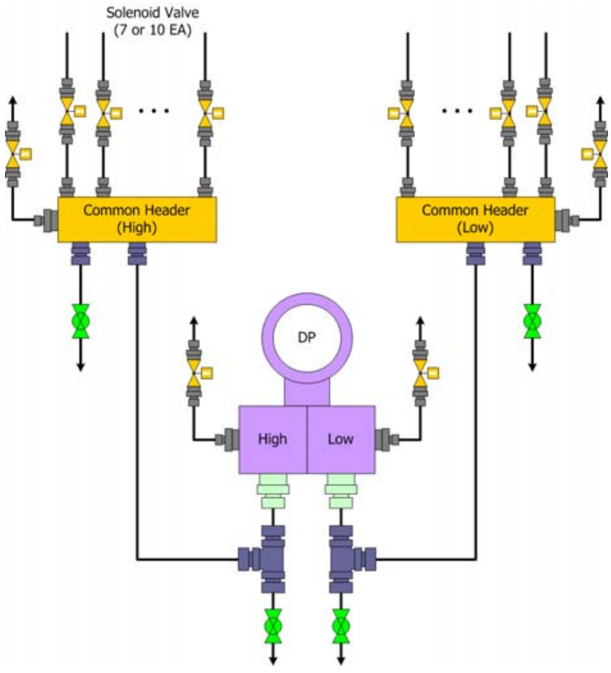

Fig. 2. Solenoid Valve Network

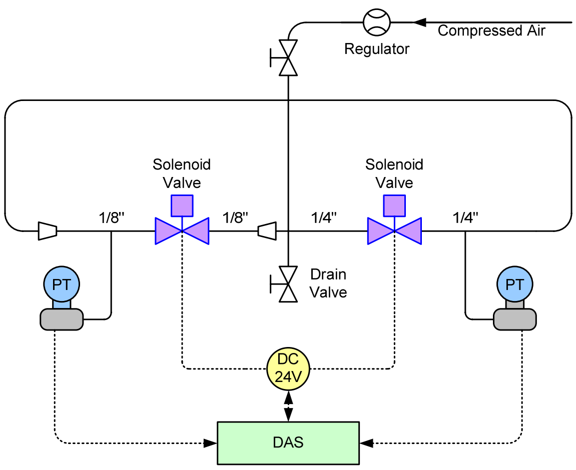

Fig. 3. Schematics of Test Loop

Table 1. Specifications of Solenoid Valve

Model	WV121S122NV 1-1S-C2
Power	24VDC, 6W
Operating Pressure	4 Bar
Orifice	3 mm
Port	1/4", 1/8"

Table 2. Specifications of Pressure Transmitter

Model	Rosemount 3051CG
Outputs	4~20mA
Pressure Range	0 ~ 10 Bar
Damping time	0.3 sec

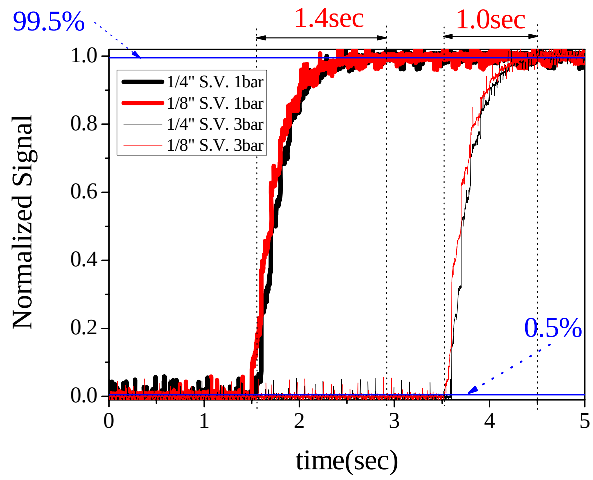

Fig. 4. Performance Results

2.3 Test Results

Fig. 4 shows a performance results for the data transition after activation of the solenoid valve. In order to quantify the transient time, the threshold time was set at 0.5% and 0.95% of measured signal band. As shown in Fig. 4, the response time to move to a new steady condition depends strongly on the system pressure. At 3 bar conditions, the response is faster than at 1 bar condition. The figure also shows that the valve size of 1/4" and 1/8" doesn't induce significant difference.

Therefore, the measured data after just a few seconds are supposed to be effective since the transient time is just 1.4 second even for the 1 bar condition.

3. Conclusions

The response time and line size effect of the pressure transmitter has been investigated using the solenoid valve test loop. The results show that the response time to move to a new steady condition depends strongly on the system pressure and the valve size of 1/4" and 1/8" doesn't induce significant difference.

REFERENCES

[1] Dongjin Euh et al., Basic Design and Scaling Report on the Flow and Pressure Distribution Test Facility for SMART Reactor, 752-TF462-002, KAERI, 2009