Introduction of Measuring Instruments Used at Sodium Thermal Hydraulic Test Facilities in KAERI

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1. Introduction

The KAERI (Korea Atomic Energy Research Institute) will be performed a test for thermal hydraulic simulation with CPTL (Component Performance Test Sodium Loop) in the year 2012 and in the next stage it will test the STEF(Sodium Thermal-hydraulic Experimental Facility)[1]. The STEF consists of the reactor vessel, core of electric heaters, four IHXs, two PHTS pumps, two DHXs, two AHXs, and auxiliary systems (the sodium purification system, the IHX gas cooling system, heat loss compensation system, power supply system, gas supply system, and fire protection system), and also the CPTL for testing to use components in the STEF consists with scaled AHX component, scaled DHX, scaled IHX, and scaled PHTS pump. In these sodium test facilities several kinds of measurements exists.

In this paper, some of the instruments used in these systems are introduced, for examples, short-range sodium level transducer, long-range sodium level transducer, sodium flow meter for measuring the flow rate of the outlet of PHTS pump, local velocity transducer, differential pressure transmitter between inlet and outlet in loop of components of DHX, IHX, and AHX.

2. Survey

Physical properties of measuring locations were surveyed, according to the physical properties, measurement methodology and transducer type that was decided. The measurement locations in the STEF and in the CPTL are as shown in Fig. 1 and Fig. 2.

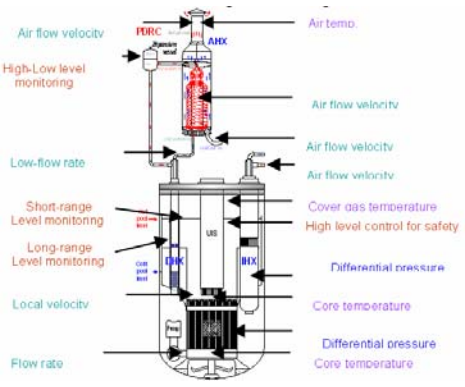

Fig. 1. Measurement locations in the STEF.

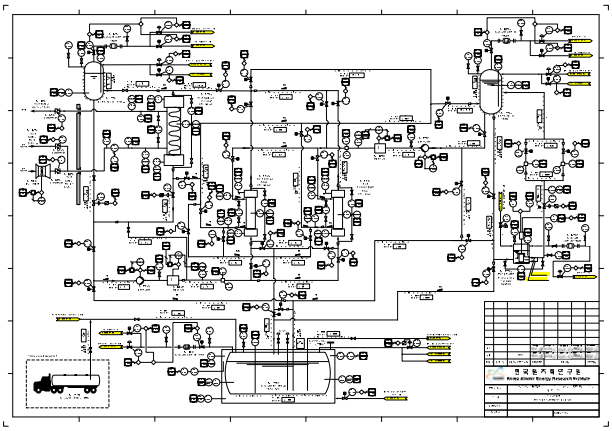

Fig. 2. P&ID of the CPTL process.

Also, some commercial instruments that were able to be used in the CPTL process were surveyed and the STEF process.

3. Experiment

After selection of instruments, the manufacture and design of the prototypes of instruments for instrument development and measuring methodologies in KAERI, and then calibrated and tested in a sodium loop manufactured transducers, prototypes, in KAERI.

The process and piping diagram (P&ID) of sodium loop for testing the transducers manufactured in KAERI, as shown in Fig. 1. This sodium loop consists with two of buffer tanks, cold trap, plugging meter, electro-magnetic pump, and the sodium storage tank contained two tons of sodium. The purification degree of oxygen concentration was about 10~30PPM.

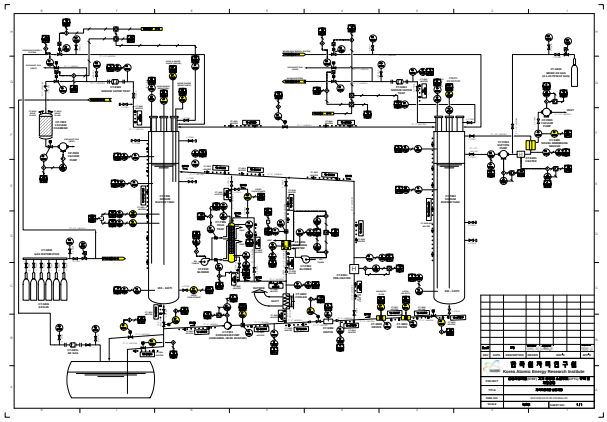

Fig. 3. P&ID of sodium loop for testing and calibration of manufactured transducers.

Now a sodium loop at the sodium technology experiment building was constructed at the KAERI site, and it will be finished in the year 2010.

4. Results and Discussion

4.1 Short-range level transducer

For short-range level measurement with a range of 200mm and accuracy +/- 1%, we consider two kinds of transducers. The first one was a resistance type, and next was induction type. A solution to a problem of the transducer of resistance type was a circuit design to be able to measure low resistance of sensing part. And also a solution to a problem of the transducer of induction type was to take a performance of high resolution. Of course, to take high resolution and stability of level value the structure of two types of transducers will be designed specially.

4.2 Long-range level transducer

The instrument types considered with this measurement are induction type, radar level gauge of stick type, and guide wave radar level transmitter. The accuracy of induction level transducer was generally within +/- 3% and application temperature 600^{o}C, and the measurement is 3meter. In case of radar level gauge of stick type the accuracy was 1mm and measurement range is max. 100meter by product catalogue. This type of radar level gauge was non-contact type. The guide wave radar level transmitter was contact type in sodium. The application temperature of it was about 300^{o}C optionally.

To apply radar level gauge to sodium additionally, the induction level transducer must have experience to apply to the sodium loop.

4.3 Flow meter for PHTS pump

For measuring flow rate at outlet of PHTS pump we consider electro-magnetic transducer with sensing part inside pipe. The accuracy of electro-magnetic flow meter is generally +/-3% FS (Full Scale). The calibration of this transducer will be in a test section of the CPTL as shown in Fig. 4. The measuring velocity of designed flow meter for the PHTS pump was about 10m/sec in 6 inch pipe.

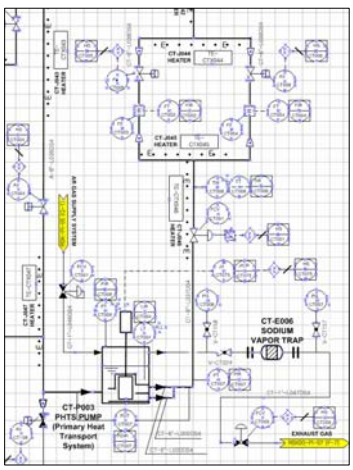

Fig. 4. A part of P&ID of PHTS system in CPTL.

4.4 Local velocity transducer

For local velocity measurement the considerable transducer types are electro-magnetic, Pitot tube, and ultrasound Doppler velocity. We consider with electro-magnetic transducer with the accuracy of +/-3% FS to be able to use in sodium at 600^{o}C. The size of sensing part manufactured of electro-magnetic transducer will be 10mm.

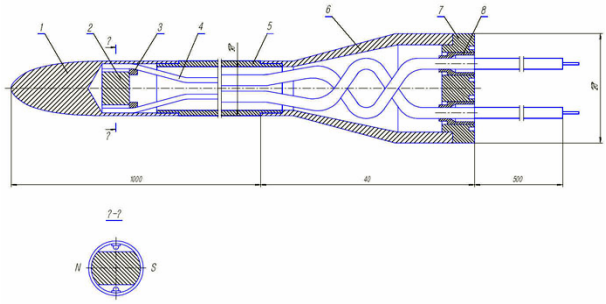

Fig. 5. Drawing of local velocity transducer.

4.5 Differential pressure transmitter

For differential pressure measurement in sodium loop, we consider with diaphragm differential transmitter. To use in sodium loop of the CPTL and the STEF, a part of diaphragm chamber and capillary line with commercial products needs to be modified.

5. Conclusion

Physical properties at measuring locations was surveyed, and selected some of transducers to be able to use in the CPTL and the STEF. The prototype of transducers to test in the CPTL or sodium loop for calibration of prototype transducers will be manufactured in this year.

ACNOWLEDGEMENT

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REFERENCES

[1] T.H. Lee, J.H Eoh, H.Y. Lee, J.H. Lee, T.J. Kim, J.Y. Jeong, S.K. Park, J.W. Han, Y.B. Lee, D.H. Hahn, “Scientific Design of Large Scale Sodium Thermal-Hydraulic Test Facility in KAERI”, IAEA-CN-176/09-03, pp299-300, 7-11 December 2009.