The Self-Calibration Test of flowmeter installed in STELLA(Sodium Integral Effect Test Loop for Safety Simulation and Assessment) facility

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1. Introduction

In regard to the long-term SFR development plan, a large-scale sodium thermal-hydraulic test project is being progressed by KAERI. This project is called STELLA (Sodium Integral Effect Test Loop for Safety Simulation and Assessment), and it is proceeding by adopting the QA (Quality Assurance) program.

Due to the specificity of an experiment using sodium(Na) categorized as Class 3(pyrophoric material & water-prohibiting substance) by the Safety Control of Dangerous Substances Act, it is necessary to apply QA in consideration of the sodium experiment environment in certain parts. The one of them is about calibration of measuring instrument such as a flowmeter, thermocouple and pressure gauge.

It is described in the QAP (Quality Assurance Procedures) of KAERI that calibration work should be conducted in accordance with self-calibration procedures in a special case where conventional calibration is not practicable. The calibration of two flowmeters (FT-101, FT-102) installed in STELLA facility is the typical example. The objective of this study is to describe the procedure of the self-calibration test for the flowmeters and to analyze the result of the test.

2. The Flowmeters of STELLA-1 Facility

The flowmeters (FT-101, FT-102) are used for measuring a rate of flow of hot loop and cold loop respectively during the sodium experiment. They should be calibrated by the outside calibration organizations at least once a year for assurance of instrument capacity, if possible. However, it is impossible to calibrate the flowmeters installed in STELLA facility in a way of utilizing external organization for the following reasons.

First, they were welded to pipe of sodium experimental loop so if they are dismantled from pipe for calibration, overall sodium loop will deteriorate and eventually be badly affected by the work. The real pictures of the flowmeters installed in STELLA-1 facility are shown in Fig 1.

Second, there is no qualified institution that performs a role calibrating the flowmeters used for the measurement of the Na-flow rate. Therefore, the calibration work for the flowmeters was implemented with self-calibration procedures developed by the sodium experimental division.

Fig. 1. The flowmeters installed in STELLA-1 facility

3. The Self-Calibration Test Procedure

The calibration test was implemented according to DHX design point test described in DHX performance test matrix of STELLA-1 heat exchanger (DHX, AHX) performance test procedure. (SFR-710-TF-433-003 Rev. 01, 2014). It works in an indirect way to examine reproducibility by comparing temperature values of specific locations with ones a year ago after setting up a flow rate as that of a DHX design point. The specific locations consist of two places: DHX shell outlet and tube inlet where an average of TE143/145 and TE130A/B is respectively measured. The table.1 shows a pass criterion of the test.

Table 1. The pass criterion of self-calibration test

Measurement location	Measurement value(℃)	Acceptable criterion
DHX shell outlet	Average of (TE143/TE145)	±3.67 ℃*
DHX tube inlet	Average of (TE130A/B)	±2.11 ℃*

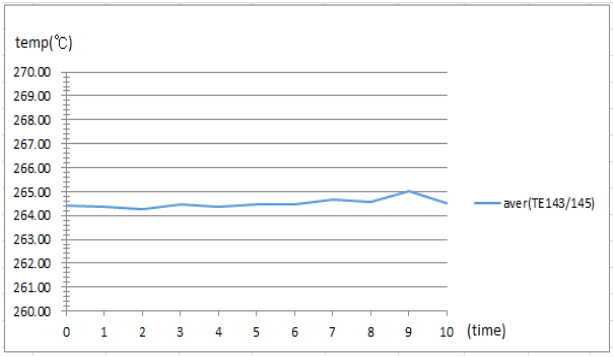
* A calculated error from Performance Test Result of STELLA-1 Heat Exchanger, DHX (J. G. Hong, SFR-710-TF-458-012) (2015)

The errors were calculated on the basis of bias error and repetitive error. In case of meeting the criterion, the flowmeters are considered to maintain instrument capacity including previous calibration error.

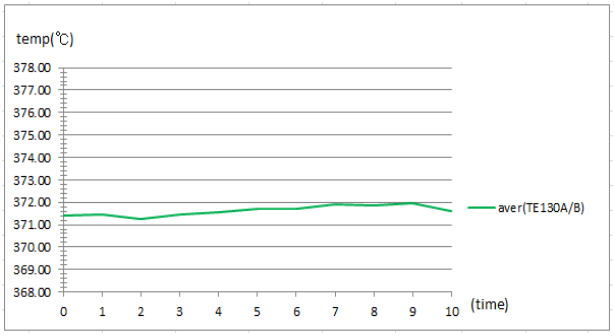
4. Test result

The test was implemented on June 26, 2015 and 10 minutes'(16:40~16:50) state is regarded as a normal one, which means stable condition to fluctuate within an allowable limit, ±1.0 ℃.

The graph 1, 2 show changes in measurement value(℃) during the 10 minutes. As can be seen from the graph below, the deviation of the data during 10 minutes of normal state is within 1.0 ℃ respectively.



Graph. 1. Trend of average value of TE143/145 during 10 minutes of normal state



Graph. 2. Trend of average value of TE130A/B during 10 minutes of normal state

5. Assessment of Acceptance

Table 2. The result of assessment of acceptance

	2014.07 (A) (℃)	**2015.06 (B) (℃)**	**(B-A)**	**Result**
Average of (TE143/145)	**264.7	264.5	- 0.2	Pass
Average of (TE130A/B)	**373.7	371.7	- 2.0	Pass

** The average value of 3 times repetitive experiment conducted at DHX design point in July, 2014.

The table 2 show the difference values (B-A) of average of (TE143/145), (TE130A/B) meet the pass criterion, respectively.

6. Conclusion

In this work, the test procedure of the self-calibration of two flowmeters (FT-101, FT-102) installed in STELLA facility was described and the test result was analyzed. As a result of test, it was confirmed that the flowmeters meet the pass criterion. Therefore, it was concluded that the flowmeters maintain instrument capacity a year ago.

As long as STELLA-1 facility is operated, the self-calibration test for the flowmeters should be conducted by qualified experimenter in one-year intervals for the reliability of data obtained by the instruments. In addition, the calibration work of measuring instrument installed in sodium experimental loop should be considered from early design step of the future sodium experimental facility.

ACKNOWLEDGMENTS

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REFERENCES

[1] M. H. Jung, Self-Calibration Procedures for Flowmeters installed in STELLA-1, KAERI Internal Design Document of SFR NSSS SYSTEM DESIGN DIVISION, SFR-710-TF-433-004 (2014)
[2] M. H. Jung, Test Result of Self-Calibration for Flowmeters installed in STELLA-1, KAERI Internal Design Document of SFR NSSS SYSTEM DESIGN DIVISION, SFR-710-TF-458-014 (2014)
[3] J. G. Hong, Performance Test Procedures of STELLA-1 Heat Exchanger (DHX, AHX), KAERI Internal Design Document of SFR NSSS System Design Division, SFR-710-TF-433-003 (2014)
[4] J. G. Hong, Performance Test Result of STELLA-1 Heat Exchanger DHX, KAERI Internal Design Document of SFR NSSS System Design Division, SFR-710-TF-458-012 (2015)