

Sodium Purification and Impurity Measurement in STELLA-1 Facility

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1. Introduction

To support the development of Prototype Gen IV SFR design by KAERI, Sodium Integral Effect Test Loop for Safety Simulation and Assessment(STELLA) program has been launched and the STELLA-1 facility is currently in operation yielding important experiment data. The sodium amount in the facility is about 18 tons and it is the largest sodium facility in Korea. The impurity control is one of the issues that all sodium facilities including the reactors have, especially with large amount and purification with impurity measurement is essential system.

In this study, sodium purification experience and impurity measurement method in STELLA-1 facility are described. Also the result of purification and measurement is specified.

2. Sodium Purification

2.1 Purification Method

There are various ways of purifying the liquid sodium but in general cold trapping is used. A cold trap is a large tank with wire-mesh zone where the impurities are precipitated by the temperature difference. Outside of the mesh zone is designed same as a heat exchanger to make this temperature difference and an economizer is usually installed to recover the waste heat for efficiency. The cooling medium is generally air but inert gas or liquid sodium can be also used for special purposes.

2.2 STELLA-1 Purification System

In STELLA-1 facility, the purification loop is separately installed from the main experiment loop but the sodium is shared in both loops. During the experiment, both loops cannot be operated at the same time. Therefore the purification system works only before and/or after the main experiment.

The main components in the purification system are a cold trap (Fig. 1), an electro-magnetic pump(EMP), a heater, a blower and impurity measurement subsystem, namely, plugging meter system. The plugging meter system has additional EMP which works for different purpose.

2.3 Purification Experience

The purification system was operated in 3 steps to reduce the effect of flow-path blockage due to liquid

sodium solidification at local points with high concentration of impurities. If it is pure sodium, there is no difficulty, but once the sodium solidifies with impurities, it is hard to re-melt it even with large heat and high temperature. Table 1 is the step-by-step process of impurities precipitation.

Table 1 Step-by-step cold trapping

Step	Sodium Temp (°C)	Cold Trapping Temp (°C)	Target Impurities (ppm)
1	200	150	-
2	250	150	-
3	300	150	~ 3

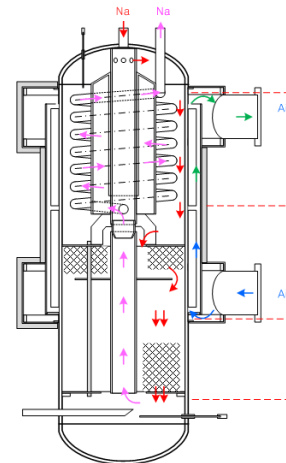


Fig. 1 Cold trap in STELLA-1

3. Impurity Measurement

3.1 Impurity Measurement Method

Impurities are measured by the plugging meter and the principle is same as the cold trap. By lowering the temperature in thin and narrow tube, the local precipitation occurs resulting in reduced flowrate. This flowrate change is measured with temperature at that time and the impurities concentration can be calculated from this temperature data. In general, Eichelberger's correlation is used and Takeda's and Cafasso's are often used in several research area.

3.2 Plugging Meter System

The plugging meter system is usually operated on-line with the purification system. While the cold trap is

in operation, the sodium flows through this subsystem and the impurities are measured whenever it is needed.

The plugging meter system consists of a plugging meter, an EMP, an electro-magnetic flowmeter(EMF) and a blower.

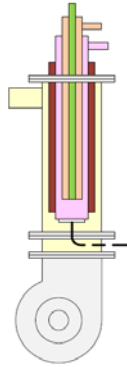


Fig. 2 Plugging meter in STELLA-1

3.3 Measurement Result

The temperature for impurities calculation is generally an average value of T_{plug} and T_{unplug} . In Fig. 2 the plugging meter operation result is shown. The blue line is the flowrate change and the black line is the corresponding temperature.

The plugging temperature is 137.1°C and the impurities (mainly oxygen) solubility is 1.9 ppm by Eichelberger's correlation.

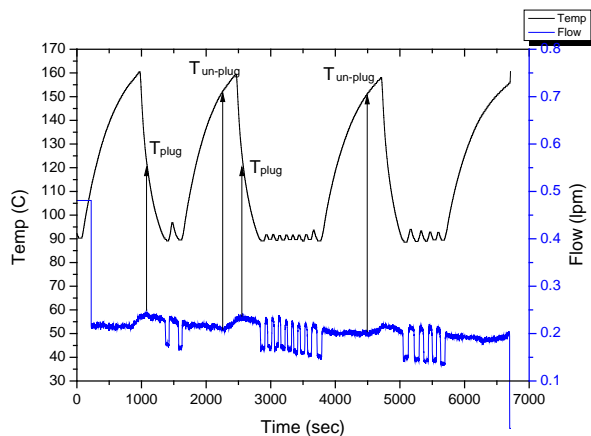


Fig. 3 Plugging meter operation result

4. Conclusion

In this study, the operational experience of sodium purification system for STELLA-1 facility is carried out and the corresponding result of impurity measurement is included. For further purification improvement, lower level of R&D on each component will be needed.

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