

Sodium Purification and Impurity Measurement in STELLA-1 Facility

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Introduction

- ✓ Sodium Integral Effect Test Loop for Safety Simulation and Assessment(STELLA) program launch : to support the development of Prototype Gen IV SFR design by KAERI
- ✓ Total amount of sodium in the facility : 11 tons
- ✓ Prerequisite work : Impurity control and measurement technique

Sodium Purification

➤ Purification Method

- Cold Trapping : large tank with wire-mesh zone
- Principle : precipitation (partially physical filtering)
- Economizer : to increase the efficiency

➤ STELLA-1 Purification System

- Purification loop : separately installed from the main experiment loop
- Sodium is shared
- Only works before and/or after the main experiment
- Main components : cold trap, EMP, heater, blower, plugging-meter subsystem
- Instrumentation : flowrate(Coriolis mass flowmeter), temperature(TC)

➤ Purification Experience

- 3 steps operation : to reduce the effect of flow path blockage due to solidification at local points with high concentration of impurities

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

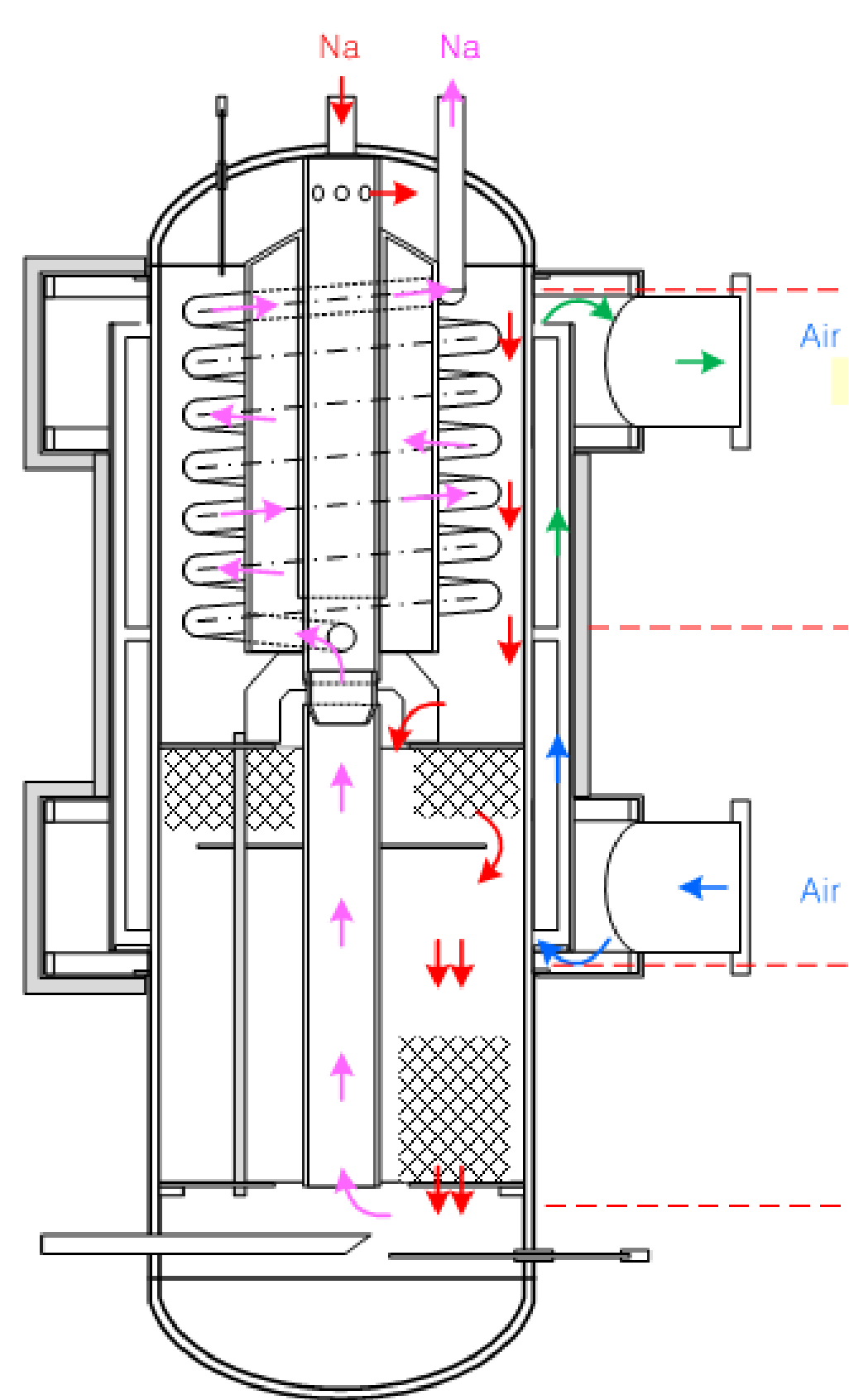


Fig. 1 Cold trap in STELLA-1

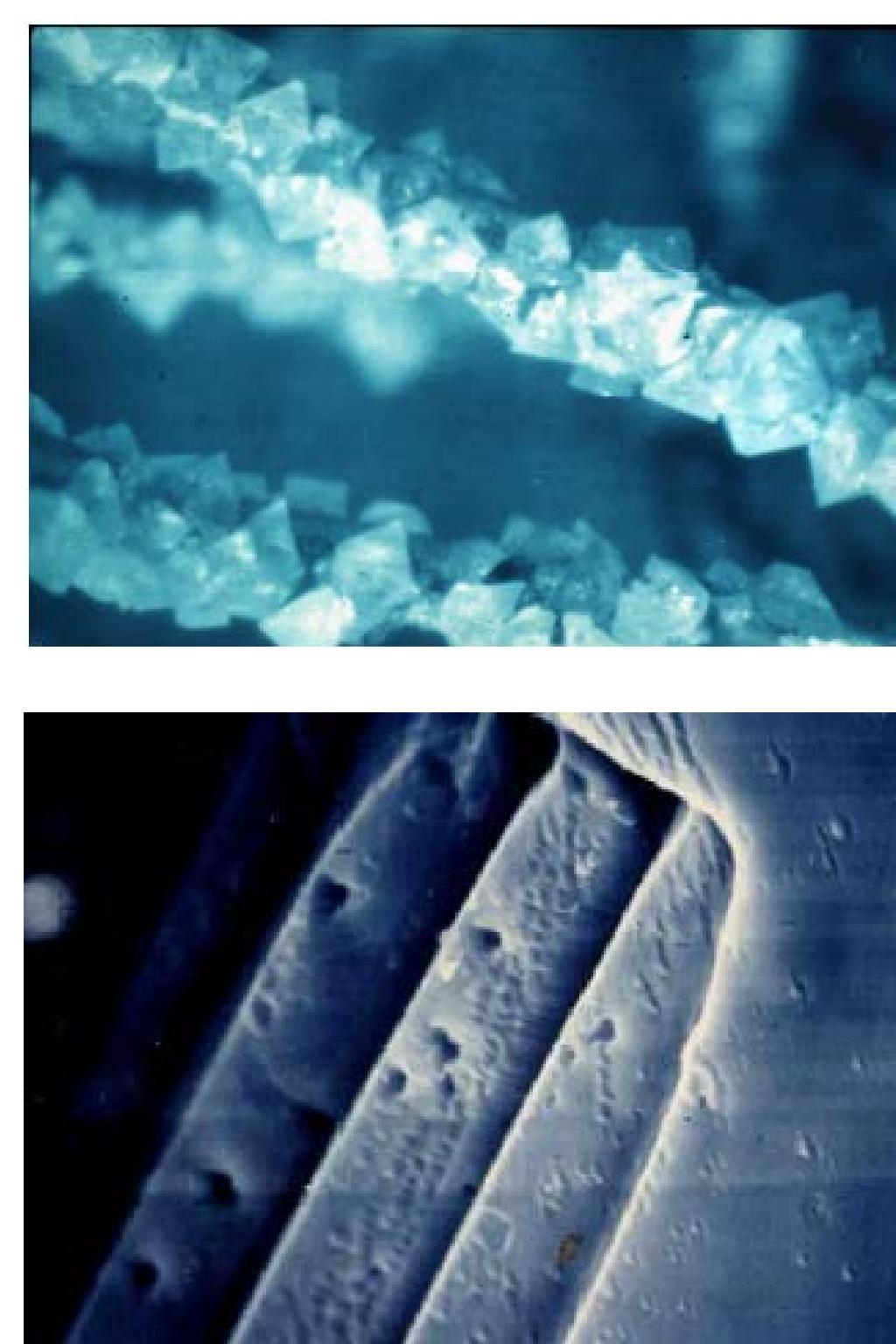


Fig. 2 Na₂O crystallization

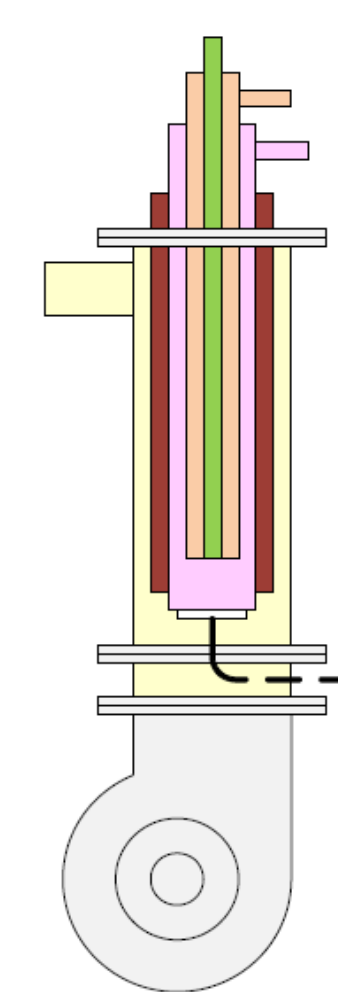


Fig. 3 Plugging-meter concept

Impurity Measurement

➤ Impurity Measurement Method

- Plugging-meter : narrow flow channel with orifice
- Principle : precipitation (similar to the cold trap)
- Reduced flowrate due to flow channel narrowing and corresponding temperature measurement
- Plugging temperature : indicates the impurities solubility

➤ Plugging-meter Subsystem

- Plugging-meter sub-loop : installed in parallel to the cold trap
- Operates on-line with the cold trap
- Main components : plugging-meter, EMP, heater, blower
- Instrumentation : flowrate(EMF), temperature(TC)

➤ Impurity Measurement Result

- Plugging temperature calculation : $\frac{T_{plug} + T_{unplug}}{2} = 137.1^\circ\text{C}$
- In Fig. 4, blue line(flowrate) and black line(corresponding temperature)
- Impurities solubility : Eichelberger's correlation ~ **1.9 ppm**

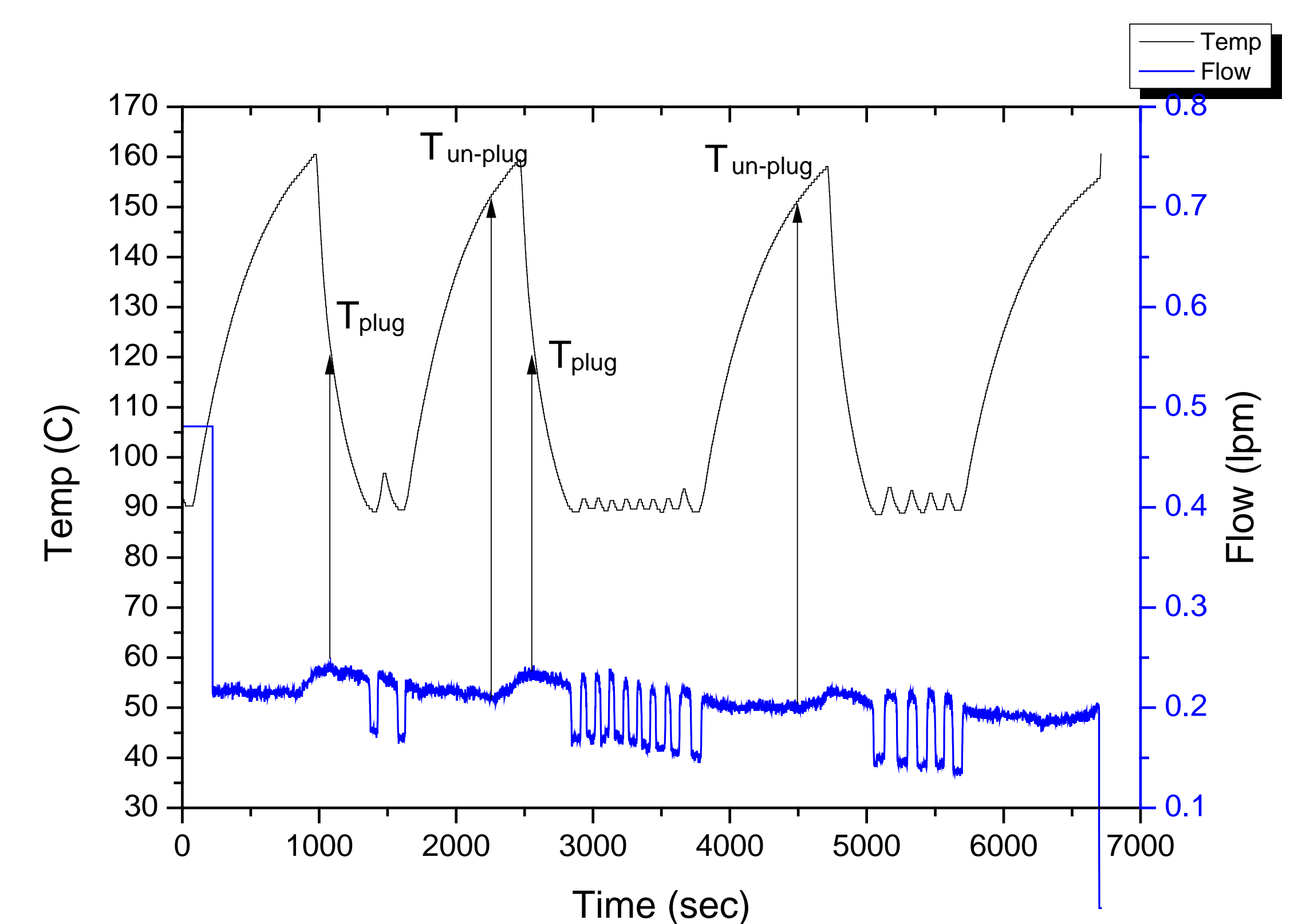


Fig. 4 Plugging-meter operation result (flowrate + temperature)

Conclusion

- ✓ Operational experience of sodium purification system for STELLA-1 facility
- ✓ Impurity measurement technique demonstration and the result
- ✓ For further improvement, basic and lower level R&D on each component(cold trap, plugging-meter, EMF and etc.) is needed.