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Helium Inlet Temperature Maintenance Performance of a Vertical-type Metal Hydride Bed

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1. Introduction

A nuclear fusion fuel cycle plant is composed of various subsystems such as a hydrogen isotope storage and delivery system [1-2]. A metal hydride bed is used for storing hydrogen isotopes [3-5]. The in-bed calorimetry of a metal hydride bed is important. Helium temperature is the major parameter of the in-bed calorimetry [6-7]. The optimal helium flow condition determines the performance of the in-bed calorimetry [8]. In the present study, the helium inlet temperature variation was measured for evaluation of heater. A flow rate of 15 ℓ/min and an initial temperature of 303 K, 313 K and 323 K are experimental conditions.

2. Characteristics and Structure of the vertical-type bed system

A vertical-type of ZrCo bed was fabricated for the recovery/ delivery of hydrogen isotopes. A specially designed ZrCo bed was fabricated as shown in fig. 1, 2. The ZrCo bed consists of a primary vessel containing ZrCo hydride and a secondary vessel. In the primary vessel, a cable heater directly heats up the $ZrCoH_x$ to desorb the hydrogen isotopes. A helium loop in the primary vessel removes and measures the tritium decay heat. In the secondary vessel, a vacuum blocks the heat of the primary vessel. The secondary vessel is kept under a vacuum during a calorimetry operation.

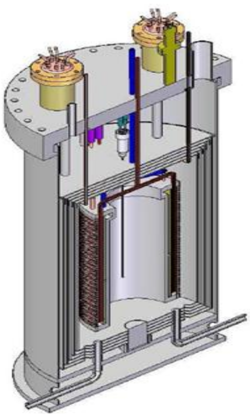

Fig. 1. Cross-section of the vertical-type ZrCo bed

Fig. 2. Vertical-type ZrCo bed

Figs. 3 and 4 show the flow diagram of this in-bed calorimetry system. The experimental apparatus mainly consists on the above gas flowing vertical-type ZrCo bed, a circulation metal pump, a heat exchanger, a mass flow controller, and pressure & temperature sensors.

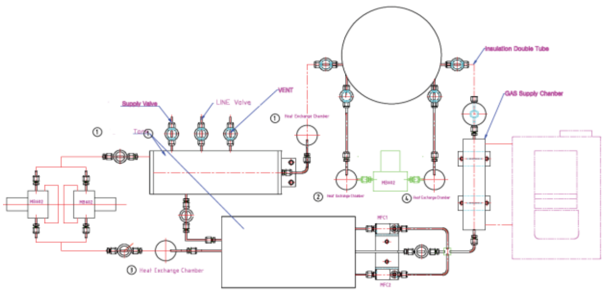

Fig. 3. Diagram of the in-bed calorimetry

Fig. 4. Experimental apparatus for the in-bed calorimetry

3. Results and Discussion

The helium inlet temperature variation was measured. A mass flow rate of 15 ℓ/min, initial temperature of 303 K, 313 K and 323 K are experimental conditions (Table. 1).

Table Ⅰ: The experimental conditions of helium

Flow rate (ℓ/min)	Temperature (K)
15	303
	313
	323

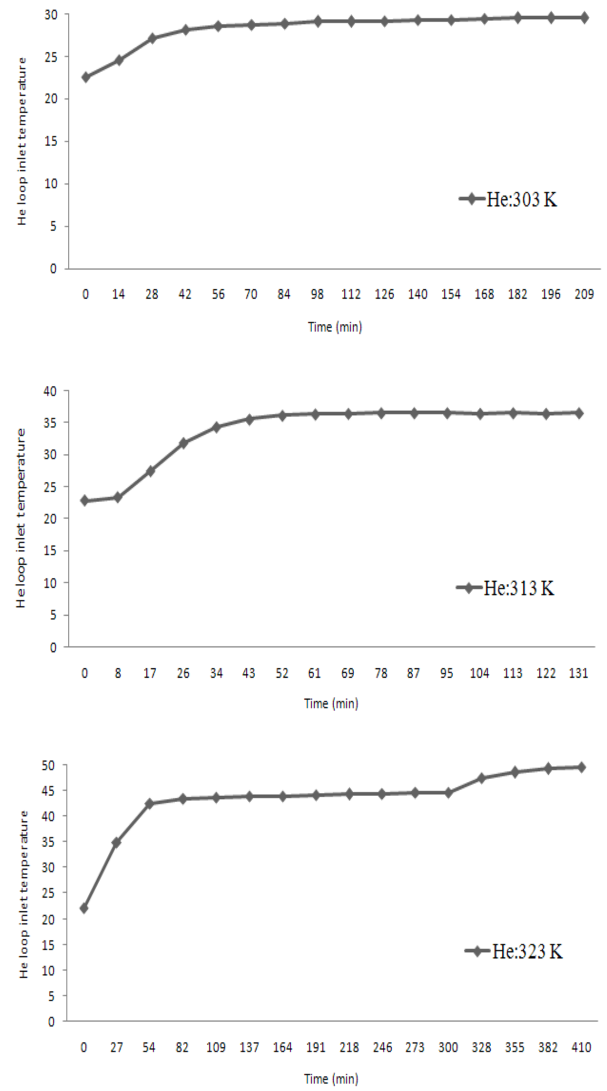

Fig. 5. The temperature curve of Helium loop inlet at 303 K, 313 K, 323 K

Fig. 5 shows the temperature of the helium loop inlet. For the first case of T=303 K, $\dot{m}$=15 ℓ/min, it took 70 minutes to reach a steady state. For T=313 K, $\dot{m}$=15 ℓ/min, 95 minutes are taken to reach a steady state. For T=323 K, $\dot{m}$=15 ℓ/min, it took 191 minutes to reach a steady state. Thus the time to a steady state increases with higher temperature. By the way, the increase of temperature results in a change of the slope. This means the time to reach a steady state is extended.

4. Conclusion

The variation of the helium inlet temperature was measured. With a mass flow rate of 15 ℓ/min, initial temperatures of 303 K, 313 K and 323 K were tested. We confirmed that the steady state temperature was reached. The temperature of the helium inlet affects the in-bed calorimetry system operating temperature. We are going to develop the operation procedure of the in-bed calorimetry for a metal hydride bed.

Acknowledgements

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