Performance of a Simulated Decay Heater in a Hydrogen Storage Bed

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1. Introduction

Deuterium and tritium fuels are used for thermonuclear reactors. The measurement of tritium inventory is required because the tritium inventory in each bed frequently changes according to the operation scenario of the thermonuclear reactors [1-4]. One gram of tritium emits about 0.324watt of decay heat. Performance tests of simulated tritium decay heat measurement on a hydrogen storage bed are required to measure the tritium inventory of a storage & delivery vessel in the thermonuclear reactors [5-11].

In this study, a hydrogen storage bed was designed and fabricated. The performance tests of a simulated decay heat measurement of tritium were carried out. The experimental powers of the simulated heaters were compared with the calculated values of tritium decay heat.

2. Experimental Apparatus and Measurement

2.1 Experimental Apparatus

The hydrogen storage bed was designed and fabricated as shown in Fig. 1. Three simulated heaters (30V, 8W per heater) in a dual cylindrical vessel were installed as shown in Fig. 2.

2.2 Measurement

Fig. 3 shows the experimental apparatus of a hydrogen storage bed. The resistances of the three simulated heaters in dual cylindrical vessel were measured three times. We calculated the simulated decay heat (watt) from direct voltage and average resistance of the simulated heaters. The simulated decay heat of tritium was measured and analyzed using the voltage of the simulated heaters due to tritium inventory (5, 10, 20, 40, 70g). Table I indicates the experimental conditions for a simulated decay heat measurement due to the tritium inventory.

Table I: Experimental conditions

Tritium)g)	5	10	20	40	70
Voltage(V)	7.7	10.9	15.4	21.7	28.8
Calculated Power(W)	1.62	3.24	6.48	12.96	22.68
Time(min)	30	30	30	30	30

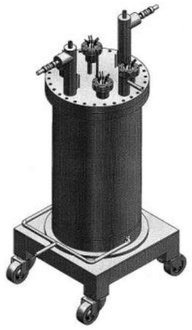

Fig.1. A front view of a hydrogen storage bed.

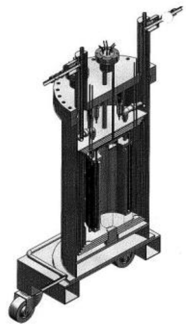

Fig.2 A cross section of a hydrogen storage bed.

Fig. 3. Apparatus of a hydrogen storage bed.

Fig. 4. Simulated heater panel.

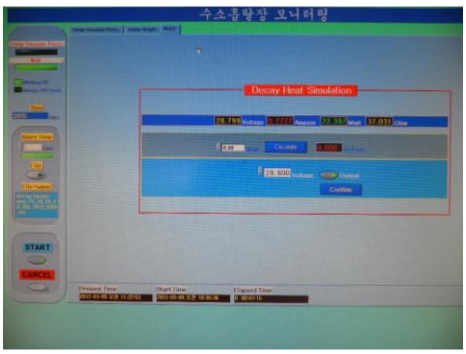

Fig. 5. Data acquisition of simulated decay heat.

Fig. 4 shows a simulated heater panel. The simulated voltage (21.7V) and current (0.5861A) makes up the simulated power (12.72W). Fig. 5 indicates the data acquisition of simulated decay heat. The simulated voltage (28.799V) times the simulated current (0.777A) equals the simulated power (22.397W) from Fig. 5.

3. Results and Discussion

Table II shows the experimental results of simulated decay heat measurement due to tritium inventory. The calculated decay heat and experimental heat on tritium inventory were analyzed. Fig. 6 indicates the simulated decay heat on tritium inventory. The experimental decay heat on tritium inventory was in good agreement with calculated values. Fig. 7 shows the temperatures of ZrCo powder due to the simulated decay heat. The increases of ZrCo powder temperatures in 30 minutes of heating time were rapider than those in 10 minutes of heating time.

Table II: Experimental Results

Tritium(g)	5	10	20	40	70
Calculated Power(W)	1.62	3.24	6.48	12.96	22.68
Experimental Power(W)	1.59	3.20	6.39	12.69	22.34
ZrCo Power Temp.(℃)	28.1	28.7	30.0	32.7	37.6

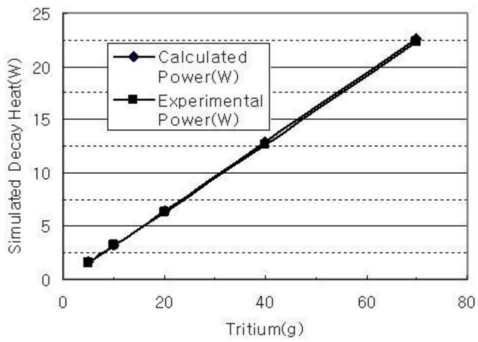

Fig. 6. Tritium amount vs. simulated decay heat.

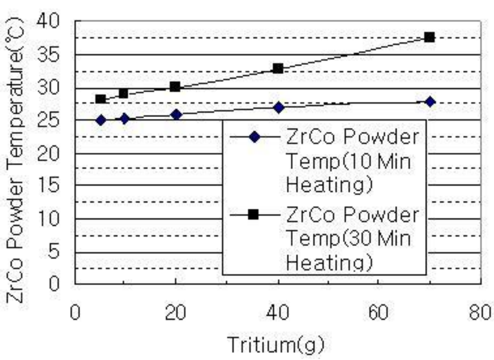

Fig. 7. Tritium amount vs. ZrCo powder temperature.

4. Conclusions

The hydrogen storage bed was designed and fabricated. The performance tests for the simulated decay heat measurement using simulated heaters were carried out. The experimental decay heat on tritium inventory was in good agreement with the calculated values. The increases of ZrCo powder temperatures in 30 minutes of heating time were rapider than those of 10 minutes in heating time. These experimental results of simulated decay heat measurement will be utilized for an in-bed calorimetric measurement of a hydrogen storage bed.

Acknowledgement

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