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Characteristics of heating and hydriding temperature in depleted uranium

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1. Introduction

To develop nuclear fusion technology, it will be necessary to store and supply hydrogen isotopes needed for Tokamak operation. SDS is used for storing hydrogen isotopes as a metal hydride form. A tritium storage vessel for a nuclear fusion plant requires the performance of a fast tritium storage and supply. Stable metal tritides are viewed as potential candidates for the high-density storage of tritium. For the storage, supply, and recovery of hydrogen isotopes, depleted uranium (DU) has been extensively proposed [1-4].

In this study, a medium-sized DU bed was fabricated to study the characteristics of hydriding/dehydriding. The effect of the temperature increase of exothermic reaction on hydriding at the initial temperatures (RT, 100, 200, 300℃) of the bed was analyzed.

2. Experimental Apparatus and Measurement

Fig. 1 shows the DU bed hydriding/dehydring system. It is composed of a DU bed, a hydrogen tank, several manifolds, a temperature/pressure monitoring panel, a heater control panel, a data acquisition device, and three pumps. A DU bed contains 191.1 grams of hydrogen for the hydriding/dehydriding experiments. A couple of heaters (3kW×2) are used for the dehydriding experiment. Three thermocouples are installed for the temperature of each location in a DU bed. A lapview program (v. 8.2) is used for collecting data. One datum per second is collected and stored using a DAQ device.

Fig. 1. DU bed hydriding/dehydring system.

3. Results and Discussion

Fig. 2 shows the temperatures of exothermic reaction from the hydriding of the DU bed. The temperatures of the DU powders rapidly increase from 21.4℃ to 123.6℃ in 2 minutes for hydriding, and fast cooling by 6 minutes, whereby the cooling of the temperatures is slowed. The temperatures of thermal shield rapidly increase from 21.5℃ to 29.7℃ in 14 minutes of hydriding, and the cooling of the temperatures is then slowed. The temperatures of the thermal shields rapidly increase from 22.6℃ to 36.5℃ in 10 minutes for hydriding, and the cooling of the temperatures is then slowed. Therefore, the exothermic reaction of hydriding barely has an influence on the temperatures of the heaters and thermal shields.

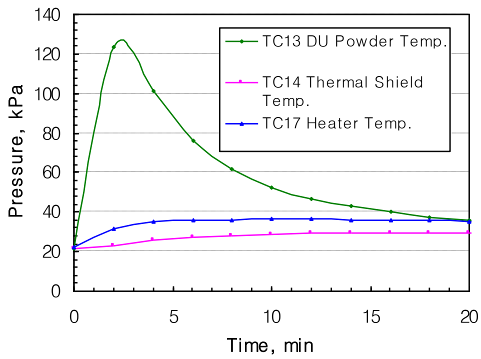

Fig. 2. Temperatures of exothermic reaction.

Fig. 3 shows the temperatures of the exothermic reaction for hydriding due to the initial temperatures of the DU bed. The temperatures of the exothermic reactions at room temperature increase from 21.3℃ to 124.7℃ in 2.1 minutes of hydriding, and then decrease. The temperatures of exothermic reactions at 100℃ increase from 78.8℃ to 181.6℃ in 2.4 minutes of hydriding, and then decrease. The temperatures of exothermic reactions at 200℃ increase from 165.0℃ to 246.8℃ in 2.9 minutes of hydriding, and then decrease. The temperatures of exothermic reactions at 300℃ increase from 269.0℃ to 312.7℃ in 2.4 minutes of hydriding, and then decrease. It was determined that the initial temperatures of the DU bed have an influence on the temperatures of the exothermic reaction of hydriding.

Table 1 shows the temperature increase due to an exothermic reaction of hydriding. The temperature increase at room temperature is 103.4℃. As the initial temperatures of the DU bed increases, the temperature increase of the exothermic reaction for hydriding gradually decreases. The temperature increase at 300℃ is 43.7℃.

Fig. 4 shows the temperature increase due to exothermic reaction for hydriding of the DU bed. As the initial temperatures of the DU bed increases, the temperature increase of the exothermic reaction for hydriding gradually decreases.

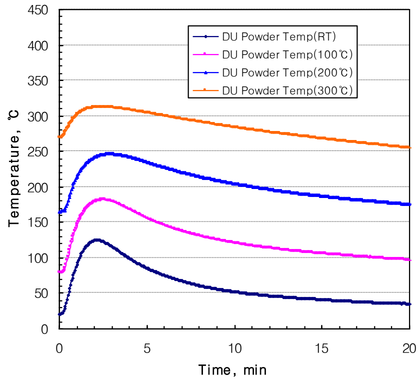

Fig. 3. Temperatures of exothermic reaction for hydriding due to the initial temperatures.

Table 1. Experimental Conditions

	Initial Temp.	Final Temp.	Δ T
RT	21.3	124.7	103.4
100℃	78.8	181.6	102.8
200℃	165.5	246.8	81.3
300℃	269.0	312.7	43.7

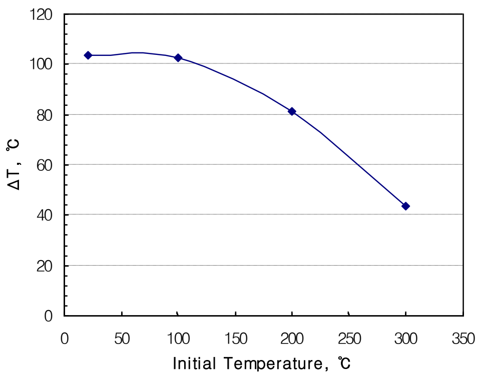

Fig. 4. Temperature increase due to exothermic reaction for hydriding of the DU bed.

Fig. 5 shows the dehydriding temperature and dehydriding of the DU bed. The heaters are heated from 25.6℃ to 300℃ for 10 minutes and are heated from 300℃ to 400℃ for 15 minutes, and then their temperatures are maintained for 1 hour. The dehydriding is carried out under the heating process.

The pressures of a hydrogen tank are nearly 0 for 10 minutes of preheating. When a hydrogen outlet valve is open at 10 minutes of preheating, the pressures of a hydrogen tank rapidly increase by 40 minutes of dehydriding. From 40 minutes of dehydriding, the pressures of a hydrogen tank slowly increase.

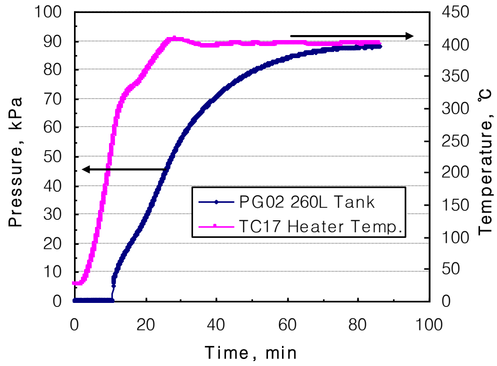

Fig. 5. Dehydriding temperature and dehydriding of the DU bed.

4. Conclusions

A medium-sized DU bed was fabricated to study the characteristics of hydriding/dehydriding. The effect of the temperature increase of an exothermic reaction on hydriding at the initial temperatures (RT, 100, 200, 300℃) of the bed was analyzed. As the initial temperatures of the bed increases, the hydriding speeds are gradually slow. As the initial temperatures of the DU bed increases, the temperature increase of exothermic reaction for hydriding gradually decreases. It was determined that the initial temperatures of the DU bed have an influence on the temperatures of the exothermic reaction for hydriding.

Acknowledgement

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