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A DU bed system for storing and supplying hydrogen isotopes

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1. Introduction

It will be necessary to store and supply hydrogen isotopes needed for Tokamak operation to develop nuclear fusion technology. Stable metal tritides are viewed as potential candidates for the high-density storage of tritium. A tritium storage vessel for a nuclear fusion plant requires the performance of a fast tritium storage and supply. Depleted uranium (DU) has been extensively proposed for the storage, supply, and recovery of hydrogen isotopes [1-2]. SDS is used for storing hydrogen isotopes as a metal hydride form. To control the SDS, it is necessary to monitor the tritium amount in a bed [3-7].

In this study, a full-sized DU bed was designed and fabricated including cylindrical-type copper foam of nine layers to study the characteristics of hydriding/dehydriding and simulate the tritium amount in a bed. The integrity and leak inspection on the welding of a primary vessel was performed using a penetration test, helium leak test, and pressure test. A leak inspection of the helium tube of a primary vessel for simulating the hydriding of hydrogen isotopes was also performed using a helium leak test and pressure test. Vacuuming on the DU bed system was carried out. Auto tuning on the cable heaters of two pairs in the DU bed was also be performed. In our next study, the hydriding/dehydriding on a DU bed will be performed. A simulation on the depleted uranium hydriding will be carried out.

2. Bed Design and Fabrication

2.1 Bed Design

Figure 1 shows schematic models of a DU bed. The DU bed system consists of a DU bed, hydrogen tank, several manifolds, a temperature/pressure monitoring panel, a heater control panel, three pumps, an in-bed calorimetric equipment, and a data acquisition device. A DU bed contains about 1,840 g of depleted uranium for the hydriding/dehydriding experiments. A couple of heaters (2kW╳2) is used for the dehydriding experiment. A couple of simulators (12kW╳2, 30V DC) is also used for the simulation of in-bed calorimetric. A couple of helium loops (Φ 3/8 inch) are brazed on the groove of the outer surface of the primary vessel for simulating the calorimetric of depleted metal hydriding.

The cylindrical-type copper foam of nine layers (10 ppm) with depleted uranium rods is well installed for transferring the heat of stainless steel 316 to depleted uranium. A couple of hydrogen filters (Φ 1/2 inch, pore size:0.05 ㎛) is installed for preventing a leak of the powder of depleted uranium from the primary vessel. A Labview program (v. 8.6) is used for collecting data. One datum per one second is collected and stored using a DAQ system.

Fig.1. Schematic models of a DU bed.

2.2 Bed Fabrication and Leak Test

Figure 2 shows a penetration test on the welding of the primary vessel for inspecting its integrity.
Figure 3 shows the wiring of the thermal shield including four layers (thickness of 0.5 mm). Figure 4 shows the wiring of eight thermocouples. Figure 5 shows a leak test of two helium tubes for inspecting leaks on them. Figure 6 shows the leak and pressure test of the primary vessel for inspecting leaks on it.

Fig.2. Welding of primary vessel.

Fig.3. Wiring of thermal shield.

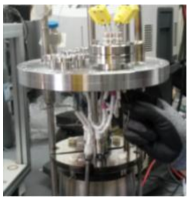

Fig.4. Wiring of thermocouples.

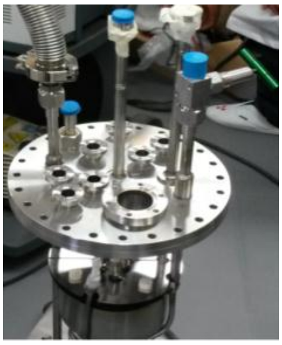

Fig.5. Leak test of helium tube.

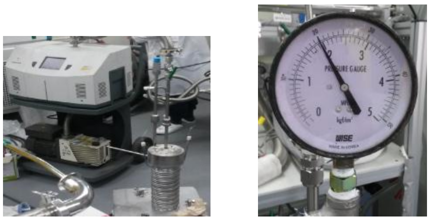

Fig.6. Leak and pressure test of a primary vessel.

3. Operation and Planning

Figure 7 shows the DU bed system including in-bed calorimetric equipment. Through a penetration test, it was confirmed that the welding of the primary vessel has a good integrity. It was confirmed that the two helium tubes are sound by inspecting the helium leak test on the welding of the primary vessel. It was also confirmed that the primary vessel has a good integrity by inspecting the helium leak and conducting a pressure test on it.

Vacuuming of the DU bed system was carried out. Vacuuming of the in-bed calorimetric equipment was also carried out. Auto tuning on a couple of heaters was also performed. In a next study, hydriding/dehydriding on a DU bed will be performed. A simulation on a depleted uranium hydriding bed will also be conducted.

Fig. 7. A DU bed system for storing/supplying hydrogen isotopes and simulating tritium inventory.

4. Conclusions

A DU bed was designed and fabricated including cylindrical-type copper foam of nine layers to study the characteristics of hydriding/dehydriding and simulate the tritium amount in a bed. Through a penetration test, it was confirmed that the welding of the primary vessel has a good integrity. It was confirmed that the two helium tubes is sound by inspecting a helium leak test on the welding of the primary vessel. It was also confirmed that the primary vessel has a good integrity by inspecting a helium leak and conducting a pressure test on it.

Vacuuming of the DU bed system was carried out. Vacuuming of the in-bed calorimetric equipment was also carried out. Auto tuning on a couple of heaters was performed. In our next study, hydriding/dehydriding on the DU bed will be performed. A simulation on a depleted uranium hydriding bed will also be performed.

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