The Absorption-Desorption of Hydrogen by 1.5 g Depleted Uranium

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1. Introduction

The form of metal tritides is one of the most popular methods for the storage of hydrogen isotopes. Particularly when metal is in a powder form, the storage capacity of hydrogen isotopes become the maximum value. Here, a 1.5g depleted uranium metal was decrepitated into a powder upon an absorption and desorption of hydrogen gas. The conditions for an activation, absorption-desorption of the hydrogen were defined.

2. Experimental

As a chemical, isotopic properties of a 1.5g depleted uranium (=DU, M.W = 238g/mol) used in this experiment, are the same as that of S.W. Paek et al. [1] The experimental apparatus is shown in Figure 1. Simply, this consists of a manifold, a sample cell, a rotary pump and turbomolecular pump (TMP), a thermocouple and a capacitance manometer. And the used hydrogen is a highly pure hydrogen gas (> 99.99%).

Figure 1. Experimental apparatus

3. Results and Discussion

3.1. The activation of the depleted uranium metal

Depleted uranium metal usually does not react with hydrogen at room temperature, because its surface is covered with a protective layer of oxide. But it can be activated by a heating to a high temperature under a hydrogen atmosphere. The activation cracks the oxide layer and breaks the metal into small particles. The uranium in the reaction cell was activated using the following steps. First, heat the reaction cell to 723K under a vacuum for five hours to remove the volatile impurities. Second, expose the uranium to about a 670 torr hydrogen pressure while the temperature is increased to about 473K, until the uranium is saturated with hydrogen, which takes about three hours. Finally, heat the uranium hydride to 723K under a vacuum until a desorption of the hydrogen is complete, which requires about five hours.[2] Figure 2 shows the variation of the hydrogen pressure and temperature during the activation of 1.5g depleted uranium in accordance with the above procedure.

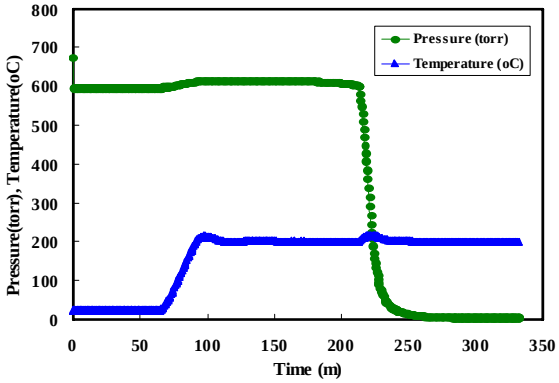

Figure 2. The variation of the hydrogen pressure and temperature during the activation of depleted uranium

3.2. The absorption-desorption of the depleted uranium metal

After 1.5g depleted uranium was activated, reaction cell was slowly cooled down to room temperature. The absorption of the hydrogen on the depleted uranium was done simply by feeding the hydrogen to the reaction cell at room temperature. A variation of the hydrogen pressure, temperature and hydrogen content (H/U) with a time function during the absorption of hydrogen on the depleted uranium is shown in Figure 3. When the depleted uranium was exposed to about a 670 torr hydrogen pressure, the absorption rate was very fast, as indicated by the rapid decrease of the pressure, and the increase of the temperature and hydrogen content. The reaction was almost completed within 5 min. The hydrogen content was about 2.86 after 10 min of a reaction. Because the reaction of the metal with hydrogen is exothermic, the temperature of the reaction cell was increased. The maximum temperature of the

reaction cell was about 363K, and then the temperature was lowered to room temperature.

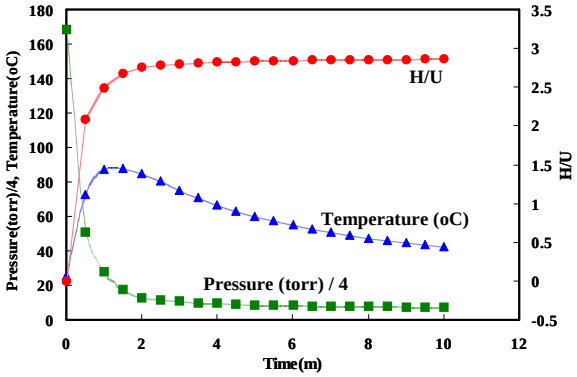

Figure 3. A variation of the hydrogen pressure, temperature and hydrogen content (H/U) with time function during the adsorption of the hydrogen

This process of an absorption and a desorption of the hydride was repeated several times. Figure 4 shows the experimental results. Only the first absorption showed a slightly slower reaction rate during the initial step of the reaction, but there were no other differences in the second, third absorptions of hydrogen. This phenomenon was caused by the reduction of the uranium particle size according to the absorption and desorption of hydrogen.

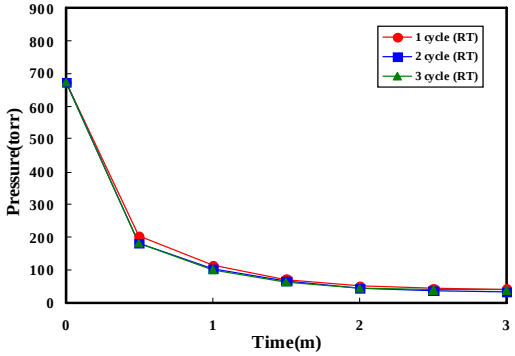

Figure 4. The variation of adsorption rate according to the cycle of the adsorption-desorption of the hydrogen

3. Conclusion

The absorption-desorption of hydrogen on 1.5g depleted uranium metal was carried out to develop temporary storage materials for tritium gas. To get rid of the oxide layer of on the surface, depleted uranium was activated by a heating to a high temperature under a hydrogen pressure prior to an absorption of the hydrogen. The absorption of hydrogen by depleted uranium was almost completed within 5 min, as indicated by the rapid decrease of the pressure, and the increase of the temperature and hydrogen content. The variation of the adsorption rate according to the cycle of the adsorption-desorption of the hydrogen revealed no other differences in the second, third absorptions of hydrogen except for the first absorption of hydrogen.

REFERENCES

[1] S. W. Paek, Characteristics of reaction between hydrogen isotope and depleted uranium, J.Ind. Eng. Chem., 8, 12-16 (2002)
[2] L. K. Heung, Tritium transport vessel using depleted uranium, WSRC-MS-94-0491