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Sorption of Hydrogen on Sponge Titanium

FELICIA VASUT, ANISOARA PREDA*, IOAN STEFANESCU,
MARIUS ZAMFIRACHE and CLAUDIA DAVID
National R & D Institute for Cryogenics and Isotopic Technologies-ICIT Rm. Valcea,Valcea, Romania
E-mail: adelina_preda@yahoo.com

To build a detritiation facility for heavy water that has been used as moderator and cooling agent in the CANDU reactor from Cernavoda, Romania is necessary to have in place a storage vessel to deposit the hydrogen isotopes, especially tritium. In preparation for the design of the storage vessel, sponge titanium and hydrogen gas were used during experiments as storage material and gas to be stored, respectively. The presence of tritium was simulated by mixing helium into the hydrogen. During the adsorption process, several parameters may affect the titanium adsorption capacity and the hydrogen adsorption rate such as metal activation temperature, gas pressure, helium content, *etc.* The present paper presents the influence of these parameters on the metallic titanium hydrogenation reaction.

Key Words: Sorption, Hydrogen, Titanium.

INTRODUCTION

National R and D Institute for Cryogenics and Isotopic Technologies-ICSI Rm. Valcea has a facility to obtain the sorption experimental results for hydrogen and its isotopes on metals and intermetallic compounds. Investigated material was titanium used in two structural forms: sponge and powder. For obtaining of the titanium sorption characteristics, protium was used. The results will be providing a database for tritium storage and control on titanium[1].

The reaction between titanium and hydrogen is spontaneous at room temperature for both forms of titanium, powder or sponge. The obtained results at sorption process are: for powder titanium atomic ratio H/Ti was 1.86 and for sponge titanium, the atomic ratio H/Ti was 1.92. These results were confirmed by X-Ray diffraction[1,2]. The parameters that could influence sorption process are activation temperature, alimentation gas pressure, helium content in case of tritium simulating presence.

EXPERIMENTAL

For illustrating the parameters which influenced the sorption process, it was realized that the experiments using a facility reported earlier[3]. The tested material was sponge titanium and selected because of good atomic ratio[1].

RESULTS AND DISCUSSION

One of the parameters that can influence sorption capacity of the metal is the temperature which was applied for sample activation. Fig. 1 presented the activation temperature on hydrogen sorption process.

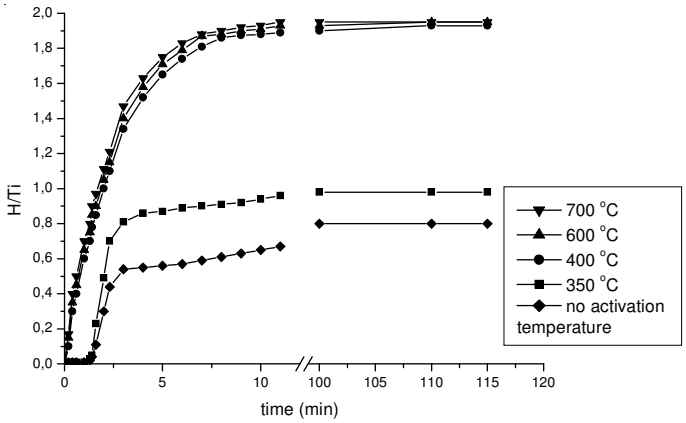

Fig. 1. Effect of activation temperature on sorption process

It is observed that if the sample activation is used at < 400 °C, the sorption reaction becomes slow and the sample is not complete reacted (the maximum atomic ratio obtained was equal with 1 for an activation temperature of 350 ºC). Influence of the temperature between 400 and 700 °C on the sorption process is negligible.

The experimental results of activation time on sorption rate are presented in Fig. 2. It is observed that 4 h is sufficient to activate the sample for obtaining good results for sorption of hydrogen.

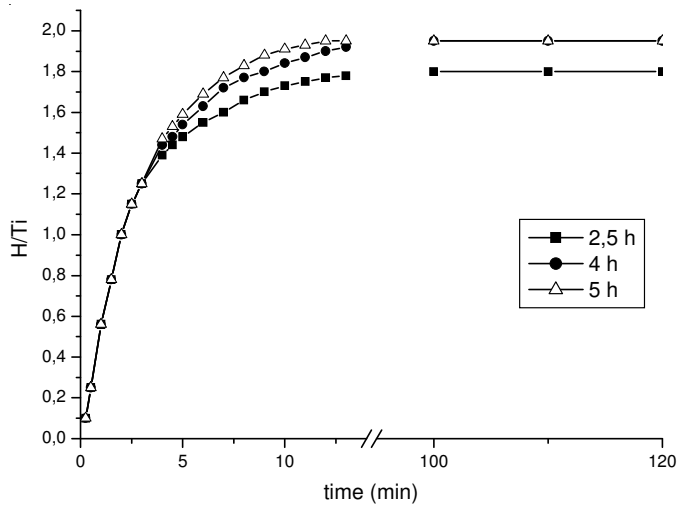

Fig. 2. Effect of activation time on sorption process

Activation temperature for the experiments was established at 600 °C and activation time 2.5-5.0 h. It was observed that there is no significant difference in the sorption process for activation time.

Dependence of hydrogen sorption rate by initial hydrogen pressure is presented in Fig. 3. For each experiments, the sample was new one, without retained hydrogen in it. The hydrogenation rate increase when initial pressure is high. These results indicated that the initial pressure of hydrogen is an important factor for the sorption rate.

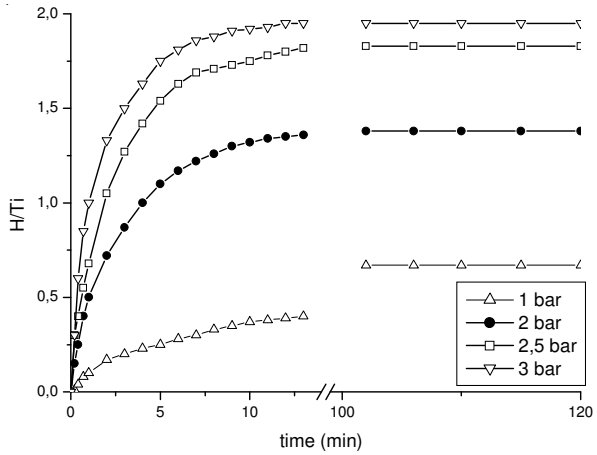

Fig. 3. Atomic ratio dependence by initial hydrogen pressure

Major difference between tritium reaction with titanium sample and protium with the same material is ^{3}He that is obtained from tritium β-decay. Fig. 4 illustrated the experimental results for reaction between sponge titanium and mixture of helium and hydrogen.

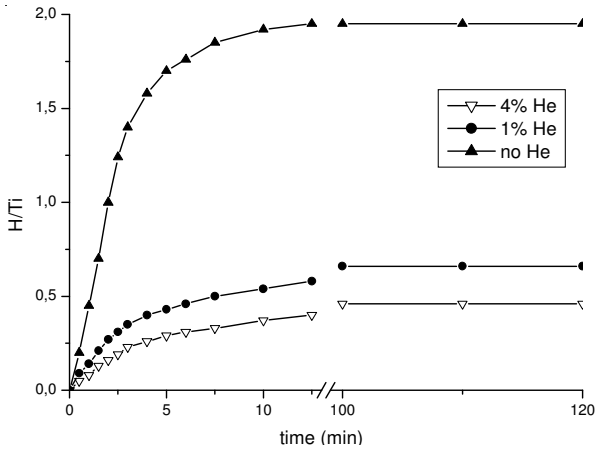

Fig. 4. Helium content influence on hydrogen sorption reaction

Decrease in atomic ratio H/Ti is observed for more than 1 % helium in hydrogen. This process take places because of "blanketing" effect produced by helium on metallic surface that restrain the hydrogen access at titanium active surface.

Conclusion

Activation of metal samples using a temperature high enough, leading to incomplete reaction between titanium and hydrogen. Compounds which are adsorbed on metal surfaces are not completely removed and hydrogen can not adhere to the metal to start the process of absorption.

Pressure at which hydrogen is placed in contact with metallic material is must be large for obtaining high concentration of hydrogen in metal. Initial helium content in gas affect storage capacity of the metal because of blanketing effect of helium on metallic surface.

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