Commissioning test of a hydrogen diffuser in various hydrogen concentrations

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1. Introduction

Tritium extraction system (TES) is one of the ancillary systems to extract the tritium produced from breeding blankets and to supply the purified tritium to the fuel cycle of a fusion reactor. Cryogenic molecular sieve beds (CMSB) and Ambient molecular sieve beds (AMSB) extract Q_2 and Q_2O during the adsorption phase and the diffuser purifies the regenerated hydrogen isotopes during the desorption phase. Array of TBS relevant size unit tests of TES have been performed using PGLoop facility. Adsorption performance tests of large scale CMSB were carried out using various parameters of total pressure, flow rate and partial pressure of hydrogen [1]. As a next step, desorption experiments using regeneration loop of the CMSB module coupled with the diffuser module that purifies hydrogen isotopes by hydrogen permeation are planned. Therefore, it is necessary to assess unit performances of the Pd/Ag diffuser before the next series of experiments. In this paper, results of commissioning test of the diffuser are introduced.

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2. Experimental description

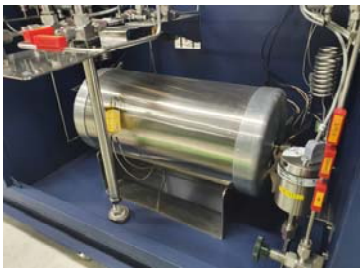

Fig. 1. Experimental Setup of the diffuser

Fig.1 shows the Pd/Ag diffuser installed in PGLoop. The diffuser is purged before the experiments to remove oxygen and air in the operation line. Then it is started to heat up to around 380℃. When it is at the operation temperature, the feed gas containing hydrogen of various concentration is supplied through the feed inlet. The concentration of hydrogen permeated to the sweep side is measured by Quadrupole Mass Spectrometers (QMS). Schematic of the diffuser module is illustrated in Fig. 2.

3. Experimental results

The conditions and gases of commissioning tests for the diffuser were chosen and adjusted from the CMSB results previously performed since the diffuser will process gases desorbed from the CMSB [1]. Inert gases such as argon or nitrogen can be used as a sweep gas, but helium is chosen in this experiment.

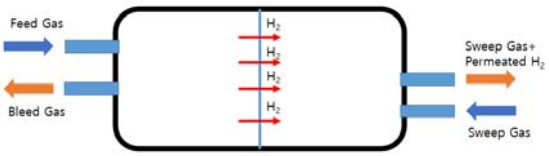

Fig. 2. Diagram of the diffuser

The commissioning conditions are summarized in table 1. Amount of hydrogen permeated to the sweep side is plotted according to feed gas flowrate in Fig. 3. The graph shows that more hydrogen was permeated at higher pressure when compared at the same flowrate and hydrogen concentration of the feed side. Fig.4 shows hydrogen recovery of the diffuser according to hydrogen concentration in feed gas. Hydrogen recovery of the diffuser shows at least 60% in lower concentration of hydrogen. As the flowrate of the feed side was increased, hydrogen recovery was decreased. These trends shown in Fig. 3 and Fig.4 agree well with typical results of previous studies [2-4].

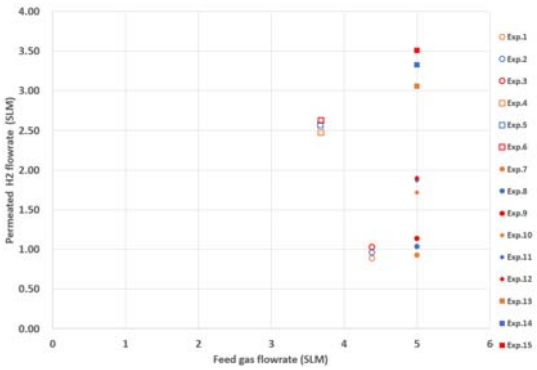

Fig. 3. Permeated hydrogen flowrate according to feed gas flowrate

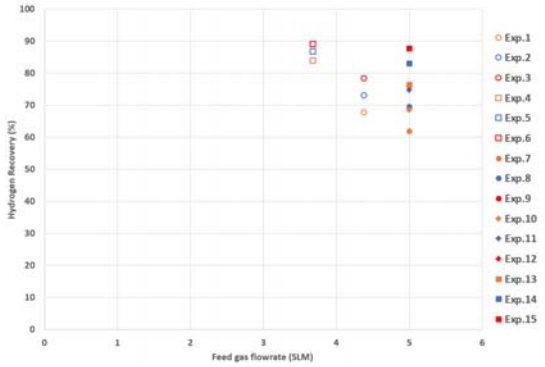

Fig. 4. Hydrogen recovery of the diffuser according to feed gas flowrate

Table 1. Summary of gas conditions in diffuser experiments

No.	Mix gas concentration (%)	Feed gas Flowrate (SLM)	Feed gas pressure (Bar)
1	30	4.38	1.2
2	30	4.38	1.5
3	30	4.38	2
4	80	3.68	1.2
5	80	3.68	1.5
6	80	3.68	2
7	30	5	1.2
8	30	5	1.5
9	30	5	2
10	50	5	1.2
11	50	5	1.5
12	50	5	2
13	80	5	1.2
14	80	5	1.5
15	80	5	2

4. Conclusions

Commissioning tests were successfully performed for several conditions with respect to pressure, flowrate and hydrogen concentration at feed side. It was confirmed that it showed a similar tendency when compared with other papers. More experiments are planned to be performed to clearly understand the characteristics of the diffuser. In the future, diffuser experiments will be carried out in conjunction with the CMSB module to investigate integral performance during desorption phase.

Acknowledgments

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