Status of the experimental study on the gas coolant purification system

Chang Wook Shin*[a], Seok-Kwon Son[b], Youngmin Lee[b], Suk-Kwon Kim[a], Hyung Gon Jin[a], Dong Won Lee[a], Mu-Young Ahn[b]

[a] *Korea Atomic Energy Research Institute, Daejeon, Republic of Korea* [b] *Korea institute of Fusion Energy, Daejeon, Republic of Korea*
**Corresponding author: cwshin@kaeri.re.kr*

1. Introduction

In the fusion reactor, helium circulates to convert the heat generated in the fusion reaction into electricity. At this process, a small amount of tritium may penetrate into the helium and cause safety problems such as leakage to the outside. CPS, which separates tritium and other impurities from helium, is an auxiliary system to prevent such problems [1] Small-sized tritium is converted into water molecule through an oxidation and then adsorbed using a molecular sieve. In the fusion reactor, the concentration of tritium - the target of purification - is very small, and the adsorption performance needs to be high. Therefore, experiments under various conditions are required to perform stable operation in numerous accident scenarios. The purpose of this study is to conduct an experiment to verify the performance of major devices in the CPS and to create a performance prediction model for design optimization.

2. Test facility and methods

RAVAD (Research Apparatus for Vapor Adsorption and Desorption) was established to confirm the main component of CPS in the gas cooling reactor. The verification test of an ambient molecular sieve bed (AMSB), as the first major component of CPS, is currently being conducted. Nine different AMSBs were manufactured and these AMSBs were analyzed for the effects of the column length and diameter under various gas condition: flow rate and contained vapor concentration. The adsorption performance depends on the vapor partial pressure rather than the system pressure or the gas type. Therefore, although the tests were conducted under low pressure condition, the characteristics of AMSB can be evaluated by simulating the moisture concentration and velocity similar to the actual operating conditions [2]. First, adsorption test was conducted with the air with vapor instead of helium. Then, the experiments were conducted to confirm the gas effect using argon and helium [3]. The test conditions are shown in Table 1. As can be seen in Figure 1, the results of the air and argon experiments are consistent. In the case of helium, since the size of the molecule is very small, additional experiments are currently being performed due to leakage problems.

Table 1. Test condition of gas effect tests

	Unit	Argon	Air	Helium
AMSB Size	-	D24/H24		
System pressure	kPa	323.7	323.7	322.3
Vapor concentration	ppm	99.85	100.36	100.04
System Temp.	C	22.4	23.3	24.1
H2O pressure	Pa	32.48	32.67	323.2

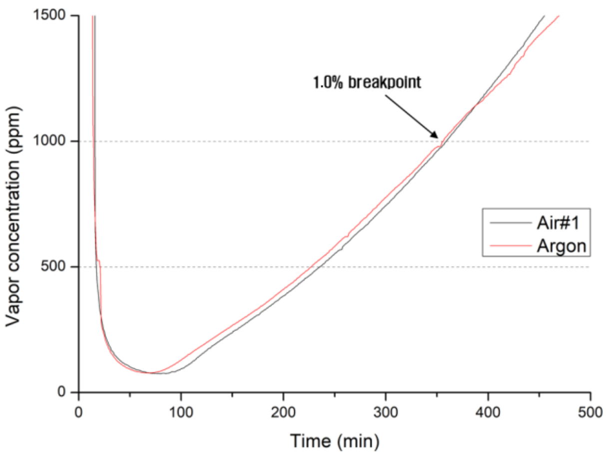

Figure 1 Comparison of breakthrough curves of two columns with vapor in air flow and in argon flow.

3. Conclusion and further works

Using RAVAD, adsorption experiments were performed to verify the performance of AMSB, which is a major component of CPS. The effect of diameter and length on adsorption in an air environment was evaluated, and the failure of AMSB was experimentally confirmed depending on speed and vapor concentration. Through this process, stable operating conditions could be suggested and an optimized AMSB design could be derived. In addition, it is possible to analyze various accidents and prepare for changes in operating conditions by comparing the operations under the vapor concentration environments ranging from few ppm to several hundred ppm. As the next step, a verification experiment on oxide bed performance is under preparation along with some additional experiments on AMSB.

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