Adsorption of Krypton on Porous Carbon at Low Temperature

Ju Ho Lee*, Seok-Min Hong, Jae-Won Lee, and Yung-Zun Cho
Korea Atomic Energy Research Institute, 111, Daedeok-daero 989beon-gil, Yuseong-gu, Daejeon, Republic of Korea
*jhlee835@kaeri.re.kr

1. Introduction

In pyro-processing of spent-fuel, volatile fission products such as Krypton-85 and Xenon are released during high-temperature treatment in head-end processes. As Krypton-85 exhibits a half-life of 11 years, it should be trapped and stored until it reduces to non-radioactive species. Several trapping strategies [1] were developed and in KAERI, the process based on solid adsorption has been considered and tested [2]. In this study, the adsorbent based on porous carbon developed for CO_2 adsorption are tested for low-temperature Krypton trapping.

2. Experimental Procedure

Porous carbon were prepared by carbonizing poly (vinylidene fluoride) powders. The powers of 13 to 15 g were contained in crucible and heated to 1000°C in argon environment at heating rate of 5°C/min and maintained during 1 hr. As demonstrated in Fig 1, the prepared porous carbon were found to shrink due to the release of hydrogen and polymer attached to polymer backbone during heat treatment and its final weight were found to be approximately 34% of original powder weight implying complete carbonization, less than the yield of theoretically complete carbonization of 37.5%.

Fig. 1. Prepared porous carbon.

The prepared porous carbons were fragmented to the particles of 1 – 3.35 mm through sieving for increasing packing fraction in adsorbent container and the employed mass was 17.7 g. The packing density for the fragmented porous carbon was found to 0.2 g/ml

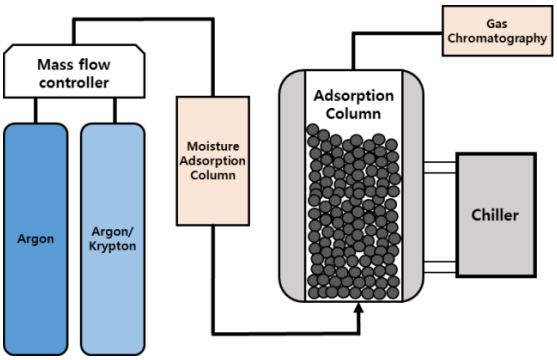

Fig. 2. Schematic Diagram of Kr adsorption process.

3. Results

As shown in Fig. 2, Kr adsorption process is composed of gas supplying unit, adsorption column and concentration analyzer. By adjusting flow rates of gases and mixing, the gas of the desired concentration are fed to adsorption column filled by porous carbon and its breakthrough curve are measured by gas chromatography. The adsorption test was carried at -74°C and 500 ppm Kr/Ar for 17.8 g porous carbon. The breakthrough adsorption time is considered at the condition that the concentration of Krypton in effluent corresponds to 5% of inlet concentration. Fig. 3 shows that the breakthrough of Krypton begins at 165 min.

4. Conclusion

In this study, we prepared porous carbon for

Krypton adsorption by carbonizing poly(vinylidene fluoride) and implemented the adsorption test at -74°C. Further study is in progress for the evaluation of the adsorption capacity for porous carbon at different condition and the derived data is expected to design Krypton adsorption process for pyro-processing.

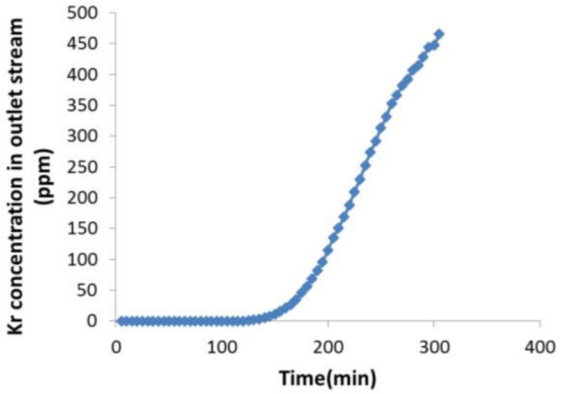

Fig. 3. Breakthrough curve for porous carbon (-74°C, 126 ml/min, Kr 500 ppm).

REFERENCES

[1] W.R. A. Goossens, G.G. Eichholz and D.W. Tedder, "Treatment of Gaseous Effluents at Nuclear Facilities", Harwood academic publishers (1991).

[2] S.M.Hong, G.Lim, S.H.Kim, J.H.Kim, K.B.Lee, and H.C.Ham "Preparation of porous carbons based on polyvinylidene fluoride for CO_2 adsorption: A combined experimental and computational study", Micropor. Mesopor. Mat, 15, 59-65 (2016).