Organic iodide capture using a zeolite dry filtration

Sanggil Park [a,b*], Joonyoung Sung[b], Gi-ppeum Kim[b], Jaeyoung Lee[b]
[a]*ACT Co. Ltd., Tecnho 9 Ro, Yuseong-gu, Daejeon, 34027, Korea*
[b]*School of Control and Mechanical Engineering, Handong Global Univ., Pohang, 37554, Korea*
[*]*Corresponding author: act-park@handong.edu*

1. Introduction

An organic iodide, especially, methyl iodide (CH_3I) would generated non-negligibly from a severe accident in a nuclear power plant. This CH_3I will be dangerous for human when it was inhaled, it is highly toxic and causes a serious nerve disorder. Even it is a major contributor to a thyroid cancer. In order to prevent its environmental release, it is required to decontaminate using a filtration system. There are two kinds of filtration methods, one is a wet-type using a pool scrubbing and the other is a dry-type using absorbents like zeolite, sand, charcoal, etc. For the removal of CH_3I from the release gases, wet-type is not ideal due to a high re-volatile characteristics of CH_3I. It may become volatile after dissolving in a pool and forms CH_3I again at the surface of water pool. Therefore, a dry-filtration should be installed to remove the CH_3I. In this study, we preliminary investigate the characteristics of zeolite filtration methods for the removal of CH_3I. We used both silver ion exchanged ZSM-5-zeolite (Ag^+-ZSM-5) to study the effect of silver ion for the removal of iodine from CH_3I.

2. Experimental results and discussions

In order to investigate the adsorption capacity of the Ag^+-ZSM-5, we set up the experimental facilities using the coupled TGA-GC (Thermogravimetric Analyzer)-(Gas Chromatography). By using the TGA the mass change was measured and the concentration of CH3I was measured by the GC. If the zeolite absorbs the iodine, the mass will be increased, and vice versa. The absorption mechanism of the Ag^+-ZSM-5 with the methyl iodide is as follows:

$$Ag^+ + I^- \rightarrow AgI \quad \text{(Equation 1)}$$

The experiment was performed at 50-150°C and the sample loading is shown in Fig. 1.

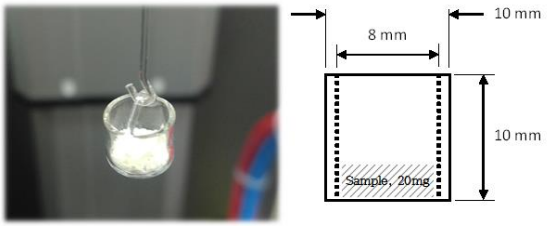

Fig. 1 Zeolite sample loading in the TGA

As shown in Fig. 1, 20 mg of Ag^+-ZSM-5 was loaded in the sample holder in the TGA. Fig. 2 shows the TGA configuration.

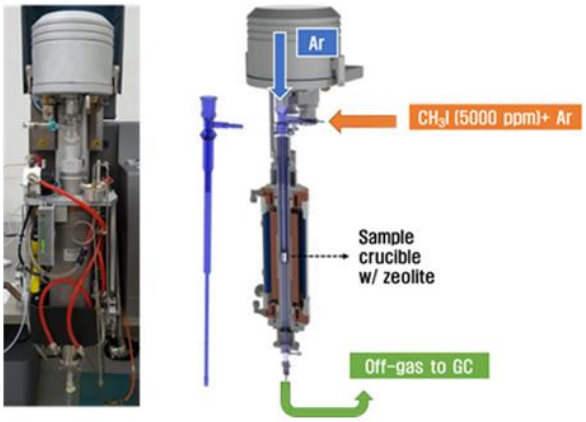

Fig. 2 TGA configuration

The test procedure is given in Fig. 3.

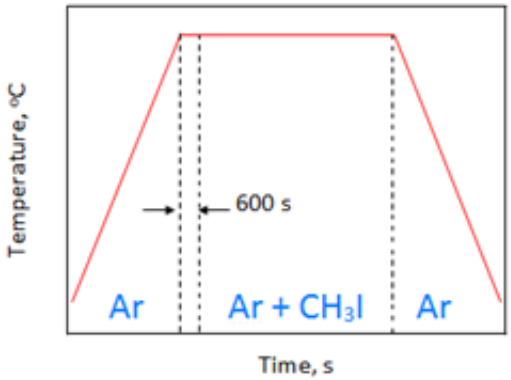

Fig. 3 Test procedure

As shown in Fig. 3, the target temperature was firstly achieved during the heating phase and the additional 600 second was required for the thermal stabilization. After the thermal stabilization phase, the isothermal phase was followed and the mass change was recorded in real time in this isothermal phase.

After the tests, all the mass gain curves of 50-150°C were over-plotted in Fig. 4.

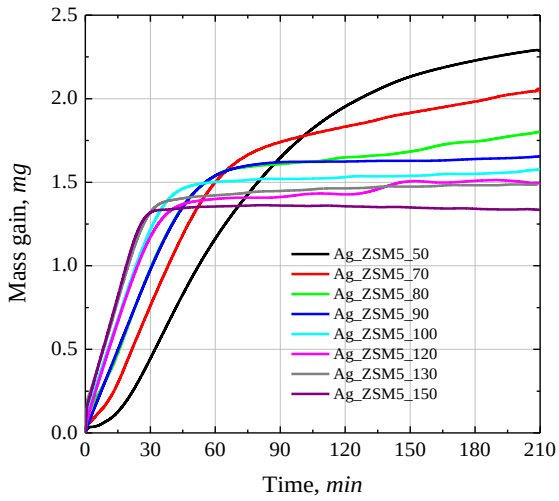

Fig. 4 Mass gain curves of tests

As shown in Fig. 4, firstly absorption rate was fast and a relatively high mass gain was recorded for all the tests. However the interesting phenomenon was observed. At the higher temperature, the lower mass gain was observed.

In addition, the mass change rate and the absorbed concentration of CH_3I was exactly matched as shown in Fig. 5.

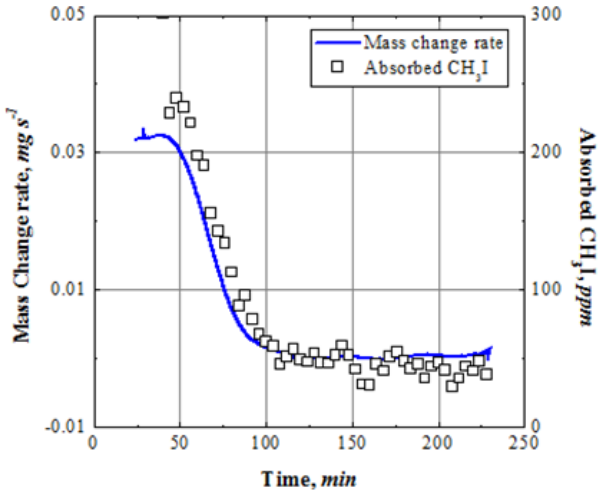

Fig. 5 Mass change rate and absorbed CH_3I concentration at 70°C test

As shown in Fig. 5, the absorbed iodine mass was exactly recorded in the TGA. Fig. 5 was one of examples of all tests results.

After the test, the color of samples were changed to the yellow as shown in Fig. 6.

Fig. 6 Samples before (left) and after (right) the test

As shown in Fig. 6, the sample after the test looked yellow due to the compound of AgI. The SEM/EDS images were also taken to study their surface characteristics.

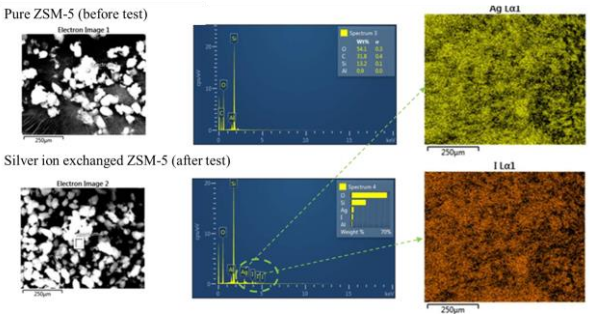

Fig. 7 SEM/EDS results of samples

As shown in Fig. 7, the pure ZSM-5 sample showed the relatively large amount of pores in SEM image but the Ag^+-ZSM-5 after test showed almost no pores in SEM images. In addition, the Ag and I were observed in EDS scan in the Ag^+-ZSM-5 sample after the test, and their locations were identical. This behavior supports that the Ag^+ was reacted with I^- from the CH_3I and forms the AgI at the same place in the pores in Ag^+-ZSM-5 and filled the pores.

3. Conclusion

In summary, the CH_3I capture tests using a silver ion exchanged zeolite was conducted in the coupled TGA-GC test set-up. The mass change of the sample and concentration of CH_3I were measured. The samples were investigated by the SEM/EDS to see its surface characteristics.

ACKNOWLEDGEMENT

This work was supported by the Nuclear Safety Research Program through the Korea Foundation Of Nuclear Safety (KOFONS), granted financial resource from the Nuclear Safety and Security Commission(NSSC), Republic of Korea (No. 1305008-0416-SB130).