Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 23-24, 2019

Long-term Effect of Different Temperature and Humidity Conditions on TEDA-Impregnated Activated Carbon

Hyun-Chul Lee[a], Gyu-Tae Kim[a], Doo-Yong Lee [a*], Hak-Soo Kim[b], Cho-Rong Kim[b]
[a] *FNC Technology Co. Ltd, Heungdeok IT Valley, Heungdeok 1-ro, Giheung-gu, Yongin-si, Gyeonggi-do, 446-908, Korea*
[b] *Korea Hydro & Nuclear Power Co., Ltd., Central Research Institute, 70, 1312-gil, Yuseong-daero, Yuseong-gu, Daejeon, 34101, Korea*

1. Introduction

Impregnated activated carbons for air purification of nuclear power reactor have been used for decades. Especially, TEDA (Tri-Ethylene-Di-Amine) of activated carbon has been chosen as an adsorbent to remove the radioiodine under normal and accident condition.

During the past years, there have been considerable efforts to understand the aging mechanism of the activated carbon. Deitz [1] conducted experiments to clarify the aging mechanism of activated carbon, and confirmed that exposure to moisture for more than 50 hours affected the performance degradation of activated carbon. Also, Park et al. [2] has shown that methyl iodide adsorption decreases at 21 ~ 23^{o}C with more than 50% relative humidity. There is no experimental data on the effect of temperature and humidity on long-term operating conditions of more than 1 month until now.

In this study, the lab scale test facility has been developed to investigate the long term effect of temperature and humidity on the TEDA activated carbon.

2. Test Facility and Conditions

2.1 Test facility

Fig. 1 shows the P&ID for the test facility which is composed of vertical bed of 4 inch depth and 6 inch diameter and auxiliary components such as fan, heater, moisture generator as well as instrumentations. 4 test sections having same configuration were installed to simulate different test conditions.

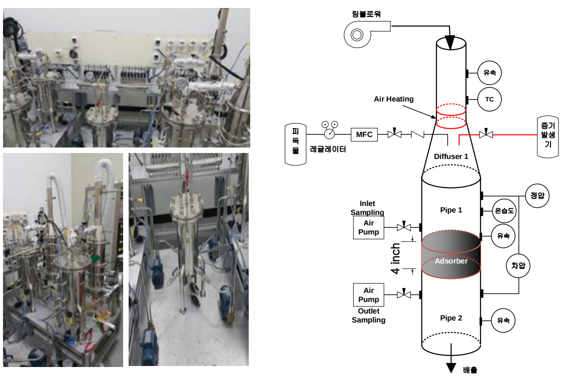


Fig. 1. Installation layout and P&ID of test facility

2.2 Test conditions

The tests were carried out with the downward flow by the fan corresponding to 0.5 second of residence time in 4 inch adsorption bed. The experimental conditions for each test section are as follows.

-Test Section 1 : 25℃, RH 90%, RT 0.5s
-Test Section 2 : 80℃, RH 90%, RT 0.5s
-Test Section 3 : 25℃, RH 50%, RT 0.5s (long-term)
-Test Section 4 : 25℃, RH 50%, RT 0.5s

During the experiment periods, four test sections are operated continuously and samples are collected periodically to analyze the characteristics and performance of TEDA-AC with different test conditions. Table 1 shows the sampling period for each test section.

Table 1. Sampling period of test sections

No.	1st	2nd	3rd	4th	5th	6th
Test section 1	1 month	1.5 month	3 month	4 month	5 month	6 month
Test section 2	1 month	1.5 month	3 month	4 month	5 month	6 month
Test section 3	7 month	13 month				
Test section 4	1 month	1.5 month	3 month	4 month	5 month	6 month

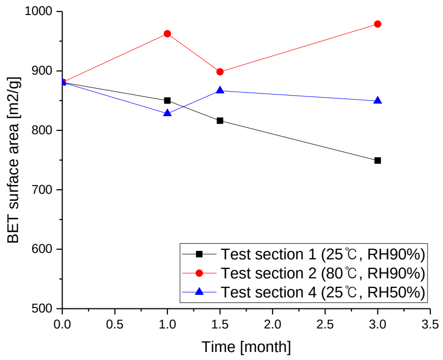
The analysis of the periodic samples of TEDA-AC is based on the BET to observe the change of surface area and TGA to confirm the change of TEDA contents.

The methyl iodide (CH_3I) adsorption performance for the TEDA-AC samples is also analyzed by the CH_3I penetration test according to ASTM D3803.

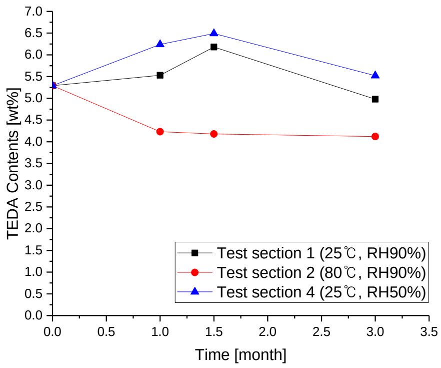
3. Test Results

The analysis data for the TEDA-ACs sampled from each test section 1 to 4 up to 3 months are shown in Fig. 2.

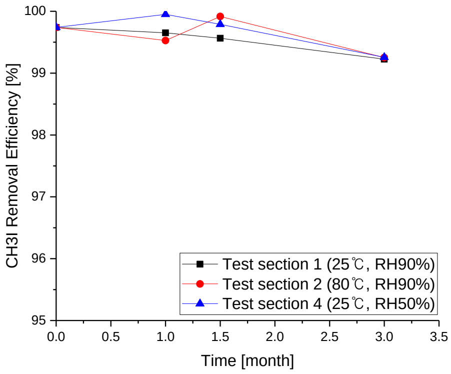
The surface area shown in Fig. 2 (a) indicates that those from test section 2 and 4 are fluctuated over time from the initial surface area. That from test section 1 decreases with time. Compared to data of test section 2 which is higher temperature and humidity, further data of test section 1 needs to be confirmed.



(a) Surface area by BET



(b) TEDA contents by TGA



(c) CH_3I Removal Efficiency

Fig. 2. Analysis data for TEDA-ACs sampled from test section 1 to 4

TEDA contents are important for the iodine adsorption performance. The TEDA contents from test section 1 and 4 shown in Fig.2 (b) are fluctuated from the initial contents. That from test section 2 decreases from 5% to 4% for the sample after 1 month and then does not show significant change. However, these TEDA losses of test section 2 might not affect the CH_3I removal performance based on the CH_3I removal efficiency shown in Fig. 2 (c).

Based on the test section 1 (25℃, RH90%) and the test section 4 (25℃, RH50%) which are different humidity at the same temperature, the relatively lower TEDA contents of test section 1 seems to be affected by higher humidity and this might affect the slight difference of the CH3I removal efficiency.

In the test section 2 (80℃, RH90%) and test section 4 (25℃, RH90%) which are different temperatures at the same humidity, the CH_3I removal efficiency seems not to be affected by the TEDA content, even though the TEDA content of test section 2 is relatively lower than that of test section 4. Thus, further data with time needs to be confirmed.

TEDA is a water-soluble substance. In high humidity conditions, a large amount of water can dissolve TEDA in water to reduce the amount of impregnation. As a result, the decrease of TEDA content in test section 2 was remarkable.

4. Conclusion

The tests to confirm the long term effects of different temperature and humidity conditions(temperature: 25, 80℃, relative humidity: 50, 90%) on the TEDA-AC are being performed. The analysis data up to 3 month does not show any significant changes on the surface area, TEDA contents and CH_3I adsorption performance of TEDA-AC.

The tests will be continued for more than 12 months. Thus, further data will be collected to confirm the long term effects of temperature and humidity on TEDA-AC.

ACKNOWLEGEMENT

This work was supported by Korea Hydro & Nuclear Power Co., Ltd. (No. L16S054000)

REFERENCES

[1] V.R. Deitz, Depth Profile of Methyl Iodide-131 in the Testing of Used and Regenerated Activated Carbons. IN: NUREG/CP-0086, 19th DOE/NRC Nuclear Air Cleaning Conference, Seattle, P.243-264, WA, USA, 18 Aug 1986.

[2] G.I.Park et al., Effect of Temperature on the Adsorption and Desorption Characteristics of Methyl Iodide over TEDA-Impregnated Activated Carbon, Carbon Science, Vol 2, No. 1 pp.9-14, March 2001.