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A study on the adsorption material for methyl iodine using waste generated from nuclear power plants

Sang Wook Lee [a], Seong Joo Kang [a], Ji Hyun Kim [a], Min Ho Kwak [a], Seung Il Kim [a*], Jang yul Kim[b]
[a]*Elim-Global Co. Ltd., 767, Sinsu-ro, Suji-gu, Yongin-si, Gyeonggi.do, Republic of Korea*
[b] *Materials & Processing, Research Division, RIST(Research Institute of Industrial Science & Technology) 65, Jigok-ro 127beon-gil, Nam-gu, Pohang-si, Gyeongsangbuk-do, Republic of Korea*
[*]*Corresponding author: Seungil.kim@elim-global.com*

1. Introduction

Various types of radioactive waste are generated during the operation and decommissioning of nuclear power plants, and since the amount of radioactive waste is directly related to the cost of disposal, various studies for volume reduction are in progress [1]. It has been mainly carried out for the purpose of self-disposal of radioactive waste by extracting, separating, and removing radionuclides from radioactive waste. In previous studies, it is difficult to obtain additional reduction effects due to technical limitations according to the characteristics of radionuclides and wastes. This study is being carried out to present a new paradigm for waste reduction. It was conducted to develop materials capable of treating other radioactive wastes using concrete and soil waste, which generates the largest amount during decommissioning of nuclear power plants.

In previous studies, we have suggested the development of filter materials for gaseous waste treatment and geopolymer materials for liquid waste and solid waste treatment using concrete and soil waste [2].

In this study, among them, the development of materials for gaseous waste treatment was presented. In the development of materials for radioactive gas waste treatment using radioactive waste, waste concrete and waste soil are converted into raw materials through pulverization and classification, and a filter media is manufactured after an appropriate sintering process using the raw materials. It is being carried out as a method of imparting functionality to the media to remove radiocarbon and radioiodine. In this paper, the results of evaluating the radioiodine removal performance of filter media manufactured using waste concrete and soil waste as raw materials are presented.

2. Methods and Results

2.1 Materials

The waste concrete used in the experiment was used by pulverizing simulated concrete cured with concrete of the same composition and strength as the concrete applied during the construction of the nuclear power plant. The composition of the material shown in Table 1 was obtained by grinding and mixing waste concrete, soil, and waste refractory materials. After foam molding, ceramic filters were manufactured as shown in Fig. 1 by sintering at 1,250°C at RIST and TEDA adhesion and adsorption performance tests were performed at Elim Global Radiation Engineering Research Institute.

Table I: Compound composition of ceramic filter.

element	ceramic filter
CaO	34.4
SiO_2	37.0
Al_2O_3	14.2
Fe_2O_3	7.43
Na_2O	1.08
TiO_2	0.69
SO_3	0.04
MgO	2.79
C	-
K_2O	1.67
etc	0.07
Total	100

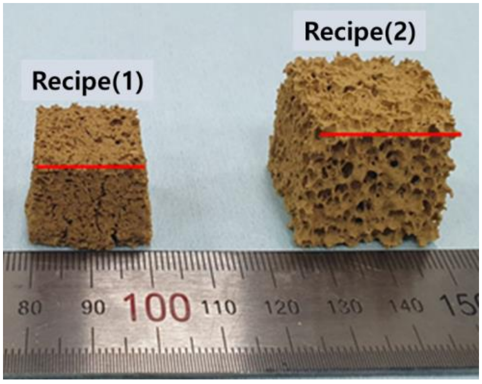

Fig. 1. Pictures of ceramic foam filter.

2.2 Breakthrough test

The methyl iodine adsorption performance test apparatus of the manufactured filter was referred to ASTM-D3808, the basic adsorption performance evaluation apparatus was configured as shown in Fig. 2, and the experimental conditions are shown in Table 2. High purity nitrogen gas and nitrogen gas/methyl iodine mixed gas (Regas Co. Ltd., South Korea) were used, the supply amount of methyl iodine was 1.75 ppm, the gas flow rate was 12 m/min, and the temperature of 30 ℃ to maintain 95% relative humidity was used. The water supply was determined using the vapor pressure value of water and the ideal gas equation [3].

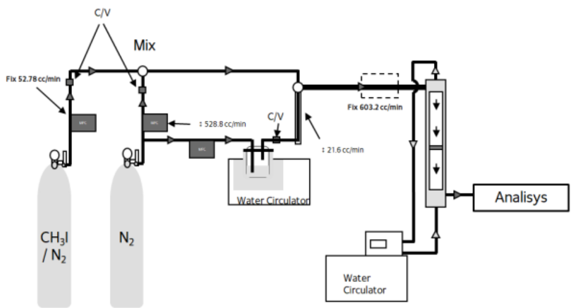

Fig. 2. Schemetic diagram of adsorption experimental equipment.

Table II: Experimental conditions of adsorption facility.

condition	unit	amount
Bed length	m	0.025
Bed diameter	m	0.008
Gas flow rate	m/min	12
Relative humidity	%	95
CH_3I gas concentration	ppm	1.75
STD CH_3I gas flow	cc/min	603.18

A mass flow controller (MFC) was used to accurately control the flow rate of the mixed gas, and the temperature condition of the adsorption reaction was maintained at 30°C using a constant temperature water bath. To analyze the removal efficiency of methyl iodine, the gas from the gas collection device was sampled, and the amount of methyl iodine detected using a methyl iodine detector was measured.

2.3 Result

The removal efficiency increased as the amount of TEDA deposited increased, and the amount of gas removed by reaction with the adsorbent material as time increased. In addition, experiments are in progress on the optimal amount of TEDA, direct comparison experiments with existing TEDA-impregnated activated carbon, and the methyl iodine adsorption capacity (mg/cm^2) of the developed material.

3. Conclusions

The possibility of developing a material that can replace the TEDA-impregnated activated carbon used to remove the existing radioactive iodine using concrete and soil waste generated during nuclear decommissioning was confirmed. If the performance can be improved through additional research on the stability of the foam filter, specific surface area, appearance, and shape of internal micropores, as well as comparative experiments with the adsorption material for removal of radioactive gas applied in existing nuclear power plants, it will be possible to maximize the reduction effect of decommissioning waste through the development of waste treatment materials using waste as a raw material.

Acknowledgements

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REFERENCES

[1] J. S. Song, Y. G. Kim, and S. H. Lee, A Pre-Study on the Estimation of NPP Decommissioning Radioactive Waste and Disposal costs for Applying New Classification Criteria, Journal of nuclear fuel cycle and waste technology, Vol.13, p. 45-53, 2015.

[2] S. J. Kang, M. H. Yoon, J. H Lee, G. B. Park, S. I. Kim, D. W. Kang. Development of decontamination technology for contaminated soil using non-radioactive isotopes, Nuclear Engineering and Technology, 2021

[3] K. Ho. S. h. Moon, H. C. Lee, Y. K. Hwang, C. H. Lee, Adsorptive removal of gaseous methyl iodide by triethylenediamine (TEDA)-metal impregnated activated carbons under humid conditions, Journal of Hazardous Materials, Vol.368, p.550-559, 2019.