Performance Evaluation of Ca-based Adsorbent for C-14 Trapping

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1. Introduction

Generally ion-exchange materials were applied to liquid processes in nuclear reactor. In the case of heavy-water reactor, zeolite, active carbon, anion resin, and cation resin were used to treat liquid processes such as reactor primary coolant cleanup and liquid radioactive waste management system. Then, spent ion exchangers were stored at storage tanks. Spent ion-exchange resins contaminated with the C-14 radioisotope influences the strategy for the disposal of the spent resin. In order to overcome the disposal concentration limit of the spent resin loaded with C-14, it is recommended that the removal of C-14 from spent resin and its concentration to solid adsorbents become a desirable feature which can be disposed of as intermediated level radioactive waste (ILW). Therefore, develop of technology for effective desorption of C-14 from spent ion-exchange resin and its treatment is needed. In this study, evaluates the performance of CO_2 trapping according to the manufacture conditions of adsorbent. The CO_2 trapping performance according to the effect of alcohol added to the adsorbent and the heat treatment temperature of the adsorbent was examined.

2. Experimental

2.1 Materials and methods

The adsorbent was prepared by using calcium acetate monohydrate ($Ca(CH_3COO)_2 \cdot H_2O$, Shinyo 98%), calcium hydroxide ($Ca(OH)_2$, Junsei, 96%), ethylene glycol ($C_2H_6O_2$, Daejung, 99%), isopropyl alcohol (C_3H_8O, Daejung, 99.7%). The calcium acetate monohydrate dissolved in D.I. water and then added ethylene glycol in the solution while stirring. By adding calcium hydroxide powder was produced paste form the solution. After adding isopropyl alchol, it can be extruded a pellet form by aging for a day. Finally, Ca-based adsorbent is prepared through heat treatment from 110 to 900 degrees Celsius. The batch composition of Ca-based adsorbent was indicated in table 1.

Table 1. The batch composition of Ca-based adsorbent

	C-1	C-2	C-3
D.I. Water	45(ml)	45(ml)	45(ml)
Calcium acetate monohydrate	15(g)	15(g)	15(g)
Ethylene glycol	13(g)	13(g)	13(g)
Calcium hydroxide	80(g)	80(g)	80(g)
Isopropyl alcohol	-	10(ml)	200(ml)
Heat treatment	110~900(^{o}C)		

2.2 Performance evaluation

The performance evaluation of the Ca-based adsorbent was determined by the trapping of CO_2 and shown in Fig. 1. In order to remove CO_2 using a Ca-based adsorbent, the moisture in the gas must be 85% or more to enhance the CO_2 removal efficiency. Nitrogen gas is supplied to the humidify generator to control a gas condition of 85% relative humidity, using a 10% CO_2 cylinder supply the desired flow rate and mix the two gases in the mixing tank.

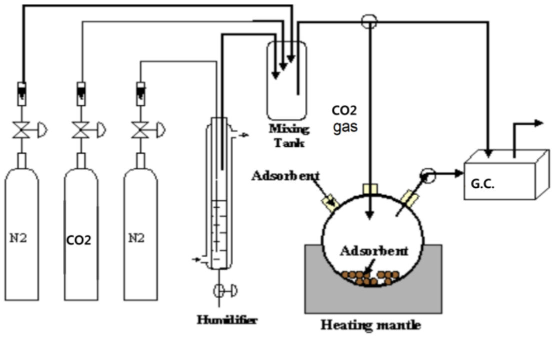

Fig. 1. Batch type test equipment of CO_2 adsorption.

3. Result

The changes in CO_2 concentration according to the conditions of adsorbent manufacturing are shown in Fig. 2, and when isopropyl alcohol was added 200 ml, the rate of removal was the fastest. The alcohol added to the adsorbent increases the porosity in the adsorbent, and is considered to have excellent CO_2 removal efficiency. The concentration variation of CO_2 by adsorption heat treatment temperature of adsorbent is shown in Fig. 3, and the rate of removal of CO_2 was the fastest when the heat treatment temperature was 900°C. As carbon attached to the surface of the adsorbent is removed at a heat temperature of 900°C or higher, the adsorption rate of the adsorbent seems to have increased.

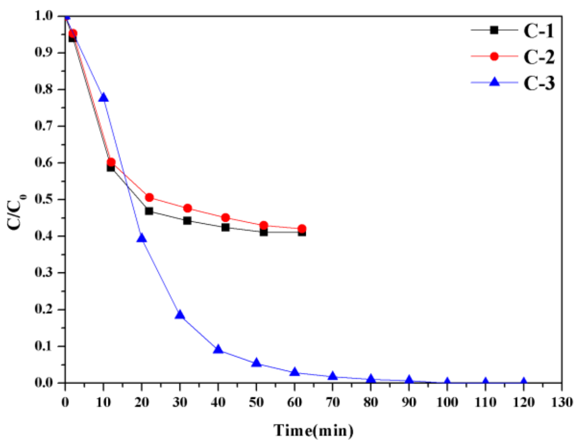

Fig. 2. Variation of CO_2 concentration according to adsorbent manufacturing conditions.

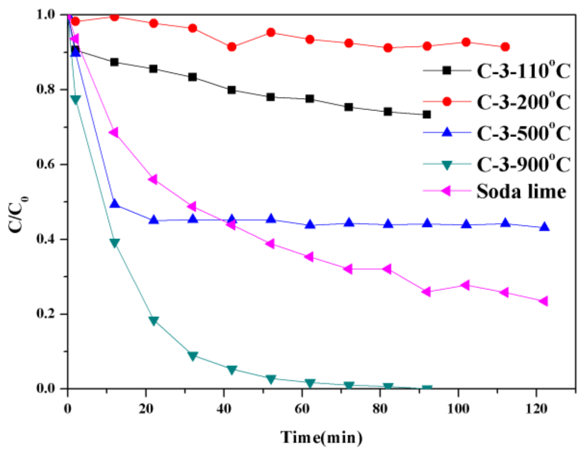

Fig. 3. Variation CO_2 concentration with heat treatment temperature of adsorbent.

4. Conclusion

In high concentration CO_2 conditions, Ca-based adsorbent has been found to have excellent adsorption performance compared to soda lime.

REFERENCES

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