Treatment of Soil Decontamination Solution by the Cs^+ Ion Selective Ion Exchange Resin

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1. Introduction

Occasionally, radioactively contaminated soils have been excavated and stored at the temporary storage facility. Cesium as a radionuclide is one of the most toxic elements and it has a long half decay life. During the operation of nuclear facility, soils near the facility would be contaminated with radioactive cesium and it will cause the deleterious effect to human body and environment[1,2]. In this study, Cs^+ ion selective ion exchange resin was prepared by changing the functional group of commercial anion exchange resin for a ferro-cyanide ion. Ion exchange capability of using the soil decontamination solution was investigated. We also performed the feasibility test of recycling the spent Cs ion selective ion exchange resin.

2. Methods and Results

In this section some of the experimental methods, procedures and results are described.

2.1 Ion Exchange Resin Preparation

The hydroxide form of IRN-78(Supelco Co., nuclear grade macro-rectangular anion exchange resin) was converted to ferrocyanide form in concentrated potassium ferrocyanide solution(0.5 M). The contact time was 24 hours. After 3 times of washing in distilled water, it was contacted with the 1M cupric nitrate solution. Then, it was fully washed by distilled water again. The prepared ion exchange resin was used to investigate the sorption characteristics.

2.2 Preparation of Spent Soil Decontamination Solution

Soils near the Korea Research Reactor site in Seoul were gathered. They were dried in a shadow place. The soils were sieved on a 2 mm screen sieve. To remove the organic materials, soils passed through the sieve were contacted with 1 M sodium acetate and 30 % hydrogen peroxide mixed solution. The diffraction pattern of soil is shown in Figure 1. 50 g of soils (particle size is in the range from 0.063 to 1 mm) were contacted with 500 ml of 0.03 M nitric acid and 0.05 M citric acid mixed solution for 3 hours. After removing soils in a solution by the Whatman filter, the metal ion concentration in a solution was measured by AAS(Perkin Elmer Co. Analyst 300). The result is listed in Table 1. The solution was used as a spent soil decontamination solution.

2.3 Purification of Soil Decontamination Solution

Cs^+ ion selective ion exchange resin was inserted in a batch type reactor containing the soil decontamination solution and purification test was performed. Amount of adsorbed metal ion was investigated by varying the amount of ion exchange resin.

2.4 Recycling of the Spent Ion Exchange Resin

Spent Cs^+ ion selective ion exchange resin was contacted with hydrogen peroxide solution. The variation of metal ion concentration according to the time was investigated. After oxidation test, it was contacted with hydrazine solution. In this step, the variation of metal ion concentration according to the time was also investigated.

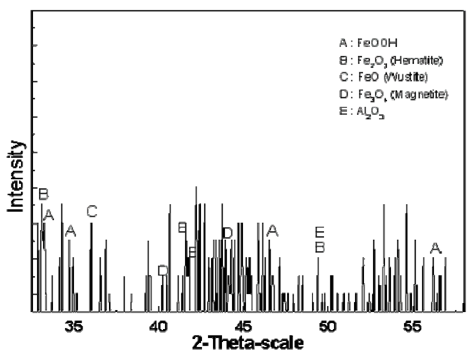

Figure 1. X ray diffraction pattern of soils.

2.5 Test Results

A plot of metal ion concentration in a decontamination solution against the amount of the commercial cation exchange resin is shown in Figure 2. And, a plot of metal ion concentration against the amount of Cs^+ ion selective ion exchange resin is shown in Figure 3. As shown in Figure 2, commercial cation exchange resin adsorbs all kinds of metals. As shown in Figure 3, Cs^+ ion selective ion exchange resin selectively adsorbs cesium ion.

Table 1. Metal ion concentration in a decontamination solution.

Metal ion	Concentration, M
Fe	1.4×10^{-3}
Ca	1.5×10^{-3}
Al	1.8×10^{-3}
Mg	4.5×10^{-4}
Co	8.5×10^{-5}
Cs	2.3×10^{-5}
Si	1.7×10^{-3}

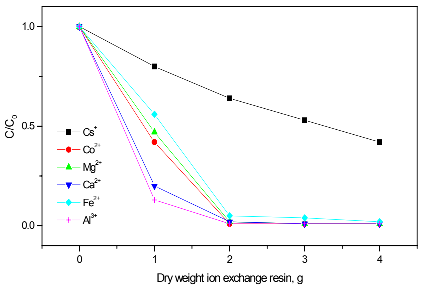

Figure 2. Change of metal ion concentration in the soil decontamination solution(cation exchange resin).

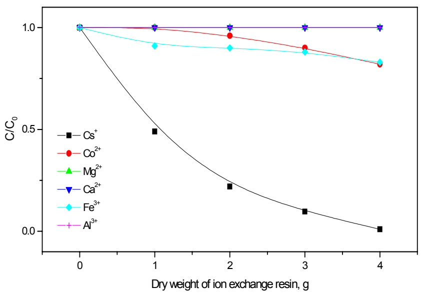

Figure 3. Change of metal ion concentration in the soil decontamination waste solution(Cs^+ ion selective ion exchange resin).

Figure 4 shows release of metal ion from the resin by hydrogen peroxide solution. At this stage, Cs^+ ion on the ion exchange resin is predominantly released. This is explained by the electro-neutrality condition. Ferrocyanide ion on the ion exchange resin is oxidized to ferricyanide ion by the hydrogen peroxide. To compensate the electro-neutrality, Cs^+ ion is released. After reduction of ferricyanide ion to ferrocyanide ion by the hydrazine solution, the surface of Cs^+ ion selective ion exchange resin was investigated by SEM. There was no scratch and degradation after oxidation and reduction treatment.

3. Conclusion

Cs^+ ion selective ion exchange resin used in this study showed good selectivity to Cs^+ ion. The recycling tests by the successive applications of hydrogen peroxide and hydrazine solution showed that the Cs^+ ion selective ion exchange resin can be easily recycled. The most important thing in the nuclear industry is to reduce the generation of the radioactive waste volume. The developed recycling process will be helpful to minimize the radioactive waste generated from the decontamination of soils contaminated with radioactive Cesium.

Acknowledgement

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