Removal of ^{60}Co and ^{152}Eu in Wastewater From Volume Reduction Treatment of Activated Concrete Waste

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1. Introduction

When Co, Eu, etc elements, which are inherently present in the cement phase of concrete, are irradiated by neutron, ^{60}Co and ^{152}Eu are known to be generated, and are major nuclides in the irradiated concrete waste[1]. It is known that the concrete usually consist of aggregate (gravel and sand) and cement and the radioactive nuclides exist in the cement phase. Accordingly, if the aggregate part is completely removed from the concrete, the volume of concrete waste to be disposed can be greatly reduced. The separation of cement and aggregate is known to be carried out by thermally-assisted mechanical way[1,2]. However the method known so far is practically difficult to separate the clean aggregate enough to be released to environment as clearance. Accordingly, the KAERI process considers chemical washing by using acid after the mechanical treatment concrete waste. In that case, all the cement remained on the aggregate surface should be dissolve, which results in the generation of a lot of wastewater. Also KAERI is considering even the separation of the radionuclides of ^{60}Co and ^{152}Eu from the cement phase by chemical way for possibility of further volume reduction yield of the concrete waste, which should generate the same wastewater as the above-mentioned wastewater, as well. The elements to be studied in this work were determined as major elements found in the solution prepared from actual dissolution of ordinary concrete including Co and Eu, as shown in Table 1. The radionuclides existing in the wastewater should be removed from the solution for the separated solution to be released to environment. The nuclides in the solution, of which concentrations are extremely low and lower than their solubilities, are known to be separated by coprecipitation using HFO (Hydrous Ferric Oxide) material and HAlO (Hydrous Aluminum Oxide)[3]. For that, it is necessary to understand exact hydro-chemical behavior of all the elements included in the wastewater. This work studied the thermodynamic behaviors of the major elements in the wastewater generated from the volume reduction process of concrete waste.

Table 1. Concentration of elements from cement paste with Co and Eu

Element	Concentration (mg/L)	Element	Concentration (mg/L)
Al	1200	Ca	20000
Mg	600	Si	3700
Fe	900	K	500
Na	100	Co	10
Eu	1		

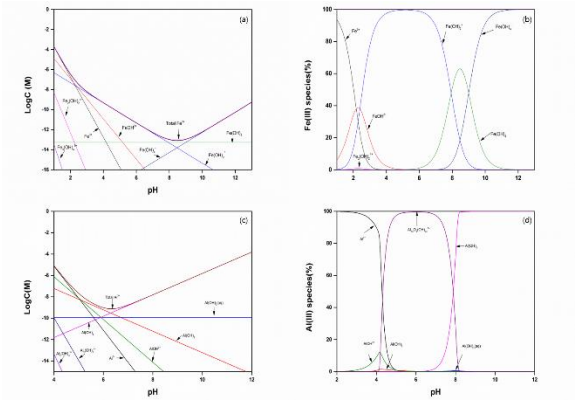

Fig. 1. Equilibrium solubility diagram and distribution of hydrolysis speciation of Fe(III)(a,b) and Al(III)(c,d).

2. Result and discussion

For the removal of elements, which exist in the concentration below their solubilities, by the HFO and HAlO, it is necessary to evaluate exact speciation of major elements as well as Al and Fe in solution. The distribution of Fe^{3+} and Al^{3+} ion species and their total solubilities were evaluated by using a chemical equilibrium modeling code of MINEQL 5.0 with relevant thermodynamic data and their results are shown in Fig. 1 Fe^{3+} and Al^{3+} forms various hydrolysis species with pH. Fe and Al has the lowest solubility around pH 8 and pH 6 with dominant species of $Fe(OH)_3$ and $Al(OH)_3$, respectively. It is necessary to evaluate coprecipitation of target elements by HFO and HAlO. For the experiment, precipitation of the solutions of Table 1 was conducted at pH 6, 7, 8 and 9. Concentration of Ca, Al, Fe, Co and Eu in the solution were analyzed by ICP-OES. Figure 2 shows the removal yield of each element. The Co and Eu could be removed from the solution together by more than 99% at pH 8.

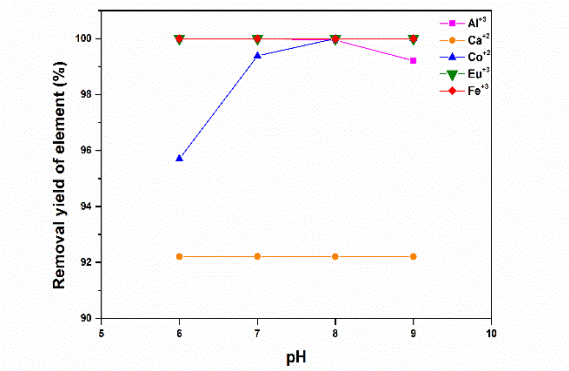

Fig. 2. Removal yields of elements(Al, Ca, Co, Eu and Fe) at pH 6, 7, 8 and 9.

3. Conclusion

The hydro-chemical behavior of all the major elements of wastewater generated from concrete waste treatment were evaluated. The nuclides of Co and Eu in included in the cement phase of concrete waste were confirmed to be removed from the solution by HFO and HAlO with DF $2x10^4$.

ACKNOWLEDGEMENT

This work was supported by the National Research Foundation of Korea grant (No. NRF-2017M2A8A5015147) funded by Ministry of Science and ICT.

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