

## Selective Removal of Uranium from the Washing Solution of Uranium-Contaminated Soil

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### 1. Introduction

A great amount of uranium-contaminated (U-contaminated) soil had been generated from the decommissioning of a uranium conversion plant. Our group has developed a decontamination process with washing and electrokinetic methods [1] to decrease the amount of waste to be disposed of. However, this process generates a large amount of waste solution containing various metal ions. This study examined selective removal methods of uranium from the waste solution by ion exchange resins or solvent extraction methods to reduce amount of the 2<sup>nd</sup> waste.

### 2. Experiment and Results

#### 2.1 Solvent extraction [2]

Alamine-336 (tricaprylyl amine) has known the one of the useful reagents to extract uranium from acidic sulfate media in the uranium ore processing [3]. Thus Alamine-336 was examined to collect uranium from the soil washing solution in sulfuric acid medium. The detailed procedure for the extraction of uranium by Alamine-336 is as follows.

- ① The washing solution of U-contaminated soil was filtered with a Whatman 4 filter paper.
- ② Alamine-336 and 1-dodecanol were dissolved in Exxsol™ D40.
- ③ The soil washing solution was added into ② solution, and the mixed solution was shaken for more than 1 hour.

- ④ The mixed solution was transferred to a separation funnel.
- ⑤ The aqueous layer was separated from an organic layer, and small amount of aqueous solution was sampled to analyze the concentration of uranium.
- ⑥ The aqueous solution was again added a new ② solution, and shaken for more than 1 hour.
- ⑦ ④-⑤ processes were performed.
- ⑧ ⑥-⑦ processes were repeated two more times.

From the Alamine-336 extraction experiment, Table I was obtained. In this table, the uranium concentration in both washing solutions with pH 0.4 and 0.9 was not greatly changed after extraction with Alamine-336 while it decreased at pH 0.9 greater than at pH 0.4. Even four times of extraction did not significantly change the uranium concentration in the washing solution, which means that uranium in the soil washing solution was not removed by the Alamine-336 extraction.

#### 2.2 Ion exchange resins

Rahmati et al. [4] reported that uranyl sulfate anion complexes are formed in 0.02–9.0 M of the sulfuric acid solution, and 70–80 % of these complexes were adsorbed by IRA 910, a strong anion exchanger. Thus, soil was washed with 1.0 M sulfuric acid solution, and the solution was filtered. 5 g of IRA 910 resin was put into 50 mL of soil washing sulfuric acid solution. After 2 hours of shaking, the supernatant was collected and its uranium concentration was measured.

Table I: Experimental conditions for the solvent extraction by Alamine-336, and their results

Concentration of Alamine-336 (mole/L)	1-Dodecanol (%)	Exxsol™ D40 (mL)	Washing solution		Uranium concentration in aqueous solution (mg/L)		
			pH	Volume (mL)	Before extraction	After 1 <sup>st</sup> extraction	After 4th extraction
0.05	3	5	0.4	50	721	724	722
0.05	5	5	0.4	50	721	720	690
0.15	5	5	0.9	50	721	671	-
0.15	5	15	0.9	50	721	687	-

Unlike in the literature, the concentration of uranium in a soil washing solution was not significantly changed by IRA 910. Even when a pure uranyl solution dissolved in 1.0 M sulfuric acid instead of soil washing solution was used, the uranium concentration was not remarkably reduced by the IRA 910. Ag198 (100–200 mesh) manufactured BioRad Co., as another strong anion exchanger, also did not decrease the uranium concentration in the washing solution.

An ampholyte resin was examined for the sorption of uranium from the washing solutions. When 10 g of ampholyte resin was added into 100 mL of the washing solution (pH 1.50), the relative sorption efficiency for uranium is greater than those of other dominant ions. 97% of uranium was sorbed on the ampholyte resin, and 94% of uranium was desorbed from the resin by a washing with 0.5 M Na<sub>2</sub>CO<sub>3</sub> solution at 60°C.

### **3. Conclusions**

Alamine-336, known as an excellent extraction reagent of uranium from the leaching solution of uranium ore, did not remove uranium from the acidic washing solution of soil. Uranyl ions in the acidic waste solution were sorbed on ampholyte resin with a high sorption efficiency, and desorbed from the resin by a washing with 0.5 M Na<sub>2</sub>CO<sub>3</sub> solution at 60°C. However, the uranium dissolved in the sulfuric acid solution was not sorbed onto the strong anion exchanger resins.

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