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A Device for reduction of metal oxides generated in electrokinetic separation equipment

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1. Introduction

A large number of nuclear facility sites have been contaminated by a leakage of radioactive waste-solution during a long-term operation of nuclear facilities. Indoor electrokinetic decontamination equipment for treatment of 1.2 tons of the contaminated soil per batch was manufactured to remove uranium from soil with high removal efficiency during a short time. For a reduction of waste electrolyte volume and metal oxide volume, the reuse period of waste electrolyte in the electrokinetic decontamination experiment and the method of a reduction of metal oxide volume in the cathode chamber were drawn out through several experiments with the manufactured electrokinetic equipment.

2. Methods and Results

2.1 The generation of metal oxides

During operation of electrokinetic decontamination equipment, a lot of waste electrolyte in the cathode chamber was generated. Waste electrolyte contains a lot of metal ions released from the contaminated soil. The metal ions in the cathode chamber changes to metal oxides as the following equations. Namely, Al^{3+} in the cathode chamber became metal oxide. A lot of metals oxides generated in cathode chamber on operating practical-scale electrokinetic separation equipment as shown in Fig. 1, because the pH of electrolyte in the cathode chamber had risen due to generation of OH- in the cathode chamber.

$$2H_2O + 2ⓔ \rightarrow 2OH^- + H_2$$
$$2Al_3+ + 6OH- \rightarrow 2Al(OH)_3$$
$$2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$$

Because Al, Fe, Ca, U, Mg, and Si ions were released from the soil in high pH, Al2O3, Fe2O3 CaO, UO2, MgO, SiO2 were existed at high pH in the cathode chamber. Therefore, it is impossible for the soil electrokinetic decontamination equipment to be operated due to the severance of the electric current flow by a lot of metal oxides in the cathode chamber. So, it is needed to draw out a method for a reduction of generation of metal oxides in the cathode chamber. Meanwhile the electrolyte in the cathode chamber maintains the temperature of 70 ℃ by cathode electrode heating. The pH of electrolyte decreases as the temperature of electrolyte increases as shown.

Fig. 1. Metal oxides generated in the cathode chamber

However the volume of metal oxides can be reduced by controlling the pH of the electrolyte in the cathode chamber. So, the percentage of metal oxide volume generated in cathode chamber according to the pH of the electrolyte at 25 ℃ was investigated through several experiments. And the method of a reduction of metal oxide volume in the cathode chamber was finally drawn out.

2.2 The method for a reduction of metal oxide volume in the cathode chamber

Photographs of metal oxides generated in cathode chamber according to the pH of electrolyte were shown in Fig. 2. When the pH of waste electrolyte in cathode chamber increased, the percentage of metal oxide volume generated in cathode chamber increased. The percentage of metal oxide volume generated in cathode chamber according to the pH of electrolyte at 25 ℃ was shown in Table 1. Namely, when the pH of waste electrolyte was more than 5.49, the percentage of metal oxide volume generated in cathode chamber was more than 90%. Conclusively, it was found that the optimum pH of waste electrolyte in cathode chamber for a reduction of volume of metal oxides was below 2.35 (1.12 at 70 ℃).

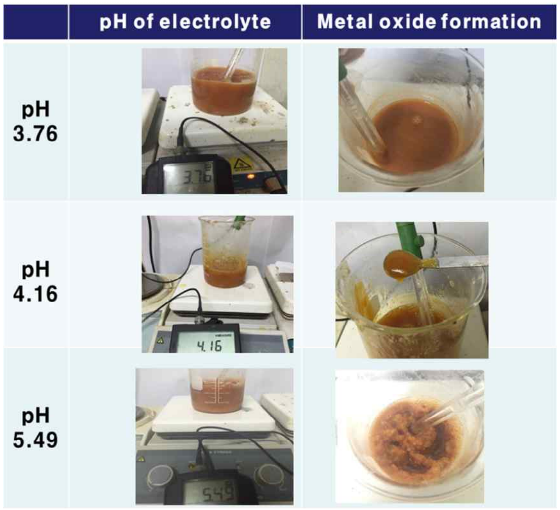

Fig. 2. Metal oxides generated in cathode chamber according to the pH of electrolyte

Table 1. Percentage of metal oxide volume generated in cathode chamber according to the pH of electrolyte at 25 ℃

pH (25℃)	pH 2.35	pH 3.76	pH 4.16	pH 5.49
Percentage of metal oxide volume in cathode chamber	2%	3.5%	70%	90%

3. Conclusions

Indoor electrokinetic decontamination equipment for treatment of 1.2 tons of the contaminated soil was manufactured to remove uranium from soil during a short time. For a reduction of waste electrolyte volume and metal oxide volume, the reuse period of the waste electrolyte in the electrokinetic decontamination experiment and the method of a reduction of metal oxide volume in the cathode chamber were drawn out through several experiments with the manufactured 1.2 ton electrokinetic decontamination equipment. The optimum pH of electrolyte in cathode chamber for a reduction of volume of metal oxides was below 2.35.

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