Removal of Uranium in Soil Using Large-scale Electrokinetic Decontamination Equipment

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1. Introduction

Most nuclear facility sites have been contaminated by a leakage of radioactive waste-solution due to corrosion of the waste-solution tanks and connection pipes by their long-term operation set up around underground nuclear facilities. Therefore, a method to remediate a large volume of radioactive soil should be developed. Until now the soil washing method has been studied to remediate soil contaminated with uranium, cobalt, cesium, and so on. However, it has a lower removal efficiency of nuclide from soils and generated a large volume of waste-solution. In addition, its application to the soil composed of fine particle is impossible. Thus, the electrokinetic method has been studied as a new technology for soil remediation recently. In this study, for a reduction of the waste electrolyte volume, the reuse period of waste electrolyte in the electrokinetic decontamination experiment through several experiments with the manufactured 1.2 ton electrokinetic decontamination equipment. In addition, the time required to reach below the clearance concentration level for self- disposal was estimated through several experiments using the manufactured electrokinetic decontamination equipment.

2. Electrokinetic Decontamination

The large-scale electrokinetic decontamination equipment for the treatment of 1.2 tons of contaminated soil per batch was manufactured to remove uranium from soil with a high removal efficiency during a short time. Large-scale electrokinetc decontamination equipment consists of soil electrokinetic decontamination equipment and the waste solution treatment equipment for the removal of uranium. The soil electrokinetic decontamination equipment consists of an anode chamber, soil cell, cathode chamber, soil cloth sack, pH and pump controllers, an equipment support system, a power supply, gas release cover, and a nitric acid box. The waste solution treatment equipment consists of precipitation equipment, concentration equipment, and a filter press. A photograph of the soil electrokinetic decontamination equipment is shown in Fig. 1.

A diagram of the soil decontamination process for the removal of uranium from the contaminated soil is shown in Fig. 2. The 50-60% of the uranium was removed from the soil through the soil washing equipment, and the washed soil was then put in a soil cell in the electrokinetic decontamination equipment to remove uranium from the soil. Meanwhile, the waste electrolytes discharged from the electrokinetic decontamination equipment, which contains a low concentration of metal ions, are reused for soil washing with the addition of nitric acid. The waste solution discharged from the first soil washing equipment flows into a precipitation tank for precipitation, then flows into a filter press for filtration through a concentration tank, and the treated solution filtered by the filter press flows into a reclaimed electrolyte tank for reuse in the soil electrokinetic decontamination equipment

In this study, for a reduction of waste electrolyte volume and metal oxide volume, the reuse period of waste electrolyte in the electrokinetic decontamination experiment was drawn out through several experiments using the electrokinetic equipment. Reclaimed electrolyte was used as the electrolyte of the electrokinetic decontamination equipment to remove uranium from the washed soil below 1.0 Bq/g for the last 20 days. The electrokinetic decontamination conditions with reclaimed electrolyte were similar to those with waste electrolyte except the electrolyte inflow rate. Namely, the inflow rate of reclaimed electrolyte was reduced from 800 ml/min to 120 ml/min for a reduction of waste electrolyte.

Fig. 1 Manufactured large-scale electrokinetic decontamination equipment

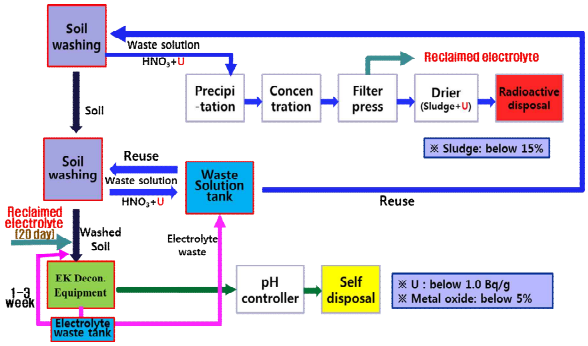

Fig. 2 A diagram of the soil decontamination process for the removal of uranium from the contaminated soil

3. Results and Discussions

Until the uranium concentrations in soils reached below 1.0 Bq/g, electrokinetic decontamination experiments with the manufactured equipment were continuously carried out. The uranium concentrations in soils were measured using an MCA with an interval of 5 days. As a result of the experiments, as shown in Fig. 3, it was found that when the initial uranium concentrations in the washed soils were 20.0 Bq/g, 14.0 Bq/g, and 7.0 Bq/g, the times required for uranium concentrations in the washed soils to reach below the clearance concentration level (1.0 Bq/g) for self-disposal of soils were 40 days, 35 days, and 25 days. Meanwhile, for reduction of waste electrolyte, the waste electrolyte was reused during 1-3 weeks for operation of electrokinetic equipment, and then the reclaimed electrolyte was used for 20 days as shown in Fig.3.

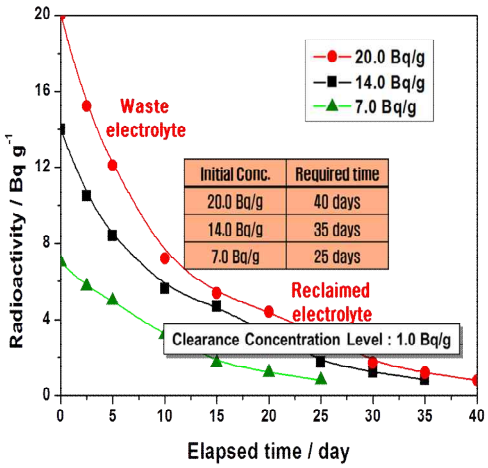

Fig. 3 Uranium radioactivity concentration versus elapsed decontamination time per different initial concentration of soil when using waste electrolyte and reclaimed electrolyte

3. Conclusions

Large-scale electrokinetic decontamination equipment for treatment of 1.2 tons of contaminated soil was manufactured to remove uranium from soil during a short time period. When the initial uranium concentrations in the soils were 7.0–20.0 Bq/g, the times required to reach below the clearance concentration level for self-disposal were 25-40 days with the waste and reclaimed electrolytes.

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