

1 An analysis on the effect of the electrokinetic remediation of a soil around decommissioning site by reagent

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1. Introduction

Most nuclear facility sites have been contaminated by the leakage of a radioactive waste-solution due to the corrosion of concrete and pipes by a long-term operation of waste-solution tanks and connection pipes set up in an underground around nuclear power plant. Also, a great volume of radioactive soil has been generated due to the loss of radioactive contaminants during a long-term operation of nuclear facilities and nuclear operational accidents. Even if people's health has been threatened by a dissolution of radionuclide from such a contaminated soil, the existing soil remediation technologies have a lower removal efficiency for radionuclide. Therefore, it is necessary to develop a soil remediation technology suitable for the contamination characteristics of national nuclear facility sites.

2. Results and Discussion

The pHs in the initial electrode compartments were near 3, because the concentration of the washing solution was 0.01 M. Because H^+ was produced at the anode due to the electrolysis reactions, the pH in the anode compartment decreased to about 2.3. While the OH^- produced in the cathode compartment resulted in a pH-increase after about 1 day. If the pH in the cathode compartment increases to more than 10, hydroxides are formed in the soil and the pore solution flow rate slows down. Generally, under low pH values, Co^{2+} and Cs^+ exist in an ionic form in a solution and migrate towards the cathode due to a positive charge. Accordingly, in order to keep the pH of the soil lower than 6, HCl was periodically put into the cathode compartment. After the experiment of 15 days, the pH distribution values in a soil cell were between 2.5 and 3.5 and the pHs at a 0.15 normalized distance showed slightly high values. When acetic acid was used as a washing reagent, the pH in the anode compartment appeared to be the lowest value.

Fig. 1 shows the solution flow rate variation versus time at the cathode compartment during test. Movement

of the pore solution was mainly due to an electro-osmosis. When EDTA was used as a washing reagent, the average solution flow rate was 58.1 ml/day. When oxalic acid was used as a washing reagent, the average solution flow rate was 64.4 ml/day. When citric acid was used as a washing reagent, the average solution flow rate was 78.7 ml/day. And when Acetic acid was used as a washing reagent, the average solution flow rate was 65.6 ml/day. When citric acid was used as a washing reagent, the average solution flow rate was the fastest. Also, it was found that the effluent volume generated from the electrokinetic remediation was smaller and below 10% of that from the soil washing.

Fig. 2 shows the Co^{2+} distribution versus the normalized distance in a soil cell after test I experiment of 15 days. The removal efficiency of cobalt in a soil cell with EDTA was 83.5 %, that of cobalt with oxalic acid was 90.5 %, that of cobalt with citric acid was 86.9 %, and that of cobalt with acetic acid was 95.2 %. Therefore, it was found that the removal efficiency of cobalt in a soil cell with the acetic acid was the highest. Fig. 3 shows the Cs^+ distribution versus the normalized distance in a soil cell after 15 days of test I experiment. The removal efficiency of cesium in a soil cell with EDTA was 57.9 %, that of cesium with oxalic acid was 81.9 %, that of cesium with citric acid was 67.1 %, and that of cesium with acetic acid was 84.2 %. Therefore, it was found that the removal efficiency of cesium in a soil cell with acetic acid was the highest than those of EDTA, citric acid and oxalic acid. Meanwhile, the removal efficiency of cobalt and cesium near the anode was reduced by about 10% because the negative complex ions formed by a combination of a washing reagent and cobalt or cesium had transported to the anode.

Results of the above experiments show that the removal efficiency of cobalt and cesium with acetic acid was the highest than those of EDTA, citric acid and oxalic acid. So, acetic acid was selected as an optimum reagent and continuously used for test II and test III.

The removal efficiencies of cobalt and cesium in a soil cell with the acetic acid were the highest values of 95.2 % and 84.2 %, respectively. Meanwhile, the removal efficiencies of cobalt and cesium near the anode were reduced by about 10% because the negative complex ions formed by a combination of a washing reagent and cobalt or cesium had transported to the anode.

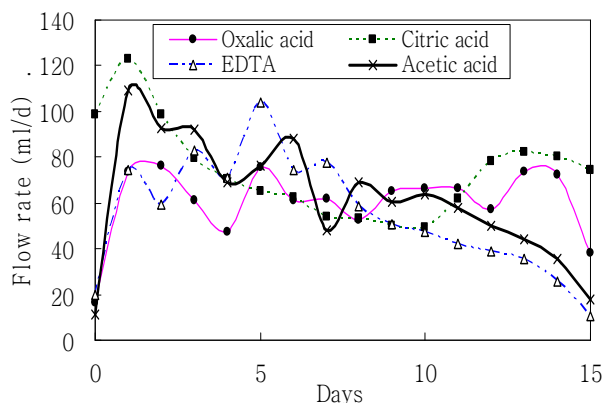


Fig. 1. The solution flow rate variation with time at the cathode compartment during test I.

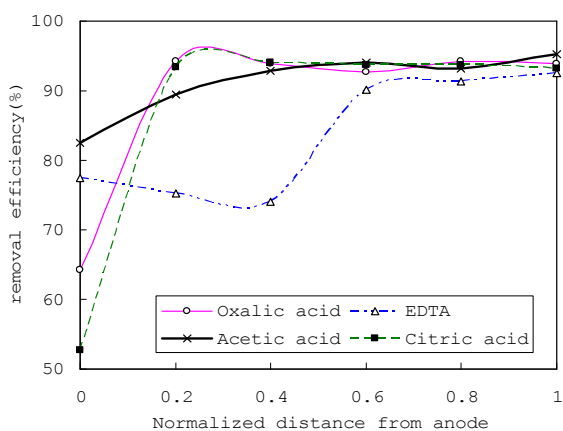


Fig. 2. Co²⁺ removal efficiency versus the normalized distance in a soil cell after a completion of test I.

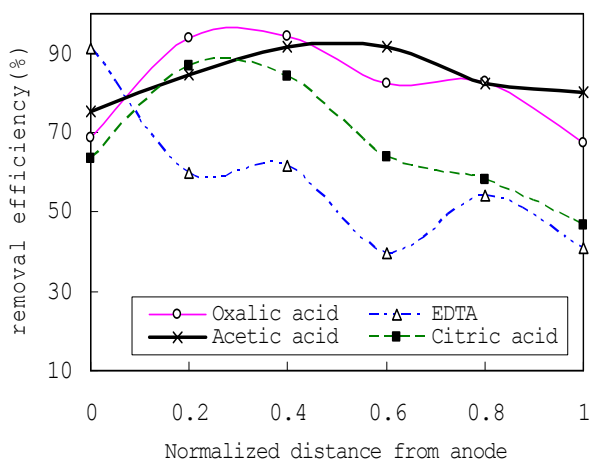


Fig. 3. Cs⁺ removal efficiency versus the normalized distance in a soil cell after a completion of test I.

3. Conclusion