Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 29-30, 2014

A Comparison of Electrokinetic Method and Electrokinetic-electrodialytic Method for Soil Decontamination

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1. Introduction

The soil contaminated with cesium was sampled at an area near a nuclear facility in Korea. The electrokinetic decontamination equipment and electrokinetic-elctrodialytic decontamination equipment were manufactured to decontaminate the contaminated soil. The removal efficiency according to the lapsed time by the electrokinetic decontamination equipment and the electrokinetic-elctrodialytic decontamination equipment was investigated through several experiments. The difference between the removal efficiency of the electrokinetic-elctrodialytic decontamination without anion exchange membrane and that of with anion exchange membrane was investigated through several experiments. In addition, the removal efficiency trend according to different cesium radioactivity of soil was drawn out through several experiments.

2. Manufacturing of electrokinetic decontamination equipment

Electokinetic equipment decontamination was manufactured for the experiments. The electrokinetic decontamination equipment consists of n horizontal soil cells, two electrode compartments (anode/cathode rooms), a reagent reservoir, an effluent reservoir, and a power supply, and 480 g of contaminated soil was placed into a horizontal soil cell of 4.5x5.9x14.5 cm for Experiment 1. In Experiment 1, a paper filter was inserted between the electrode compartment and the contaminated soil to protect against an influx of soil. A pump supplies a reagent to the reagent reservoir at 0.5-1 ml/min, and the reagent reservoir supplies a chemical solution to the anode room. The electric current between electrodes is 0.6A, and the electric voltage between electrodes is 4.5-5.2 V. The temperature in the cathode room was below 65 °C. Experiments 1and 2 used a different soil sample radioactivity, and the electrokintic decontamination period was 21 days without exception.

In experiment 2, an anion exchange membrane was inserted between the anode room and the contaminated soil to protect against an influx of cesium ions, and a paper filter was inserted between the cathode room and the contaminated soil. 200g of contaminated soil was placed into a horizontal soil cell, namely, the ratio of liquid (mg)/ soil (g) is 0.5. Experiments 3 and 4 used soil samples with a different radioactivity, and the electrokintic decontamination period was 21 days without exception. Also, 200g of contaminated soil was placed into a horizontal soil cell, namely, at a ratio of liquid (mg)/soil (g) of 0.5. Fig. 1 shows schematic diagram of the electrokinetic-electrodialytic decontamination equipment.

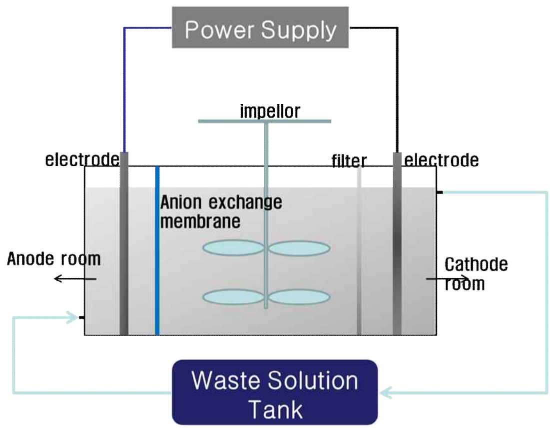

Fig. 1. A schematic diagram of the electrokinetic-electrodialytic decontamination equipment

3. Electrokinetic-electrodialytic decontamination results

Cesium (137Cs+) in the contaminated soil in the electrokinetic-electrodialytic decontamination equipment was removed by electro-osmosis, electro-migration, and a hydraulic pressure flow. The experimental electrokinetic-electrodialytic conditions were as follows. When the decontamination period of 0.3 days, 2 days, and 7 days elapsed, 137Cs+ in the soil was removed by about 10%, 37%, and 68%. However, the removal efficiency of 137Cs+ was reduced after 7 days, because the 137Cs+ on the surface of the soil particle had almost been removed for 7 days. However, the removal efficiency of Experiment 3 was increased more than Experiments 1 and 2, because Experiment 3 used an impellor to increase the surface area of soil particles making contact with electrolyte in the horizontal soil cell. In addition, when the decontamination period of 10 days, 14 days, and 21 days elapsed, the 137Cs+ in soil was removed by about 75%, 78%, and 81%. The removal efficiency of Experiment 3 was increased more than Experiment 1 and 2 owing to the impellor.

An anion exchange membrane was inserted between the anode room and the contaminated soil to protect against an influx of cesium ions in the electrolyte occupying an upper part of a horizontal soil cell. When the decontamination period of 0.3 days, 2 days, and 7 days elapsed, 137Cs+ in the soil was removed by about 12%, 38%, and 83%. However, the removal efficiency of 137Cs+ was reduced after 7 days, because the 137Cs+ on the surface of the soil particles had almost been removed for 7 days. The removal efficiency of Experiment 4 was increased more than that of Experiment 3 because Experiment 3 used the anion exchange membrane to prevent the contamination of 137Cs+ in the anode room.

When the decontamination period of 10 days, 14 days, and 21 days elapsed, the 137Cs+ in soil was removed by about 91%, 93%, and 97%. Meanwhile, the more the origin radioactivity of soil decreased, the more the removal efficiency of 137Cs+ was reduced. Table 2 shows removal efficiency according to the lapsed time by electrokinetic-electrodailtic decontamination with an anion exchange membrane (Expariment 4).

Conclusively, the removal efficiency of 137Cs+ from soil by electrokinetic-electrodialytic decontamination technology was higher than that of 137Cs+ from soil by electrokinetic decontamination technology. In addition, the anion exchange membrane in electrokinetic-electrodialytic decontamination increased the removal efficiency of 137Cs+ from soil owing to the interception of an infiltration of 137Cs+ in the anode room.

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Table 1. Removal efficiency according to the lapsed time by electrokinetic-electrodailtic decontamination with an anion exchange membrane(Expariment 4)

	OriginRed.	0.3 (days)	2 (days)	7 (days)	10 (days)	14 (days)	21 (days)
Removal Eff. 1	20.5 (Bq/g)	14.0%	40.7%	86.5%	92.3%	95.1%	98.2%0.37
Removal Eff. 2	12.4 (Bq/g)	12.7%	38.1%	83.9%	91.1%	93.5%	97.2% 0.35
Removal Eff. 3	5.8 (Bq/g)	11.9%	36.7%	81.4%	87.5%	91.3%	95.4% 0.27
Removal Eff. 4	1.7 (Bq/g)	11.1%	35.3%	79.5%	85.3 %	89.2%	94.1% 0.1