Development of Decontamination Process for Soil Contaminated Uranium

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1. Introduction

Full-scaled electrokinetic equipment, soil washing equipment, and gravel washing equipment were manufactured to decontaminate soils contaminated with uranium within Korean nuclear facilities. Various experiments with full-scaled electrokinetic equipment, soil washing equipment, and gravel washing equipment were performed to remove ^{238}U from contaminated soils of below 0.4 Bq/g. The repetition number and the removal efficiencies of the soil and gravel washing equipments were evaluated. The decontamination periods by the soil and gravel electrokinetic equipments were evaluated. Finally, a work process of full-scaled decontamination equipment was developed.

2. Decontamination Experiments

The full-scaled soil decontamination equipment was manufactured to remove uranium from the contaminated soils with high removal efficiency during a short time, and consists of $3M^3$ of soil washing equipment, 0.2 M^3 of gravel washing equipment, and 800L of electrokinetic equipment. The manufactured $3M^3$ of washing decontamination equipment consists of a washing tank, an impellor, and a sieve. A photograph putting the washed soils into the electrokinetic decontamination equipment is shown in Fig. 1. The manufactured 800 L of electrokinetic decontamination equipment consists of a soil cell, a cathode room, an anode room, power supply, electrolyte supply box, filter box, and pH control plate. The manufactured 0.2 M^3 of gravel washing equipment consists of a trammel, nozzles, a waste solution collect box, and nitric acid

Fig. 1. A photograph of putting the washed soils into the electrokinetic decontamination equipment

2.1 Soil hydraulic properties

Contaminated soils were classified into soils and gravels using a 8.0 cm sieve. Soils were sent to the soil washing equipment, while gravels were sent to the gravel washing equipment. Soil pH was measured by pH meter (JENCO 6010) with a soil/water ratio of 1:2.5. The saturation degree of the surface at a nuclear facility site is about 25-30 %, and the hydraulic conductivity of the soil is a little lower. The larger the particle size of the soil, the higher its radioactivity concentration.

2.2 Electrokinetic decontamination

To verify the decontamination performance by the electrokinetic decontamination equipment for soil contaminated with uranium, the washed soil that had been scrubbed with the washing equipment was used for the electrokinetic decontamination experiment. In this study, several experiments were performed to select an optimum electrolyte concentration for electrokinetic decontamination, and the removal efficiency versus decontamination time was analyzed. Nitric acid was used as an electrolyte for electrokinetic decontamination in consideration of previous experimental results and was supplied from a nitric acid box to a cathode room. Also, the electrical voltage used 20V with a power supply in consideration of the previous experimental results. In the initial equipment operation, the electrical current in the soil cell appeared to be below $10mA/cm^2$ under 20V due to an unsaturated state of soil in the soil cell, but the electrical current in the soil cell increased with the elapsed time at the same voltage.

2.3 Gravel washing

After contaminated soils were classified into soils and gravels using a 8.0 cm sieve, gravels were sent to the gravel washing equipment. The manufactured 0.2 M^3 of gravel washing equipment is shown and gravels of a radioactivity concentration of more than 0.4 Bq/g are shown in Fig. 2. The results of the removal efficiency according to the gravel size by washing using the manufactured gravel washing equipment. Meanwhile, Gravel contaminated with a high concentration needs crushing after gravel washing. The crushed gravels were sent to the soil washing equipment. Crushing of high concentration of gravel is shown in Fig 3.

	Concentration (Bq/g)
1	1.2
2	1.4
3	2.5
4	2.6
5	3.9
6	5.3
7	6.5
8	7.4
9	13
10	16.1

Fig. 2. Gravels of a radioactivity concentration of more than 0.4 Bq/g

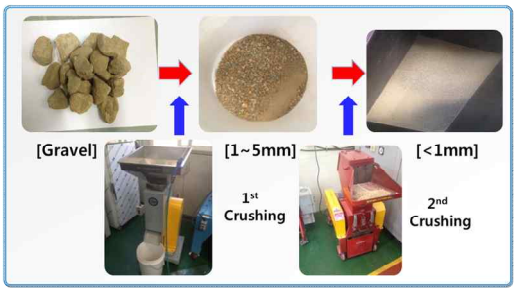

Fig. 3. Crushing of high concentration of gravel

3. Conclusions

Contaminated soils were classified into soils and gravels using a 8.0 cm sieve. Soils were sent to the soil washing equipment, while gravels were sent to the gravel washing equipment. Soils sent to the soil washing equipment were sent to the soil electrokinetic equipment after soil washing. A repetition number of soil washing was two times. The washed gravels were sent to the gravel electrokinetic equipment. Gravel contaminated with a high concentration requires crushing after gravel washing. The crushed gravels were sent to the soil washing equipment. Finally, the work process of full-scaled decontamination equipments was drawn out to remove uranium from contaminated soils as shown in Fig. 4.

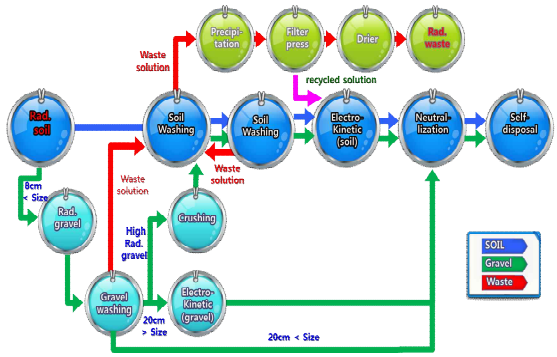

Fig. 4. Work process of full-scaled decontamination equipments to remove uranium from contaminated soils

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