A Study on the Removal of Cesium in Soil Contaminated with Radiation Using a Soil Washing Process

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1. Introduction

A number of methods have been developed for the decontamination of soil contaminated with radiation from a nuclear facility. Among such methods, the one of which is commonly used to decontamination from the contaminated soil is the soil washing process. There are mainly two principles which are applied to the purification of contaminated soil based on the soil washing process. The first principle is related with the washing process which is carried out to transfer the contaminated mass from the soil to water by dissolving it with a cleansing solution. The second is concerned with the size of the separation process which focuses on the reduction of the volume by separating the subject matters based on the different sizes of the soil. The complex agents used in the soil washing process include HCl, Oxalic acid, Citric acid, $CaCl_2$, $BaCl_2$, NH_4NO_3, and NaOH. It is known that the complex-forming capacity of such complex agents and radionuclides influences the decontamination from the soil. Also, since the forms of the chemical species related with the complex agents and the surface potential of the soil vary based on the changes of acidity observed in the cleansing solution, the level of acidity in the cleansing solution can be regarded as a factor that influences the decontamination.

Therefore, in this study, H_2SO_4 was selected as the complex agent and used to check the influence of the temperature when the subject contaminated soil was washed. Then, by applying the sieve grading process with a sieve-shaker, the size separation process was carried out to measure the level of radiation for each size. By washing the contaminated soil separated into different sizes with the complex agent H_2SO_4, the different removal tendencies for each size were considered.

2. Experimental and Results

By drying 50g of soil, which was stored in a laboratory, in a dryer at a temperature of 105℃, the level of radioactivity was measured using a Multi-Channel Analyzer (MCA). Based on the solid-liquid ratio of 1g:2ml, H_2SO_4 was injected into the soil until the pH became 0. Without applying heat, it was stirred for two hours. The supernatant was then separated and dried before the level of radioaction was measured using the MCA. After carrying out the washing process several times repeatedly to increase the washing efficiency of the contaminated soil, a removal efficiency of 56% was shown when the washing process was carried out four times. By following the above process by washing and stirring the soil, the temperature was increased up to 95℃ to apply heat during the washing process. It was found that the removal efficiency of 92% was shown when the washing process was carried out four times. Therefore, by checking the influence of the temperature when washing the contaminated soil using H_2SO_4, the heat washing process showed a higher level of removal efficiency compared to the case of the non-heat washing process.

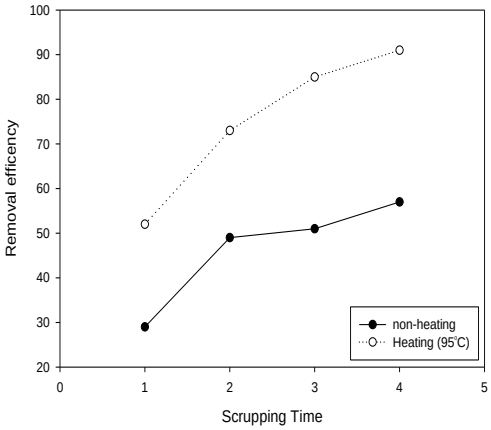

Fig. 1. Removal efficiency for Cs in soil with heating and non-heating of washing

The sieve process was carried out in order to find out the level of radioactivity for each size. Four sections were saperated based on sizes of less than 0.075mm, 0.075-1mm, 1-2mm, and more than 2mm for the measurement of radioactivity, and used for the soil washing experiment. The soil with the sizes of 0.075-1mm and less than 0.075mm showed a relatively high level of radioactive concentration, respectively. Meanwhile, the level of radioactive concentration was found to be low in soil with sizes of 1-2mm and more than 2mm. Also, the soil with a size of less than 0.075mm and the one with the size of more than 2mm showed a difference of 5.8 times regarding the

radioactive concentration. As a result, it was found that as the particle of the soil became smaller, the level of radioactive concentration became higher.

To check the washing efficiency for each size when carrying out the soil washing process, the experiment was carried out by following the heat-washing process for 30g of contaminated soil of each size. As a result, cases with a size of 1-2mm and more than 2mm showed a removal efficiency of 91.6% and 93.8% respectively through only four washings. Meanwhile, the cases with a size of less than 0.075mm and less than 0.075-1mm showed removal efficiencies of 57.7% and 72.4% respectively through four washings.

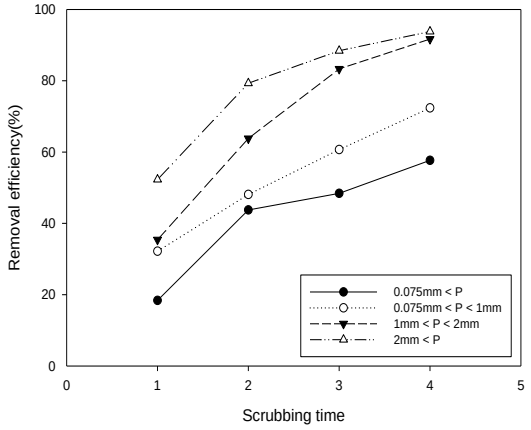

Fig. 2. Removal efficiency for Cs in soil each size

3. Conclusions

After selecting the complex agent H_2SO_4 and checking the influence of temperature when the contaminated soil was washed based on the solid-liquid ratio of 1g:2ml, it was found that the heat washing process at a temperature of 95℃ showed a higher level of efficiency for the removal of Cs compared to the case of the non-heat washing process. Also, according to the results given by the process of considering the different removal tendencies for each size based on the heat washing process after the sieve grading process was applied with the sieve-shaker prior for the size separation process, it was found that the soil with a size of more than 1mm showed a removal efficiency of more than 90% through only four washings. Meanwhile, it was found that the soil with the size of less than 1mm showed a removal efficiency of less than 70% through four washings.

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