A study on the decontamination of the gravels contaminated by uranium

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1. Introduction

When dismantling any nuclear facility due to the suspension of its operation, it is inevitable to have a considerable amount of soil contaminated by radioactivity. In particular, such soil contains many different sizes and kinds of gravels which are also subject to the contamination by radioactivity. According to the results of the radioactivity analysis which was carried out for the gravels contained in the soil contaminated by radioactivity when the uranium-converting facility of Korea Atomic Energy Research Institute was dismantled, it was found that most of the gravels were actually contaminated by uranium. The amount of gravels contaminated by uranium is usually about 10% of the contaminated soil. Since such contaminated gravels show different kinds and volumes, it would cost a considerable amount of money if they are to be disposed of without going through any special process. Also, there has not been any particular way or technology for processing the gravels contaminated by uranium. Therefore, various fundamental experiments and researches have been carried out for the decontamination of the gravels contaminated by uranium. Through such experiments and researches, it has been possible to obtain some significant results. The acid cleaning process, which is based on the application of the soil cleaning method, can be regarded as one of the major ways used for decontamination. When the gravels contaminated by uranium are cleaned as they are, most of them tend to show an extremely-low level of decontamination. Therefore, it could be said that the inside of each gravel is also contaminated by uranium. As a result, the gravels contaminated by uranium need to be crushed before being cleaned, which would result in a higher level of efficiency for decontamination compared to the previous way. Therefore, it is more effective to crush the subject gravels before cleaning them in terms of decontamination. However, such test results can only be applied to the gravels contaminated by an average level of uranium concentration. Regarding the gravels showing a higher level of uranium concentration than the average, it is still necessary to carry out more researches.

Therefore, this study focused on the level of efficiency for decontamination after the contaminated gravels were crushed before being cleaned, in order to find a way to effectively dispose of the gravels contaminated by high-concentration uranium and secure a high level of efficiency for decontamination.

2. Experimental and Results

Gravels were collected from the soil contaminated by uranium, which was kept at the institute, before being crushed by using the jaw crusher. Each gravel of the 50 g sample was crushed until every particle became less than 1.5mm. The level of radioactivity for all the crushed gravels was measured by using the multi-channel analyzer (MCA). HNO_3 with the solid-liquid ratio of 1 g: 2 mL was applied to the sample until pH became 0. Then, the sample was cleaned for two hours by using the shake-flask batch test before the supernatant was separated. After it was completely dried at the 105℃ drier, the level of radioactivity was measured by using the MCA.

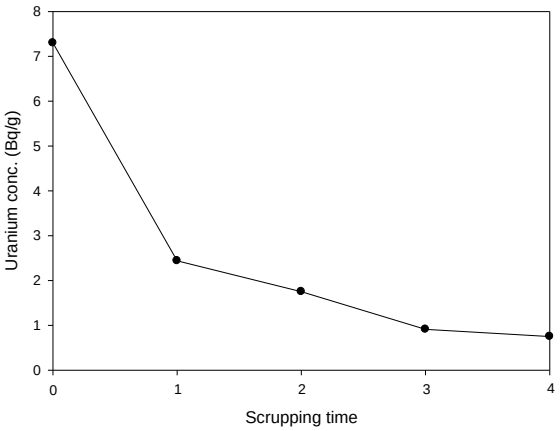

Fig. 1. Removal efficiency for uranium in gravel.

The initial concentration of uranium for the contaminated gravels which were crushed was 7.3 Bq/g. In order to increase the level of efficiency for decontamination regarding the contaminated gravels, the cleaning process was repeated several times. When the process was repeated for the fourth time, the concentration of uranium was found to be 0.75 Bq/g and the level of efficiency for decontamination was 89.7%. Such a result showed a relatively-high level of efficiency for decontamination. Through the first cleaning process, a considerable amount of uranium was removed from the crushed gravels. However, from the second cleaning process, even if it was still possible to see a certain level of decontamination, the level of efficiency decreased, which was not good enough to satisfy 0.4 Bq/g, the allowed level of concentration for the soil contaminated by uranium. After the gravels were crushed, the surface area became larger, making it easy to remove uranium through the first cleaning

process. However, as it was hard to clean the inside of each gravel, which was also contaminated by uranium, the level of efficiency for decontamination started to decrease from the second cleaning process.

Therefore, it is necessary to crush the gravels contaminated by uranium into small pieces in order to decrease the number of cleaning processes and obtain a high level of efficiency for decontamination. By crushing the contaminated gravels into fine pieces and sifting them, such classification categories as less than 0.075 mm, 0.075-0.45 mm and 0.45-1.0 mm were applied before the level of radioactivity was measured and the cleaning experiment was carried out. The level of radioactivity was found to be not much different for each diameter. However, the crushed gravels in the category of less than 0.075 mm showed a relatively-higher level of radioactivity than those with different diameters. By carrying out the cleaning experiment for the third time, the crushed gravels with the diameter of less than 0.075 mm showed 95.8% of efficiency for decontamination as the concentration of uranium decreased from 8.75 Bq/g to 0.36 Bq/g. Also, the concentration of uranium for the diameter of 0.075-0.45 mm decreased from 5.58 Bq/g to 0.51 Bq/g, showing 90.8% of efficiency for decontamination, while the one for the diameter of 0.45-1.0 mm decreased from 5.12 Bq/g to 0.56 Bq/g, showing 89.1% of efficiency for decontamination. Regardless of the sizes, most of the crushed gravels showed a similar level of concentration after decontamination compared to the allowed level of concentration. For the crushed gravels with the diameter of less than 0.075 mm, it was found that uranium could be removed more effectively when the cleaning process was carried out for the first time.

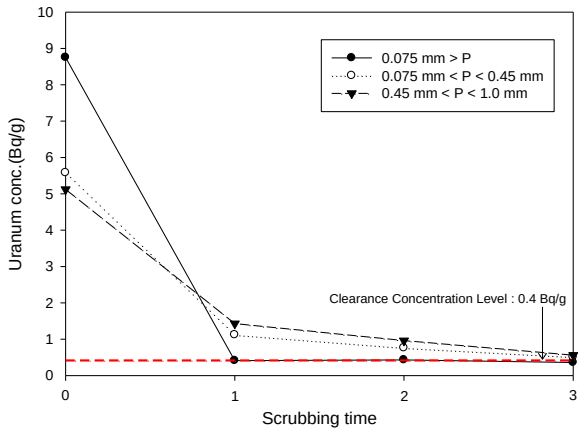

Fig. 2. Removal efficiency for uranium in gravel each sizes.

3. Conclusions

In order to decontaminate the gravels which were contained in the soil contaminated by uranium and showed a higher level of uranium contamination than the average, the cleaning process was carried out for decontamination. Also, in order to increase the level of efficiency for decontamination, the gravels were crushed before the cleaning experiment was executed. As a result, for the contaminated gravels with the diameter of less than 1.5 mm, it was possible to obtain 89% of efficiency for decontamination. However, the concentration of uranium was not satisfactorily removed after the last cleaning process was carried out. Therefore, the contaminated gravels were crushed based on the diameter of less than 1 mm. By classifying each size and observing the removing tendency, it was found that 95.8% of efficiency for decontamination was obtained for those with the diameter of less than 0.075 mm. In particular, a satisfactory level of concentration was shown by carrying out the cleaning process once. In conclusion, it can be said that in case of the gravels showing a high level of uranium concentration, it is still possible to carry out the decontamination process effectively by crushing them into small particles.

REFERENCES

[1] U. R. Park, G. N. Kim, S. S. Kim, H. M. Park, W. S. Kim, J. K. Moon," A Study on the Removal of Cesium in Soil Contaminated with Radiation Using a Soil Washing Process ", Transactions of the Korean Nuclear Society Spring Meeting, Vol. 1, pp. 279 (2013)

[2] U. R. Park, G. N. Kim, S. S. Kim, J. K. Moon, " Basic experiment on the decontamination of the gravels contaminated by uranium ", Korean Society Soil & Groundwater Env, pp. 471～472 (2013)