Removal of Uranium from Radioactive Concrete using Washing Technology

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1. Introduction

This study developed a concrete washing system to remove uranium from concrete and investigated the optimum experimental conditions of the elemental equipment to maximize the removal efficiency of uranium. The concrete washing technology was developed to decontaminate the radioactive concrete generated during nuclear facility operation. Chemical washing equipments of 15L size for concrete particle was manufactured, which consists of washing tank, vacuum screen, precipitation tank. In order to obtain optimum experiment conditions for concrete washing, washing experiments were performed as a function of several factors.

2. Crusher of radioactive concrete particle

Fig. 1. concrete crusher

The radioactive waste storage house of nuclear facilities has taken care of 20~50cm of concrete debris in 200 L drums. Radioactive concretes in 200L drums were taken out and crushed by a crusher as shown in Fig. 1. Weight distribution of concrete particles is 75% for particles of more than 5mm, 4% for particles of 1-5 mm, and 21% for particles less than 1.0 mm. Meanwhile, the larger the size of concrete particle is, the lower the concentration of concrete particle is. The unconditional clearance level of uranium in IAEA and Europe countries are about 1.0 Bq/g. On the other hand, the radioactive concentration of particles of more than 5mm satisfied the unconditional clearance level. But the radioactive concentrations of particles of 1-5 mm and particles less than 1 mm didn't satisfy the unconditional clearance level , that is, were over 1.0 Bq/g. Therefore, particles of 1-5 mm and particles less than 1 mm are needed to lower their concentration under 1.0 Bq/g by concrete washing.

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3. Experiments for radioactive concrete particles

Crushed concretes were put into in a washing tank and were mixed with several concentrations of HNO_3 and then were scrubbed by an impellor. The scrubbed concretes were sent to a vacuum vibrator, where concretes and waste solution of HNO_3 were separated by a vacuum vibrator. The separated concretes were measured their radioactive concentration by MCA (Multi-Channel Analyzer). If the radioactive concentration of concretes is over 1.0 Bq/g, concretes are sent to a washing tank for scrubbing again. Meanwhile, waste solution is sent to precipitation tank and uranium in waste solution forms a precipitate with the added NaOH. And a precipitate was removed from waste solution, and the treated waste solution was reused for a soil washing process.

Chemical washing equipments of 15L size for concrete washing were manufactured, which consists of washing tank, vacuum screen, precipitation tank. Removal efficiencies of uranium as a function of reagent type, mol number, scrubbing time, particle size, and number of washing repetition were measured for a decision of optimum washing conditions through washing experiments.

Radioactivity level of the concrete particles was measured by MCA with a standard tube of 50cc, QCY48 (Amersham), manufactured by KRISS(Korea Research Institute Standards and Science). A total of 45 concrete particles were measured with a sensitivity of 0.1Bq by MCA. Also, the time suitable to measure the radioactivity level of the concrete particles by MCA was estimated at more than 8 hours.

4. Results and Discussion

Concrete particles of 0.15-1.0mm were used for washing. The mixing rate of weights of concrete and reagent solution was 1:5 and repetition number of washing was 2. 120 minutes was selected as an optimum scrubbing time, because the increasing rate of removal efficiency of uranium was abruptly decreased after 120 minutes.

Results of washing experiments as a function of particle size are shown in Fig. 2. Scrubbing time of washing was 2 hours and the mixing rate of weights of concrete and reagent solution was 1:5 and repetition number of washing was 2. The smaller the particle size of concrete is, the higher the removal efficiency of uranium from concrete particle is. Namely, it is about 50% for particles of more than 5mm, about 60% for particles of 1-5 mm, and about 93% for particles less than 1.0 mm.

Results of washing experiments as a function of number of washing repetition are shown in Fig. 3. Concrete particles of 0.15-1.0mm were used for washing. Scrubbing time of washing was 2 hours and the mixing rate of weights of concrete and reagent solution was 1:5. The more the number of washing repetition is, the higher the removal efficiency of uranium from concrete particle is. Namely, the removal efficiency on one-time washing is 66.6% and that on two-time washing is 92.7% and that on three-time washing is 95.4% .

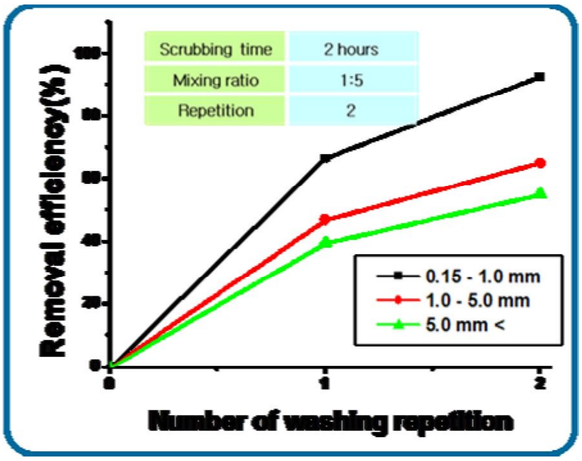

Fig. 2. Removal efficiency of uranium as a function of particle size

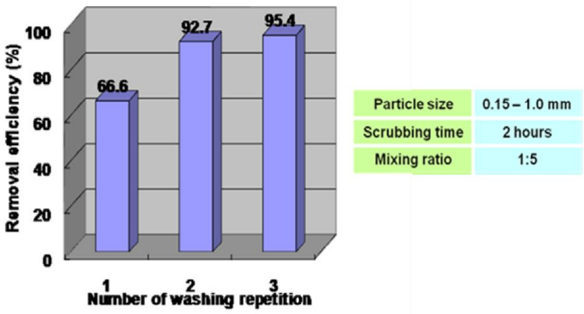

Fig. 3. Removal efficiency of uranium as a function of number of washing repetition

5. Conclusion

120 minutes was selected as an optimum scrubbing time, because the increasing rate of removal efficiency of uranium was abruptly decreased after 120 minutes. The smaller the particle size of concrete is, the higher the removal efficiency of uranium from concrete particle is. The more the number of washing repetition is, the higher the removal efficiency of uranium from concrete particle is. Namely, The removal efficiency on one-time washing is 66.6% and that on two-time washing is 92.7% and that on three-time washing is 95.4% .

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