

Reduction of waste solution volume generated on electrokinetic remediation

Gye-Nam Kim*, Dae-Seo Koo, Seung-Soo Kim, Jung-Whan Jeong, Gyu-Seong Han, Jei-Kwon Moon

Korea Atomic Energy Research Institute, 1045 Daedeokdaero, Yuseong-gu, Daejeon, 305-353, Korea

kimsum@kaeri.re.kr

1. Introduction

Lots of nuclear facility sites have been contaminated by leakage of radioactive waste-solution during a long-term operation of nuclear facilities. Therefore it was needed that the method to remediate a large volume of radioactive soil should be developed. In this study, for the reduction of volume of metal oxides generated in cathode chamber, the optimum pH of waste electrolyte in cathode chamber were drawn out through several experiments with the manufactured electrokinetic decontamination equipment. Also, the required time to reach to below the clearance concentration level for self-disposal was estimated through experiments using the manufactured electrokinetic decontamination equipment. A diagram of soil decontamination process for the removal of uranium from contaminated soil was drawn out.

2. Methods

The indoor electrokinetic decontamination equipment for treatment of 1.2 tons of contaminated soil per batch was manufactured to remove uranium from lots of soil with high removal efficiency during a short time. The equipment consists of anode chamber, soil cell, cathode chamber, soil cloth sack, pH and pump controllers, an equipment support system, a power supply, gas release cover, and a nitric acid box as shown in Fig. 1. Uranium soil was poured into a soil cloth sack in the soil cell. If the electricity is given at the anode and cathode by the power supply, UO_2^{2+} in the uranium soil moves mainly by electro-migration and electro-osmosis to the cathode chamber.

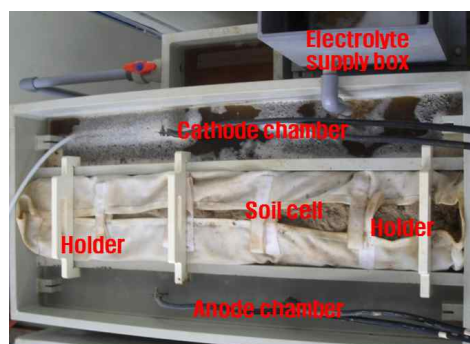


Fig. 1. Manufactured indoor electrokinetic decontamination equipment

During operation of electrokinetic decontamination equipment, lots of waste electrolyte in the cathode chamber was generated. Waste electrolyte contains lots of metal oxides produced due to metal ions released from the contaminated soil. The volume of metal oxides can be reduced by controlling the pH of waste electrolyte in cathode chamber. Meanwhile, for the reduction of the volume of waste electrolyte being generated in cathode chamber, the waste electrolyte was reused as the electrolyte in the anode chamber. But water or reclaimed solution was used for the last 20 days to elevating the removal efficiency of uranium from soil. The times required for three concentrations of soil to reach to below the clearance concentration level were estimated through experiments using the manufactured electrokinetic equipment.

3. Discussion and Results

The percentage of metal oxide volume generated in cathode chamber according to the pH of electrolyte at 25 °C was shown in Table 1. When the pH of waste electrolyte in cathode chamber increased, the percentage of metal oxide volume generated in cathode chamber increased. Conclusively, it was found that the optimum pH of waste electrolyte in cathode chamber for the reduction of volume of metal oxides was below 2.35. Meanwhile, the electrokinetic decontamination experiments using the manufactured equipment were carried out with maintaining the pH of waste electrolyte in cathode below 2.35 by injecting nitric acid. When the initial uranium concentration of the soils were 20.0 Bq/g, 14.0 Bq/g, and 7.0 Bq/g, the required times to reach to below the clearance concentration level for self-disposal were 40 days, 35 days, and 25 days as shown in Fig. 2.

Table 1. Percentage of metal oxide volume generated in cathode chamber according to the pH of electrolyte at 25 °C

| Percentage of metal oxide volume generated in cathode chamber | | | | |
|---|------|------|------|------|
| pH (25 °C) | 2.35 | 3.76 | 4.16 | 5.47 |
| Metal oxide volume in chamber | 2% | 3.5% | 70% | 90% |

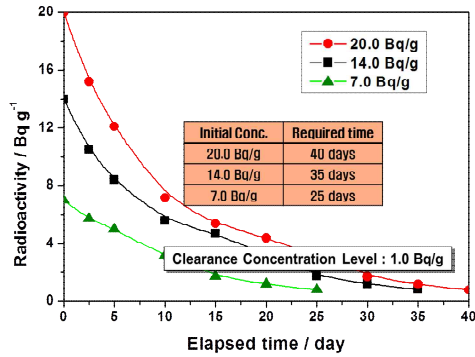


Fig. 2. Uranium radioactivity concentration decrease versus decontamination elapsed time per different initial concentration of soil

A diagram of soil decontamination process for the removal of uranium from contaminated soil is shown in Fig. 3. 50-60% of the uranium was removed from the soil through the soil washing equipment, and the washed soil was then put in a soil cell in the electrokinetic decontamination equipment to remove the uranium from soil. Meanwhile, waste electrolytes released from the electrokinetic decontamination equipment, which contains a low concentration of metal ions, are reused for soil washing with the addition of nitric acid. The waste solution released from the first soil washing equipment flows into a precipitation tank for precipitation, then flows into a filter press for filtration through a concentration tank, and the treated solution filtered by the filter press flows into a reclaimed electrolyte tank to reuse in the soil electrokinetic decontamination equipment. For the reduction of the volume of waste electrolyte being generated in cathode chamber, waste electrolyte was reused as the electrolyte in the anode chamber during 1-3 weeks. But reclaimed electrolyte was used to elevate the removal efficiency of uranium from soil for the last 20 days.

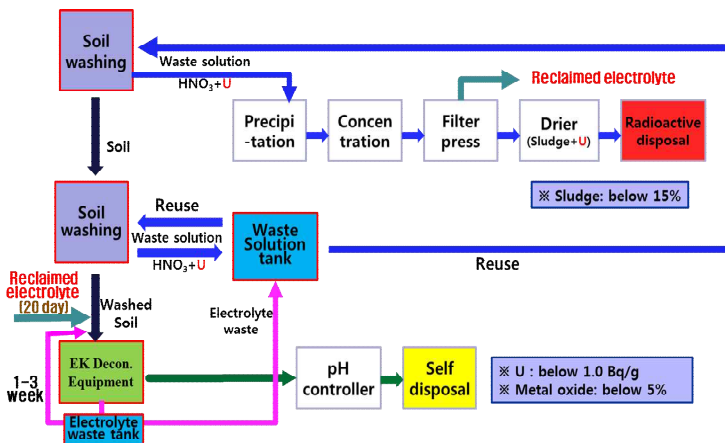


Fig. 3. A diagram of soil decontamination process for the removal of uranium from contaminated soil

4. Conclusions

The optimum pH of waste electrolyte in cathode chamber for the reduction of volume of metal oxides was below 2.35. Also, when the initial uranium concentration of the soils were 7-20 Bq/g, the required times to reach to below the clearance concentration level for self- disposal were 25-40days. A diagram of soil decontamination process for the removal of uranium from contaminated soil was drawn out.

REFERENCES

1. G. N. Kim, W. K. Choi, C. H. Bung, J. K. Moon, J. Ind. Eng. Chem. 13 (2007) 406-413.
2. G.N. Kim, Y.H. Jung, J.J. Lee, J.K. Moon, Journal of the Korean Radioactive Waste Society. 25(2)(2008) 146-153.
3. K. Reddy, C.Y. Xu, S. Chinthamreddy, J. Hazard. Mater. B84 (2001) 279-296.
4. S. Pamukcu, J.K. Wittle, Environ. Prog. 11(3) (1992) 241-270.
5. K. Reddy and S. Chinthamreddy, J. Geotech. Geoenviron. Eng., March. (2003) 263-277.