A Device for Uranium series Leaching from Glass Fiber in HEPA Filter

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1. Introduction

A great amount of radioactive waste has been generated during the operation of nuclear facilities. Recently, the storage space of a radioactive waste storage facility in the Korea Atomic Energy Research Institute (KAERI) was almost saturated with many radioactive wastes. To derive an optimum method for the removal of uranium series from HEPA glass fiber, five methods were applied in this study. That is, chemical leaching by 4.0 M HNO_3-0.1M Ce(IV) solution, chemical leaching by 5 wt% NaOH solution, chemical leaching by 0.5M H_2O_2-1.0M Na_2CO_3 solution [17], chemical consecutive leaching by 4.0 M HNO_3 solution, and chemical repeated leaching by 4.0 M HNO_3 solution were used to remove uranium series. Also, in order to reuse the leaching waste-solution contaminated with ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th, the precipitation-filtration experiment was carried out with NaOH and alum as precipitants.

2. Methods and Results

In order to remove uranium series from glass filter, the leaching experiments by the three methods were carried out as follows. The removal efficiencies of uranium series from glass fiber were measured and compared. Finally, an optimum method for glass fiber leaching was selected through a comparison of removal efficiencies.

3.1. Chemical leaching by 5 wt% NaOH solution

Results of chemical leaching by 5 wt% NaOH solution were shown in Fig. 1. Initial radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th were 77.0, 3.4, 64.5, and 72.7 Bq/g. The residual radioactivity concentrations of ^{238}U and ^{235}U from glass fiber after leaching by 5 wt% NaOH solution for 12 hour were 76.9 Bq/g and 3.4 Bq/g, respectively. Those of ^{238}U and ^{235}U after leaching for more than 18 hours maintained constant values, 76.9 Bq/g and 3.4 Bq/g, respectively. On the other hand, The residual radioactivity concentrations of ^{226}Ra and ^{234}Th from glass fiber after leaching by 5 wt% NaOH solution for 12 hour were 63.7 Bq/g and 71.9 Bq/g, respectively. Those of ^{226}Ra and ^{234}Th after leaching for more than 18 hours maintained constant values, 63.7 Bq/g and 71.9 Bq/g, respectively. The residual radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th in glass after leaching for 36 hours by 4.0 M HNO_3-0.1M Ce(IV) solution were 76.9 Bq/g, 3.4 Bq/g, 63.7 Bq/g, and 71.9 Bq/g. Finally, the total amount of radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th was above radioactive clearance concentration level for self disposal of HEPA glass fiber.

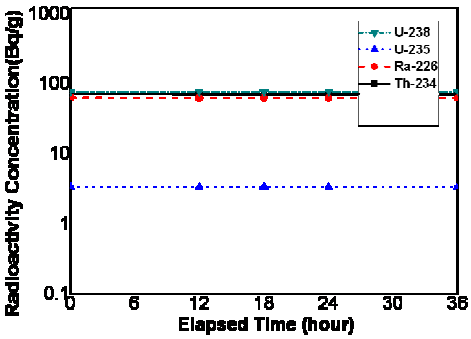

Fig.1. Radioactive concentration during leaching by 5 wt% NaOH solution

3.2 Chemical leaching by 0.5M H_2O_2-1.0M Na_2CO_3 solution

Results of chemical leaching by 0.5M H_2O_2-1.0M Na_2CO_3 solution were shown in Fig. 2. Initial radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th were 77.6, 3.6, 59.6, and 68.6 Bq/g. The removal efficiency of ^{238}U from glass fiber after leaching by 0.5M H_2O_2-1.0M Na_2CO_3 solution for 1 hour was 84.1%. That of ^{238}U after leaching for 8 hours was 88.5%. On the other hand, The removal efficiencies of ^{235}U, ^{226}Ra, and ^{234}Th after leaching for 1 hour were 100%, 96.8%, and 93.3%, respectively. Those of ^{235}U, ^{226}Ra, and ^{234}Th after leaching for more than 3 hours maintained constant values, 100%, 96.8%, and 93.3%, respectively. The residual radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th in glass after leaching for 8 hours by 0.5M H_2O_2-1.0M Na_2CO_3 solution were 8.9 Bq/g, 0.0 Bq/g, 1.91 Bq/g, and 6.4 Bq/g. Finally, the total amount of radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th was above radioactive clearance concentration level for self disposal of HEPA glass fiber.

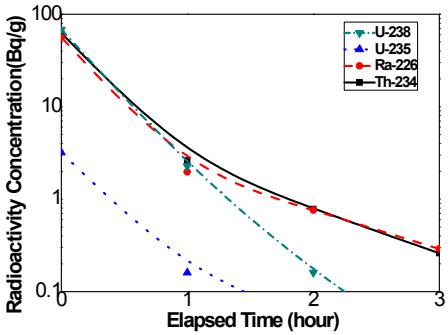

Fig. 2. Radioactive concentration during leaching by 0.5M H_2O_2 - 1.0M Na_2CO_3 solution

3.3 Repeat chemical leaching by 4.0 M HNO_3 solution

Results of repeat chemical leaching by 4.0 M HNO_3 solution were shown in Fig. 3. Initial radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th were 68.4, 3.2, 56.3, and 62.7 Bq/g. The removal efficiency of ^{238}U from glass fiber after one repetition of leaching by 4.0 M HNO_3 solution for 1 hour was 96.7%. That of ^{238}U after three repetitions of leaching for 3 hours was 100%. On the other hand, The removal efficiencies of ^{235}U, ^{226}Ra, and ^{234}Th after one repetition of leaching for 1 hour were 95.0%, 96.5%, and 95.8%, respectively. Those of ^{235}U, ^{226}Ra, and ^{234}Th after three repetitions of leaching for 3 hours were 99.4%, 99.5%, and 99.6%, respectively. The residual radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th in glass after three repetitions of leaching for 3 hours by 4.0 M HNO_3 solution were 0.02 Bq/g, 0.02 Bq/g, 0.29 Bq/g, and 0.26 Bq/g. Finally, the total amount of radioactivity concentrations of ^{238}U, ^{235}U, ^{226}Ra, and ^{234}Th was below radioactive clearance concentration level for self disposal of HEPA glass fiber. Consequently, results of above five kinds of leaching experiment methods showed that the only method for self disposal of HEPA glass fiber was repeat chemical leaching by 4.0 M HNO_3 solution.

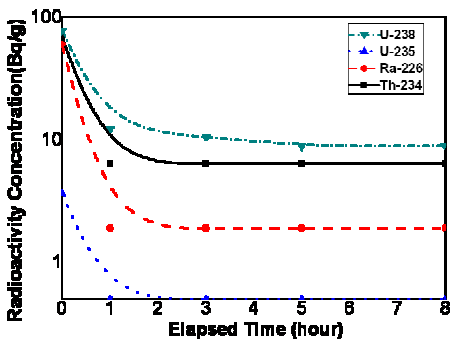

Fig. 3. Radioactive concentration during repeated leaching by 4.0 M HNO_3 solution

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