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Technetium Removal from Aqueous Waste Streams by Ferrous Iron Minerals and Subsequent Stability in Grout Waste Forms

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Technetium-99 (Tc) is a fission product with a long half-life, high mobility in oxidizing conditions that raises many environmental concerns and is present in legacy nuclear wastes destined for immobilization. To enhance the performance of waste forms for eventual disposal, Tc can be selectively sequestered from these liquid nuclear wastes using a variety of materials. The ability of candidate mineral phases to Tc capture and their long-term stability in waste form used to immobilize Tc must be understood.

One of the most promising and economical routes for long-term stabilization and retention of Tc is through the use of ferrous iron (Fe(II))-containing materials. Incorporation of reduced Tc(IV) into iron oxide minerals has been explored extensively as a potential Tc sequestration mechanism [1,2,3]. This study evaluates various commercially available forms of Fe(II) for their ability to capture Tc from representative liquid nuclear waste streams, and the stability of the resulting Tc-bearing Fe phases when included in cementitious waste forms proposed as a stabilizing matrix for final disposal. Batch contact experiments were conducted in simplified (deionized water) and complex simulated waste streams with candidate Fe(II) minerals under ambient conditions. The behavior of each Fe(II) mineral for Tc sequestration was evaluated based on the Tc removal efficiency and the Tc stability in the produced Fe-oxy(hydr)oxide mineral phases against aqueous leaching. The down-selected Fe(II) materials were then incorporated into a cementitious waste form as a demonstration of a possible final disposal material. A series of solid phase characterizations for mineral identification and Tc speciation etc. were conducted on the solids, both from the batch contact experiments, and the cementitious waste form leaching tests, to determine the mechanisms of Tc sequestration or release. This work will provide the technical basis to propose economically friendly solutions for the long-term stabilization of Tc and other redox-sensitive contaminants in the environments.

References

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