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Technetium Sequestration and Stability in Cementitious Waste Forms by Ferrous Iron Minerals

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Technetium-99 (Tc) is a fission product with a long half-life and high mobility in oxidizing conditions driving environmental risk in the disposal of some legacy nuclear wastes. Uncertainty persists around the long-term mobility of Tc within cementitious waste forms destined for disposal at locations where a pathway to potable water exists. To enhance the performance of cementitious waste forms for eventual disposal, 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 as a potential Tc sequestration mechanism [1,2,3], but limited exploration in waste forms.

This study evaluates two Fe(II)-materials (lab synthesized pyrite-Fe(II) and FerroBlack®-Fe+ from Redox Solutions (Carmel, IN)) for their ability to capture Tc from representative liquid nuclear waste streams, the stability of the resulting Tc-bearing Fe phases and the ability of an Fe(II) material to improve Tc retention in cementitious waste forms. Batch contact experiments were conducted under ambient conditions, where different dose amount of each Fe(II)-material or sequential multiple strike addition approach was tested for complete removal of Tc from simulated waste solutions. Each Fe(II)-material was then added to two cementitious waste forms (Cast Stone (CS) and Portland cement only (PLC)) as a test of waste form performance under varying redox conditions. These results were supported by a series of solid phase characterizations for mineral identification and Tc speciation conducted on the Tc-Fe solids from batch contact experiments and the cementitious waste form leaching tests. 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 disposal environment.

References

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