EVOLUTION OF FLUID CHEMISTRY INSIDE A WASTE PACKAGE DUE TO CARBON STEEL AND SIMULATED HIGH-LEVEL WASTE GLASS CORROSION

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ABSTRACT

A co-disposal waste package (WP) designed for the potential high-level waste (HLW) repository at Yucca Mountain (YM) may contain a mix of 304L stainless steel (SS) canisters with HLW glass and U.S. Department of Energy (DOE)-owned spent nuclear fuel canisters. These canisters are placed inside a WP with carbon steel inserts that provide support to individual canisters.

Radionuclide release from the WP is a complex process that depends upon the chemical composition and flux of groundwater contacting the wasteforms; the dissolution rate of HLW glass and spent nuclear fuel; the corrosion rates of WP components made of Alloy 22, 304L, 316L SS, and carbon steel; the solubility of radionuclides; and the retention of radionuclides in secondary phases. Typically, the corrosion rate for carbon steel is significantly higher than for stainless steel or Alloy 22 and has a significant effect on the chemical evolution of the in-package solutions.

In this study, a series of bench-scale experiments were conducted to monitor the evolution of the chemical composition, pH, and redox potential of the fluid inside the WP for corroding carbon steel samples for expected groundwater compositions. The pH of the solution is an important parameter that controls the dissolution of wasteforms and determines the speciation of radionuclides between solid and aqueous phases. Results indicate that the corrosion processes increased the pH of the solution from near-neutral to alkaline (pH > 9), accompanied by the formation of iron-bearing corrosion product precipitates. The addition of simulated HLW glass to the corroding carbon steel solution caused a further increase in pH. These results are in contrast to the DOE proposed model abstraction for in-package chemistry for YM in which the pH is expected to remain near neutral after initially acidic conditions (pH around 4).

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