**Integration Group for the Safety Case (IGSC) Symposium 2024**  
*MOVING TOWARDS THE CONSTRUCTION OF A SAFE DGR – GETTING REAL*

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| **Abstract Title:** Quantifying the Impact of Sorption on Iron Corrosion Products on Actinide Solubility: Considerations for Safety Cases in Salt Repositories  U.S. Environmental Protection Agency, USA, [santillan.jay@epa.gov](mailto:santillan.jay@epa.gov) | |
| **Abstract (300-500 words):**  Iron (Fe) from steel waste canisters is important in establishing reducing chemical conditions for deep geologic repositories (DGR) in salt. Anoxic corrosion products from zero-valent iron (Fe0) catalyze and stabilize reduction of soluble oxidized actinide species to less soluble reduced species. Hydrogen gas (H2) generated during anoxic corrosion, coupled with high pressures from salt creep, further contribute to low repository redox potentials. Fe corrosion products also immobilize actinides through sorption, a process often ignored in safety cases due to the relative insolubility of reduced actinides. This study assesses and quantifies the impact sorption has on uranium (U) and plutonium (Pu) mobility and its potential to add extra assurance to DGR safety cases.  For spent fuel DGRs, reducing conditions ensure U converts from U(VI) to U(IV). U(IV) can be represented by minerals like amorphous UO2•2H2O. In contrast, at the Waste Isolation Pilot Plant (WIPP) in Carlsbad, NM, USA, the most significant radionuclide in releases is Pu. Anoxic corrosion ensures Pu reduces from Pu(V) or Pu(VI) to Pu(III) or Pu(IV). EPA has determined that the major reaction controlling the dissolved Pu source term is Pu(III) solids (e.g., Pu(OH)3(s)) in equilibrium with aqueous Pu(III) (Schramke et al. 2020), though DOE currently includes a relatively high proportion of Pu(IV) in PA realizations.  Actinide sorption on Fe corrosion products will further immobilize dissolved species. PHREEQC calculations indicate that UO2•2H2O in equilibrium with 1 M NaCl, 1 atm H2(g), and Fe(OH)2 (s) yields [U(IV)]TOT = 3.16×10-9 M. Few studies have examined sorption of the low soluble U(IV) on Fe corrosion products (e.g., Wang et al. 2015) though many studies highlight the importance of sorption in immobilizing U(VI) and stabilizing U(IV) redox (e.g., Grambow et al. 1996). For Pu, PHREEQC calculations indicate a slightly lower solubility in similar conditions, [Pu(III)]TOT = 4.05×10-10 M. While these values fall within regulatory limits, WIPP PA does not credit sorption except on mobile mineral fragment colloids. A few studies under WIPP conditions indicate that +III analogs are strongly retained on reduced Fe species (e.g., Morelova 2020). While it is appropriate for salt DGR PAs to ignore sorption due to the low solubility of reduced actinides and for additional conservatism, quantifying the impact of sorption on actinide solubility provides further assurance in the safety case to the public.  Grambow, B., Smailos, E., Geckeis, H., Müller, R., & Hentschel, H. (1996). Sorption and reduction of uranium (VI) on iron corrosion products under reducing saline conditions. Radiochimica Acta, 74(s1), 149-154.  Morelová, N. (2020). Steel corrosion and actinide sorption by iron corrosion products under saline conditions. Doctoral dissertation, Karlsruher Institut für Technologie.  Schramke, J. A., Santillan, E. F. U., & Peake, R. T. (2020). Plutonium oxidation states in the Waste Isolation Pilot Plant repository. Applied Geochemistry, 116, 104561.  Wang, Z., Ulrich, K. U., Pan, C., & Giammar, D. E. (2015). Measurement and modeling of U (IV) adsorption to metal oxide minerals. Environmental Science & Technology Letters, 2(8), 227-232. | |