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70-Year-Old Concrete from a Hanford Nuclear Waste Storage Tank: Material Properties and Radionuclide Accumulation

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Concrete characterization, carbonation sensitivity, and radionuclide sorption test results for 70-year-old concrete core materials extracted from the concrete wall surrounding single-shell tank (SST) A-106, a nuclear waste storage tank at the Hanford Site (Washington State, USA), will be presented. Successful management of nuclear waste storage and disposal sites rely on performance assessments (PAs) to predict the long-term behavior of waste and engineered barriers. Since performance predictions often extend for hundreds of years, if not millennia, assumptions must be made for the evolving physical, chemical, and reactive properties of the waste and barrier materials. Laboratory testing and modeling of the behavior of analogs or simulated materials subjected to extreme environments that accelerate material aging can be used to inform predictions, but often lack site specificity or a known true age in the case of accelerated aging tests. The SST A-106 core is unique because it provides site-specific information on concrete properties that extend beyond traditional laboratory test durations and a snapshot of potential radionuclide accumulation and transport as the concrete aged while in service.

Concrete core segments were extracted from the concrete sidewall of SST A-106 in 2014. The core segments represent the ~38-ft (11.6 m) height of the concrete sidewall. The cores were exposed to high temperatures (maximum tank waste temperature of 312 °C) and may capture concrete thermal degradation effects. Analysis starting in 2023 focused on 1) measuring the sorption partition coefficient values for technetium-99, iodine, and nitrate; 2) detecting a potential migrating carbonation front; and 3) characterizing the moisture content and mineralogy of the cement binder. An evaluation was first performed on core segment 7-2, which was sourced from a core depth that fell below the maximum tank waste level of ~30 ft (9.1 m) above the tank floor. A second evaluation of core segment 2 represents concrete located above the maximum tank waste level. Test results are compared to highlight similarities and differences in material properties and reactions as a function of tank wall location and potential impacts to the tank closure PA at Hanford.