A stochastic model of degradation behavior of tristructural-isotropic coated particle spent fuels

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The U.S. Department of Energy is conducting research and development on generic concepts for disposal of spent nuclear fuel and high-level radioactive waste in multiple lithologies, including salt, crystalline rock, and argillaceous rock. These investigations benefit greatly from experience gained in other disposal programs in many countries around the world. Here we report constraints for a stochastic model of degradation and radionuclide-release rates for the tristructural-isotropic (TRISO) coated particle spent fuels.

High-temperature gas reactors (HTGR) that utilize TRISO particle fuel have high efficiency due to the high temperatures and high fuel burnup (i.e. the fraction of uranium that fissions). The TRISO particle coatings (e.g., a SiC layer between pyrolytic carbon (PyC) layers) add a safety feature encapsulating the fuel kernel and fission products during and after reactor operations. These TRISO particles (<1 mm diameter) are dispersed in a graphite matrix as a fuel element, and the degradation in a geologic repository is dependent on the graphite matrix reaction rate[1].

The performance model for the TRISO fuel includes stochastic representation of SiC failure from pressure increase via helium produced by alpha decay, and as excacerbated by SiC corrosion in the source-term environment, as well as additional failure mechanisms of other barriers. Even after SiC breach, the PyC layers and the graphite matrix may provide diffusive barriers. Corrosion of the PyC layers is also analyzed to assess radionuclide release from failed TRISO particles to the graphite matrix, which may degrade over longer times[1].

[1] van den Akker & Ahn (2013) *Nuc. Technol.* **181**, 408-426.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. This abstract is Sandia publication SAND2018-3286 A.