Diffusive Transport in a Deep Geological Repository for Used Nuclear Fuel

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Abstract

The Nuclear Waste Management Organization (NWMO) is developing a deep geological repository as part of Adaptive Phased Management (APM), Canada's plan for the long-term management of used nuclear fuel. The repository is a multiple barrier system to protect people and the environment. To contain and isolate radionuclides, an engineered barrier system (EBS) will be constructed within a low permeability host rock. The EBS includes robust, long lasting used fuel containers arranged in a series of placement rooms and surrounded by highly compacted bentonite (HCB) and bentonite gap fill.
Sulphide produced by microbial activity in the geosphere can cause corrosion of the containers. A three-dimensional numerical transport model was developed using the COMSOL Multiphysics® software to simulate the diffusion of sulphide from the geosphere through the bentonite material to the container. The transport modeling of sulphide provides information that can assist in the establishment of a microbiologically influenced corrosion (MIC) allowance for the UFC design and can be applied to a variety of scoping scenarios.
The developed model considers the geometry of the current NWMO EBS design. The highly compacted bentonite, in contact with the used fuel container, is defined by specific parameters including porosity. The gap fill material, placed between the HCB and the host rock, consists of bentonite pellets also with defined parameters. Because the pellets are used to fill the gap between the excavated rock surface and the HCB blocks, there is uncertainty concerning the thickness of the gap fill. The model is therefore used to assess the effect of different gap fill thicknesses on the diffusive transport of corrosive compounds and the resulting MIC allowance for the UFC.