Hydro-Chemo-Mechanical simulations of an engineered concrete barrier in a deep geological repository for nuclear waste

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Abstract

Deep geological disposal is extensively studied for the long-term containment of high-level nuclear waste, which relies on the multi-barrier concept to achieve the required degree of isolation. This study focuses on assessing the hydro-chemical-mechanical (HCM) behavior of a liner concrete structure under repository conditions through the development of predictive models. We include models for the hydro-mechanical (HM) response of materials and hydro-chemical (HC) interaction at the concrete-rock interface, which will be later integrated into a coupled HCM model. The HM model reveals that porosity changes are negligible due to HM loads, while the altered concrete may affect the liner integrity. The HC model shows that porosity changes are controled by portlandite and calcium-silicate-hidrate (CSH) dissolution and precipitation of a secondary CSH phase. The maximum increased porosity occurs near de interface, reaching 0.23. The length of geochemical affection is 3 cm, with increased porosity from 0.15 to 0.20.