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Development and testing of electromigration technique to study radionuclide transport in compacted bentonite

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Diffusion and sorption parameters are needed to assess the performance of a deep geological repository for high level waste (HLWR). Classical migration experiments are used to obtain these parameters but require long experimental time periods (months to years). The electromigration (EM) technique uses an electrical gradient as driving force to force ionic species to move, hence these data can be obtained in days. This technique was developed to determine diffusive properties for different radionuclides in Boom Clay (e.g. Maes et al. (1999), Maes et al. (2002)), extended for use on compacted sodium montmorillonite by e.g. Higashihara et al. (2004), Tanaka et al. (2008), and in crystalline rocks by Löfgren and Neretnieks (2006). In many countries, compacted bentonite is considered as a part of the engineered barrier system in HWLR. The aim of this study was to develop an EM cell for compacted bentonite and to test the applicability of the EM technique to study radionuclide transport.

The EM cell design was based on a mix of the design of Higashihara et al. (2004) and Maes et al. (1999). Plugs of the Czech commercial bentonite B75 were compacted to a dry density of 1300 kg/m3 and fully saturated with 0.033 M CaCl2 (which suppresses the swelling). Two bentonite plugs were combined in an EM set-up and in between an aliquot of 125-I tracer was spiked.

When an electric field is applied, electrolysis of the electrolyte solution occurs with creation of protons and hydroxyls respectively at the anode and cathode sides which induces pH changes over the sample that can negatively influence the EM experiment. In order to mitigate these effects, different set-ups were tested (with intermixing both electrode sides in neutralisation reservoir, without intermixing and with salt bridges). For the optimal experimental condition found during testing phase, several electromigration experiments at different electrical potential gradients were performed. From the linear regression between the dispersion velocity and the dispersion coefficient, the apparent diffusion coefficient for iodide was evaluated. This value was compared with apparent diffusion coefficient obtained from classical through-diffusion experiments.

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