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Influence of the filter properties in the diffusive transport of ions through a bentonite. Sensitivity analysis

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The deep geological repository concept for spent nuclear fuel considers many safety elements. Among them, compacted bentonite has been selected as the primary engineering barrier between the encapsulated radioactive waste and the host rock. Thermo-hydro-mechanical behaviour of this material has been studied in detail from an experimental and numerical point of view. Furthermore, the study of chemical behaviour has become very important, both for the evaluation of the transport of species through the clay matrix and for the evaluation of their coupling to other physico-chemical phenomena.

Generally, to conduct these types of studies, infiltration tests through compacted bentonite columns are carried out using an experimental setup composed of common parts: (i) porewater and infiltration water reservoirs, (ii) pumping devices and (iii) a confined sample of bentonite. The infiltration/output solutions are injected/extracted through filters positioned in the top/bottom of the sample. The results obtained in these tests are strongly influenced by the properties of these filters. For this reason, it is very important how the chemical species and the fluid are transported in the filters to correctly interpret the experimental observations. The study presented in this work is framed in this context, in which a numerical sensitivity analysis of the transport properties and size of the filters has been conducted. For this purpose, a reactive transport model for bentonites (assuming this material as a double porosity media) formulated by the authors and fully implemented in the multiphysics platform, COMSOL, has been used to simulate a cation exchange-infiltration test in MX-80 bentonite defined in the “Chemical session” of the Task Force on Engineered Barrier Systems (EBS) organised by SKB AB. The results obtained depend on the tortuosity, porosity and thickness of the filters. These parameters have been estimated for the correct interpretation of the selected test.