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Sorption of radionuclides to the cementitious material NRVB under near-field conditions

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The current concept for the disposal of intermediate- and low-level waste in the United Kingdom involves the emplacement of the grouted waste confined in stainless steel canisters in a cementitious repository deep underground [1]. The NRVB (Nirex reference vault backfill) is a cementitious material specially formulated for this purpose, composed by a mixture of ordinary Portland cement (OPC), hydrate lime (Ca(OH)2) and limestone flour [2].
The movement of the radionuclides away from the repository is expected to be retarded by their limited solubility under the chemical conditions present in the repository (high pH, due to the cement, and low Eh, due to corrosion of the waste canisters) as well as, by sorption processes.
In the present work, the sorption of a series of radionuclides (I-, Cs+, Ni+2, Eu+3, Th+4 and U+6) to NRVB was assessed under near-field conditions (highly-alkaline pH and anoxic conditions). The experiments were carried using NRVB-equilibrated water (pH ~ 12.6) in NaCl 0.1 mol dm-3 as liquid phase, under a N2 atmosphere (O2 and CO2 free), according to the procedure proposed by Sutton et al. [3]. Linear, Langmuir and Freundlich isotherms were studied for all the radionuclides, and in all cases, the sorption of radionuclides fitted well with the linear model. The Rd (Csolid/Cliquid) observed experimentally varied in a wide interval that ranged from the low values of 0.012 and 0.033 dm3 g-1 for Ni+2 and I-, respectively, to values as high as 2870 dm3 g-1, obtained for Cs+. Results of the effect of cellulose degradation product on sorption to NRVB will also be presented.
When the Rd (Csolid/Cliquid) values of the radionuclides of interest for NRVB, were compared with the experimental Rd values for the individual components of NRVB, i.e. OPC, hydrated lime and limestone, it was observed that in the case of nickel and in absence of the organic ligands, Rd(NRVB) ≈ Rd(OPC) + Rd(Ca(OH)2) + Rd(limestone), confirming the validity of the additive model for this material.
References
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