Modelling the impact of fracture geometry on bentonite erosion

F.M. Huber1*, D. Leone1, M. Trumm1, A. Wenka2, I. Neretnieks3, L. Moreno4 and T. Schäfer1

1Karlsruhe Institute of Technology (KIT), Institute for Nuclear Waste Disposal (INE), P.O. Box 3640, D-76021 Karlsruhe, Germany.
2Karlsruhe Institute of Technology (KIT), Institute of Micro Processing Engineering (IMVT), P.O. Box 3640, D-76021 Karlsruhe, Germany.
3Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden
*florian.huber@kit.edu

Natural fractures are characterized by complex geometries [1]. Numerous laboratory and numerical studies carried out in the last decades have shown the importance of fracture geometry and aperture distributions on the fracture flow field. One of the most pronounced features is flow channeling arising from heterogeneity in fracture hydraulic conductivities as function of fracture apertures and geometries. These flow gradients lead to complex patterns of hydrodynamic dispersion of e.g. solute and particle/colloids present in the seeping water.

The “KTH” model [2] on bentonite erosion was used by Moreno et al. [3] to calculate bentonite erosion rates in a parallel plate fracture geometry (constant fracture aperture of 1mm). The aim of this study is to investigate the impact of fracture aperture on bentonite erosion behavior and bentonite erosion rates. For this, the KTH model was modified to incorporate normal distributions of fracture apertures to obtain more complex fracture flow fields. Simulations cover a range of standard deviations (STDs) (0.1mm, 0.3mm and 0.5mm) and mean fracture flow velocities (315 – 0.315m/yr).

Objectives

Hydraulic conductivities and Darcy flow fields

Based on the synthetic aperture distributions, hydraulic conductivity fields were calculated using the cubic law [5]:

\[ K_f = \frac{0.69}{12\mu} \delta^2 \]

where \( K_f \) is the hydraulic conductivity [m/s], \( \rho \) is the density of water [kg/m³], \( g \) is the gravitational constant [m/s²], \( \mu \) is the dynamic viscosity [Pa·s] and \( \delta \) is the aperture [m].

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REFERENCES