

THEBES - THMC Behaviour of the Swelling Clay Barriers (VTT)

Veli-Matti Pulkkanen, Michał Matuszewicz, Joonas Järvinen, Ville Sjöblom
VTT Technical Research Centre of Finland Ltd

Hydromechanical experiments

Functioning new laboratory equipment and techniques to study bentonite mechanical behaviour

- Stress path control
- Loadframe (250 kN) + high pressure triaxial cell (32 MPa)
- Disposal conditions can be reached
- Silicon oil: high temperature is possible
- Hydraulic equipment: fast loading is possible

Work will continue

- KYT2022 project Broctio
 - Fast loading
 - Effect of chemistry
- H2020 EJP HITEC
 - Effect of temperature

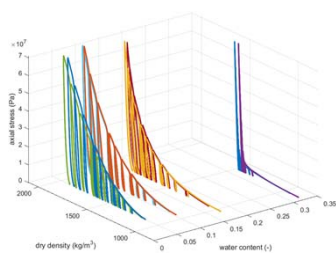


Figure 1. Example results from uniaxial confined compression.



Figure 2. Loadframe + triaxial cell with sample.

Microstructural studies

Focus on Atomic Force Microscope (AFM) studies of bentonite platelets

- Size and shape distributions
- Cooperation with KYT2018 Geobiokierto project

PhD Thesis by Michał Matuszewicz: "The microstructure of bentonite clay" (Dissertation held in Dec 2018)

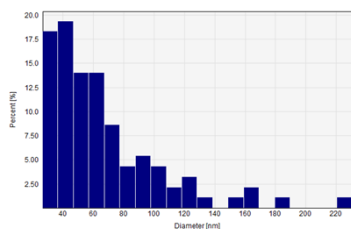


Figure 3. Montmorillonite platelet size distribution.

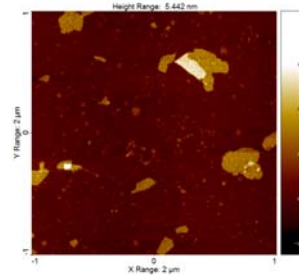


Figure 4. Montmorillonite platelets with AFM.

Chemical experiments

In situ ion selective electrode (ISE) development

- Modification of commercial ISEs
- Preparation of in-house made ISEs
- pH, Cl, Na, Ca sensitive electrodes

Experiments

- Online ISE measurements
- Standard chemical analysis of external solutions and post mortem samples

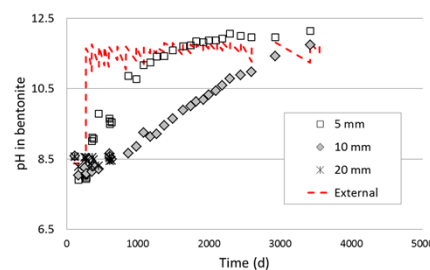


Figure 5. Example results: pH at different depths in bentonite and in the external solution of the diffusion cell sample. The solution chemistry was changed at 271 days from low-pH to high-pH.

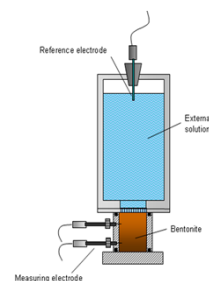


Figure 6. Schematic drawing of the diffusion cell. The diameter of the bentonite sample is 40 mm and the height 50 mm. The electrodes are 5, 10 mm from the solution-bentonite interface.

Modelling

D.Sc. (Tech.) thesis by Veli-Matti Pulkkanen:

"A large deformation model for chemoelastic porous media – bentonite clay in spent nuclear fuel disposal" (pre-examined)

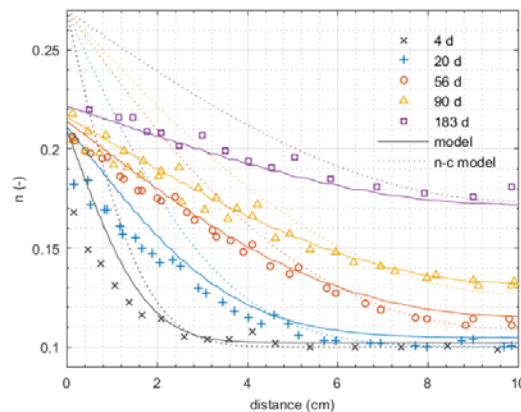


Figure 7. Example results from simulations: Water content profile of bentonite wetting by water vapour (from left). Solid lines – model in the thesis, dashed lines – non-coupled model, dots – experimental results by K-P Kröhn.