Temperature effect on in-situ THM behaviour of COx claystone

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1. Numerical Modelling, Temperature effect, In-situ THM behaviour, Over pressure
2. Introduction

The deep geological disposal is recognised as one of the most reliable solution for long-term management of radioactive wastes. The charactisation of in-situ THM behaviour of host rock is significant for the design of the underground disposal facility and for the long-term safety [1].

Indeed, the heat generated by the waste must not affect the favourable properties of the clay host rock for containment, especially its transport properties. In the near-field (the vicinity of gallery), the excess pore pressure generated by the thermal expansion of pore water could induce fracture re-opening or propagation. In the far-field, the zone subjected to thermal loading from two neighbor galleries could induce tensile or even shear failure and/or reactivate old fractures. The above behaviour could potentially alter the permeability of host rock as a result.

The overall objective of present work is to improve the knowledge of temperature alteration effect on in-situ THM behavior of host rock, to help optimize the repository design.

1. Model setup

This 2D plane strain generic model is a benchmark exercise proposed by European joint programme EURAD HITEC [2]. The geometry of this model is a cross-section of a heating gallery and host rock perpendicular to the gallery axis. Only a quarter of the full gallery is modelled thanks to the symmetry of the problem and the boundary conditions. The full computation is characterised by three phases: excavation (0 ~ 24 h), waiting (24 h ~ 6 months) and heating (6 months ~ 10 years), conducted by adjusting boundary conditions of gallery wall.

The computation is performed with the finite element code LAGAMINE, developed at the University of Liege. The Callovo-Oxfordian claystone (COx) is selected as the candidate host formation due to low permeability and good plasticity [3]. In this study, the influence of host rock behaviour is investigated: isotropic linear elasticity, transverse isotropy, and then isotropic Mohr-Coulomb criterion to represent the plasticity of host rock.

1. results & discussions

The evolution of pore pressure during waiting and heating phase is presented in Figure 1. Globally, the pore pressure drops in waiting phase due to the drainage from the gallery wall, then over pressure occurs after heating starts, which is caused by the discrepancy of thermal dilation between water and host rock.

The stress path at different locations shows the influence of the constitutive model (Figure 2). In anisotropic condition, the average stress of the host rock evolves horizontally and vertically in opposite trends. The yield surface is clearly evidenced in elastoplastic case, and the deviatoric stress decreases after the stress state becomes plastic.

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(a) (b) (c)

1. Pore pressure evolution during waiting and heating phase: (a) isotropic elasticity; (b) transverse isotropy; (c) isotropic elastoplasticity.

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(a) (b) (c)

1. Stress path: (a) isotropic elasticity; (b) transverse isotropy; (c) isotropic elastoplasticity.
2. conclusions

The over-pressure inside the host rock is strongly evidenced after the start of heating, and hydro-mechanical effect caused by anisotropy of host rock is also represented. The pore pressure has lower value where elastoplastic law is used.

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