EXPERIMENTAL STUDY OF THE IMPACT OF SELF-SEALING ON THE WATER AND GAS PERMEABILITY OF FRACTURES IN CALLOVO-OXFORDIAN CLAYSTONE

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The excavation of underground galleries for radioactive waste storage in deep clay layers typically creates a fracture-damaged zone in the surrounding rock. In Callovo-Oxfordian (COx) claystone, this fracture network desaturates the rock, leading to a loss of its confinement properties, such as low permeability and mechanical strength. However, these fractures exhibit a significant ability to self-seal, primarily driven by water resaturation, which helps reduce water permeability and partially restore the mechanical properties of the rock. This study investigates the impact of self-sealing on both water and gas permeability of COx claystone through a series of controlled experiments. Cylindrical specimens were artificially fractured and tested under different conditions, including varying orientations (parallel and perpendicular to bedding planes), temperatures, fracture opening widths, calcite content, and the use of different fluids (water and gas). The main objective was to evaluate how these factors influence the self-sealing process, particularly changes in permeability and fracture closure. The results showed that mineralogical composition plays a key role in the self-sealing effectiveness. A high calcite content, particularly above 40%, was found to hinder the self-sealing process, while a lower calcite and higher clay content enhanced it. The self-sealing process was rapid in the initial phase and typically stabilized after one month. Water permeability was partially restored to values between 10^{-18} and 10^{-19} m², compared to the natural intact permeability of around 10^{-20} to 10^{-21} m², and the fractures exhibited near-complete closure. Furthermore, the process was similarly effective for both parallel and perpendicular fracture orientations. Temperature showed minimal influence. When gas and water were simultaneously injected, a delay in permeability reduction was observed due to gas-induced desaturation. Nonetheless, self-sealing remained effective, significantly reducing water permeability in the long term.

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