Gas migration through water-saturated bentonite: laboratory experiments and microstructural analysis

Mohammed Zaidi*[1], Nadia Mokni[1], and Magdalena Dymitrowska[1]

[1]Institut de Radioprotection et de Sûreté Nucléaire – PSE-ENV / SEDRE / LETIS - 31 av de la Division Leclerc, BP 17, 92260 Fontenay-aux-Roses - France – France

Résumé

1 Introduction

France's nuclear waste repository is located 500 meters underground within a Callovo-Oxfordian clay formation, which acts as a natural barrier for containment (1). The repository is further protected by engineered barriers, such as MX80 bentonite plugs, which are designed to seal the repository (2). However, due to the expected significant production of hydrogen within the repository, this gaseous phase could modify the flows and mechanical conditions of the rock and bentonite plugs and therefore potentially impact the transport of radionuclides (3). The aim of this study was to investigate the properties of gas migration in a water-saturated bentonite-based material. For that, laboratory-scale experiments were conducted for gas injection in constant-volume cell filled with saturated MX80. X-ray computed microtomography (x-ray μCT) was used to analyse the microstructure and identify the preferential pathways for gas migration within the material.

2 Materials and Methods

The experimental setup involved using an X-ray transparent constant volume cell with dimensions of 22.8 mm in diameter and 22.1 mm in height. The cell was filled with MX80 bentonite prepared at a dry density of 1.4 g/cm3 and an initial degree of saturation of 4.37%. The MX80 sample was subjected to long-term hydration under low-pressure conditions. After the hydration stage, nitrogen gas was injected into the (saturated) specimen at controlled pressures ranging from 0.25 to 3 MPa. At regular intervals, the specimen was subjected to X-ray μCT imaging scans to monitor and observe changes in the microstructure occurring within the specimen over time.

3 Results

Preliminary results of this study indicate that gas breakthrough occurred after 30 days of injection, when the pressure reached 3 MPa. The measured gas permeability was 9.74.10-20 m2. 3D X-ray μCT images obtained at the end of gas injection showed the development of a network of porosity and microcracks, allowing the gas the migration of gas within the sample.

*Intervenant