Contribution ID: **884**

Type: **Oral Presentation**

Condensation of vapor in a cracked sandstone revealed by in-situ rapid neutron tomography

Tuesday, 23 May 2023 15:00 (15 minutes)

Among the processes that involve two-phase flow in porous media, phase change is less explored because of its complex nature due to the strong coupling between heat and mass transfer. Nevertheless, condensation processes are present in many fields, such as applications related to nuclear safety and durability of concrete structures, condensation in porous fabrics and insulations, steam-based gas recovery methods, underground contamination removal, and integrity of geothermal and CO<sub>2 storage reservoirs. Building upon the previous works on vapor condensation using high-speed neutron radiography (Lukic et al., 2021 and Gupta et al., 2022), in this work, 3D rapid *in-situ* neutron imaging acquired at 30 seconds per tomography is utilized to study condensation in a fractured sandstone. A predefined mixture of air and water vapor is injected at a constant flow rate into a cylindrical sample of Fontainebleau sandstone with a splitting crack along its height. The injection experiments were performed at the Institute Laue Langevin Grenoble (ILL) using the imaging instrument NeXT (Neutron and X-ray Tomograph) (Tengattiniet al., 2020). Successive rapid neutron tomographies are taken during the injection of vapor (2300 s) to investigate the water evolution inside the sample, and two higher resolution neutron tomographies are captured before and after the injection period to evaluate the overall condensed water. Furthermore, X-ray tomography is performed prior to the vapor injection, and part of the sample is scanned by synchrotron microtomography with a pixel size of 6.5 micrometers. This makes it possible to extract the microstructure and morphology of the crack and the porous matrix and evaluate the spatio-temporal accumulation of liquid water and its migration from the aspects of the crack and the matrix. The injected hot vapor cools down along its pathway toward the inlet of the sample causing the influx temperature to increase constantly. The condensation of the vapor fills up the pore space of the sample, thus a higher pressure is required to continue the vapor injecting as time passes. Water first appears near the inlet and propagates toward the further areas of the sample. The crack stays dryer compared with the areas around it, and the liquid water solely accumulates in the tighter areas with smaller widths inside the crack. The condensed water that is forming in and near the crack constantly diffuses into the porous matrix due to the capillary effect and the pressure buildup in the crack. Consequently, the areas near the crack accumulate more water content from the crack than the inner areas because the water content there exceeds the critical value and can be pushed away by the elevated pressure in the crack. The water front is measured and observed to linearly propagate both parallel and normal to the crack surface. Finally, the first results from a numerical model will also be introduced that further sheds light on the condensation process.

Participation

In-Person

References

- Gupta, Ritesh et al. (2022). 'Experimental characterisation of transient condensed water vapour migration through cracked concrete as revealed by neutron and x-ray imaging: Effect of initial saturation'. In: Cement and Concrete Research 162, p. 106987.

- Lukic, Bratislav et al. (2021). 'Visualising water vapour condensation in cracked concrete with dynamic neutron radiography'. In: Materials Letters 283
- Tengattini, Alessandro et al. (2020). 'NeXT-Grenoble, the Neutron and X-ray tomograph in Grenoble' . In: Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 968, p. 163939.

MDPI Energies Student Poster Award

Yes, I would like to submit this presentation into the student poster award.

Country

France

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

Primary author: NEMATI, Arash (Universite Grenoble Alpes)

Co-authors: Dr LUKIĆ, Bratislav (European Synchrotron Radiation Facility (ESRF)); Dr TENGATTINI, Alessandro; Dr GUPTA, Ritesh (Université Grenoble Alpes); Dr BRIFFAUT, Matthieu (École Centrale de Lille, LaMcube); Dr SÉCHET, Philippe (Université Grenoble-Alpes, LEGI)

Presenter: NEMATI, Arash (Universite Grenoble Alpes)

Session Classification: MS03

Track Classification: (MS03) Flow, transport and mechanics in fractured porous media