Contribution ID: **55** Type: **Oral Presentation**

Predicting and measuring pore-scale capillary pressures associated with meniscus movements during slow imbibition

Wednesday, 1 June 2022 10:30 (15 minutes)

Multiphase flow in porous rock is of vital importance to several issues facing the world at present. It is key to contaminant transport and subsequent remediation, subsurface energy storage and carbon dioxide capture and sequestration. Subsurface flow is typically characterized by having a low capillary number. The fluid displacement is therefore controlled by the capillary pressure across the fluid interface. Being able to predict the capillary pressures that lead to pore-by-pore displacement events is therefore vital to understanding the displacement patterns.

Since drainage consists predominantly of piston-like displacements, the capillary pressures resulting in these displacements can be estimated using the cylindrical Young-Laplace formulation in pore throats. Imbibition is a more complex displacement process[1], necessitating capillary pressure models for snap-off and cooperative pore filling events that require more complex formulations[2], [3]. However, it is still unclear whether these models can be used to sufficiently describe imbibition in e.g. pore network models (PNMs). Here, we address this by measuring the capillary pressures of imbibition displacement events imaged using dynamic micro-CT imaging in a glass beads pack by Schluter et al.[4], and comparing these on a pore-by-pore basis to capillary pressure calculations commonly used in quasi-static PNMs. A crucial challenge to do this, is that local contact angles and the geometry of the pore space are needed. Therefore, we determined image-based contact angles using the conventional geometric[5], thermodynamic[6], force-based[7] and local geometric[7] contact angles. The latter was deemed most suitable for use as input in the capillary pressure models as its distribution was narrower than that of the other types of contact angles, suggesting it accounts for the local hinging of contact angles which occurs during imbibition. Furthermore, (semi-)analytical capillary pressure models require a simplification of the local geometry. We used a maximum inscribed sphere[8] PNM as well as a watershed segmented (Avizo 2020.3 Thermo-Fisher Scientific) PNM to supply this. The results obtained from each PNM were compared to assess the impact they have on the output.

The analytical models were compared to local capillary pressure measurements prior to each displacement event, derived from the curvatures of the fluid interfaces in the µCT images. This makes it possible to pin down the leading cause of errors in simplified multiphase flow models and improve them in the process. The improvement of pore-scale multiphase flow models has implications for carbon dioxide sequestration, contaminant transport, etc.

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Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

Primary author: ELLMAN, Sharon (Universiteit Gent)

Co-authors: MASCINI, Arjen (University of Gent); BULTREYS, Tom (Ghent University)

Presenter: ELLMAN, Sharon (Universiteit Gent)

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