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Contribution ID: **468** Type: **Oral Presentation**

Modelling pressure-saturation curves that exhibit hysteresis and forced imbibition with the pore-morphology method

Wednesday, 2 June 2021 14:30 (15 minutes)

The key to accelerate research and production in the energy industry resides in the efficient and generally applicable modelling of two-phase flow at the pore-scale. Here, we present the capabilities of the pore-morphology method (PMM) that we developed during the past two decades and our recent advancements.

The PMM was originally introduced in 2001 by Hilpert and Miller to model the pressure-saturation curves of a drainage process based on 3D scans of the micro-structure of a porous medium, for example µCT images of rocks. Since then, the PMM has found its place somewhere between pore-network models (PNM) and direct numerical simulations (DNS), frequently using the Lattice Boltzmann method. PMM combines the geometric analysis of the pore space to distribute the two fluid phases (as does PNM) with a direct numerical simulation on the original micro-structure (as does DNS), albeit only considering single-phase flows.

In 2005, Schulz, Becker and Wiegmann added the capability to compute relative permeabilities to the PMM by running single phase flow simulations on either of the two phases. Later, Becker et al. enhanced the PMM to model also imbibition and residual phases, and added entry pressure artefacts. Additionally, the flow solver was changed from a Lattice Boltzmann implementation (ParPaC) to a FFT-based implementation (FFF-Stokes, EJ-Stokes, SIMPLE-FFT) and to an adaptive grid-based implementation (LIR). In 2014, Schulz et al. introduced varying contact angles into the PMM. The changes in the flow solver resulted in only small changes to the solution because: (a) the implementation of boundary conditions is slightly different between collocated and staggered grids (ParPaC vs. SIMPLE-FFT and LIR), (b) the grid-coarsening produces different systems of equations (SIMPLE-FFT vs. LIR), and (c) the stopping criteria can be reached by different paths even for the same discretization as the solution method changes, and all solvers are iterative in nature. Changing the flow solvers has had however a remarkable impact in decreasing run-times and memory requirements. A good example for this is the use of velocity- and pressure-fields from simulations with a similar saturation as initial guesses for the next simulation.

For all that, a higher impact comes from modifying the algorithms that distribute the phases in the micro-structure. In this spirit, this presentation will show how the PMM can be extended to model hysteresis and forced imbibition and, so, create more complex and real pressure-saturation curves than previous versions of the PMM.

Time Block Preference

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

References

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