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Extension and Uncertainty Modeling of Imbibition Processes using the Morphological Method –a Reality Check

Wednesday, 1 June 2022 11:15 (15 minutes)

A prime target of Digital Rock Physics is to compute multi-phase flow saturation functions in a time-effective and cost-competitive way. Traditional approaches for flow simulations in porous media may be split into full-physics direct numerical simulations and pore network modeling. Associated with high computational demand and scale limitations, full-physics direct numerical simulations, such as e.g. Lattice Boltzmann, are not suited for uncertainty modeling. It requires the simulation of many scenarios to explore the uncertainty range, e.g. with a Monte Carlo type of sampling. However, there are hybrid methods such as the morphological method, a geometry-based approach to model the two-phase fluid distribution in the pore space, combined with single-phase direct flow simulations on the actual pore structure, the digital twin. This approach is still computationally favorable.

Good agreements for drainage capillary pressure sets of water wet systems have already been found in the past. However, the method lacks capabilities when modeling the complementary imbibition processes, particularly the forced imbibition part, which was missing so far. To overcome the wetting state limitation, we introduced multiple contact angles and a turn of material wetting state. Further, we combine an imbibition and drainage operation in order to extend the imbibition process to the forced imbibition branch.

To achieve a realistic description and model uncertainty, we studied the impact of contact angle distribution and its spatial variation in combination with a turn of the wetting state of material after the drainage process. By the developed approach, full-scale capillary pressure and relative permeability saturation functions were calculated and varied in a physically meaningful way. Comparison to experimental data (Berg et al. 2016) showed good agreement of the relative permeabilities. Additional computation of topological measurements gave further insight into the uniqueness of the results.

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References

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Time Block Preference

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

Participation

Unsure

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