



Contribution ID: 787

Type: **Poster Presentation**

Nuclear magnetic resonance of drainage and imbibition: Correlating structure and dynamics

Thursday, 25 May 2023 15:30 (1h 30m)

Drainage, imbibition and steady state two phase flow in porous media have an abundance of applications in physics, chemistry and engineering. Experimental methods to capture this phenomena are often limited to two dimensional setups, refractive index matching and/or are too slow to capture the dynamics at a resolution relevant to the physics at the pore scale. We utilize nuclear magnetic resonance methods to retrieve 1D spin-echo intensity and phase-angle profiles with a temporal and spatial resolution of 20 ms and 70 microns respectively. We compare first and secondary imbibition, drainage and steady state two-phase flow of a wide variety of three dimensional microstructures ranging from bead-packs, sticky hard spheres and 3D printed heterogeneous porous media. The latter is used to include both model media based on Gaussian random fields and complex microstructures based on micro-computed tomography data of snow. We extend analysis of standard 1D spatial profiles used to determine water saturation, to measure velocity and correlate signal attenuation to local velocity fluctuations. With this study we demonstrate that size and duration of local surges can be related to the heterogeneity of the porous media and has future potential to measure effective dispersion coefficients in steady state two-phase phase flow.

Participation

In-Person

References

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Energy Transition Focused Abstracts

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Session Classification: Poster

Track Classification: (MS06-A) Physics of multiphase flow in diverse porous media