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# Toward integration of NMR and traditional centrifuge capillary pressure curves: A comparison study

*Monday, 30 May 2022 09:40 (1h 10m)*

Capillary pressure is the difference in pressure across the interface between two immiscible fluids and is dependent on interfacial tension, pore size, and wettability. Understanding capillary pressure is crucial in determining hydrocarbons production, CO2 and/or hydrogen underground storage. Capillary pressure laboratory measurement is performed by mercury injection, porous plate, or centrifugation. The latter "centrifuge" method has been widely accepted technique to establish capillary pressure curves, due to the time needed to complete a test and its non-destructive. Analysis of the centrifuge saturation measurement is usually performed using commercially available core analysis simulators (e.g., SENDRA or CYDAR) that function by either history matching of experimental behaviour or analytical solutions.

On the other hand, Green Imaging Technology proposed a protocol (trademarked as GIT-CAP) to obtain capillary pressure curves, through combining centrifuge method with Nuclear Magnetic Resonance (NMR) saturation distribution measurements on de-saturated core samples. The measured saturation profiles together with centrifugal force/spinning velocity enables the capillary pressure curve to be computed via correlations. This approach requires at least two, but preferably three, centrifuge speeds, while up to ten speeds might be needed if the traditional centrifuge technique is used alone. However, to the authors knowledge, the centrifuge displaced fluid measurements acquired during NMR GIT-CAP were never used to model local capillary pressure and compare to GIT-CAP. This was mainly due to the limitation of capillary pressure correlations implemented into the commercial core analysis simulators.

To that end, we have developed an in-house code (SBAG-CAP) in MATLAB to calculate drainage capillary pressure (with a view to add imbibition in future). The SBAG-CAP code has 5 models that were carefully selected due to their common acceptance by Energy companies and their compatibility with those used in GIT-CAP. The models work by finding a minimum of a constrained nonlinear multivariable function with default initial guesses provided by Adams 2016. This function is the difference between the experimentally determined average saturation at each speed during steady state/hydraulic equilibrium and that predicted by the chosen model.

Current work is meant to evaluate and validate SBAG-CAP and compare its capillary pressure results with the core analysis simulators, namely SENDRA and CYDAR. Thus, we used Vinci centrifuge to run a multi-speed drainage test on 5 outcrop sandstone and carbonate samples. Five speeds (300-1500 RPM) were selected, and each rotation was scheduled for 3 days, to ensure equilibrium. High-definition video camera (which is automatically adjusted to the rotational speed) was used to record the displaced water level in the transparent tank and then communicated to centrifuge software to calculate the displaced water volume every 30 sec. To achieve a "uniform"saturation profile, the samples were flipped and spun again at 1500 rpm for 3 hours. The recorded displaced water volume over time was used to generate local capillary pressures simulated in CYDAR, SENDRA and SBAG-CAP. Results show local capillary pressures obtained from SBAG-CAP were comparable to both SENDRA and CYDAR, indicating a close match and reliability of SBAG CAP, with very good capillary pressure curves similarity between CYDAR and SBAG-CAP.

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Time Block A (09:00-12:00 CET)

## Participation

Online

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