Centrifuge Data Correction for Complex Carbonate Rock Samples

Ahmad AlZoukani[1,*], *Farhan* Ali[1], *Mohammed* Al Hamad[1], *Gallyam* Aidagulov[1], and *Wael* Abdallah[1]

[1]Schlumberger Dhahran Carbonate Research Center, 31942, Dhahran, Saudi Arabia

[*]Corresponding author : aalzoukani@slb.com

Abstract. Capillary pressure measurements are essential to reservoir characterization. The centrifuge technique is widely used to obtain capillary pressure curves for rock samples. The generated experimental data, however, require conversion of average saturation into local saturation to get corrected capillary pressure curves, which is often complicated by the need of fitting of complex data. On the contrary, the capillary pressure curves generated from porous plate technique are considered ground truth without the need for corrections, it is, however, a lengthy technique and might require months of experimentation. Therefore, the objective of this study is to validate the corrected generated capillary pressure curves, from centrifuge with these generated from the porous plate. Two carbonate rock samples were selected for this study. The samples were first characterized and their petrophysical data were measured, along with CT scan imaging. The samples were first fully saturated with formation brine, before they were centrifuged by model oil, to irreducible water saturation. The samples were then unloaded, cleaned, and prepared for porous plate testing. The centrifuge tests were planned and conducted at ambient and 2000 psig confining pressure, while the porous plates tests were conducted at 800 and 2000 psig confining pressure. Temperature was maintained at 24°C during all the tests. The water production was determined at each pressure step after attaining production stability. Using the water production data at each applied pressure, the capillary pressure curves were generated. Standard core samples of 1.5" diameter was considered for all testing, except for the centrifugation testing at higher confining pressure, where sample of 1.0" was plugged from the original sample and used. This is due to the limitation of the centrifuge machine. The generated centrifuge data for the two samples were then corrected, using Hassler-Brunner and Forbes's second approximate solutions, to convert the acquired average water saturations from centrifuge into local saturations. The conversion required the use of a complex fitting method, due to the complexity of the experimental data, which reflects the heterogeneity of the used carbonate samples. The cubic spline fitting method was used and showed high degree of experimental data fitting and it follows the complexity of the data. The corrected capillary pressure curves at ambient and 2000 psig confining pressure centrifuge tests were then compared to the ones generated from porous plate at 800 and 2000 psig. The capillary pressure curves of ambient pressure centrifuge and 800 psig porous plate tests showed good agreement, which validates the corrected centrifuge capillary pressure data using Forbes's second solution. The capillary pressure curves of the 2000 psig confining pressure from centrifuge and porous plate tests, however, showed some degree of mismatch, especially at the early capillary pressure points. At high capillary pressure points, however, minor mismatch was observed Although the plugged sample showed similar pore structure under CT scan, the mismatch between the capillary curves could be attributed to the heterogeneity of the samples. This study provides a workflow and a robust fitting method to correct complex capillary pressure data, generated by centrifuge, for heterogeneous carbonate samples, accounting for local saturation instead of the average water saturation. Therefore, more reliable capillary pressure data. The developed workflow was validated in this study, across "the ground truth" porous plate method and showed very good agreement. The results of this study will help in valid and accurate capillary pressure curves generation from centrifuge, which is crucial for accurate reservoir characterization and fluid distribution.