Estimation of Residual Gas Saturation by Imbibition Capillary Pressure Curves

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Introduction

One of the main challenges in water saturation of gas reservoirs with aquifer strength is lack of consideration of residual gas. The technique should be widely used to describe water saturations in reservoirs with residual hydrocarbon columns, providing better estimates of initial hydrocarbons in place than with more commonly used drainage data.

Therefore, as part of a saturation-height study, an empirical model relating imbibition capillary pressure curves to their drainage precursors was created for both spontaneous and forced imbibition data. To obtain the right values, spontaneous imbibition curves was derived by IFD (Imbibition from Drainage) method. Secondly, forced curve was derived by cross plotting of difference of water saturations in core flooding values and maximum free viscous imbibition with their corresponding porosity values. In this procedure, most common MICP (Mercury Injection Capillary Pressure) data were used to capture both imbibition and drainage data. Centrifugal Imbibition water saturation tables were generated based on difference of drainage and imbibition saturations of MICP curves at corresponding capillary pressure values of centrifugal drainage data measured in laboratory.

Results and Discussion

The obtained samples; results show that there are similar values of mentioned saturation difference for each rock type in case of forced imbibition and we can allocate nearly same value for estimation of forced residual gas saturation as the final point of imbibition capillary pressure curves.

These two parts of imbibition curves were verified against log derived water saturations from wells in the initial study area. The match was excellent in those wells considered to have reliable petrophysical evaluations.

Conclusion- The mentioned procedure (IFD of both spontaneous and forced models) represents the first publication of a technique for creating meaningful spontaneous and forced imbibition capillary pressure curves and consequently reliable residual gas saturation in transition zones near the wellbore.

Image1

Full Cycle of Capillary Pressure Curves of candidate sample

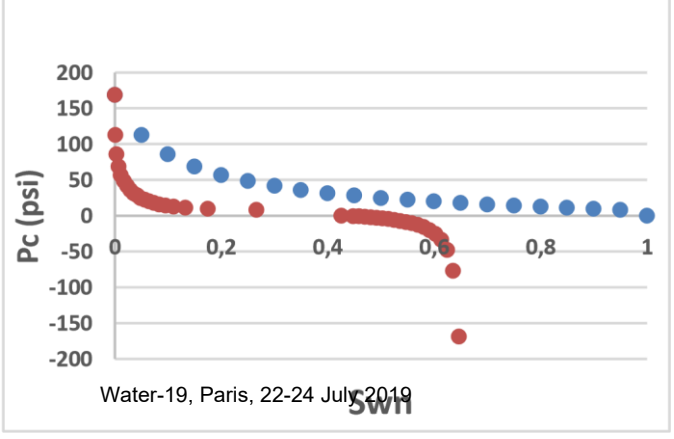


Image2

End Point Data of Forced Imbibition Capillary Pressure Curves

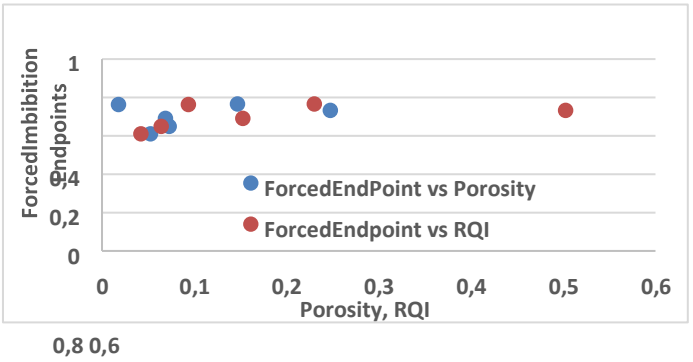
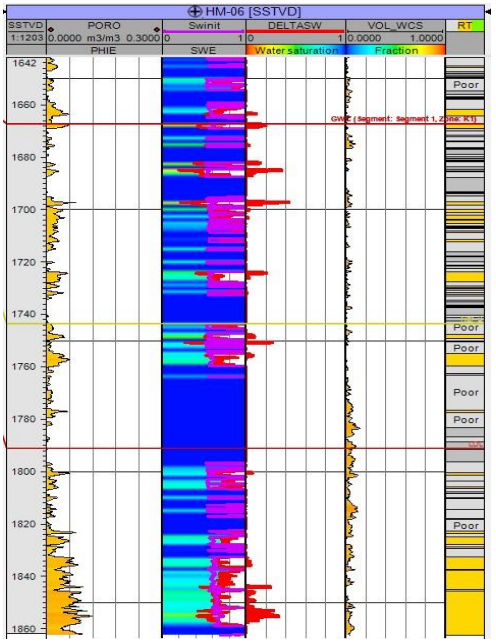


Image3

Comparison of Log and Core derived water saturation from candidate well



Recent Publications (minimum 5)

1. Civan, F., Rasmussen, M.L., (2002), "Further Discussion of Fracture Width Logging While Drilling and Drilling Mud/LossCirculation-Material Selection Guidelines in Naturally Fractured Reservoirs", SPE Drill & Compl 17 (4), 249-250, SPE 81590-DS
2. Civan, F. 2007. Reservoir Formation Damage- Fundamentals, Modeling, Assessment, and Mitigation, second edition, Burlington, Massachusetts: Gulf Professional Publishing.
3. Dyke, C.G., Wu, B., Milton Taylor, D. (1995), "Advances in Characterising Natural Fracture Permeability From Mud Log Data," SPEFE, Sept, 160.
4. Golf-Racht, Van, T. D., (1982), Fundamentals of Fractured Reservoir Engineering. Elsevier Publishing Company, 710 pp.