

Reservoir Fluids Saturation Analysis in a High GOR Environment

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Abstract

Reservoir fluids properties can change over time during the well production life Span. Monitoring fluids distribution in a producing reservoir is essential as operators consider it critical to differentiate gas phases in high GOR oil reservoirs down hole, especially when fluid samples must be analyzed in the laboratory. Analyzing two or three phase reservoirs, it becomes a big challenge when properties change, due to compression and pressurization from water injection or expansion due to production from the oil interval. Pulsed neutron logging is beneficial to characterize two or three phase saturation evaluation in high GOR environment. The study here presented shows a methodology to determine reservoir fluid distribution and current saturation profiles in specific high GOR fields. The pulsed neutron technology, used for data acquisition, is equipped with three detectors measuring gamma ray emission from generated neutrons interacting with the environment. In particular, the presence of a third extra-long spaced detector provides a significant sensitivity to gas related to the formation and allows a direct gas quantification. The subject field presents a low formation water salinity (around 20,000 ppm NaCl equivalent) and so it precludes the use of conventional pulsed neutron capture mode like sigma (Σ) logging, so a salinity independent method like inelastic carbon/oxygen (C/O) analysis is necessary for hydrocarbon detection. The integration of C/O results with inelastic gamma ray ratio-based technique used to quantify gas saturation, is capable to characterize and deliver three-phase fluid saturations. The analysis of the data to determine saturation fluid volumes requires the use of Monte Carlo N-Particle (MCNP) based modeling. These models emulate theoretical responses of formation oil, gas and water, based on well-specific details correction like well completion hardware, borehole fluid properties, cement annular composition and lithology and in-situ formation. The calibration of measured data with these model responses are measured and converted in saturation. The authors have presented Field examples showing two and three-phase hydrocarbon distribution profiles in this paper. Results clearly show the ability to differentiate gas from high GOR oil and quantify saturations in these environments.