

Laboratory Study of Oil-Based Mud Filtrate Formulations for Accurate Carbonate NMR Interpretation

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Abstract

The effect of drilling mud filtrate invasion needs to be properly considered for the logging tools of shallow investigating depth such as Nuclear Magnetic Resonance (NMR). The discrepancy may occur if the NMR interpretation workflow mainly developed for water-based mud (WBM) is applied to the oil-based mud (OBM). The potential irreducible water change is mainly attributed to wettability alteration by the emulsifier in OBM for some high-quality (permeability) rocks. This study is to assess the OBM of different formulations for accurate carbonate NMR interpretation.

The experimental procedure includes the basic characterization of rock samples of low and high quality and OBM filtrates of different emulsifier types and concentrations, the NMR T2 cutoff determination of routine water/air for WBM versus water/filtrate/air for different OBM filtrates, and in-situ dynamic filtrate invasion with NMR monitoring. The filtrate invasion is simulated by centrifuge spinning the 100% water saturated sample in the filtrate and subsequently, the T2 cutoff is determined at the same speed as the routine water/air T2 cutoff.

The experimental results of two filtrates and rock samples indicate that T2 cutoff varies with filtrate compositions and rock quality. The routine T2 cutoff of the rock samples is from 290 ms to 360 ms, higher than the carbonate default value of around 100 ms. The T2 cutoff of one filtrate with less emulsifier and higher bulk T2 decreases slightly to 300 ms for all rock samples, and T2 cutoff of another filtrate with more emulsifier and lower bulk T2 drastically decreases to around 100 ms. It is apparent that NMR interpretation workflow of WBM can be applied to one filtrate and significant adjustment is needed for another filtrate. The dynamic filtrate invasion and more rock samples confirm the above observations.

The current study identifies the oil-based mud formulation which has the least effect on the oil/water distribution and reduces the uncertainty in NMR logging interpretation of oil-based mud carbonate wells.