Nuclear magnetic resonance laboratory study of a tight sandstone for robust permeability prediction

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Abstract. Laboratory nuclear magnetic resonance (NMR) rock core experiment to obtain calibration parameters is essential for accurate formation property assessment from the NMR logs. These parameters may include T2cutoff to distinguish bulk volume irreducible (BVI) and bulk volume movable (BVM) and coefficients (C, m, and n) in the Timur-Coates equation. Unconventional tight sandstones may be desaturated by sufficiently high pressures through trial and error. This study reports a new experimental and data analysis procedure to develop the T2cutoff models from two tight gas wells and to determine parameters of Timur-Coats permeability equation with both effective and total porosity. A modified exponential model is applied to fit the T2cutoff data as a function of desaturation pressure to obtain the asymptotic T2cutoff at irreducible saturation for all samples. T2cutoff values (~15ms) are derived for two groups from their different average experimental results (16.2 and 32.1ms) at different desaturation pressures. The parameters of Timur-Coates permeability equation are obtained by an optimization procedure which minimizes difference to the 1 to 1 line in a measured vs. predicted permeability plot. The proposed laboratory calibration procedure overcomes certain instrument and sample selection limitations and determines the calibration parameters following a standardized optimization procedure instead of the qualitative criteria for different interpretation scenarios. Furthermore, the developed T2cutoff model and optimized Timur-Coats permeability equation parameters have been successfully applied to 4 tight gas wells which verified to be agreed well with production and laboratory data.