Estimating NMR T_2 Cutoff in a Brazilian Carbonate Reservoir

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Reservoir characterization involves the study of the petrophysical properties in the system; therefore determine them with accuracy represent a significant challenge in the oil industry. In carbonate formations, this analysis becomes more complex, as a result of the inherent heterogeneity in the pore architecture. This varying structure is the result of the diagenesis process caused after their deposition that affects the behavior and quality of the reservoir.

Nuclear Magnetic Resonance (NMR) logging has been widely used in the formation evaluation for determining petrophysical properties of rocks, the tool provides a measurement of the relaxation time (T_2), which is translated to the pore size and fluid volume estimation.

According to the T_2 distribution, it is possible to estimate the bound fluid volume (BFV) and free fluid volume (FFV), applying a T_2 cutoff to partitioning these volumes. Straley et al., (1994), established a default value of 33ms as a typical value to use in sandstone formations; and in Carbonates, T_2 cutoff values are generally higher due to the reduced surface relaxivity, default values of approximately 90ms have been reported in the study done by Coates et al., (1999).

Generally, T_2 cutoff value is estimated using core plugs analysis in the laboratory, however in absence of such facility; default values based on lithology are used for T_2 cutoff. T_2 cutoff, however, are affected not only by lithology, but also by several other factors, such as pore-wall chemistry, minor paramagnetic/ferromagnetic components, texture, pore throat to pore body ratios, and other factors not well understood. For all these, when core samples are not available for analysis and instead of assuming a relaxation time cutoff, an attempt has been made to determine T_2 cutoff value by integrating pressure points with NMR log data. This study was proposed by Haldia et al. (2013), after observed that in spite of good porosity and permeability, the free fluid volume estimated with NMR log after applying the classic cutoff was quite low, indicating that T_2 cutoff value was not appropriate for computing bound and free fluid porosity in that field.

The goal of this present work is to determine a T_2 cutoff value using NMR data, applying two different methodologies. A supervised method which consist in the analysis of the core lab measurements results and a non-supervised method that consist in the integration of the formation tester and NMR logs data, this suggested methodology is proposed as an alternative way to estimate a T_2 cutoff in the case not core data are available.

From the results, establish a critical analysis between the two different methodologies applied and interpret the parameters that may influence in the estimation of the T_2 cutoff value. Approaching the results, the estimated petrophysical properties will be more accurate.

At the same time, analyze the crucial relationship between the Hydraulic Units concept and NMR data making possible the hydraulic unit zonation indicators, referred to as flow zone indicators (FZI). FZI can be derived from the T_2 cutoff estimation used for determining producible fluid from relaxation time distributions which may vary slightly as a function of rock types.

Key words: Nuclear Magnetic Resonance (NMR), Transverse Relaxation Time Cutoff (T_2 Cutoff), Brazilian Carbonates.

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