NMR PETROPHYSICS ON ROCKS SATURATED WITH ALCOHOL: AN ALTERNATIVE CORE ANALYSIS WORKFLOW

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ABSTRACT

Rock core analysis provides essential data for exploration, evaluation and production of oil and gas reservoirs. Rock properties such as porosity, pore size distribution and permeability are examples of indispensable information for calibrating log measurements, and reservoir characterization and modeling.

Prior to standard core analysis, original formation fluids must be completely removed from the cores. This is generally accomplished through a extraction technique, where the rock samples are soaked into hot solvent that is continually distilled, condensed and refluxed, until the solvent in contact with the core remains free of hydrocarbons and salt. The remaining solvent and water in the core are removed with a drying oven. While routine core analysis (RCAL), such as grain density, effective porosity and absolute gas permeability, are performed with the cleaned and dried core samples, most of the special core analysis (SCAL), such as electrical properties, capillary pressure curves and nuclear magnetic resonance (NMR) , are performed on core plugs fully saturated with brine. To achieve this state, plugs are initially saturated under vacuum with degasified brine and confined into a pressure vessel for several hours.

In this work we are going to evaluate an alternative workflow that can anticipate the access to several petrophysical properties. It consist of bypassing the sample drying and saturation steps, introducing a NMR measurement step just after the last extraction cycle with the solvent methyl alcohol, so that porosity, pore size distribution and permeability can be faster and indirectly accessed from the NMR before standard measurements, which are very time-consuming. This proposed approach relies on the following assumptions: (*i*) methyl alcohol is an organic derivative of water, presenting a large degree of chemical similarity between them; (*ii*) the core is fully saturated with alcohol after the last extraction cycle for salt removal; (*iii*) the relaxation behavior of methyl alcohol and water occupying the pore space is dominated by the same mechanisms, producing equivalent NMR relaxation profiles. In order to verify this, it was compared the results from standard petrophysical characterization with the proposed workflow. A set of 19 cores samples (1.5 inch x 2 inches plugs), composed of sandstones and carbonates outcrops samples were used in this study.

According to the results, the assumption that samples were fully saturated with alcohol after the salt extraction was verified by comparing routine core porosity measured by gas expansion and the alcohol-based NMR porosity; differences among them are smaller than one porosity unity. Additionally, the assumption regarding the equivalence of the relaxation response can be further verified by comparing the NMR T2 relaxation distributions. The cores presented very similar relaxation profiles and, therefore, several SCAL deliverables from the NMR relaxation distributions, such as pore size distribution, clay bound water, irreducible and movable fluids. Moreover, if the samples are part of a core-logging program, NMR permeability estimators, such as those proposed by Kenyon and Timur-Coates, can also be obtained. In conclusion, compatibility between standard procedure and this novel approach validates the results.

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KEYWORDS: CORE ANALYSIS, PETROPHYSICS, NMR.