Experimental Determination of the Shale Wettability

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In recent years, the share of unconventional reserves in global oil production has grown. Exploration and development of unconventional resources require novel effective laboratory methods for characterizing the reservoir properties. The study and analysis of local shale deposits such as Bazhenov Formation (BF) in Western Siberia is a priority among non-traditional reservoirs. Wettability of the reservoir rock is one of the most important factors affecting the residual saturation and filtration properties in the formation. However, as multiple petrophysical studies show, conventional laboratory methods for characterizing the wettability are not applicable for this type of formations.

In this work, the fluid saturation and wettability of BF rock samples were studied utilizing a nuclear magnetic resonance (NMR) and the method of determining the wetting contact angle by a surface drop. We have provided the petrographic description of rocks using ultrathin sections for grouping the samples. In addition, we used data on the organic content (TOC) obtained by the Rock-Eval method on a HAWK RW instrument (Wildcat Technologies) and the results of lithological typing on thin sections using an Axio Imager A2m polarizing microscope (Carl Zeiss) for detailed analysis of NMR and contact angle methods results.

To assess wettability by NMR, T2 relaxation curves were constructed for extracted (cleaned), kerosene-saturated and water-saturated samples. A comparison of the relaxation spectra for kerosene and water enabled evaluation of the wettability for each by T2 log mean values. The calculation of the wetting angle was carried out for samples before and after the extraction, which revealed minor changes in the nature of the rock wettability because of cleaning. Thus, for this type of rock, the drop method for determining wettability turned out to be significantly sensitive to the shape of the OM distribution in the rock. Correlations built on wettability (by NMR results and calculated wetting angle) vs. TOC and lithotyping illustrated the dependence of rock wettability behavior on both the lithotype and the TOC content.

The calculation of the wetting angle provided an initial assessment of the surface wettability of the rock and made it possible to establish the relationship between the wetting angle and the content of organic carbon (TOC), which is relevant for BF rocks. The lithological description of thin sections was used to highlight groups with a similar wettability of the rock. For the integral characteristics of the samples wettability, the NMR relaxometry method was proposed.