NMR applications for Bazhenov shale core samples analysis and filtration experiments under reservoir conditions

In recent years, the significance of unconventional reserves in global oil production is increasing while the core analysis laboratories are searching for efficient methods on unconventional resources evaluation. Standard laboratory methods on estimating the porous structure and fluid saturation are not applicable or not accurate in study of the low-permeable porous samples. Significant part of light oil reserves in Russia is concentrated in low-permeability reservoirs, for example in Bazhenov formation. Development of Bazhenov formation has a high risk of incorrect predictions on uncertainty of reservoir variables such as rock porosity, fluid saturation and relative permeability. Nuclear magnetic resonance (NMR) studies allow us to evaluate hydrocarbon deposits at an early stage of exploration and provide important input for enhanced oil recovery (EOR) method numerical simulation.

The experimental studies were carried out on a low-field NMR relaxometry unit. Sample porosity, NMR fluid identification based on T1/T2 maps and filtration experiments under reservoir conditions (high pressure and temperature) were performed. Additional filtration experiments were conducted in order to provide information on CO_2 diffusivity and determine the relative permeability curves for complex multiphase system. The estimation of CO_2 diffusivity coefficient and relative permeability for oil-gas system was obtained for CO_2 injection EOR method.

Experimental study of NMR application for Bazhenov formation core samples has shown that proposed four-stage methodology for NMR measurements is appropriate for the samples with a high content of organic microporous components, partially saturated with bitumen and viscous hydrocarbon fractions. Results include the data on samples porous structure and oil/water saturation coefficients which are used for predicting the most perspective spots in low-permeable reservoir. The NMR experimental procedure for Bazhenov formation core samples provides reliable results on fluid identification for different lithological layers at ambient and formation conditions. New method, based on NMR saturation profiles obtained in CO_2 filtration experiment, was used for CO_2 diffusivity coefficient calculation in nano-porous media.