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Effects of Petrophysical Properties on Drainage and Imbibition Capillary Pressures in Western Siberia Sandstones

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ABSTRACT

Capillary pressures and residual saturation are critical parameters in the evaluation of the fluid distribution and recovery performance of petroleum reservoirs. Understanding of capillary phenomena is especially vital for mature petroleum systems. 70% of Western Siberia oilfields are long time in production. The study of two- phase flow characteristics results in significant reservoir surveillance improvement in these fields. Reliable capillary reservoir models can reduce the volume of water injected into the formation and increase oil recovery.

This paper presents new petrophysical models that are used to investigate the effects of reservoir properties on drainage and imbibition capillary pressure curves and model oil saturation in representative Jurassic siliclastic rocks collection varying from very fine to pebbly sands, silts and shales (alluvial and marine environments). These physically realistic models were used to analyze the complex dependences between reservoir properties and capillary pressure characteristics.

The pore geometry, pore network tortuosity and topology are represented by curvature parameter of developed capillary pressure models, same for drainage and imbibition. The curvature parameter and entry capillary pressure show close correlation with reservoir properties: effective porosity and residual water saturation. As a result, distribution of reservoir properties along the well lead to quantification of capillary pressure model parameters and calculation of capillary characteristics of the reservoir on each depth step. Model verification on representative core collections showed the reliability of developed model and stability of curvature parameter that depends on petrophysical properties only.

The proposed drainage and imbibition capillary pressure petrophysical models have been successfully applied in geological modeling of mature oilfield in Western Siberia (Russia). The saturation calculation results were verified with 15 spot control wells data including well testing and saturation evaluation from resistivity logging. Output geological model is used for optimization of well placement, recovery mechanism improvement and field development planning.