

From pore system to fluid flow: Tight oil evaluation and sweet-spotting

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Nowadays, unconventional oil & gas has become the new and important targets during the exploration. Tight oil and tight gas are the most practical hydrocarbon resources in China. Tight oil of Upper Triassic Yangchang Fm. in the Ordos Basin, which is the most successful tight oil play in China is studied.

Reservoir rock evaluation includes two key aspects, storage space characterization and mobile fluid assessment. In this study, FE-SEM, Micro-CT, MICP are adopted to characterize the storage space of tight sand. In-situ displacement and NMR are combined to study the mobility of water and oil. Temperature, pressure and fluid are similar to reservoir conditions. Moreover, NMR is combined with MICP to obtain lower limit of pore size for mobile fluid.

(1) The lithology is lithic arkose, with 25% quartz, 40% feldspar, and 20% lithic component. The porosity of tight sand is 5%~11.0%, and permeability is 0.04~0.18mD.

(2) Inter-feldspar pores dominate the storage space and a few inter-lithic component pores and micro-fractures are also observed. Micro-CT with 1 micron pixel resolution indicates that the pores with diameter <12 microns add up to 50.7% of the storage space. MICP shows the diameter of connected pore-throats is ranged in 40nm~400nm. The percentage of pores with diameter <100nm is 28.93%~79.58%, with avg.=60%. The percentage of pores with diameter 100nm~1 μ m is 20.42%~71.07%, with avg.=40%.

(2) The maximum mobile fluid saturation and maximum mobile oil saturation is 70%~90% and 40%~65%, respectively. The minimum diameter of pores for mobile fluid is around 30nm and the corresponding porosity and permeability is 2%, 0.01mD. These results are obtained based on lab condition, which is a little different from the actual reservoir condition, i.e., greater displacement pressure in the lab and thus higher mobile fluid saturation in the lab. However, the result can provide the information that the maximum potential of the rock.

In tight oil evaluation, the focus is transferred from pore system to pore system and fluid flow. In our opinion, study fluid occurrence and mobile fluid saturation based on actual pore system model is the future of tight oil evaluation and sweet-spotting.