Tight Oil from Transition Zones in Mature Reservoirs

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Abstract

A regional study showed that the Hunton Limestone, one of the most important producing reservoirs that underlie the prolific Woodford Shale in Oklahoma, could be a potential target for producing oil trapped in the tight transition zones. A mature oil field was selected and horizontal drilling with multistage completions technologies were used to recover oil left behind in the tighter sections of the reservoir.

A vertical pilot well, drilled in the study area, produced data on the current reservoir conditions. Log and core derived J-Functions showed that the Free Water Level is 6 feet below the base of the limestone indicating that the entire thickness of the reservoir 50-70 feet can be in the transition or oil zone.

Three facies of the reservoir were identified (Upper, Middle, and Lower) and characterized based on their petrophysical properties, visual descriptions of thin sections and SEM photos. The Upper and Lower are mud-dominated fossiliferous wackestones, with these characteristics GR<15API, 5%<Φ<8%, ρma=2.71 gr/cc, K=0.01 mD and Capillary entry pressure(CPE)=100 psi. The Middle is a fossiliferous mudstone with GR>15API, Φ<5%, ρma=2.75 gr/cc, K<0.01 mD and CPE=1000 psi.

According to the analysis, the Middle section is a flow barrier which extends and creates vertical compartmentalization throughout the entire area. Identification and 3D mapping of the best reservoir quality facies helped to select the target zones for drilling seven 5,000' deep and 3,500' long horizontal wells.

Analysis of borehole image logs from all horizontal wells showed that all three members of the Hunton are highly fractured. The strike of fractures varies from 60° to 110° and most dip angles vary between 70 and 90° indicating almost vertical fractures. Correlation between fractures observed in a Hunton outcrop and those identified on the image logs showed that fracture widths from 1-2 inches can be 20 feet long and could connect Upper and Lower zones, also multiple strikes represent different fracture networks. These correlations combined with natural-fractures density and mudlog shows along the wellbore pathway were helpful to design 5-6 stimulation stages per well. Production results demonstrate that new technology was helpful to produce more reserves and reactivate this abandoned field. IP rates and EUR's from those wells whom encountered both the Upper and Lower sections were 40%-50% higher than those whom only encountered the Middle and Lower sections.