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A Laboratory Study on Improving Oil Recovery Using Ultrasound Waves

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ABSTRACT

In oil reservoirs about 60% of the original oil in place remains as residual oil after primary and secondary oil recovery processes because of geological and physical factors. By means of improved oil recovery methods (IOR), additional oil can be mobilized. However, there is no universal IOR method which can be implemented in any reservoir. Therefore, efforts are made to develop alternative tertiary methods with lower application risk and lower risk. One of these alternatives is the application of sound/ultrasonic waves in the reservoirs to overcome the interfacial tension between oil and water, resulted in reduction of capillary pressure in the pores and therefore, a higher oil recovery can be achieved.

In this project, laboratory experiments on different core samples were conducted to investigate the efficiency of wave stimulation at 10 Hz and at 50 kHz on mobilizing additional oil. The core flooding was performed horizontally and vertically and the wave stimulation was applied at original oil in place and at residual oil saturation after initial waterflooding. Oil/water relative permeability were calculated to evaluate the flooding performance in presence and absence of wave stimulation and the rate of oil recovery was determined. The additional oil recovery of applying sonic stimulation (10 Hz) was not significant, while the ultrasound waves (50 kHz) were able to mobilize additional oil varying between 4.6% and 5.2% OOIP in horizontal flooding, and up to 8.2% OOIP in vertical flooding. In addition, water fractional flow curves were considered to determine the average water saturation at breakthrough in presence and absence of waves. Early breakthrough was observed in all runs

conducted horizontally, while a delay in breakthrough was noticed in the vertical runs.

Furthermore, various mechanisms responsible for the additional oil recovery were identified.

Moreover, the effect of wave stimulation on unconsolidated core samples was investigated and resulted in high pressure drop due to sand production.