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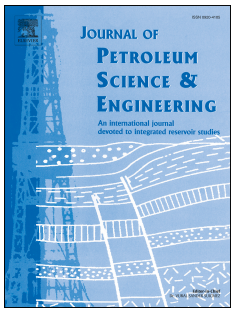

Experimental study of nanoparticle and surfactant stabilized emulsion flooding to enhance heavy oil recovery

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Abstract

It is well known that the recovery of water flooding from heavy oil reservoirs is less than 30% or even 20% of the OOIP (original oil in place), due to its very high viscosity and thus extremely low mobility comparing to light oil at reservoir condition. In order to improve residual oil recovery after water flooding in ordinary heavy oil reservoirs, this study presents an experimental study of nanoparticle and surfactant stabilized emulsion flooding to enhance heavy oil recovery. It is indicated in the emulsion stability and rheology studies that the synergistic interaction of nanoparticle with surfactant can significantly improve the emulsion stability and increase the apparent viscosity of emulsion. The results of core flooding tests show that the residual oil recovery after water flooding can be significantly improved by the nanoparticle-surfactant stabilized emulsions flooding. The incremental oil recovery gradually increases with the increase of injected emulsion volume, but there is an optimal economic value of the injected volume. The low injection rate is more effective than high injection rate, and the continuous injection pattern shows higher tertiary oil recovery as compared to cyclic injection pattern. The nanoparticle-surfactant stabilized emulsion flooding has a great potential for enhanced oil recovery in waterflooded heavy oil reservoirs, with the permeability ranging from 500 mD to 2000 mD and the crude oil viscosity being lower than 1000 mPa•s. The two-dimensional homogeneous sandpack flooding test indicates that the nanoparticle-surfactant stabilized emulsion flooding can not only improve the sweep efficiency by blocking the high permeable water channels, but also can improve the displacement efficiency by mobilizing the trapped oil.

Keywords: Emulsion flooding; Nanoparticles; Heavy oil; Sweep efficiency; Injection parameters