45h Simulation of Imbibition Experiments with Wettability Altering Surfactants

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In a fractured reservoir, the success of surfactant flooding depends on how effectively the surfactant residing in the fracture can penetrate and propagate into the matrix. Thus it is believed that spontaneous imbibition better represents what will happen in a fractured reservoir. Introduction of surfactant into the brine phase can improve oil production by lowering the interfacial tension (IFT) and by altering the wettability of the rock to water-wet or intermediate wet regime. The effects of surfactant on oil production from a lab scale core were studied with a 3-D numerical simulator. The IFT is correlated to the surfactant concentration with the data obtained from laboratory experiments, and the correlations between capillary pressure and IFT and between wettability and the absorption of surfactant on rock surface are modeled with conceptual models. The experimental results were in accordanc with the numerical simulations. The imbibition results were also scaled with different dimensionless groups present in literature. It was observed that the scaling groups were applicable at lab scale. But, at a larger scale, the scaling groups needed to be modified to include surfactant diffusion terms. The simulator also gives predictions on recovery rates using surfactant methods, which is of crucial importance for field scale applications. A sensitivity analysis was also performed on various parameters like surfactant concentration, IFT reduction and extent of wettability alteration, permeability and length of fractures to better understand the process of surfactant flooding. Simulation results indicate that both capillarity and gravity help to improve oil production: in the very early stage of the production, capillarity is found to be the major driving force, and in the late stage, gravity and diffusion dominate the production behavior.