Simulation of Nanofluid Injection as an Enhanced Oil Recovery Method

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Abstract

Water flooding and gas injection are the most commonly used EOR methods. Due to the viscous fingering, reduction of sweep efficiency and early breakthrough of the injected fluid, the performance of these methods are not appropriate. Hence, water alternating gas approach (WAG) is applied to solve the unfavorable mobility ratio and enhance the fluid contact in the reservoir by segregating gas to the top and accumulating of water toward the bottom.

Through the past years, several experimental works have been done to prove the ability of nanoparticles to increase the oil recovery efficiently. Presence of nanoparticles in water alternating gas (NWAG) is a novel method of enhanced oil recovery in intermediate and oil-wet reservoirs. This novel method results in economic and efficient oil recovery by combining improved macroscopic and microscopic sweep efficiencies. Nanoparticles sit on the rock surface and alter the wettability of the rock. Also, nanoparticles locate in oil/water interface and reduce the interfacial tension. These mechanisms modify oil properties and mobilize trapped oil in the reservoirs.

This research project aims to study the effects of the nanoparticles on the wettability alteration, relative permeability curves, and IFT changes during NWAG by modeling the fluid/rock interactions in coreflooding experiments. Moreover, the possibility of using this approach as an EOR method in the field scale is investigated.

The results show a good history match for oil recovery obtained from coreflooding experiment for WAG and NWAG injections with less than 10% error between the model and the lab data. Our simulation showed that application of nanofluid instead of water during WAG process shifts the wettability of the system toward more water wet which affects the relative permeability curves and enhances the recovery. For example application of NWAG in 6 months' time cycle with 5 months nanofluid and 1 month CO_2 injection period in 2:1 NWAG ratio with Dual Five-spot well pattern improves the oil recovery for 13% compared to the conventional WAG method.