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Smart Water Flooding: Experimental study and Molecular Simulation

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In the background of the strong oil wettability and low production by water flooding in carbonate reservoirs, low salinity water containing sulfate ions and nanoparticles can significantly change the surface wettability of carbonate rocks and thus increase the sweeping area, however, the absorption and desorption mechanisms of the oil film in the carbonate rock surface remain unclear. In this work, These problems is addressed in the framework of molecular dynamics simulation (Material Studio software) and experiments. The results were showed that sodium sulfate solution could accelerate the rate from oil-wet to water-wet and the interaction of oil molecules, water molecules, and SO42- ions at molecular scale was explained. The results of the simulations show that many water molecules travel down the water channel under the influence of several powerful forces, including the electrostatic force, the van der Waals force and hydrogen bond, crowding out the oil molecules on the calcite's surface and causing the oil film to separate.

At the same time, a hybridization technique of combining low salinity water and nanofluids was performed by using experiments such as contact angle measurement, core displacement, and NMR (Nuclear Magnetic Resonance), and the effects of different salinity water and the nanofluids concentrations on wettability alteration and enhanced oil recovery were revealed. The parameters of wettability changes and contact angle were measured at different nanofluid solutions with high/low salinity water. The experimental results revealed that the test with KCl-1+NF outperformed other compositions. As for the new method of hybridization technique, the insights presented in this study provide a good reference for further research in this area. In a word, these investigations can guide the practical application of low salinity water flooding in carbonate reservoirs.

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References

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