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Atomistic Insight into Trapped Oil Displacement by Nanofluids

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Nanofluids possess great application potential in enhanced oil recovery (EOR). However, the EOR effects and mechanisms of nanofluids with specific nanoparticles (NPs) are not clear. In the study, the molecular dynamics (MD) simulation is thus adopted to explore the displacement of trapped oil in the rough channel by various nanofluids. Our results indicate that nanofluids with hydrophilic NPs and Janus NPs hold a greater EOR effect (9.7% and 7.1%, respectively), while hydrophobic ones are not suitable for oil film (with EOR effect of 2.3%). Specifically, hydrophilic NPs increase the viscosity and the sweeping scope of injected fluid. Janus NPs are prone to stay at the oil-water interface to reduce the interfacial tension. Most of them adsorb on the bulge, alter the surface wettability, and squeeze the trapped oil while others remobilize the trapped oil by sliding along the interface. Due to the entering of a large number of hydrophobic NPs inside the oil clusters, the influence of oil molecules being bound by NPs greatly reduces the effect of volume replacement, which leads to a poor displacement effect and even a risk of plugging the channel. Among the nanofluids, the ones with Janus NPs can maintain a stable oil displacement performance under low pumping force, thanks to sufficiently long contact time between Janus NPs and the oil phase. Further analysis on capillary number highlights the applied prospect of Janus NPs in actual oil reservoirs. Our findings are favorable to understanding the mechanism of nanofluids in EOR and provide guidance on the screen of NPs.

Participation

In-Person

References

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