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Saturated carbon dioxide nanofluids enhanced oil recovery in carbonate reservoir cores using nuclear magnetic resonance

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The wettability, fingering effect and strong heterogeneity of carbonate reservoirs lead to low oil recovery. However, carbon dioxide (CO_2) displacement is an effective method to improve oil recovery for carbonate reservoirs. Saturated CO_2 nanofluids combines the advantages of CO_2 and nanofluids, which can change the reservoir wettability and improve the sweep area to achieve the purpose of enhanced oil recovery (EOR), so it is a promising technique in petroleum industry. In this study, comparative experiments of CO_2 flooding and saturated CO_2 nanofluids flooding were carried out in carbonate reservoir cores. The nuclear magnetic resonance (NMR) instrument was used to clarify oil distribution during core flooding processes. For the CO_2 displacement experiment, the results show that viscous fingering and channeling are obvious during CO_2 flooding, the oil is mainly produced from the big pores, and the residual oil is trapped in the small pores. For the saturated CO_2 nanofluids displacement experiment, the results show that saturated CO_2 nanofluids inhibit CO_2 channeling and fingering, the oil is produced from the big pores and small pores, the residual oil is still trapped in the small pores, but the NMR signal intensity of the residual oil is significantly reduced. The final oil recovery of saturated CO_2 nanofluids displacement is higher than that of CO_2 displacement. This study provides a significant reference for EOR in carbonate reservoirs. Meanwhile, it promotes the application of nanofluids in energy exploitation and CO_2 utilization.