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Study the mechanism of supercritical CO2 huff-n-puff on enhancing shale oil recovery

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Depletion recovery in shale reservoirs after fracturing suffers from a rapid decline in production and low recovery. The CO2 huff-n-puff oil production technology can effectively supplement formation energy, reduce oil-gas interfacial tension and crude oil viscosity, and improve the production of a single well. This technology has good application prospect in enhanced oil recovery of shale oil. Currently, researches on enhancing shale oil reservoir recovery by CO2 huff-n-puff primarily focus on the effects of field production parameters on recovery. However, there is limited research on the production characteristics of the degree of crude oil utilization and the effective range of CO2 under different pore sizes.
Supercritical CO2 huff-n-puff experiments were conducted to investigate the mechanism of CO2 huff-n-puff for enhanced recovery in shale reservoirs. The T2 and one-dimensional frequency coding maps before and after the huff-n-puff experiments were obtained by using nuclear magnetic resonance (NMR) technology, and the oil recovery, utilization range and porosity characteristics of shale cores were analyzed at different core permeability, huff-n-puff cycles and soaking time. A typical shale reservoir has been used to develop a mechanism model for a single well at the field scale, simulating CO2 huff-n-puff and water-CO2 alternating huff-n-puff at the field scale, studying CO2 diffusion in the reservoir, and investigating the effect of production capacity under different production parameters.
The results show that the CO2 injection volume has the most obvious effect on the CO2 huff-n-puff cumulative oil production, and the injection rate has less effect on the huff-n-puff effect under the optimal gas injection volume. By lengthening the soaking time, the distance of the injected CO2 effect from the proximal to the end of the core increased, the utilization of small pores increased significantly and there was an optimal soaking time. The increase in huff-n-puff cycles led to improved utilization of crude oil in the first half of the core, as well as increased utilization of medium and large pores, resulting in a production increase of approximately 74%. Due to capillary force, the recovery and CO2 diffusion effects near the borehole are better with supercritical water-CO2 alternating huff-n-puff than with CO2 huff-n-puff. However, water injection may drive some of the oil away from the borehole, resulting in an overall recovery effect that is not as good as that of CO2 huff-n-puff. Therefore, it is recommended to use CO2 huff-n-puff for new wells and water-CO2 alternating huff-n-puff for old wells with poor recovery. This study can serve as a reference for developing a reasonable technology plan for CO2 huff-n-puff in shale reservoirs.

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