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Large PV carbon dioxide flooding mechanism of ultra-low permeability tight reservoir in Songliao Basin

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Abstract: Based on sandstone reservoir samples in Songliao Basin, carbon dioxide displacement of saturated crude oil core experiments were carried out, combined with nuclear magnetic resonance and oil component analysis, to study the mechanism of carbon dioxide oil recovery. The rock samples with proper permeability including medium permeability, low permeability, ultra-low permeability and tight permeability in Songliao Basin were selected to analyze the effect of permeability on carbon dioxide displacement. The displacement experiment was divided into three stages to analyze the effect of injected PV number on CO2 displacement. Taking large PV carbon dioxide flooding of ultra-low and tight permeability rock samples as the research focus, the mechanism of large PV carbon dioxide flooding of ultra-low permeability and dense reservoirs in Songliao Basin is studied by using the method of controlling variables. Experiments show that large PV CO2 flooding can obtain good recovery results for ultra-low permeability and dense reservoirs. After low-PV displacement, the average harvesting degree of low-permeability and medium-permeability samples was 30.56%, and that of ultra-low-permeability and dense samples was 26.21%. After large-PV displacement, the average recovery degree of low-permeability and medium-permeability samples was 55.92%, and the average recovery degree of ultra-low-permeability and dense samples was 67.00%. This indicates that large PV carbon dioxide flooding can effectively improve reservoir recovery, and the improvement range is more obvious for ultra-low permeability and dense reservoirs. Large PV complete miscible CO2 displacement can obtain a good final recovery degree, up to 67.49%. Complete miscible displacement can well displace various components of crude oil including heavy components. There is little difference in the oil family components in different displacement stages, but there is still an obvious effect of extracting light components. The peak value of oil components gradually shifts from near C12 in the early stage to near C17 in the late stage. The carbon dioxide extraction will make the heavy components of crude oil deposited on the pore throat surface. The deposition phenomenon is more obvious in ultra-low permeability and dense reservoirs when injected with low PV number, while the deposition phenomenon is weak in medium and low permeability oil reservoirs. After large PV carbon dioxide flooding, heavy components in ultra-low permeability and dense reservoirs are well recovered, and the final recovery degree of heavy components is similar to that of medium and low permeability oil reservoirs, indicating that large PV carbon dioxide flooding is more suitable for ultra-low permeability and dense reservoirs.
Key Words: sandstone reservoir ; carbon dioxide ; ultra-low permeability and dense ; nuclear magnetic resonance (NMR) ; component analysis

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