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Pore scale characteristics of CO2 trapping and oil recovery in heterogeneous layered sandstone

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The vertical variation in permeability is a typical heterogeneity of pore structure in sandstone reservoirs. We thus constructed a millimeter sized layered sandstone, and performed water-alternating-gas (WAG) injection and CO2 foam flooding. After each gas injection, the core was placed vertically for 24 hours and horizontally for 24 hours respectively to study the influence of gravity on fluid migration. The fluid distribution obtained by high-resolution X-ray microtomography indicates that layered heterogeneity leads to a large amount of oil being trapped in the low-permeability layer. Although the WAG strategy improves the oil recovery of layered porous media, a large amount of oil is still trapped in low-permeability layers after two WAG cycles. After CO2 foam flooding, the oil in the low-permeability layer can be effectively recovered. During the no-injection period, the difference in fluid density caused fluid migration and crossflow, that is, the oil in the low-permeability layer decreased while the oil in the high permeability layer increased, which is beneficial for subsequent oil production. Increasing the number of WAG cycles is beneficial for improving the CO2 capillary trapping efficiency. The relative permeability of CO2 in low-permeability layers is relatively low, with residual gas mainly distributed in single pores. CO2 clusters in the low-permeability layer have a large surface area to volume ratio, thus the CO2 capillary trapping is more stable, and the amount of CO2 dissolution trapping will be greater.

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