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Characteristics of microscopic pore throat changes in shale reservoir after CO_2 fracturing

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The interaction of CO_2 with the shale reservoir in the process of CO_2 fracturing can change the pore-throat structure characteristics of the rock. In order to determine the microscopic pore throat change characteristics in shale reservoir after CO_2 fracturing , typical shale core samples before and after fracturing were selected, combined with casting thin slice(CST), field emission scanning electron microscope(FESEM), CT scan, high pressure mercury injection(HPMI), and nuclear magnetic resonance(NMR) test results, and quantitatively evaluate the change characteristics of micro pore throats in shale reservoir after CO_2 fracturing. The results show that various storage spaces such as intergranular pores, intragranular pores, organic pores, and microfractures can be observed in shale reservoirs before CO_2 fracturing, which are with poor pore throat connectivity, and most of them are distributed in a dispersed and isolated state. The discharge pressure is low, 0.89Mpa on average, the mercury removal efficiency is low, and the maximum mercury saturation difference is large. Movable fluid saturation ranges from 2.72% to 41.24%, with an average of 26.78%. After CO_2 fracturing the shale reservoir, FE-SEM photos often show dissolved pores. The proportion of micro-cracks increased, and the number of cracks observed for a single sample ranged from 1 to 11, with an average of 4. The average length, opening and spacing of micro-cracks are 27.75μm, 286.63μm, and 3.70μm. The average porosity and permeability of micro-cracks are 9.03% and $1.74\times10^{-3}\mu m^2$. The pore throat connectivity of the shale samples becomes better, the degree of development is higher, the displacement pressure is increased to 3.05MPa, and the mercury removal efficiency and the maximum mercury saturation are both increased. NMR results showed that the movable fluid saturation of shale core samples increased significantly after CO_2 fracturing, and the movable fluid saturation was between 1.57% and 50.25%, with an average of 38.14%. CO_2 fracturing shale reservoirs will not only produce secondary fractures, but also easily form complex fracture networks. In addition, it will also improve the dense micro-pore throat structure of the shale reservoir itself, increase fluid seepage capacity, and increase oil and gas recovery.