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The emulsification phenomenon of heavy oil in porous media studied by nuclear magnetic resonance method.

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Emulsification phenomenon is common in the displacement process of water flooding, surfactant flooding and multiple compound flooding in heavy oil reservoirs. The existence of emulsion can greatly improve the oil displacement efficiency, which has important practical significance for the development of heavy oil reservoirs. However, the description of emulsification phenomenon is basically based on the observation of produced fluid and the monitoring of pressure points along the way. The real emulsification situation in porous media cannot be observed. We have tested and analyzed the emulsification phenomenon of heavy oil in porous media by nuclear magnetic resonance experimental method.

In this study, D-T2 two-dimensional spectrum scanning was first performed on equal volume of free water, water-in-oil emulsion and oil-in-water emulsion. Secondly, the same volume of water-in-oil emulsion and oil-in-water emulsion were scanned by D-T2 two-dimensional spectrum at three different temperatures. Finally, the 60-mesh quartz sand was used as the porous medium, which was filled into the non-magnetic sand filling tube, and the equal volume of water-in-oil emulsion and oil-in-water emulsion were injected respectively. The D-T2 two-dimensional spectrum of the emulsion in the porous medium at different temperatures was tested. The results showed that the water signal fell on the free water line in the D-T2 two-dimensional spectrum of free water. In the D-T2 two-dimensional spectrum of water-in-oil emulsion, water was limited by the dispersed phase droplets, and the water signal fell below the free water line. In the D-T2 two-dimensional spectrum of the oil-in-water emulsion, the degree of water diffusion was not limited, and the water signal deviated not far from the free water line. The higher the temperature, the formation of water-in-oil emulsion was more conducive, but it would reduce the stability of oil-in-water emulsion. The existence of porous media would make the stability of water-in-oil emulsion worse, and the higher the temperature, the stability of it was worse. However, the presence of porous media would lead to a decrease in the relaxation time of the aqueous phase in the oil-in-water emulsion, and the confined diffusion of the aqueous phase was not obvious under different temperature conditions.

This new experiment provides a new method and theory for studying the emulsification of heavy oil in porous media. And its results can more accurately predict and guide the production of condensate gas reservoirs.

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