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Study on Oil Displacement Mechanism of Polymer Microspheres Based on Microfluidic Technology

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As a novel type of profile control material, polymer microspheres have the characteristics of easy for injection, able to blockage and movable, which make the application in oil production has gradually expanded. This article is based on microfluidic experiment, combined with fluorescence component tracer technology, to clarify the oil displacement mechanism of polymer microspheres from a microscopic perspective.
Polymer microspheres with fluorescence properties are selected as experimental materials, and ideal microscopic models with simple channel pattern are used to conduct experiments under fluorescent and non-fluorescent conditions respectively. The mechanism of polymer microspheres is studied from three aspects: aggregation rules, migration characteristics, and morphological changes. The typical reservoir channel models are designed and made based on casting thin sections. And the effect of polymer microspheres flooding is evaluated through displacement experiments. Then using the previous conclusions to explain experimental phenomena, and the accuracy of the oil displacement mechanism is further demonstrated.
It is found that the polymer microspheres tend to act as emulsion aggregates during the displacement process. Part of microspheres injected tend to accumulate at the inlet end, and the other microspheres successfully injected into the model will enter the relatively high-permeability region along the dominant water channeling channel. After the hydration and expansion of microspheres, the particles are interconnected, forming a "microsphere partition" to block the subsequent water flow, and changing the direction of fluid flow, thereby expanding the sweep area to enhance oil recovery. With the increase of injection time, the effect is affected by the degradation failure or the desorption movement of the microspheres. Polymer microspheres exhibit varying degrees of stimulation effects in different types of reservoirs, but they are more suitable for blocking channels with high permeability in relatively homogeneous reservoirs. Therefore, the matching between the blocking agent and the channel should be fully considered when selecting the blocking adjustment measures to further improve the effectiveness of the scheme design and parameter setting.
In this paper, the oil displacement mechanism of polymer microspheres is clarified and its accuracy is verified. This understanding is of great significance for the interpretation of experimental phenomena, the improvement of numerical simulation methods and the explanation of field application effects. It also provides reference value for the optimization of microspheres application scheme design and the adjustment of on-site implementation measures.

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