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Study on the percolation mechanism and oil displacement mechanism of a mixed solution of polymer and silica nanoparticles

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Polymer flooding is one of the important means to improve oil recovery during oilfield development. However, the performance of polymers is limited by temperature and salinity, which affects their oil displacement effect in reservoirs. Recently, studies have found that a mixed solution of polymers and nanoparticles can enhance the rheological properties of polymers and improve their oil displacement efficiency, especially in harsh geological environments where this promotion effect is more pronounced. However, research on polymer nanoparticle mixed solutions is still in its early stages, and there are few articles on the rheological properties, flow field distribution, and permeation mechanism of polymer nanoparticle mixed solutions. The aim of this experiment is to investigate the rheological properties of polymer nanoparticle mixed solutions and their promoting effect on reservoir recovery. By using a high-temperature and high-pressure rheometer, the rheological properties of a mixed solution of silica nanoparticles and partially hydrolyzed polyacrylamide were analyzed. Based on the viscosity temperature relationship, creep and creep recovery, and amplitude oscillation shear response, the viscoelastic properties and shear resistance of the mixed solution were evaluated, and the influence of silica nanoparticles on the polymer network structure was studied. Due to the unique rheological properties of mixed solutions, studying the flow state of mixed solutions in the flow channel is also crucial. In this study, a microchannel particle image velocimetry system was used to study the flow field of mixed solutions in contraction channels and porous media, and combined with a micro displacement device, the basic properties of the mixed solution were linked to actual seepage. The results indicate that silica nanoparticles can form hydrogen bonds with polymer molecular chains, and through physical crosslinking, form more complex macromolecular network structures, which can improve the rheological properties of polymers under high temperature and high salt conditions; The flow field experiment shows that as the rheological properties of the mixed solution increase, a symmetric vortex will form in the contraction channel of the mixed solution, and it can exist stably. The displacement effect of the mixed solution at the blind end position in porous media is better, and the stronger the rheological properties of the mixed solution, the better the displacement effect at the blind end position; Microscopic oil displacement experiments have shown that the better the rheological properties of the mixed solution, the better the oil displacement effect in porous media, and the more obvious the equilibrium displacement effect on non-mean porous media.

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