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Peformance evaluation on temporary plugging of magnetic responsive hydrogel in hydraulic fracturing of hydrocarbon reservoirs

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Hydraulic fracturing is a key technology for the efficient development of unconventional reservoirs (such as shale and tight sand reservoirs). Formation pressure depletion and fracture closure due to the development of oil and gas reservoirs cause low production. Thus, it is necessary to implement stimulation measures, such as refracturing or layered fracturing. However, fracturing fluid leakage into the original formation fractures results in substantial damage and pollution to the formation and may reduce production. A temporary plugging fracturing technology is often used and gel is widely used as a temporary plugging agent (TPA) to block the original fractures in near-well areas and to reduce the damage of the working fluid to the original layer. However, gel is mainly cross-linked by polymer or vegetable gum, and its bearing strength, cross-linking time and gel-breaking performance are difficult to control accurately. The emergence of magnetorheological (MR) materials provides a new basis for improving the performance of temporary plugging gels. Magnetorheological gel (MRG) is a new type of MR material, which, as a smart fluid, responds to stimulation by an external magnetic field and quickly adjusts and adapts to the corresponding treatment. The unique magnetorheological characteristics of MRG, which can be transformed from a flowable to a solid state under the influence of an external magnetic field, renders its application in temporary plugging fracturing potentially useful.
In this study, we designed a magnetic responsive hydrogel, also known as magnetorheological gel (MRG), based on a carbonyl iron particle@polyacrylamide (CIP@PAM) composite and a water-soluble PAM matrix to use as a temporary plugging agent (TPA) in the hydraulic fracturing of unconventional hydrocarbon reservoirs. The CIP@PAM composite was characterized by Fourier transform infrared spectrometry (FT-IR), scanning electron microscopy (SEM), laser particle size analysis (LPSA) and vibrating sample magnetometry (VSM). The results show that a thin and uniform PAM layer was successfully coated on the surface of the CIPs, which plays a key role in enhancing the antioxidant capacity of the CIPs. Meanwhile, the CIP@PAM composite possesses a high saturation magnetization (148.83 emu/g). MRG as a TPA has a high gel strength and magnetorheological effect under a magnetic field intensity of 1 T, providing a breakthrough pressure up to 38.13 MPa at room temperature and great potential in temporary plugging for hydraulic fracturing.

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References

Time Block Preference

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Participation

Online

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