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Evaluation of hydration expansion and plugging performance of micro-nano water plugging agent

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Summary

With the development of economy, unconventional oil and gas has become more and more important. Overcoming the problem caused by formation heterogeneity efficiently is the key to improve the recovery of unconventional oil reservoirs. Heterogeneous reservoirs account for a large proportion of the oil fields in China, and most of them have already faced the problem of very high water cut. In order to solve the problem of low recovery rate and high water production, most oilfields in China has begun to combine the profile control technology with water flooding adjustment at high water cut stage. As for profile control, micro and nano water plugging materials are injected deep into the formation, aiming to increase the sweep volume of injected water effectively improve the final oil recovery. The micro-nano water plugging agent used for water plugging and profile control in deep formation should not only be able to be injected easily into the formation, but also should be able to expand easily and withstand the effect of water injection pressure. Only in this way can the effective plugging of the deep formation be achieved and the sealing be sustained and stable. In this paper, the hydration expansion and plugging performance of the newly developed micro-nano water agent in overseas oilfields are evaluated effectively, and various influencing factors and implementation effects are analyzed to pave the way for practical application in the field.

Workflow

In this paper, four kinds of swelling micro-nano materials were selected as temporary plugging agents. The materials have the advantages of high temperature resistance, salt resistance, viscoelasticity and controllable particle size. And they can rapidly expand after water absorption, resulting in plugging of pores. First of all, the basic properties of the four kinds of micro-nano water plugging materials were analyzed respectively, in terms of their morphology, grain size, expansion, dispersion, stability, corrosion resistance and viscoelasticity. Then the hydration expansion of the four kinds of materials were studied, through which the best candidate was identified. Next, the effects of temperature, time, pH value, permeability and mineralization degree on particle size were analyzed. Finally, core flooding tests were conducted to compare the plugging performance and particle migration effects between expanded and unexpanded plugging material.

Results

The results show that the nanoscale water plugging material has good expansibility, viscoelasticity, stability and dispersion with high safety and low cost. The size of plugging particle increases with the increase of temperature and time. Also, both pH and osmosis affect the size of particles. The selected plugging agent has good plugging performance for middle and high permeability formations. It can effectively block high permeability area and achieve better plugging effect. Additionally, it can continuously migrate to deep formation and block the

pores. Especially, it has wide particle size rang, from a few microns to thousands of microns, which can be applicable for different pore size of the different formation. In summary, the micro-nano water agent has strong practicability. It can effectively act on heterogeneous formation, expand the swept area and improve oil recovery.

Novel/Additive Information

Some important graphs are listed below.

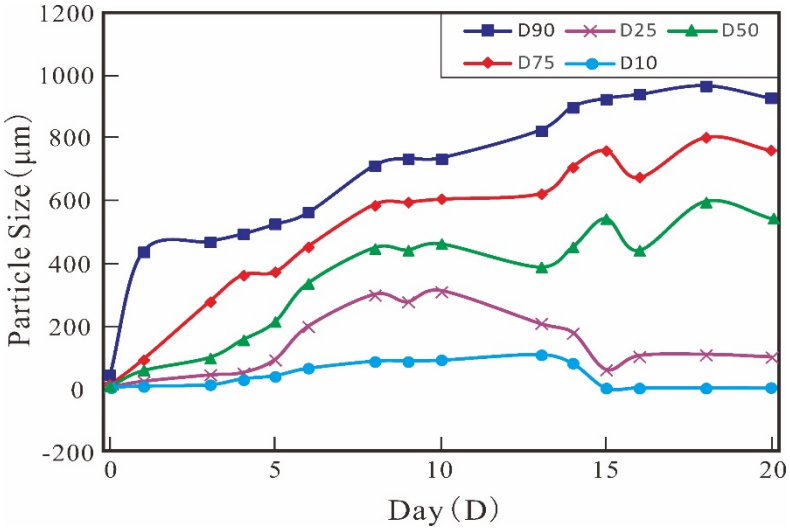

Fig.1 Particle size of the best sample expand at 80℃ for 1~20 days

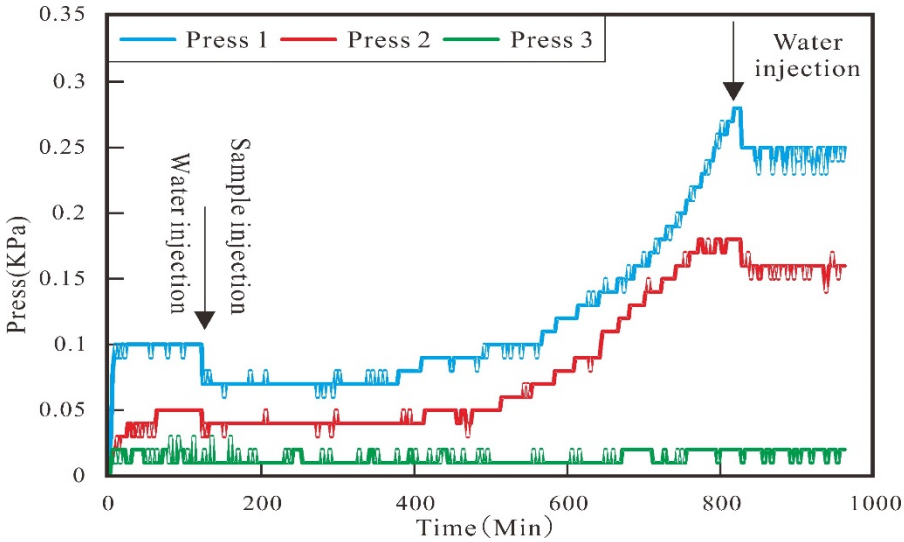

Fig.2 Pressure variation curve of elastic microsphere movement in sand-filled tube rock

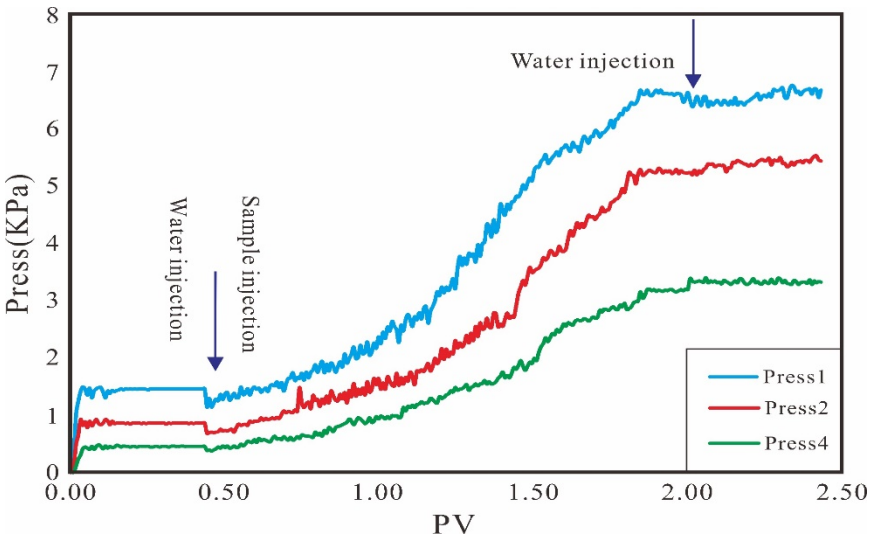

Fig.3 The relationship between plugging pressure and PV

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