Research progress of assistants for reducing CO_2-crude oil minimum miscible pressure

1 Highlights

Based on the structures of existing miscible flooding assistants, MMP reduction effectiveness are summarized, and the influencing factors on MMP reduction efficiency are analyzed. The developing directions CO_2 miscible flooding assistants designing are prospected

2 Background

The recovery rate of water-flooding oil reservoirs generally does not exceed 30%. Compared to waterflooding, CO_2 flooding has significant technical advantages, offering a win-win solution for both oil displacement and CO_2 sequestration. In Chinese field practices, CO_2 flooding can increase oil recovery by 3% to 15%. The Minimum Miscibility Pressure (MMP) is the minimum pressure required for the oil and injected gas to achieve miscibility, and it is a key parameter in determining whether miscible flooding can be achieved. Most oilfields in China are composed of continental deposits, where high viscosity and deep burial conditions result in a high MMP, which limits the application of CO_2 miscible flooding. This necessitates the development of assistants for miscible flooding to harness the advantages of miscible flooding. Currently, research on CO_2 miscible flooding assistants in China is still in the early stages, which makes it important to summarize and anticipate the progress of ongoing studies.

3 Research scheme

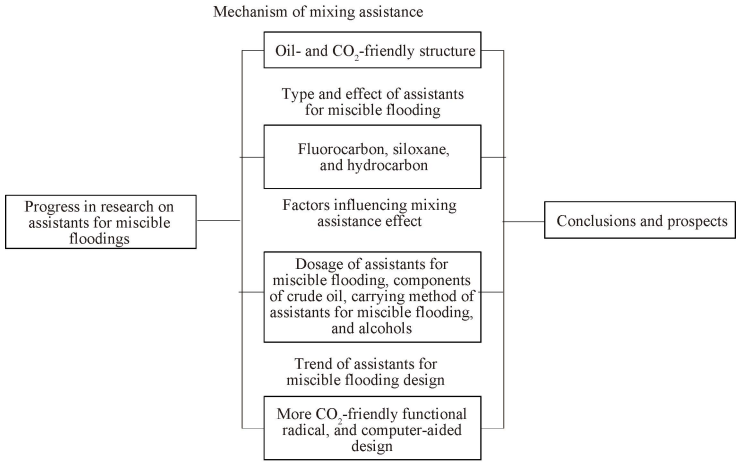

Fig. 1 Research scheme

4 Results

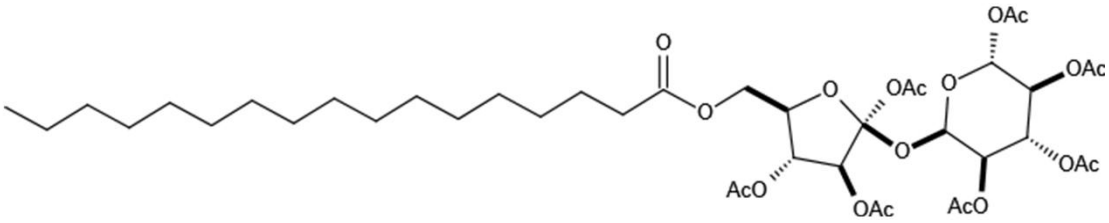

Fig. 2 Molecular structure of hexadecyl acetyl octaester-X

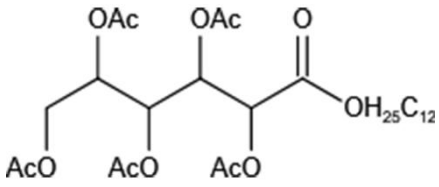

Fig. 3 Molecular structure of acetylglucosamine dodecyl ester

5 Conclusions

1) Research on CO_2 miscible flooding assistants in China is still in its early stages, with experimental methods being the primary focus. There is limited research at the microscopic level. Computer simulations can help clarify molecular interactions and mechanisms, as well as assist in the design of molecular structures. This approach

is one of the key methods for the future development of assistants for miscible flooding.

2) The design of assistants for miscible flooding typically targets specific crude oil samples. While reducing MMP, some assistants for miscible flooding also exhibit effects such as viscosity reduction, dissolution, and extraction. It is worth exploring whether the primary mechanisms for miscible flooding effectiveness are the same across different crude oil systems and whether there are dominant factors influencing miscibility. This warrants further in-depth research.

3) Commonly used assistants for miscible flooding include fluorocarbons, siloxanes, and hydrocarbons. Fluorocarbons and hydrocarbons interact with CO_2 through the fluorine and oxygen atoms, respectively. A shared characteristic is their strong electronegativity, which allows them to function as Lewis bases. Future development of assistants for miscible flooding should not be limited to the categories of hydrocarbons, fluorocarbons, and siloxanes. Research into mixed-type surfactants and surfactants containing other atoms capable of acting as Lewis bases is also promising.

4) The most effective miscible flooding assistant component currently known for reducing MMP values is oil-soluble hydrocarbon assistants for miscible flooding (such as tri-iso-butyl citrate), which can lower the MMP by 7.2 MPa. However, its large-scale promotion is still limited by cost-related factors. For assistants for miscible flooding to transition from laboratory research to field applications, efforts are needed on two fronts. On one hand, more CO_2-affinitive groups should be sought, and more efficient co-solvent structures should be designed to offset the cost of assistants for miscible flooding by enhancing oil recovery at large scale. On the other hand, reducing the cost of assistants for miscible flooding, such as optimizing synthesis processes and lowering costs through large-scale production, is crucial. Therefore, assistants for miscible flooding with excellent performance, low cost, and environmental friendliness are the future direction for the development of assistants for miscible flooding.

6 About the author

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