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Experimental investigation on self-generated heat foam system for offshore heavy oil reservoir

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Foam fluid is a gas-liquid dispersion system whose range of application covers various fields due to its excellent properties, especially in oil and gas field development including enhanced oil recovery, matrix acidizing, gas breakthrough control, profile control, plugging removal, etc. However, factors such as dependence on natural N2 sources, breakthrough of N2 to production wells, transportation of N2 and field equipment, environmental problems and safety have restrained broad use of the N2 foam injection technique in offshore reservoir.
To overcome these issues and extend the application of foam fluid, a new method, namely, underground foaming method, should be used to replace the conventional foaming method and the foam should carry heat. In this paper, we used a self-generated heat system (SGHF) to achieve this goal. The technique is based on the injection of two aqueous solutions i.e. gas-forming and gas-yielding solutions of certain concentrations into the reservoir. In this research, SGHF was obtained by a chemical reaction between gas forming ammonium chloride and sodium nitrite and the reaction products are very friendly, which are N2 gas, H2O, NaCl, and heat. This system has been studied and used in petroleum engineering.
In this work, we firstly perform surfactant evaluation experiments to identify the temperature resistance and salt resistance surfactant suitable for application conditions of offshore reservoirs. Then, we carried out sandpack flooding experiment including single sandpack flooding experiment and parallel sandpacks flooding experiment, as well as the 2 dimension visualization model experiment of three different research systems (SGHF systems, self-generate heat (SGH) system and conventional foam system) to study and analyze the enhancing oil recovery mechanisms of SGHF system.
After analyzing and discussing the experimental results including trap gas volume analysis, calculation of internal chemical reaction degree in sandpack, temperature distribution inside sandpack and temperature variation coefficient, we draw the conclusion that the main mechanisms of enhancing oil recovery are：(1) SGHF system can generate more uniform and even foam than the conventional foam, which not only eliminate the need of gas resource and gas transport, but also provide better gas fluidity control and adjust the production profile of heterogeneous reservoirs. (2) Foam can adjust the temperature distribution. Temperature distribution inside the sandpack is relatively uniform and high for SGHF system which benefits to reduce the viscosity of heavy oil in a larger scale, and we think the reasons are mainly including: Firstly, the presence of foam and the properties of trap gas cause the gas to accumulate near the inlet area, the effective permeability at the inlet decreases, therefore, the reaction heat production is performed evenly in the front and rear parts. Secondly, the presence of a large amount of trapped gas in the sandpack reduce the overall thermal conductivity inside the sandpack and delays the loss of heat.

References

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