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Multi-parameter Screening Study on Static Properties of Nanoparticle Stabilized Supercritical CO2 Foam

Wednesday, 2 June 2021 16:00 (1 hour)

Foam technology has been widely employed for enhancing oil recovery from mature reservoirs as well as the unconventional oil reserves. Employing CO2 as the foam internal phase could not only explore extra oils from reservoirs but also in the meantime store large amount of CO2 in underground formations, thereby fulfill the resourceful utilization and geological storage of the greenhouse gas. The CO2 foam field applications, however, may suffer from the high-temperature, high-pressure and high salinity reservoir conditions. Adding nanoparticles (NPs) in the surfactant solution has been proven an efficient technique to increase the foam stability under harsh reservoir conditions, therefore attracts wide attention from international scholars.

As a complex gas/liquid/solid system, multiple parameters contribute in a synergic way to the static properties of the NP-stabilized Supercritical CO2 (ScCO2) foam. In order to obtain the optimal recipe for excellent foam performance in terms of foamability and foam stability, comprehensive parameter screening studies have been carried out in this paper on the static properties of NP-stabilized foam with help of the Orthogonal Experimental Design (OED) method. Six influential factors, including NP concentration, surfactant concentration, temperature, pressure, oil existence, salinity, have been investigated on four levels for each factor in the range of 0-0.2wt%, 0.1-0.5wt%, 20-60℃, 5.5-9.5Mpa, 0-4wt% and 0-8wt% respectively.

The experimental results show that temperature and pressure are the main factors affecting the formability of NP-stabilized ScCO2 foam, and temperature is the dominant factor on the stability of the foam. When the system condition is close to the supercritical point of CO2, the foam generation height and the foam decay rate within certain period of time shows the worst behavior. While under the system conditions far from the CO2 supercritical point, such as lower temperature and higher pressure, the static properties of the NP-stabilized CO2 foam behave much better. Based on parameter screening results, we obtained the formula for the NP-stabilized CO2 foam with satisfactory static properties, that is, NP concentration of 0.15wt% and surfactant concentration of 0.4wt% within the studied ranges of temperature, pressure, oil and salinity values. To validate the screening study method as well as the experimental technique, the obtained formula is employed to generate NP-stabilized CO2 foam under two sets of conditions of temperature of 45℃ & 55℃, pressure of 9.5MPa, salinity of 2.5wt%, and oil concentration of 2.5wt%. Satisfactory foamability and foam stability properties were obtained, indicating the validity of the research works.

It is expected the experimental techniques and results reported in this paper could help on the laboratory screening and optimization of foaming agent formulations under reservoir conditions, and therefore on guidance of the NP-stabilized CO2 foam technology in field practices.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

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