Influence of Surfactant YB-1 on Core Wettability

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Abstract. Based on the core self-priming displacement experiment, the change of self-priming oil displacement and rock wettability of Gemini surfactant in different permeability cores is analyzed. The experimental results show that the self-priming oil displacement of core increases with the decrease of interfacial tension, and the larger the permeability of core is, the more the self-priming oil displacement is. At the same time, the wettability of core changes from lipophilic to hydrophilic. It is found that the relationship between the interfacial tension and the moisture index is logarithmic.

Keywords: Heterogemini surfactant; Wettability; Interfacial tension; Water wet index.

1. Introduction

Wettability is an important parameter affecting seepage characteristics [1-2]. The oil film adhered on the rock pore surface is not easy to be driven away due to the adhesion work. After injecting surfactant, due to the adsorption of surfactant on the rock wall, the lipophilic surface will be converted to hydrophilicity, reducing the adhesion work of crude oil, thus starting the residual oil on the rock surface, that is to say, it plays the role of washing, thus improving the oil recovery [3-7].

In this paper, the effect of YB-1 surfactant on the wettability of cores with different permeability and the relationship between the interfacial tension of YB-1 surfactant and water wet index are studied by using core self-priming displacement experiment.

2. Experimental Part

2.1. Experimental Materials
(1) Water for experiment: simulate formation water, and the composition of formation water ions is shown in Table 1.
(2) Experimental oil: simulated formation oil, degassing oil and kerosene in Shengli Oilfield are 1:0.61. The viscosity of the simulated oil is 2.30mpa s at 70 °C;
(3) Experimental core: core of Shengli Oilfield, core basic data are shown in Table 2.
(4) Active system: 0.05% YB-1 surfactant with the interfacial tension of 0.005755 Mn / m, the interfacial tension is 0.1% YB-1 surfactant with surface tension of 0.01217 Mn / m and 0.3% YB-1 surfactant with interfacial tension of 0.45348 Mn / m.
### Table 1. Ion composition and viscosity of formation water

| Water sample category | Ca^{2+} mg/L | Na^+K^+ mg/L | Mg^{2+} mg/L | SO_4^{2-} mg/L | Cl^- mg/L | HCO_3^- mg/L | Total salinity mg/L | Viscosity mPa.s |
|-----------------------|--------------|--------------|--------------|----------------|-----------|-------------|---------------------|----------------|
| Source well water     | 596.4        | 5679.8       | 1114.7       | 97.2           | 249.7     | 20581.9     | 0.41                |                |

### Table 2. Core parameter table

| Serial number | number | Diameter cm | Length cm | porosity % | Permeability 10^-3 μm^2 |
|---------------|--------|-------------|-----------|------------|------------------------|
| 1             | 10-19  | 2.512       | 5.108     | 15.85      | 46.03936               |
| 2             | L-9    | 2.482       | 4.704     | 20.36      | 38.3748                |
| 3             | 66-213 | 2.520       | 4.398     | 20.51      | 6.7575                 |

#### 2.2. Experimental Methods

1. Record the dry weight of the core, vacuum the core to saturate the formation water, record the wet weight and calculate the pore volume.
2. At 70 °C, the simulated oil drive cores were used to reach irreducible water saturation, and aged at the experimental temperature for 48h.
3. After removing the oil slick on the surface, the aged core is put into the water absorption instrument (after sealing the top with rubber plug, put into the incubator) to absorb formation water / surfactant and drain oil.
4. Record the change of oil displacement V1 of self-priming formation water / surfactant with time until the oil displacement is stable for 24 hours unchanged.
5. Remove the rock sample from the water absorption instrument and move it into the core holder, and then drive it with water / surfactant at the flow rate of 0.1ml/min until no oil is produced at the outlet of the core, and record the oil displacement VO2 of the water / surfactant drive of the rock sample.

#### 3. Results and Discussion

3.1. Effect of Interfacial Tension of YB-1 Surfactant on Self-priming Oil Displacement of Core

According to the experimental method, the cores with different permeability are tested in different interfacial tension (IFT) solutions for self water absorption and oil drainage, and the experimental results are shown in Fig. 1-3.

![Figure 1. Self priming oil discharge of core with permeability of 6.76md](image-url)
3.2. Relationship between Interfacial Tension and Moisture Index of YB-1 Surfactant

![Relationship curve between rock sample interfacial tension and water moisture index](image)

Figure 2. Self priming oil discharge of core with permeability of 38.37md

Figure 3. Self priming oil discharge of core with permeability of 46.04md

Figure 4. Relationship curve between rock sample interfacial tension and water moisture index (permeability 6.76mD)
By exploring the relationship between oil-water interfacial tension and water humidity index, it can be found that there is a logarithmic relationship between interfacial tension and water humidity index. As shown in Figure 6, the smaller the interfacial tension, the greater the water humidity index.

4. Conclusion
1) In the experiment of self-priming displacement, water entering the core enhances the hydrophilicity; The interfacial tension decreases and the self-priming oil displacement increases; The greater the permeability of the core, the more the self-priming oil displacement.
2) YB-1 surfactant can gradually change the wettability of rock samples from lipophilic to hydrophilic. At the same time, the smaller the permeability is, the smaller the water wet index is, and the stronger the lipophilicity is.

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