Optimization of Microemulsion Formulation of Fracture reservoirs

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Abstract. In order to screen out the optimal microemulsion oil drive system, the effect of microemulsion performance on the residual oil of pore is selected, and the remarkable effect of improving recovery rate is proved from both macro and micro aspects by analyzing the fissure core oil drive experiment and the distribution law of the residual oil of the pore. The results showed that the best microemulsion system is made of positive octane 8mL, water 8mL, 4.5% mass fraction of the beetroot, 6% mass score of positive butanol, 5% quality score of NaCl. And that microemulsion system has a smaller particle size distribution range, higher viscosity, strong stability and a smaller proportion of pore residual oil.

1. Introduction

In 1985, Shah had a relatively perfect definition of microemulsion, which was considered to be a thermodynamic stability system consisting of surfactants and surfactants and oils and water. After 1986, microemulsion drive became the focus of research in the oil industry. Because the particle size distribution range of microemulsion is narrow, it can effectively control the flow, expand the ripple volume and improve the oil washing efficiency, so it is more suitable for low-permeable reservoir with a smaller radius of the pore throat channel. Microemulsion can form an ultra-low interface tension, and reduce the flow resistance, so as to achieve the effect of improving recovery rate [1-2]. High viscosity microemulsion has an increasing effect, and can reduce the viscosity of crude oil and increase liquidity, so as to remove the residual oil on the pore wall, to improve the efficiency of oil removal. The theory of instantaneous negative interface tension and the theory of gel increase theory put forward by Schulman and Prince fully explain the spontaneous formation and stability of microemulsion [3]. The strong stability of the microemulsion oil drive system can maintain the surfactivity of the surfactant, and increase the interface energy, and promote the reduction of interface tension. At present, microemulsion drive is widely used in three oil extractions and plays a vital role in improving recovery rates. There have been more studies on the compounding system of microemulsion, but there are relatively few studies on the selection of microemulsion formulations by analyzing the relationship between microemulsion properties and microporous residual oil. In this paper, the influence of microemulsion performance on pore residual oil is analyzed by changing the type of surfactant, and the optimal microemulsion exorcism oil repellent system is finally selected.

2. Experimental design

2.1. Experimental instruments and drugs
Experimental materials: the Huabei oilfield crack core, Huabei oilfield crude oil and kerosene according to a certain proportion of preparation, mineralization of 6778mg/L of simulated salt water.

Experimental drugs: positive octane; pyridine beetroot; sodium sulphate (SDS); Twain-60; positive butanol; NaCl.

Experimental instruments: MS3000 laser granulizer; TX500C screw-drop interface tension meter; vacuum pump; insulation box; core gripper; piston container; ring pressure pump.

2.2. Experimental procedure
The performance of microemulsion is not only related to the types of components, but also to the content and proportion of each component. By changing the type of surfactant to study the effect of microemulsion system performance on pore residual oil to select the best microemulsion oil repellent oil drive system. The specific formula is as follows.

Formula 1: positive octane 8mL, water 8mL, 4.5% quality score of sodium sulphate (SDS), 6% quality score of positive butanol, 5% quality score of NaCl.

Formula 2: positive octane 8mL, water 8mL, 4.5% quality score of Twain-60, 6% quality score of positive butanol, 5% quality score of NaCl.

Formula 3: positive octane 8mL, water 8mL, 4.5% quality score of the beetroot, 6% quality score of positive butanol, 5% quality score of NaCl.

3. Experimental Results and Analysis

3.1. Formula Preferred

3.1.1. Particle size distribution. The particle size distribution of the microemulsion system is measured by a laser granulizer, which measures a range of 0.01-3500μm, and the particle size distribution of microemulsion can be observed by magnifying different multiples. The particle size of each microemulsion was recorded and the distribution of the particle size was compared. The results of the experiment are shown in the figure.

![Figure 1: Particle size distribution diagram](image1)

![Figure 2: Relationship between microemulsion particle size and pore remaining oil](image2)

The results of the above experiments show that there is a narrow peak in the microemulsion particle size map. The different microemulsion system has different particle size, but they are similar to the normal distribution, and the particle size distribution range of each microemulsion is 0.01-0.2μm, mainly concentrated between 0.07-0.12μm. Among them, the particle size of formula three is mainly distributed in the range of 0.05-0.1μm, indicating that the particle size is relatively small to easily enter the fine pores. From Figure 2, it can be found that the proportion of residual oil containing pores decreases with the reduction of the pore radius. The smaller the microemulsion particle size, the easier it is to enter the pore to replace the remaining oil. The same pore radius, the smaller the microemulsion particle size, and the smaller the proportion of oil left with pores. Low-permeable reservoir of core pores are relatively small, because the particle size of microemulsion drive is generally distributed in...
the range of 1-10nm, and it can through small pores to increase the oil repellent area. So microemulsion drive can be widely used in low-permeable reservoir, significantly improve recovery rate.

3.1.2. Viscosity. Microemulsion viscosity is an important index to measure the effect of oil repellent, and the effect of microemulsion with different viscosity is different. The fluidity and salt concentration of the solution all affect the viscosity of the microemulsion, and the microemulsion content is different in the solution of different viscosity. The relationship between the viscosity of microemulsion system and the content of microemulsion in different formulations is studied, as shown in Figure 3.

![Figure 3. Relationship between viscosity and microemulsion](image)

As can be seen from Figure 3, when the critical adhesive beam concentration is reached, microemulsion is generated in the solution, and the viscosity of the system increases with the increase of the microemulsion content. The viscosity of formula three is large, and the content of microemulsion is high. The viscosity of formula two is the least. Generally speaking, because the viscosity of microemulsion is much larger than water, it will reduce the flow of repellent and the ratio of water oil flow in the process of oil repellent, thus reducing the finger-infusion phenomenon to further expanding the volume of the ripples and achieving the goal of improving the recovery rate of crude oil. From Figure 4, it can be found that the proportion of residual oil with pore decreases with the reduction of pore radius. The microemulsion system with high viscosity has a good increasing effect, and can change the oil flow ratio, and can increase the oil washing efficiency, thereby increasing the oil removal efficiency. Under the condition of the same pore radius, the higher the viscosity of the repellent, the smaller the proportion of oil left with pores.

3.1.3. Stability. Microemulsion is a thermodynamic stability system with ultra-low interface tension. Under ideal conditions, its stability does not change over time. But in the actual field, the stability of microemulsion changes over time [4]. There are two experiments to study the stability of microemulsions. First, different concentrations of surfactant solution after placing 2d, and mixing with crude oil, then using the spin-drop interface tension instrument to determine the interface tension of the system. Second, the microemulsion content of microemulsion was determined after 2 days of placement of the microemulsion system with different concentrations of surfactant solution. The results of the experiment are shown below.

![Figure 4. Relationship between viscosity and residual oil](image)
From the experimental results of Figure 5, it can be seen that the interface tension and microemulsion content of the original sample and formula one are relatively different after two days of placement. The interface tension of formula two is relatively large, and the microemulsion content is relatively small after two days of placement. The interface tension of formula three is relatively small, and the interface tension growth is relatively small after two days of placement, but the microemulsion content is larger. Therefore, the stability of formula three is better. At the same surfactant concentration, the interface tension of the microemulsion system after two days was slightly higher than the interface tension of the original sample, and the microemulsion content was slightly reduced. This is because the stability of the microemulsion system decreased slightly with time, but the microemulsion system was able to maintain low interface tension and high microemulsion content after two days, then indicating that the microemulsion system has a better stability.

In summary, the best microemulsion oil repellent oil drive system is made of positive octane 8mL, water 8mL, 4.5% quality score of the pyridine beetroot, 6% quality score of positive butanol, 5% quality fraction of NaCl.

4. Conclusions
(1) The particle size of formula three is mainly distributed between 0.05-0.1μm. The particle size is small, and the characteristics of smallness for low osmosis reservoir throat are highly applicable.

(2) The proportion of residual oil with pore in formula three is small, which indicates that the oil repellent effect is better. In summary, the optimal microemulsion oil repellent system is made of positive octane 8mL, water 8mL, 4.5% quality score of the beetroot, 6% quality score of positive butanol, 5% quality score of NaCl.

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