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Study on Increasing Oil and Gas Recovery in Oilfield by Active Water - Driven Surfactant

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Surfactant flooding is one of the main methods of tertiary oil recovery. At present, there are a lot of experimental researches on the problem of microscopic active water flooding mechanism at home and abroad. There are many kinds of research methods, but most of them use core flow experiment. This method can not visualize the effect of oil displacement and oil displacement. In this paper, the micro-model of flat glass can be used to observe the mechanism, and oil displacement in the process of oil displacement. In this experiment, the surface active agents were screened, and two kinds of surfactants were selected from several surfactants commonly used in oilfields such as temperature, salt tolerance. The selected surfactant and the use of appropriate instruments are the means of interfacial tension, emulsification capacity of the determination and evaluation, which helps to determine the optimal formula. Then, the mechanism of emulsification, polymerization and emulsification of oil droplets during active water flooding was studied by using micro plate model of glass. And then we study the effect, significance and influence of active water flooding on enhanced oil recovery. Experiments show that it is feasible to study the effect of active water flooding on the recovery of oil and gas in oil field. It is feasible to study the effect of active water flooding experiment on the oil displacement efficiency.

1. Introduction

With the increase in energy demand in the world, the demand for oil extraction and extraction efficiency is getting higher and higher. Conventional oil production methods are generally only 1/3 of crude oil reserves. Increasing crude oil recovery will play an important role in resource utilization when conventional production of crude oil is declining (Flores et al., 2015). The development of tertiary oil recovery technology is increasingly demanding for surfactants (Zhao et al., 2015). Not only it requires having low oil-water interface tension and low adsorption value, but also it requires being compatible with reservoir fluid and cheap.

In the current oil prices, the cost of surfactants is the main factor that restricts the development of tertiary oil recovery surfactants (Abidina et al., 2012). So the oil field with the surfactant system proposed high resistance to salt, high temperature, low loss of adsorption, low cost requirements (Munirasu et al., 2016). At the same time, the microcosmic mechanism of water flooding in porous media has been of great significance to the understanding of oil and water movement laws and the development of economically reasonable reservoirs (Cheraghian et al., 2015). The mechanism of the oil surfactants was reviewed by analyzing the characteristics of surfactant interaction at oil and water, the stress of residual oil after water flooding and the effect of surfactant on residual oil stress.

Based on the analysis of the status quo of research on surfactants for micro-oil displacement in China, combined with the current research work, it is believed that the development of cheap and high-performance surfactants is the key to carry out surfactant flooding and its associated flooding technology, and it is the key to active agent and its related oil displacement technology prospects (Cheraghian, 2015.). In this paper, the microcosmic visualization of the emulsions was investigated (Hendraningrat and Torsæter, 2014). The active water flooding method with theoretical and practical significance was obtained by injecting the optimized active agent to improve the oil recovery.

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2. Experiments

2.1 Water and oil physical and chemical properties

The oil used in the oil field can be divided into two categories, which are namely natural and synthetic water oil. Natural water oil is the most used in the xanthan gum; it is the organism in the carbohydrate to produce microbial action and the production of biological water oil (Cheraghian et al., 2015). Synthetic water is mainly partially hydrolyzed polyacrylamide, which is obtained by polymerization and hydrolysis of acrylamide monomers (Cheraghian et al., 2013). Both the cytosol and partially hydrolyzed polyacrylamide can achieve higher molecular mass, but their molecular structure is completely different, partially hydrolyzed polyacrylamide molecular structure characteristics of its molecular has a softness, and the molecular structure of the cortiset makes it semi-rigid or rigid, resulting in some differences in their aqueous solution. In the practice of oilfield chemical flooding, the bio-water oil weaknesses such as micro-organisms are more sensitive, which is making the mine more selective part of the hydrolysis of polyacrylamide as a water-oil thickener.

Table 1: Technical requirements for polyacrylamide for flooding

NO.	Project	Specification	9.5≤M<12 (×106)	12≤M<16 (×106)	16≤M<19 (×106)	19≤M≤22 (×106)
1	Exterior		White powder			
2	Viscosity average molecular (×106)		≥9.5	≥12	≥16	≥19
3	Characteristic viscosity, dL/g		≥15	≥17.5	≥21.2	≥23.7
4	Solid content, %		≥88			
5	Degree of hydrolysis, mol%		23—27			
6	Filter factor		≤1.5			/
7	Screen factor		≥15	≥20	≥24	≥28
8	Water insoluble matter, %		≤0.2			
9	Viscosity, mPa.s		≥31	≥40	≥45	≥50
10	Dissolution rate, h		≤2			
11	Residual monomer, %		≤0.05		≤0.1	
12	granularity%	≥1.0mm	≤5			
		≤0.20mm	≤5			

2.2 The water micro-oil drive mechanism

The traditional theory of water and oil flooding is that the water and oil flooding only increases the oil viscosity by increasing the viscosity of the injected water, and it enlarges the turbulence flow rate in the oil layer, increases the oil recovery rate, and the oil flooding cannot increase the reservoir. The microscopic oil displaces efficiency of the rock, and the volume of oil remaining in the pore medium water flooding is the same as that after water flooding. After several years of laboratory experiments found, the water and oil flooding can not only spread to the volume, but also it needs to improve the oil displacement efficiency.

Micro-oil drive mechanism

(1) Water and oil flow ratio is lower, and it is the water and oil to replace the cluster of residual oil which is one of the main reasons. Because water is a water-soluble polymer, the molecule contains many hydrophilic groups, these hydrophilic groups in the water and oil molecules formed outside the "water sheath", increasing the relative movement of the internal friction (Cheraghian et al., 2014). At the same time, the above groups in the water dissociation are resulting in many symbols of the same link; these links are mutually exclusive, so that water molecules in the water more stretch, and the water has a strong ability to increase viscosity. Water oil drive not only increases the viscosity of the displacement phase, but also it reduces the oil-water viscosity ratio, and because of the water and oil macromolecule characteristics, the rock needs to produce retention, increased displacement of the fluid in the porous medium flow resistance, which is causing the water phase.

The decrease in permeability makes the oil-water flow ratio further reduced (Ye et al., 2013). As the water and oil flooding significantly reduced the water flow ratio, reducing the water into the finger, it needs to improve the micro-wave coefficient, which will be washed after the water-driven residual oil out of the alternative.

(2) The increase of shear stress in water oil solution is the mechanism of flooding island-like and membrane-like residual oil (Cheraghian, 2016). Dynamic tracking of water and oil flooding experiments show that the water and oil solution can be stripped by the way to gradually remove the island-like residual oil and membrane-like residual oil, until the entire move or push away.

In this process of oil displacement, the role of displacement in the oil phase on the shear stress can be expressed as follows, $T=dv/dz \cdot \mu r$(3-1-1).

T means the displacement phase on the oil phase of the shear stress;
dv/dz represents the interface velocity gradient between two - phase fluids;
μr is the viscosity of the displacement phase at the oil phase.
Since the water and oil solution is a non-Newtonian viscoelastic fluid, the flow field distribution in the rock channel is distinct from that of the water which is shown in Figure 1.

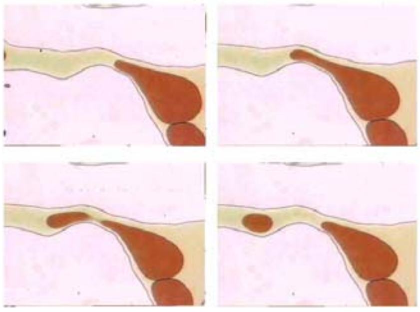

Figure 1: Polymer flooding the island-like residual oil process

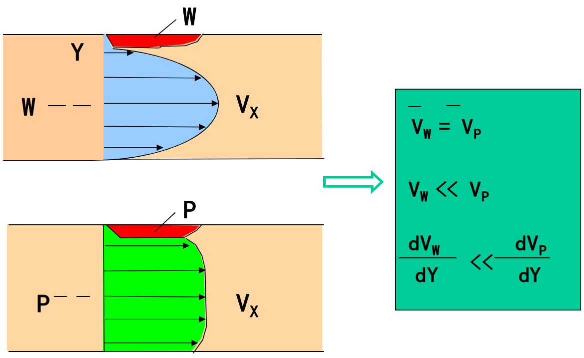

Figure 2: Schematic diagram of the flow field distribution of water and polymer solutions in the pipeline

2.3 Micro activated water flooding experiment

Water flooding process
As the oil and water viscosity difference is large, and the viscosity of crude oil is greater, that is, the difference between the viscosity of crude oil and injected water is greater. The fluidity ratio becomes greater, the water will soon be broken in the oil layer during the water flooding process, and at the same time it can be observed that the water will break into the oil layer, and the injected water will flow along the water directly reaching the production well, the injected water will not reach the oil, so most of the oil in the formation will remain in the form of the remaining oil, thereby reducing oil recovery.
The interfacial tension of oil and water is reduced, so that the residual oil droplets are easily deformed and the area affected by the flooding solution is added. After adding the surfactant, the lipophilic ends extend into the oil phase, the hydrophilic ends extend into the water phase and form the orientation at the oil- Adsorption, the surface layer of the net suction greatly weakened, the results of surface shrinkage significantly reduced, so that the oil and water interface tension decreased significantly, the oil droplets are easy to deformation. At the same time it can also make the original card in the more deformation.
The small oil droplets that cannot flow at the small throat are displaced and become movable oil due to ease of deformation (Barati, 2013). The deformation of the oil droplets drops at the throat and the force of the oil bead are drawn as shown in Figure 3.
Reactive water to change the rheological mechanism of crude oil
After the surfactant, the overall viscosity of the oil can be reduced, so as to improve the flow ratio of the displacement liquid and the crude oil, the water absorption index is obviously decreased, the water content at the outlet end is decreased and the oil displacement efficiency is improved. And the viscosity of crude oil is greater, that is, the viscosity difference between the crude oil and the injected water becomes greater, so the fluidity ratio is more obvious. Thus the active agent on the dispersion of crude oil is increasing and expanding the displacement of the liquid, which can also improve the efficiency of oil displacement and the development effect. This is shown in Figure 4.

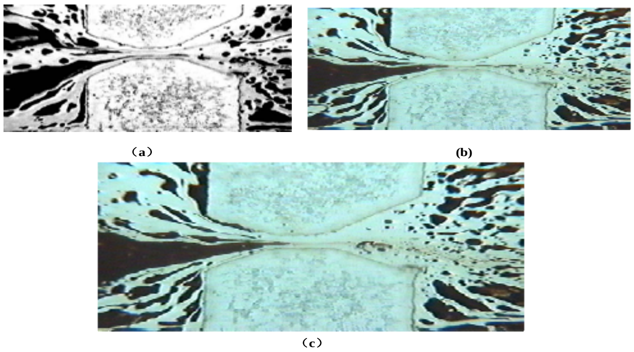

Figure 3: Oil droplets (beads) are elongated at the throat

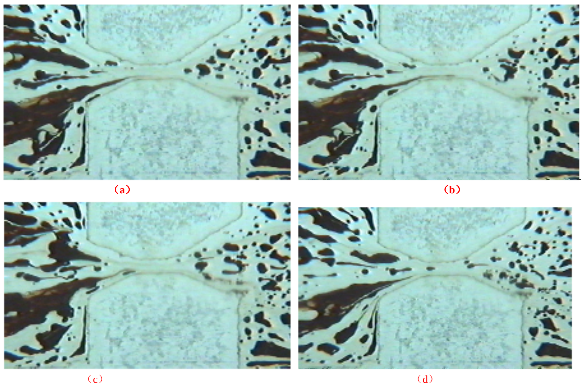

Figure 4: Active water improves the flow ratio of the displacement liquid to the crude oil

2.4 Discussion and analysis

The velocity distribution of water and oil in the capillary was measured in a single tube micro-scale with a radius of 90 μm. The experiment was carried out with the concentration of 1500mg/L water oil solution and the concentration of 1000mg/L saline, the two liquids by adding density are close to 1, particle size of 2μm standard insoluble polymer spherical particles, in the same model. The flow velocity profile of the measured water and water oil solution is shown in Figure 5 which is under the condition of an average flow rate of 4.0 × 10-5 m/s (Hendraningrat and Zhang, 2015.).

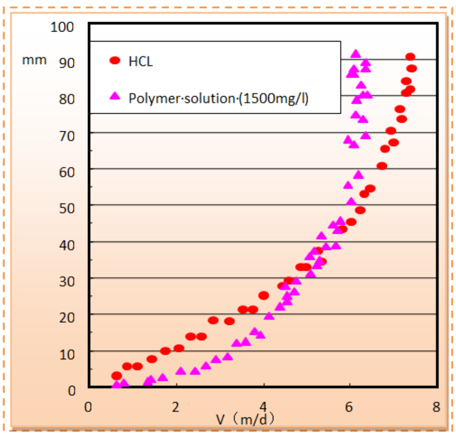

Figure 5: Distribution of polymer solution and water in capillary

It can be seen from the figure that the leading velocity of the water and oil solution is much lower than that of the water, the velocity profile is more "flat", the velocity gradient at the wall boundary is larger, and the rapid movement of the tiny particles at the boundary can be observed. And for the water, the boundaries of the tiny particles do not move; only a certain distance from the wall can be observed in the phenomenon of small particles moving. Since the velocity gradient of the water-oil solution at the capillary boundary is much greater than that of the water, the viscosity of the water-oil solution at the surface of the residual oil is much greater than that of the water. Therefore, the ability of the water-oil solution to "peel off" the oil film on the wall is much larger than water.

In order to verify the water flooding, we can reduce the oil film more than the water drive, the wetting test of the oil flooding and the water flooding is carried out.

Table 2: Determination of wet ability of rock reservoirs by water flooding and water flooding

Hashtag	NO.	Permeability (×10-3 μm2)	Self- absorbed oil (ml)	Self-priming oil displacement (ml)	Wetting index
C5	10-1	1525	0.04	0.6	-0.42
			1.64	0.48	0.15
	10	1560	0.04	0.5	-0.38
			0.34	0.4	-0.15
PO5	183	2067	0.40	1.20	-0.33
			0.80	0.16	0.09
	183-1	1946	0.04	1.10	-0.35
			0.31	0.6	-0.12
122-45	233	830	0.20	0.72	-0.18
			0.52	0.24	0.04
	233-1	720	0.19	0.70	-0.22
			0.28	0.78	-0.09
	288	888	0.36	0.60	-0.16
			0.84	0.24	0.09
	290	965	0.34	0.62	-0.15
			0.26	0.80	-0.10

Table 2 shows the experimental results of the influence of water flooding and water flooding on the wet ability of rock surface. It can be seen that the rock samples are converted to the hydrophilic direction after water and oil flooding. The average wetting index of water and oil is 0.0925, and after water flooding, it is at -0.115. The wetness is strong in the hydrophilic direction. It is indicating that the water-oil drive flooded more water-covered oil film than the surface of the rock.

3. Conclusion

Experiments on active water flooding with a flat glass model show that the use of surfactant flooding is an effective method for oil recovery. We can active water to reduce the interfacial tension of oil and water, so that the residual oil droplets are easy to deform, the original cannot move the oil into movable oil by expanding the spread of flooding area. After the injection of active water, the surface of the surfactant adsorption on the rock surface can make the wettability of the rock more partial hydrophobic, so that the original partial oil is the oil film state adsorption on the rock surface of the residual oil from the rock surface which was driven out, and increased oil recovery.

After the injection of active water, the surfactant increases the dispersion of the crude oil in the water, making it easy to be carried by the displacement liquid. The residual oil is scraped into small oil droplets by leaking into the solution with the solution. From the surface of the surface of the oil droplets washed down in the forward collision can be collide with each other, the oil can be brought into a mixture of oil, oil and active water is emulsified into oil droplets with the displacement solution with the forward flow, increased crude oil Recovery rate. The experimental results show that the use of active water flooding can change the rheological properties of the displacement liquid, reduce the flow ratio between the displacement liquid and the crude oil, and expand the volume of the displacement liquid. Hence, the use of active water flooding can improve the oil displacement efficiency and improve the development effect.

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