Study and Evaluation on Clean Fracturing Fluid Performance

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Abstract. VES fracturing fluid is mainly composed of long chain fatty acid derivatives quaternary ammonium salt surfactants. This surfactant is a kind of small molecules with viscoelastic, its molecular size in the order of 5, 000 times smaller than the melon glue molecules, it includes long chain hydrophobic group and hydrophilic group, molecular chain has positive side and negative side. In the presence of salt, they form stretch of micellar aggregates. When the concentration of surfactants in solution is higher than the critical micelle concentration, the micelles wrapped around each other and form space net structure, present a viscoelastic fluid, can effectively carry prop pant. This fracturing fluid system can meet the requirements of oilfield.

Keywords: clean fracturing fluid, carrying sand, viscoelastic surfactant.

1. Introduction

Fracturing fluid without polymer is known as micelles fracturing fluid, also known as clean fracturing fluid. Its main components are surfactants, inorganic salt and water. In saline, the surfactants could form rod-like micelles, which highly increases the fluid viscosity and viscoelasticity, to achieve the viscosity requirement for the fracturing fluid [1]. The viscosity of the fracturing fluid depends on the quality of the micelles, fracturing fluid can be damaged by changing the micelle structure. When fracturing fluid encounters hydrocarbon liquid or diluted in water, the viscosity breaks.

The feature of clean fracturing fluid is without need to add any polymers, which viscosity can meet the needs of fracturing. Without adding any chemical breaker, the crude oil or natural gas can be used as breaker and the gel can be completely breaking without residues, which fundamentally solves the damage of fracturing fluid residues to fracture and reservoir. The fracturing fluid also has excellent properties of shear resistance and tiebreaking, which applies to the low temperature (less than 90 ℃) of oil and gas well fracturing. Due to domestic research started late, and the cost is higher than the ordinary fracturing fluid, there is no universal application [2].

2. Screening of viscoelastic surfactant

Common surfactants are divided into four categories: anionic surfactants, cationic surfactants [3], nonionic surfactants and zwitterion surfactants [4]. We select surfactants which can represent features in each category and evaluate their gelling properties of rheological aspect.

In order to improve the effect of tackifying , while reducing the cost of reagents, we further select the ratio of concentrations of the cationic surfactants, which are 1831 and the newly developed XQH, and a thickening agent .we also add Polyethylene glycols to improve the dispersibility of the proppant. The experiment is operated at room temperature, and under a shear rate of $170s^{-1}$, the results measured under the condition shown in Table 1 to 3

Table 1 Complex test of1831 and XQH

No.	1831/%	XQH/%	Sal/%	Polyethylene glycol/%	KCl/%	PH	Visocity/mPa.s
1	0.10	0.04	0.10	0.04	1	9	9
2	0.10	0.06	0.15	0.06	1	9	12

3	0.10	0.08	0.20	0.08	1	9	12
4	0.15	0.04	0.15	0.08	1	9	15
5	0.15	0.06	0.20	0.04	1	9	15
6	0.15	0.08	0.10	0.06	1	9	12
7	0.20	0.04	0.20	0.06	1	9	18
8	0.20	0.06	0.10	0.08	1	9	9
9	0.20	0.08	0.15	0.04	1	9	15

Table 2 Complex test of1831 and XQH

No.	1831/%	XQH/%	Sal/%	Polyethylene glycol/%	KCl/%	PH	Visocity/mPa.s
1	0.25	0.04	0.12	0.04	1	9	12
2	0.25	0.06	0.15	0.06	1	9	15
3	0.25	0.08	0.18	0.08	1	9	21
4	0.30	0.04	0.15	0.08	1	9	15
5	0.30	0.06	0.18	0.04	1	9	21
6	0.30	0.08	0.12	0.06	1	9	15
7	0.35	0.04	0.18	0.06	1	9	24
8	0.35	0.06	0.12	0.08	1	9	12
9	0.35	0.08	0.15	0.04	1	9	15

Table 3 Complex test of1831 and XQH

No.	1831/%	XQH/%	Sal/%	Polyethylene glycol/%	KCl/%	PH	Visocity/mPa.s
1	0.28	0.04	0.16	0.04	1	9	15
2	0.28	0.06	0.17	0.06	1	9	15
3	0.28	0.08	0.18	0.08	1	9	19.5
4	0.30	0.04	0.17	0.08	1	9	15
5	0.30	0.06	0.18	0.04	1	9	21
6	0.30	0.08	0.16	0.06	1	9	19.5
7	0.32	0.04	0.18	0.06	1	9	18
8	0.32	0.06	0.16	0.08	1	9	18
9	0.32	0.08	0.17	0.04	1	9	18

So the fracturing fluid system uses the 1831 and XQH complex system by selecting, the fracturing fluid system has a higher viscosity. Then we will evaluate the performances of suspended sand and heat resistance.

3. Performance Evaluation

3.1 Performance Evaluation of suspended sand.

According to the relationship between viscosity and the performance of carrying sand, we select the systems whose viscosity are around 20mPa.s under different temperature conditions, as shown in Table 2.

Methods: Put the configured fracturing fluid into the 250ml graduated cylinder, add 4-5 particles ceramic (diameter 20/40m), sedimentation velocity was measured at room temperature conditions.

Table 2: Sedimentation rate of Different fracturing fluid system

No.	1831/%	XQH/%	Sal/%	Polyethylene glycol /%	Viscusity/mPa.s	Rate/cm/min
1	0.30	0.10	0.15	0.04	19.5	0.181
2	0.25	0.04	0.20	0.02	21	0.217

3	0.30	0.02	0.20	0.04	22.5	0.065
4	0.30	0.06	0.15	0.02	21	0.071
5	0.20	0.04	0.20	0.06	18	0.154
6	0.25	0.08	0.18	0.08	21	0.059
7	0.30	0.06	0.18	0.04	22.5	0.072
8	0.35	0.04	0.18	0.06	24	0.061
9	0.28	0.08	0.18	0.08	19.5	0.179
10	0.30	0.08	0.16	0.06	19.5	0.182

Through data research, the sedimentation rates of these groups can meet the requirement .By comprehensive consideration , the fracturing fluid selected is: 0.30% 1831 + 0.06% XQH + 0.18% Sal + 0.04% Polyethylene glycol + 1% KCl, The viscosity of this system is 22.5 mPa.s at a shear rate of 170s-1 and the sedimentation rate is 0.072cm / min.

3.2 Performance evaluation of viscosity-temperature. Experimental conditions included the shear rate of 170s-1 and the experimental temperature ranging from 20 to 60 ℃. The experimental results were shown in Figure 1 and 2.

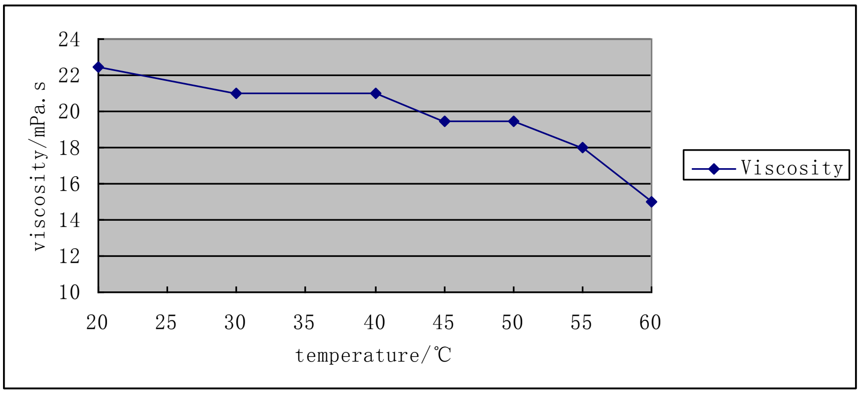

Fig. 1 Variation Figure of Fracturing fluid viscosity with temperature

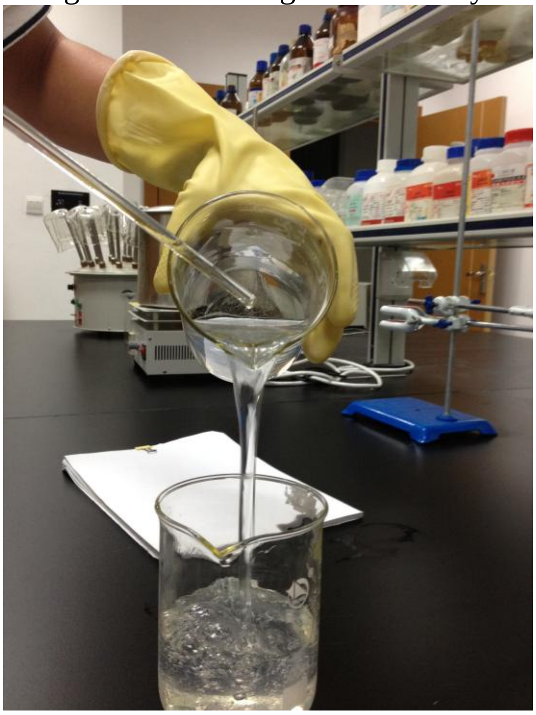

Fig. 2 Experiment Picture

Figure 1 shows that viscosity of the fracturing fluid system had a downward trend when the temperature increased, but declining slowly. When the temperature was above 55 ℃ or more, the viscosity remained at 18mPa.s, still had a certain carrying capacity.

4. Conclusion

The laboratory tests confirm a good performance of the fracturing fluid as a clean system.

1. Clean fracturing fluid system was: 0.30% 1831 + 0.06% XQH + 0.18% Sal + 0.04% Polyethylene glycol + 1% KCl. The effective concentration was low, and the apparent viscosity of the system was 22.5mPa.s at room temperature.

2. Through qualitative comparison, joining Polyethylene glycol in the fracturing fluid systems can improve the dispersion of ceramic to some extent.

3. The Fracturing fluid system has a good carrying capacity, the sedimentation rate of ceramists is 0.072 cm / min under normal temperature condition, which can be able to meet the site.

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