Experiment Study on the properties of Su-53 fracturing fluid

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Abstract. The sand carrying performance of the fracturing fluid is one of the decisive properties of the sand laying form of the proppant in the reservoir, and the sand carrying performance of the seven fracturing fluids on appeal is tested according to the Stokes theoretical formula for two melon samples and five viscoelastic surfactant samples. Single-particle sedimentation test and multi-particle sedimentation test were carried out and the fracturing fluid was optimized based on test data.The treatment of fracturing fluid flowback has always been a problem in the industry. In this paper, a redistribution experiment was carried out on 7 samples according to a redistribution method of fracturing flowback fluid, and viscosity was used as the main reference index. The recyclability of each fracturing fluid was compared based on the retention rate; the fracturing fluid with the most recyclability was selected.

Keywords: Fracturing fluid, Sand performance, Flowback treatment.

1. Introduction

At present, the commonly used fracturing fluids in oilfield production are mainly water-based fracturing fluids. One of the main functions of fracturing fluids is to carry proppant into the reservoir. The sand-carrying performance directly determines the sand-laying shape of the proppant, and is one of the determinants of fracture conductivity. In this paper, the sand-carrying performance of water-based fracturing fluid is analyzed, and on this basis, the laboratory experiment of fracturing fluid is carried out.

Fracturing flowback fluid is a liquid containing solid phase discharged after fracturing in oil and gas fields. The main components of this type of liquid are guar gum, preservatives, gel breakers, petroleum and other various chemical additives. "High" (high COD value, high stability, high viscosity) characteristics, if it is directly discharged without treatment, it will cause harm to the environment.

① The cost is complex, there are many types of pollutants (oil, SS, guar gum, various drugs), and the content is high;

② High viscosity, serious emulsification, and difficult separation;

③ The water quality and water volume fluctuate greatly, and the equipment has high requirements for impact resistance and stability;

④ It is mostly located on the job site, with a remote location and few supporting public works, requiring a high degree of automation, small footprint, skid-mounted, and highly mobile processing equipment.

How to deal with fracturing fluid flowback has become a difficult problem in the industry. In this regard, we propose a method for recycling the flowback liquid. The flowback fluid is reconfigured into fracturing fluid according to a certain method, and the recycle of the fracturing fluid can not only treat the fracturing fluid harmlessly, but also reduce the construction cost. But not all fracturing fluid flowbacks can be reconfigured as fracturing fluids. Therefore, in this paper, a performance optimization experiment was carried out on the reusability of fracturing fluid. Fracturing fluids that meet redistribution requirements are preferred.

2. Experimental section

2.1. Materials

The fracturing fluid used herein is taken from the Surig block, where the Fracturing Fluids No. 1 and No. 5 are melon fracturing fluids, and the 2nd, 3rd, 4th, 6th and 7th are viscoelastic surfactant fracturing fluids.

The proppants used herein are all 20/40 mesh ceramic particles with a density of 2.7g/cm^3.

2.2. Principle

The sand suspension property of fracturing fluid is an important parameter to measure the performance of fracturing fluid. At present, there are two main methods for testing and evaluating the sand suspension and proppant settling properties of fracturing fluids in the laboratory: one is the single-particle proppant settling method based on the Stokes theoretical formula [1-8], which is to observe and evaluate in a static state. The time required for the single-particle proppant to settle to the bottom of the vessel in the fracturing fluid was measured and the settling rate was calculated. The other is the sand-carrying liquid (multi-particle) suspended sand performance test method [5, 9], which is to observe and measure the time required for the complete settling of proppants with different sand concentrations in the sand-carrying liquid in a static state and calculate the settling velocity. Compared with the single-particle proppant settling method, this method can more objectively reflect the settling characteristics of the fracturing fluid suspended sand and proppant, and is closer to the actual situation of fracturing. The mechanism of proppant settling in multi-particle or sand-carrying fluids is completely different from that of single-particle free settling [9].

The basic principle of both methods is to determine the complete settling distance of the proppant and the time required to obtain the settling rate.

$$v = \frac{L}{t} \tag{1}$$

v—Sedimentation rate, mm/min;

L—Settlement distance of the proppant, mm;

t—The sedimentation time of the proppant, min.

The viscosity of fracturing fluid is one of the important properties of pressure fluid, especially in terms of sand-carrying performance, viscosity and sand-carrying performance show a positive correlation to a certain extent, so we choose viscosity as the main reference index for redistribution fluid. The ratio of the viscosity of the reconstituted fluid to the viscosity of the fracturing fluid is taken as the viscosity retention rate, and whether the fracturing fluid is recyclable is judged by the level of the viscosity retention rate. Higher viscosity retention indicates better recyclability.

$$R_1 = \frac{\eta_2}{\eta_1} \times 100 \tag{2}$$

R_1—— Viscosity retention, %;

η_1—— Fracturing fluid initial preparation fluid viscosity, mPa·s;

η_2—— Fracturing fluid repeat preparation fluid viscosity, mPa·s.

2.3. Method

(1) Proppant settling

1) Determination of 20% sand-liquid specific sedimentation rate

a) Take the prepared base fluid, measure the proppant at a volume ratio of 20%, and add the proppant to the base fluid;

b) Place the base liquid with proppant under the agitator and set the rotation speed to 350r/min;

c) Turn on the agitator, and configure the base fluid as a sand-carrying fluid after the proppant is completely suspended. Turn off the mixer;

d) Measure the liquid level immediately after taking it out, and record the time. Stop timing when the proppant is completely settled.

2) Determination of sedimentation rate of single-grain proppant

a) Take 500mL of the prepared sand-carrying liquid and put it into a large number of cylinders;

b) The proppant is place 3-5mm below the surface of the sand-carrying liquid with tweezers, when the proppant position is recorded;

c) Record the new position of the proppant every hour and measure the drop distance.

(2) Recyclable performance of fracturing flowback fluid

a) Prepare the corresponding fracturing fluid according to the formula, test the viscosity and record it;

b) Add gel breaker as required and place fracturing fluid at reservoir temperature to complete gel breaking. (viscosity lower than 5mpa.s);

c) Mix according to the ratio of flowback liquid: standard brine = 9:1;

d) Using the liquid configured in c, reconfigure the fracturing fluid according to the formula, test the viscosity and record.

2.4. Outcome

(1) Proppant Settling Experiment

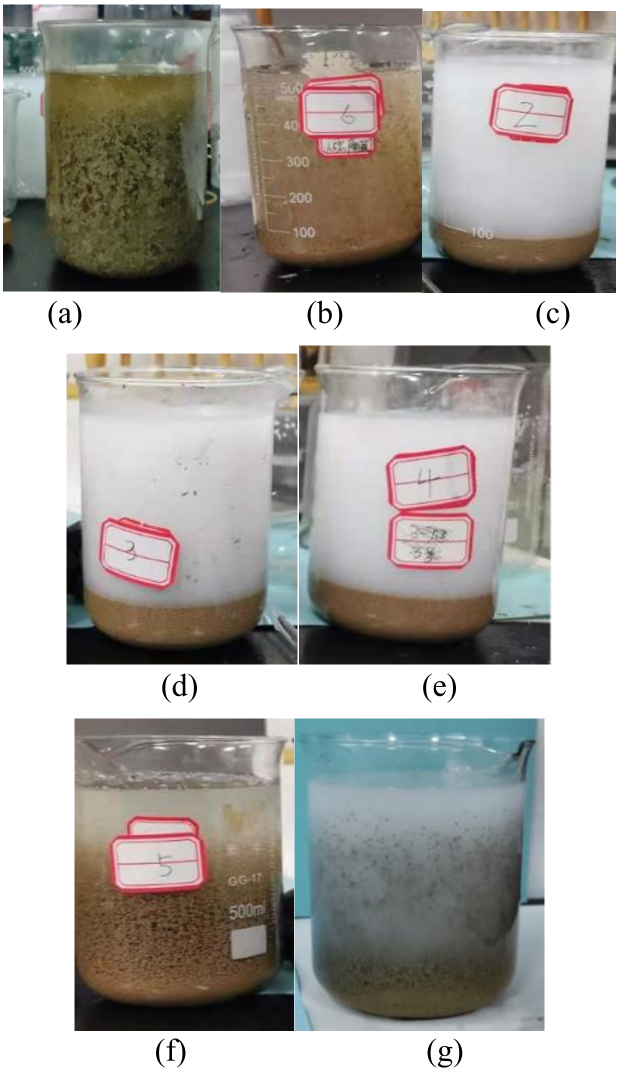


Figure 1. Multi-particle sedimentation test plot (a: No.1 b: No.2 c: No.3 d: No.4 e: No.5 f: No.6 g: No.7)

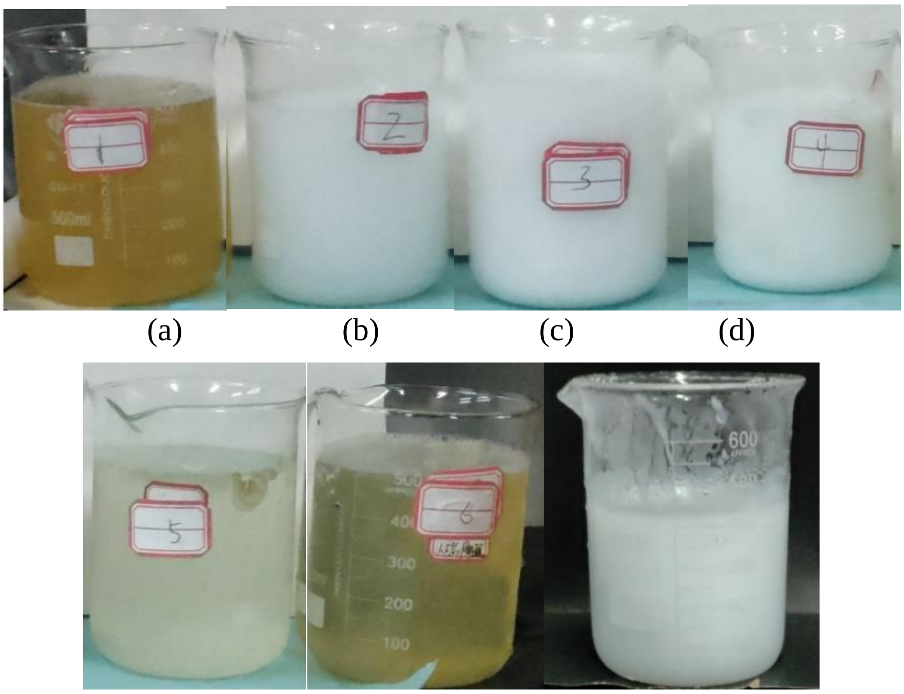
Table 1. The ability of the fracturing fluid to carry sand

sedimentation rate(mm/min)	1	5	2	3	4	7	6
Single particle	0.241	0.249	0.453	0.406	0.332	0.299	0.882
Muti particle	0.0343	0.0199	14.28	9.85	10.23	0.14	12.5

From the single particle sedimentation test, there is little difference between No. 1 and No. 5 in the guar gum sample. Among the non-guar gum samples, the ceramsite sedimentation rate of sample No. 7 was slower, indicating that the proppant laying shape was more ideal, and the sedimentation rate of ceramsite of sample No. 6 was the fastest.

From the multi-particle sedimentation test, the sedimentation rate of No. 1 guar gum is lower than that of No. 5 guar gum, indicating that No. 5 has better sand-carrying performance. Compared with other non-guar gum fracturing fluids, No. 7 has a stronger ability to suspend sand, and the rest have average ability to suspend sand.

(2) Fracturing fluid recyclability



(a) (b) (c) (d) (e) (f) (g)

Figure 2. Reconstituted liquid diagram (a:1 b:2 c:3 d:4 e:5 f:6 g:7)

Table 2. Reconstituted Fluid Viscosity Retention

Number	1	5	2	3	4	7	6
Reconstituted FluidViscosity Retention (%)	Cannot be cross-linked	Cannot be cross-linked	60.77%	53.85%	62.5%	81.63%	61.76%

3. Conclusions

Judging from the results of the appeal test, No. 7 and No. 4 performed best in the single-grain settlement test, while in the multi-particle sedimentation test, the data of sample No. 7 was far superior to other samples, so sample No. 7 could be preferably used as a viscoelastic surfactant fracturing fluid used in oilfield production.

In the melon sample, the two samples performed equally well in the single particle sedimentation experiment, but sample 5 performed better than the number 1 in the multi-particle sedimentation test. Therefore, sample No. 5 can be preferably used as a guar fracturing fluid used in oilfield production.

In terms of recyclability, No. 7 fracturing fluid was selected, and the viscosity retention rate of the reconstituted fluid reached 81.63%, making it the only fracturing fluid with reusable properties. To sum up, in this paper, No. 7 VES fracturing fluid is selected as the fracturing fluid used in the construction of Su 53 block.

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