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Application of fracturing and reforming in low permeability and tight reservoir of MA-S drag reducer fracturing fluid

In view of the characteristics of low permeability and tight reservoir and the requirement of fracturing fluid, the fracturing fluid system of MA-S high efficiency drag reducer is developed, and its performance is evaluated. Using the indoor evaluation device of drag reducer, the MA-S high efficiency drag-reducing agent fracturing fluid system has high drag reduction performance, the best concentration is 0.07%, and has a certain stability, the 120h drag reduction rate is lowered by 8%. The resistance to mild and shear properties was tested by Rheometer, the temperature rises from 25 to OC, viscosity drops 0. 025Pa.s, shearing time from 0 s to 1800s, apparent viscosity reduces 0.0075 Pa.s, when the velocity is 20m/s, the drag reduction rate is 61%, then with the flow rate increases, the drag reduction rate drops, But the decline was smaller, at a minimum of 53%. With the successful application of 5 wells in the field of MA-S drag-reducing agent fracturing fluid, the maximum frictional resistance of the tubing can be reduced by 61%, which provides an effective way for the efficient reconstruction of tight reservoirs.

Keywords: Low permeability tight reservoir, drag reducer fracturing fluid, fracturing.

1. Introduction

With the development of oil and gas exploration from high permeability reservoir to low permeable tight reservoir, the number of fractured wells in low permeable tight reservoir is increasing, and the difficulty of fracturing is increasing gradually[1-3]. The requirements of fracturing fluid from conventional cross-linked gel to low viscous liquid and slippery water fracturing fluid system, the drag reducer in the slippery water fracturing fluid must have a good frictional resistance performance, to better reduce the construction pressure, meet the requirements of large displacement construction, reduce the construction difficulty. The drag-reducing agent in the slippery water fracturing fluid must have good friction resistance, so as to reduce the construction pressure, meet the requirement of large displacement construction and reduce the construction difficulty.

At present, mainly in the domestic linear plant gum[4-6], but the actual application process of drag reduction effect is not obvious, the price of foreign similar products is higher, difficult to large-scale application.

In view of the performance of fracturing fluid, The MA-S effective drag reduction agent was synthesized with AM, AA, MPEG methacrylate, AMPS and MMA as monomer. MA-S fracturing fluid system with good comprehensive performance is developed[7-10], with the application of fracturing in the tight reservoir of Yuchangqing oilfield, the high efficiency drag-reducing agent shows good applicability in the field, reduces the construction frictional resistance and provides an effective way for the high efficient transformation of the tight reservoir.

2. Performance evaluation of MA-S drag reducer fracturing fluid

2.1. Preparation of fracturing fluid

Performance evaluation of MA-S drag reducer fracturing fluid test formula is as follows:

1. Drag-reducing water: 0.06% MA-S high efficiency drag reducer + 0.5% help agent + 1% clay stabilizer.
2. Slippery water: 0.1% cj 2-15 + 0.5% tof-1 + 0.5% tos-1.
3. Base fluid: 0.1% help solvent + 0.35% surface active guanidine + 0.5% clay stabilizer + 0.5% tof-1 clay stabilizer + 0.3% regulator + 0.1% bactericide.
4. Cross-linking agent: 0.3% cross-linking agent.

2.2. Relationship between drag reduction rate and usage concentration

In the test pipe diameter 4mm, flow rate of about 20m/s, the test temperature is room temperature, compared to the high efficiency drag reducer MA-S and hydroxypropyl guar gum drag reduction rate, at the same time, compared

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to the foreign two kinds of drag reducer products, Fig. 1 is the relationship between the drag reduction of the high efficiency drag reduction agent, Hydroxypropyl guanidine gum, the foreign types I and II drag reduction agents and the use concentration.

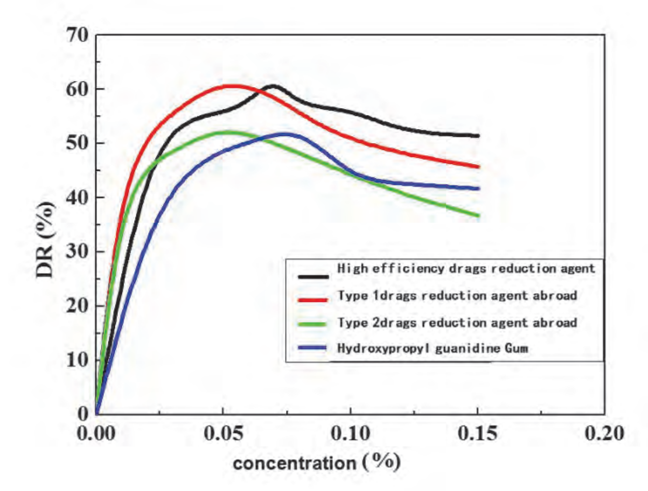

Fig.1: The change of drag reduction rate of high efficiency drag reducer with the use concentration

It can be seen from the figure that the effect of the effective drag reduction agent is close to that of the foreign type I drag reducer, compared to hydroxypropyl guar gum and the Foreign type II drag reducer; the high efficiency drag reduction agent shows a higher drag reduction effect. The drag reduction rate increases rapidly with the increase of the concentration of the effective drag-reducing agent before the concentration reaches 0.025%. However, when the concentration of the use of more than 0.025%, the reduction rate with the increase in the use of the concentration of the change is very small, the use of the concentration of 0.07% drag reduction rate reached the maximum, about 62%, the agent concentration of more than 0.07% drag reduction rate began to decline. In the use of hydroxypropyl guar gum at 0.08%, the drag reduction rate reached the maximum (consistent with the site use concentration), I-type and type II drag-reducing agents in the use of concentration of 0.05% are to achieve the maximum drag reduction rate.

Fig. 1 shows that the drag reduction rate increases with the increase of the use concentration, however, the drag reduction rate is not linear with the concentration, and when the concentration is small, the reduction rate decreases with the increase of the concentration, and the reduction rate decreases with the increase of the use concentration. It can be seen from the trend line in the graph that when the concentration is increased to 0.07%, the drag reduction rate does not increase with the increasing of the use concentration, but tends to a fixed value, that is, the maximum drag reduction rate. This is because when the concentration of drag reduction agent is low, the more obvious is drag reduction effect, the greater is the drag reduction rate, with the increase in the concentration of drag reducer, in a certain flow of pressure will increase the viscosity of the fluid, which will lead to a further increase in fluid resistance, reducing drag efficiency, therefore, when the concentration of drag reduction agent increases to a certain number, the drag reduction rate tends to stabilize. In the application process of the drag reducer, the larger quantity is not the better, but the best concentration should be determined according to the experiment, so the optimum concentration is 7%.

2.3 Anti-drag water stability test of high efficiency drag reducer

Field application found that, due to weather and other natural factors, reducing drag water in the match, may not be immediately used, must be placed a few days before fracturing, which requires a better stability of drag reduction water to meet field applications. In this paper, the stability of drag-reducing water with high efficiency drag reducer is studied. Configure 0.07% effective drag reduction agent MA-S solution, in the diameter of 4mm, flow rate 20m/s, 25°C placed 120h, daily test its drag reduction rate, observe the placement of 5-day drag reduction rate changes, as is shown in Fig. 2.

It is seen from Fig. 2 that with the increase of placement time, the drag reduction rate of the effective drag reduction agent decreases slightly. But the drop is small, placed 120h, the drag reduction rate from 60% to 52%, reduced by 8%, therefore, the placement time on the high efficiency drag reducer fracturing fluid drag reduction rate is not much, can meet the requirements of field fracturing, However, the proposal is to be used as far as possible to avoid long time placement.

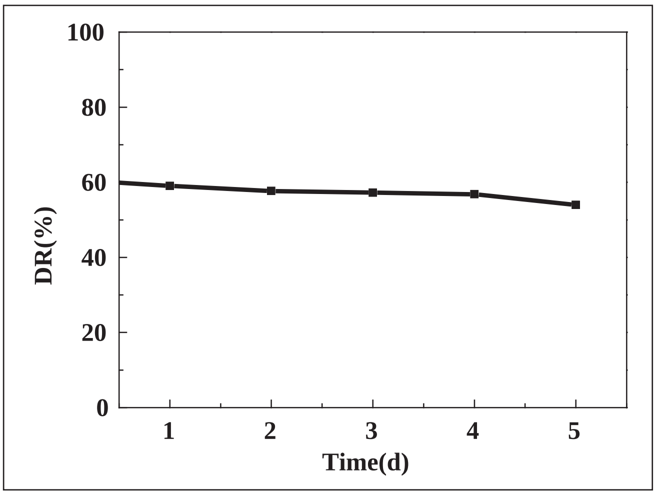

Fig. 2: Variation of drag reduction rate with time of placement

2.4 Test of temperature resistance of high efficiency drag reducing agent solution

In the process of injecting the drag-reducing agent into the underground, because of the rising of the stratum, in order to achieve the performance of drag reduction, it is required to have a certain temperature resistance performance. The heat resistance of the solution of the temperature 25°C to 80°C high efficiency drag-reducing agent was investigated by using rheometer, which was prepared by 0.07% effective drag-reducing agent solution, and the shear rate was 170s-1, as is shown in Fig. 3.

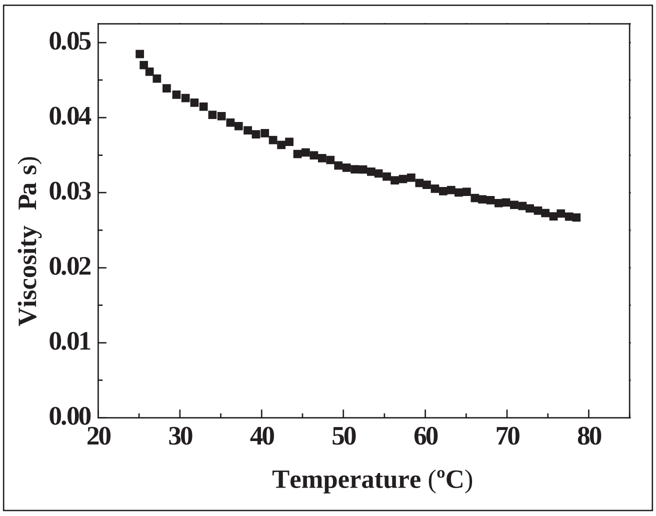

Fig.3: The variation curve of apparent viscosity with temperature

Seeing from Fig. 3, the apparent viscosity of the solution decreased from 0.05 Pa.s to 0.025 Pa.s. As the temperature increased from 25°C to 80°C, and decreased 0.025Pa.s. This is because the system in the high temperature of the rubber beam movement, occurred in the heat rearrangement, the entanglement of the molecules began to separate with each other, viscosity also decreased, but the viscosity drop is not large, indicating that the solution of high efficiency drag reduction agent has a certain temperature resistance performance.

2.5 Anti-shearing performance test of high efficiency drag reducing agent solution

0.07% high efficiency drag reduction agent solution, the shear rate is 170s-1, the temperature is 25°C, the test time is 1800s. At fixed temperature 25°C, under the condition of $170s^{-1}$ shear rate, the shear resistance of high efficiency drag reducing agent was determined by rheometer, the apparent viscosity of solution and the curve of shear time from 0s to 1800s were measured, as is shown in Fig. 4.

As shown in Fig. 4, the shear rate is $170s^{-1}$, the temperature is 25°C, the test time is 1800s, the apparent viscosity drops from 0.045Pa.s to 0.0375 Pa.s, reducing by 0.0075 Pa.s, the apparent viscosity changed little with the increase of shear time, and the descending amplitude was smooth. Therefore, the high efficiency drag reduction agent has good shearing resistance at a certain temperature.

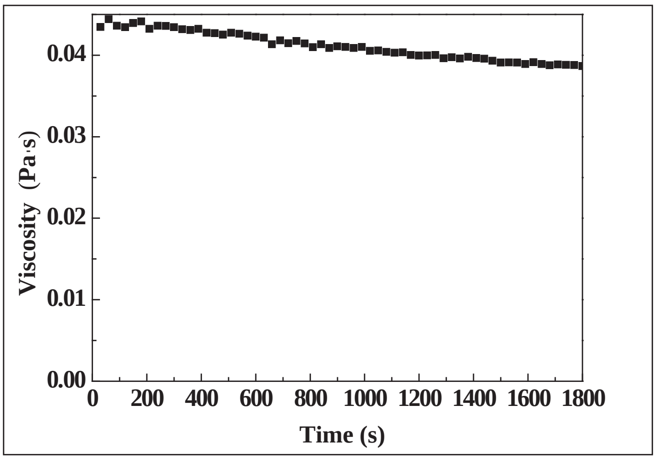

Fig.4: The variation of apparent viscosity with shear time

2.6 Resistance of reduction performance test of high efficiency drag reducer

In the tube diameter of 4mm, fixed temperature 25°C, using drag reduction agent in the indoor evaluation device to test the effective drag reduction agent and hydroxypropyl guar gum at different flow rate of drag reduction (Fig. 5).

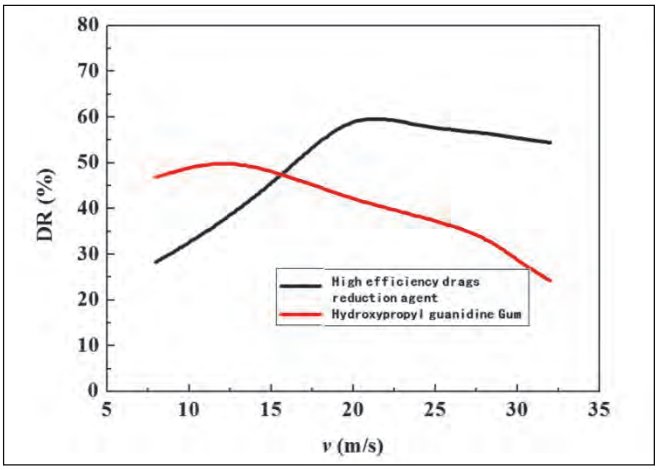

Fig. 5: Drag reduction rate-velocity change chart

From Fig. 5, it can be seen that the drag reduction rate is about 61% of the maximum when the flow rate is about 20m/s, and after this, the resistance reduction rate decreases, but the decrease is smaller and the drag reduction rate is still over 53%. However, when the velocity of hydroxypropyl guar gum is about 12m/s, the drag reduction rate reaches about 51%, after which, the drag reduction rate decreases with the increase of flow velocity. It is indicated that the hydroxypropyl guar gum has obvious drag reduction effect at lower flow rate, but it is less effective to reduce the resistance of hydroxypropyl guar gum, and the effective drag-reducing agent has obvious drag-reducing effect to meet the condition of field conditions.

3. Field test and application

MA-S drag-reducing agent fracturing fluid has been tested in

5 wells in Changqing oilfield, which has been successful, and the high efficiency drag-reducing agent shows good applicability in the field, which satisfies the requirement of the site's higher displacement construction. In the field construction, the drag reduction water can be reduced by 61% compared to that of the existing guanidine rubber slippery water construction tubing.

The field construction curve is shown in Fig. 6.

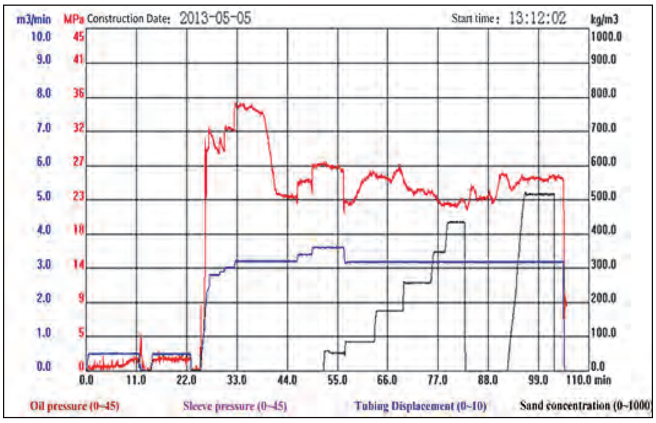

Fig.6: L 55 well fracturing construction curve

Construction begins: Pump injection liquid type is cj2-6 hydroxypropyl guanidine glue slippery water, displacement 2.8m^3/min, pressure value from 32MPa gradually drops, gradually rises displacement to 2.9m^3/min, pressure is 30.6MPa, again to 3.0m^3/min, pressure is 32MPa, Two minutes later mentioned 3.2m^3/min, pressure for the 35.8mpa,10 min after maintenance in 33.95MPa, starts to replace the high efficiency drag reduction water pressure gradually drops to 22.97MPa, maintains 3 min after the displacement to 3.4m^3/min, The pressure rises to the 24.92mpa, 2 min after the lift to the 3.6m^3/min, the pressure rises to 27.03MPa and gradually declines. After 3 min, start to add sand, the pressure is maintained at 26.5MPa. Then reduces the displacement to 3.2m^3/min, pressure to 19.3MPa, and then replace the liquid type as the base liquid, pressure rises to 26.3MPa, then according to the normal construction process to pump into.

During the construction, the pressure rises slightly during the sand-stopping stage, and the sand starts to stabilize.

It is known from the fracturing process that under the 3.2m^3/min displacement, the phase pressure of the hydroxypropyl guar gum is 33.95MPa, and the average pressure of the MA-S phase is 24.5MPa. High-efficiency drag reducer water tubing frictional resistance then guanidine gel slip water reduced to 9.45MPa, and in the high efficiency drag reduction phase, the maximum displacement can reach 3.6m^3/min, pressure is 26.5MPa. Under the 3.2m^3/min displacement, the frictional resistance of water reduction is reduced to 60.6% compared to that of guanidine gel.

The developed MA-S drag reducer fracturing fluid field application 5 wells, (Table 1), the field test application success rate reaches 100%, the high efficiency drag reduction agent displays the good field applicability, satisfies the field high displacement construction request.

4. Conclusions

(1) The developed MA-S high efficiency drag reduction agent fracturing fluid system has high drag reduction performance, the best use concentration is 0.07%.

(2) By evaluating its performance, the fracturing fluid with MA-S effective drag reducer has a certain stability, and the 120h drag reduction rate is lowered by 8%. The resistance to mild and shear properties was tested by rheometer, the temperature rises from 25°C to 80°C, viscosity drops 0.025Pa.s, shearing time from 0s to 1800s, apparent viscosity reduces 0.0075 Pa.s, when the velocity is 20m/s, the drag reduction rate is 61%, then with the flow rate increases, the drag reduction rate drops, But the decline was smaller, at a minimum of 53%.

(3) The successful application of 5 wells in the field of MA-S drag reduction agent fracturing fluid can reduce the maximum frictional resistance by 61%, which provides an effective way for the efficient reconstruction of tight reservoirs.

Table 1. MA-S drag reduction agent fracturing fluid application datasheet

Well number	Deep in the oil layer (m)	Injection mode	Displacement (m^3/min)	Construction pressure	
				The slippery water stage of guanidine gum (MPa)	MA-S drag reducing agent slippery water stage (MPa)
L55	2170	Tubing Injection	3.2	35.8	26.5
X307	1945	Light Casing	10	16	13.8
B28	1660	Oil sleeve with note	8	35.7	33.8
Z171-154	1352	Oil sleeve with note	8	29.8	25.7
W100-22	1215	Oil sleeve with note	8	32.8	29

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