Preparation of oligosaccharide CQ01 and its lubricity in drilling fluid

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Abstract: Based on its good water solubility, temperature resistance and environmental protection, oligosaccharides are widely used in food and beverage, baking and medical care. In view of the poor lubrication performance of drilling fluid in ultradeep wells, long horizontal wells and highly deviated wells, and the problems of environmental protection and temperature resistance faced by drilling fluid lubricants, its application is limited. Therefore, in order to reduce its limitations and improve its application, it is necessary to study oligosaccharides. Using vegetable gum rich in oligosaccharides as raw materials, oligosaccharide CQ01 high-performance lubricant can be developed, and its action efficiency in drilling fluid can be experimentally investigated. High performance drilling fluid lubricant meeting the requirements of environmental protection and drilling engineering can be developed, and its lubrication performance, temperature resistance and compatibility can be evaluated in laboratory experiments. The results show that oligosaccharide CQ01 has multiple effects of increasing viscosity and cutting, reducing filtration and improving the lubricating performance of drilling fluid. CQ01 lubricating fluid with low content of oligosaccharide has good adaptability to drilling bentonite. The lubrication mechanism of oligosaccharide CQ01 is that the hydrophilic group (- OH) in oligosaccharide CQ01 molecule is adsorbed on the borehole wall rock surface or drilling cuttings surface to form a chemical adsorption film, resulting in the friction surface being separated by the chemical adsorption film to play the role of lubrication.

Keywords: Lubrication; Temperature resistance; Mechanism; Hydrophilic.

1. Introduction

Oligosaccharides, also known as oligosaccharides or oligosaccharides, refer to 3 to 10 sugars that form straight or branched chains through glycosidic connection [1]. It usually has good physicochemical properties such as high temperature resistance, stability and non-toxicity [2]. Oligosaccharides can be divided into ordinary oligosaccharides and functional oligosaccharides, in which ordinary oligosaccharides can be digested and absorbed directly by the intestine. On the contrary, functional oligosaccharide monosaccharides are oligosaccharides that cannot be directly digested and absorbed by the intestine, because there are glycosidic bonds in the intestine that cannot be degraded by digestive enzymes. Because the types, molecular configurations and binding modes of oligosaccharide monosaccharide molecules are very different, their physiological functions and physicochemical properties are very different [3]. Xylo oligosaccharides have the physiological functions of high temperature resistance, low viscosity, acid resistance, preventing constipation and reducing serum cholesterol [4]. Maltooligosaccharides have physicochemical properties such as moisture retention, low water activity, acid resistance and heat resistance, and physiological functions of disease prevention and resistance [5]. Fructooligosaccharides and galactose are beneficial to the proliferation of bifidobacteria and lactic acid bacteria in infant intestine [6]. Therefore, we understand the physicochemical properties and functions of oligosaccharides. We can find that oligosaccharides have good physicochemical properties such as high temperature resistance, stability and non-toxicity, regulate intestinal function, absorb exogenous pathogens and improve the disease resistance of livestock.

Because oligosaccharides have a variety of physicochemical properties and physiological functions, oligosaccharides are widely used in food and beverage, baking, medical care and other fields. Although functional oligosaccharides can not be absorbed by human body, they are similar to sucrose with high sugar content in sweetness, viscosity and water activity, so they can also be used in cake processing. Functional oligosaccharides can also promote the absorption of trace elements such as calcium and magnesium, and also improve human fatigue and immunity, so they are often used in health drinks. However, the application of oligosaccharides has never been reported in some special fields, such as oilfield chemistry. At present, in the field of oil and gas drilling, with the gradual increase in the number of complex wells such as ultralong horizontal wells and extended reach wells, the requirements for the performance of drilling fluid are higher and higher. Although the traditional oil-based drilling fluid can meet the high requirements for drilling fluid in complex wells because of its good lubrication performance and inhibition performance [7]. However, its damage to the natural environment is very serious and can not be easily ignored [8]. Therefore, the development of water-based drilling fluid is a trend in the field of oil and gas drilling, that is, the development of drilling fluid treatment agents with high performance, such as high temperature resistance, oxidation stability and high lubricity [9]. In addition, with the increasing attention to environmental protection in China, it is imperative to ban the original treatment agents that pollute the environment. At the same time, it is also necessary to develop green treatment agents [10]. Therefore, another requirement for treatment agents is environmental protection, non-toxic and degradable [11]. Comparing the physicochemical properties and physiological functions of oligosaccharides with the requirements for drilling fluid treatment agents, it can be found that they have a high degree of agreement. Therefore, based on the physical and chemical properties and physiological functions of oligosaccharides, oligosaccharide CQ01 was prepared with vegetable gum, and the drilling fluid performance evaluation and action mechanism analysis of oligosaccharide CQ01 were carried out.

2. Experiment

2.1 Experimental drugs and instruments

Calcium bentonite was purchased from Xi'an permanent Chemical Co., Ltd., sodium bentonite was purchased from Changqing oilfield site, Na_2CO_3 was purchased from Tianjin Damao Chemical Reagent Co., Ltd., and anhydrous ethanol was purchased from Tianjin Fuyu Fine Chemical Co., Ltd, Sodium benzoate was purchased from Tianjin kemio Chemical Reagent Co., Ltd., potassium hydroxide and sodium hydroxide were purchased from Tianjin Tianli Chemical Reagent Co., Ltd., pac-lv, XCD, NAT, NFA and plant rubber powder were taken from the drilling site of Changqing Oilfield.

Six speed rotary viscometer (ZNN-D6S, Qingdao hengtaida Electromechanical Equipment Co., Ltd.), quadruple medium pressure filter instrument (GJSS-B12K, Qingdao hengtaida Electromechanical Equipment Co., Ltd.), variable frequency high-speed mixer (SD6, Qingdao hengtaida Electromechanical Equipment Co., Ltd.), variable frequency roller heating furnace (BGRL-5, Qingdao Tongchun Petroleum Instrument Co., Ltd.), EP-extreme pressure lubricator (112-00-01, Austin test equipment company, Houston, Texas, USA) are adopted according to the formula in Chinese national standard GB / T 16783.1-2006.

2.2 Preparation of oligosaccharide CQ01

Firstly, 75 g vegetable gum and 25 g CH_3CH_2OH were put into the mud aging tank, then 175 mL distilled water was added to the tank, and the resulting solution evenly was stirred at room temperature, and then placed it at room temperature for 3 h to make it swell evenly and measured the pH.

Next, 0.5 g KOH was fully dissolved by 25 mL distilled water, added it to the prepared solution while stirred, then measured the pH, and then sealed the aging tank. Placed the aging tank in the high-temperature roller furnace at 100 ℃ for rolling reaction for 5 h, then cooled it naturally to room temperature and measured the pH.

Then, 0.75 g Sodium bentonite was fully dissolved by 25 mL distilled water and measured the pH.

Finally, the sodium bentonite solution and the solution after high-temperature aging were stirred to make it mixed evenly, and measured the pH. The resulting solution is oligosaccharide CQ01.

Note: the effective concentration of the sample is about 75 / (175 + 25 + 25) = 33%

2.3 Drilling fluid preparation

The preparation procedure of 4% calcium bentonite mud was as follows: Accurately measure 1 L tap water into the mud preparation barrel, then 2 g Na_2CO_3 and 40 g calcium bentonite were added to the mud barrel, and the resulting solution was stirred at 25 ℃ for 2 h, and then placed it at room temperature for 24 h for use [12].

The preparation procedure of 1% sodium bentonite mud was as follows: Accurately measure 1 L tap water into the mud preparation barrel, then 5 g NaOH and 100 g sodium bentonite were added to the mud barrel, and the resulting solution was stirred at 25 ℃ for 2 h, and then placed it at room temperature for 24 h for use [13].

When drilling fluids experiments were conducted, the required quantity of additive was added to the base mud under stirring at high speed for 20 min. Then, the rheological property of the treated mud as well as that of the base mud was measured to determine the rheological parameters such as apparent viscosity.

2.4 Performance evaluation experiment of drilling fluid

According to the method of evaluating water-based drilling fluid in GB / t16783-1997, the performance of drilling fluid was evaluated. High temperature aging refers to the heating aging of drilling fluid in variable frequency roller heating furnace for 16h.

3. Results and discussion

3.1 Performance evaluation of oligosaccharides CQ01

3.1.1 Performance evaluation of oligosaccharide CQ01 in different drilling fluids

Oligosaccharide CQ01 (5%) was added to different mud, evaluated the performance of drilling fluid, the experimental conditions were room temperature (25 °C). The experimental results are shown in Table 1.

It can be seen from Table 1, after being added 5% oligosaccharide CQ01 to 4% calcium bentonite mud, 4% sodium bentonite mud and 5% sodium bentonite mud respectively. The rheological parameters of drilling fluid changed, which shows the increase of AV, PV and YP, the increase of PV is mainly due to the good hydration of oligosaccharide CQ01 [14]. It can significantly improve the liquid viscosity of drilling fluid, increase liquid phase internal friction resistance and improve PV. The increase of YP is due to the adsorption group and hydration group in the molecular structure of oligosaccharide CQ01 adsorbed on the surface of clay particles, which increases the network forming ability of clay particles and enhances the strength of spatial grid structure.

After being added oligosaccharide CQ01 to different drilling fluid base muds, the filtration of drilling fluid decreases. This is mainly because after oligosaccharide CQ01 is adsorbed on the surface of clay particles, it avoids the aggregation of clay particles and reduces the dispersion and expansion trend of clay particles. The thicker the hydration film, the lower the permeability, and finally leads to the decrease of drilling fluid filtration. By measuring the kinematic viscosity of drilling fluid filtrate, it can be found that the kinematic viscosity of drilling fluid filtrate increases significantly after adding oligosaccharide CQ01. According to the inverse ratio between the filtration amount of drilling fluid and the square root of filtrate viscosity, it can also show that oligosaccharide CQ01 can reduce the filtration amount of drilling fluid.

Table 1 Performance evaluation of oligosaccharide CQ01 in different drilling fluids

Sample	AV /mPa•s	PV /mPa•s	YP /Pa	YP/PV /m•s	F_L /mL	Lubrication coefficient	Decrease /%	v/mm^2/s
1	3.5	3.0	0.5	0.1667	29.0	0.4290	-	1.09879
1+5% CQ01	24.5	18.0	6.5	0.3611	7.6	0.1983	53.78	1.28929
2	13.5	9.0	4.5	0.5000	18.0	0.5100		0.83051
2+5% CQ01	48.0	34.0	14.0	0.4118	6.8	0.1413	73.25	1.42111
3	19.5	11.0	8.5	0.7727	16.0	0.5120		0.82551
3+5% CQ01	55.5	32.0	23.5	0.7344	6.0	0.1530	70.12	1.43199

Note: Sample 1 is 4% calcium bentonite mud, sample 2 is 4% sodium bentonite mud, and sample 3 is 5% sodium bentonite mud

After being added oligosaccharide CQ01 to different drilling fluid base muds, the lubrication coefficient of drilling fluid decreases in varying degrees, it shows that oligosaccharide CQ01 has good lubricating performance in drilling fluid base mud. In addition, the reduction rate of lubrication coefficient of oligosaccharide CQ01 in sodium bentonite base mud is greater than that of oligosaccharide CQ01 in calcium bentonite base mud, it shows that oligosaccharide CQ01 is more conducive to play its lubricating role in sodium bentonite base mud. The main reason may be that the hydration dispersion of sodium bentonite is stronger than that of calcium bentonite, resulting in finer clay particles, which is conducive to the adsorption group and hydration group in the molecular structure of oligosaccharide CQ01, more adsorption on the surface of clay particles, forming lubricating film, and improving the lubrication performance of drilling fluid [17].

After being added oligosaccharide CQ01 to different drilling fluid base muds, the pH value of drilling fluid is reduced from 9 to 7, indicating the addition of oligosaccharide CQ01 will reduce the pH value of drilling fluid. However, the decrease of drilling fluid pH is not conducive to the hydration and dispersion of clay, so that the colloidal structure of drilling fluid disintegrates, clay settles and the performance of drilling fluid changed. Therefore, in order to protect the colloidal properties of drilling fluid and maintain the performance of drilling fluid, oligosaccharide CQ01 and NaOH should be added to the drilling fluid to maintain the alkaline pH of drilling fluid. It can be concluded that oligosaccharide CQ01 has the functions of increasing viscosity, lifting and cutting, reducing filtration and improving the lubricating performance of drilling fluid.

3.1.2 Effect of bentonite content on properties of oligosaccharide CQ01 in drilling fluid

The effect of bentonite content on oligosaccharide CQ01 at room temperature was studied by measuring the performance parameters of oligosaccharide CQ01 before and after adding different sodium bentonite base muds. The experimental results are shown in Table 2.

It can be seen from Table 2, with the increase of sodium bentonite content in drilling fluid, the performance parameters of drilling fluid without oligosaccharide CQ01 have changed greatly, it shows the increase of AV, PV, YP and lubrication coefficient. At the same time, the filtration rate is gradually decreasing, it shows that the bentonite content in drilling fluid will have a great impact on the performance of drilling fluid. Therefore, in order to maintain good rheological, filtration and lubricating properties of drilling fluid, the amount of bentonite should be reduced. After being added 5% oligosaccharide CQ01 into the drilling fluid, the rheological parameters of drilling fluid increase, the filtration loss and lubrication coefficient are reduced, improvement of lubricating performance of drilling fluid. Again, oligosaccharide CQ01 has the functions of increasing viscosity and cutting, reducing filtration and improving the lubricating performance of drilling fluid. With the gradual increase of bentonite content, the lubrication coefficient of drilling fluid added with 5% oligosaccharide CQ01 keeps increasing gradually, but the change range is small. It shows that oligosaccharide CQ01 can not only reduce the lubrication coefficient of drilling fluid, improve the lubrication performance of drilling fluid, and have good adaptability to drilling fluid with high bentonite content or low bentonite content.

Table 2 Effect of bentonite content on properties of oligosaccharide CQ01 in drilling fluid

Sample	AV /mPa•s	PV /mPa•s	YP /Pa	YP/PV /m•s	F_L /mL	Lubrication coefficient	Decrease /%	v/mm²/s
1	1.5	1.5	0.0	0.0000	50.0	0.4444	-	0.81981
1 +5%CQ01	15.5	15.0	0.5	0.0333	10.0	0.1231	72.30	1.37491
2	3.5	3.0	0.5	0.1667	36.0	0.4655		0.83051
2 +5%CQ01	25.5	19.0	6.5	0.3421	8.4	0.1236	73.45	1.36777
3	7.5	6.0	1.5	0.2500	23.0	0.5040		0.85405
3 +5%CQ01	35.5	27.0	8.5	0.3148	7.2	0.1286	74.48	1.37776
4	13.5	9.0	4.5	0.5000	18.0	0.5100		0.83051
4 +5%CQ01	48.0	34.0	14.0	0.4118	6.8	0.1413	73.25	1.42111
5	19.5	11.0	8.5	0.7727	16.0	0.5120		0.82551
5 +5%CQ01	55.5	32.0	23.5	0.7344	6.0	0.1587	69.00	1.43199

Note: Sample 1 is 1% Sodium bentonite mud, sample 2 is 2% Sodium bentonite mud, sample 3 is 3% Sodium bentonite mud, sample 4 is 4% Sodium bentonite mud, sample 5 is 5% Sodium bentonite mud

3.2 Drilling fluid formulation optimization

It can be seen from the above experimental results that although oligosaccharide CQ01 shows excellent characteristics in improving the viscosity and shears force of drilling fluid, reducing filtration and improving the lubrication performance of drilling fluid. At the same time, the addition of oligosaccharide CQ01 into the drilling fluid system will cause great changes in the performance of drilling fluid and can not ensure the normal progress of drilling. Therefore, before using oligosaccharide CQ01, the formula of drilling fluid system should be optimized to meet the requirements of drilling fluid and finally ensured the normal drilling.

Based on Changqing drilling fluid formula 1, the most reasonable and optimal ratio of oligosaccharide CQ01 and Changqing drilling fluid formula is finally obtained through orthogonal experiment [18]. Firstly, oligosaccharide CQ01 was used to replace the treatment agent in Changqing drilling formula, then the performance parameters of relevant drilling fluid were measured, and the action effects of oligosaccharide CQ01 and different treatment agents are analyzed. The experimental results are shown in Table 3.

It can be seen from Table 3 that after being added oligosaccharide CQ01 into drilling fluid formula 1 at room temperature, the effect of oligosaccharide CQ01 is consistent with the conclusion obtained in 3.1.1. In different drilling fluid formulations, oligosaccharide CQ01 replaced the original treatment agent, resulting in obvious changes in the performance of drilling fluid compared with that of drilling fluid formulation 1, such as increased shear force, reduced filtration and lubrication coefficient, but generally poor rheology. Therefore, after oligosaccharide CQ01 was added into the drilling fluid formula, how to ensure that the drilling fluid formula has the properties of high shear force, low filtration loss, low lubrication coefficient and good rheology has become the key. Therefore, the orthogonal experiment is designed to find the drilling fluid formula with low viscosity, high shear, low filtration and low lubrication coefficient. Seeing Table 4 for the orthogonal experimental design and Table 5 for the orthogonal experimental data.

Comparing the data of different drilling fluids in Table 5, it can be found that the drilling fluid with test No. 6 has good rheology, dynamic plastic ratio, low filtration and low lubrication coefficient at room temperature. Compared with the drilling fluid performance in drilling fluid formula 1, the optimized drilling fluid has higher shear force, dynamic plastic ratio, lower filtration loss and lubrication coefficient, so the optimal drilling fluid formula is:

1% Site bentonite+0.05%NaOH+0.3%PAC-LV+0.15%XCD+0.3%NAT+0.6%NFA+5%CQ01.

Table 3 Effect of oligosaccharide CQ01 with different treatment agents

Temperature	Sample	AV /mPa•s	PV /mPa•s	YP /Pa	YP/PV /m•s	F_L /mL	Lubrication coefficient	v/mm²/s
25°C	1	37.5	26.0	11.5	0.4423	8.0	0.2964	2.47227
	2	62.5	27.0	35.5	1.3148	6.2	0.1146	3.64332
	3	47.5	30.0	17.5	0.5833	7.2	0.1465	1.68956
	4	72.5	50.0	22.5	0.4500	6.4	0.1238	1.89791
	5	69.0	40.0	29.0	0.7250	7.6	0.1586	1.68929
	6	84.5	49.0	35.5	0.7245	7.6	0.1446	5.26563
120°C	1	31.5	25.0	6.5	0.2600	9.6	0.2776	2.87552
	2	55.0	28.0	27.0	0.9643	7.4	0.1024	4.19664
	3	44.0	35.0	9.0	0.2571	8.6	0.1360	2.08445
	4	60.0	44.0	16.0	0.3636	7.0	0.1254	1.98912
	5	60.5	38.0	22.5	0.5921	8.8	0.1273	2.25378
	6	75.0	42.0	33.0	0.7857	9.0	0.1360	5.78321

Notes：Sample 1 is drilling fluid formula 1 (bentonite containing 1% sodium bentonite mud+1% PAC-LV+0.2% XCD+0.5% NAT-20+1% NFA-25);

Sample 2 is drilling fluid formula 2 (bentonite containing 1% sodium bentonite mud +1% PAC-LV+0.2% XCD+0.5% NAT-20+1% NFA-25+5% CQ01);

Sample 3 is drilling fluid formula 3 (bentonite containing 1% sodium bentonite mud +5% CQ01+0.2% XCD+0.5% NAT-20+1% NFA-25);

Sample 4 is drilling fluid formula 4 (bentonite containing 1% sodium bentonite mud +1% PAC-LV+5% CQ01+0.5% NAT-20+1% NFA-25)；

Sample 5 is drilling fluid formula 5 (bentonite containing 1% sodium bentonite mud +1% PAC-LV+0.2% XCD+5% CQ01+1% NFA-25)；

Sample 6 is drilling fluid formula 6 (bentonite containing 1% sodium bentonite mud +1% PAC-LV+0.2% XCD+0.5% NAT-20+5% CQ01).

Table 4 Orthogonal experimental design

Number	Factor				
	PAC-LV/%	XCD/%	NAT/%	NFA/%	CQ01/%
1	0.30	0.10	0.10	0.30	1.00
2	0.30	0.10	0.10	0.30	3.00
3	0.30	0.10	0.10	0.30	5.00
4	0.30	0.15	0.30	0.60	1.00
5	0.30	0.15	0.30	0.60	3.00
6	0.30	0.15	0.30	0.60	5.00
7	0.30	0.20	0.50	1.00	1.00
8	0.30	0.20	0.50	1.00	3.00
9	0.30	0.20	0.50	1.00	5.00
10	0.60	0.10	0.30	1.00	1.00
11	0.60	0.10	0.30	1.00	3.00
12	0.60	0.10	0.30	1.00	5.00
13	0.60	0.15	0.50	0.30	1.00
14	0.60	0.15	0.50	0.30	3.00
15	0.60	0.15	0.50	0.30	5.00
16	0.60	0.20	0.10	0.60	1.00
17	0.60	0.20	0.10	0.60	3.00
18	0.60	0.20	0.10	0.60	5.00
19	1.00	0.10	0.50	0.60	1.00
20	1.00	0.10	0.50	0.60	3.00
21	1.00	0.10	0.50	0.60	5.00
22	1.00	0.15	0.10	1.00	1.00
23	1.00	0.15	0.10	1.00	3.00
24	1.00	0.15	0.10	1.00	5.00
25	1.00	0.20	0.30	0.30	1.00
26	1.00	0.20	0.30	0.30	3.00
27	1.00	0.20	0.30	0.30	5.00

Table 5 Evaluation results of orthogonal experiment

Number	AV /mPa•s	PV /mPa•s	YP /Pa	YP/PV /m•s	F_L/mL	Lubrication coefficient	v/mm^2/s
1	15.0	11.0	4.0	0.3636	10.0	0.2019	2.0584
2	23.0	17.0	6.0	0.3529	9.4	0.1537	2.6007
3	33.5	23.0	10.5	0.4565	8.0	0.1561	2.6086
4	19.5	14.0	5.5	0.3929	8.0	0.1392	2.6970
5	32.0	22.0	10.0	0.4545	8.0	0.1316	2.7469
6	43.0	28.0	15.0	0.5357	7.6	0.1480	3.7045
7	24.0	16.0	8.0	0.5000	10.4	0.1365	4.3145
8	39.0	26.0	13.0	0.5000	11.6	0.1499	3.5575
9	46.5	30.0	16.5	0.5500	7.2	0.1335	2.7363
10	24.0	18.0	6.0	0.3333	8.8	0.1365	2.4801
11	32.0	22.0	10.0	0.4545	8.0	0.1421	2.9560
12	47.0	33.0	14.0	0.4242	8.0	0.1834	3.5739
13	28.5	21.0	7.5	0.3571	10.0	0.1585	3.9492
14	38.0	26.0	12.0	0.4615	8.8	0.1448	4.5286
15	55.5	35.0	20.5	0.5857	8.4	0.1641	4.5864
16	24.0	16.0	8.0	0.5000	10.0	0.148	4.4129
17	40.0	25.0	15.0	0.6000	7.2	0.2372	2.5814
18	53.0	31.0	22.0	0.7097	9.6	0.2368	3.7459
19	41.0	29.0	12.0	0.4138	8.0	0.2157	3.0438
20	56.0	37.0	19.0	0.5135	6.4	0.2153	2.4644
21	77.5	47.0	30.5	0.6489	7.2	0.2085	1.9714
22	36.5	25.0	11.5	0.4600	8.0	0.2151	3.4983
23	51.0	33.0	18.0	0.5455	7.2	0.1991	2.7063
24	63.5	38.0	25.5	0.6711	8.0	0.1796	3.3242
25	43.0	27.0	16.0	0.5926	8.0	0.1996	3.9457
26	61.5	37.0	24.5	0.6622	8.0	0.1902	5.3249
27	81.5	46.0	35.5	0.7717	7.0	0.1892	4.4159

3.3 Mechanism

Oligosaccharide CQ01 is a surfactant, which can change the energy of mutual contact interface [19]. The change from high energy to low energy may be due to the polyhydroxy strong adsorption groups in the molecular structure of oligoglycan CQ01 arranged inside the solution and adsorbed on the metal surface or mud cake to form a lubricating film. The dry friction between the borehole wall and the drilling tool is transformed into the boundary friction with the adsorption film, which reduces the friction, rotating torque and tripping resistance between the drilling tool and the borehole wall.

4. Conclusion

Based on the good physicochemical properties and physiological functions of oligosaccharides, in order to develop oligosaccharide CQ01 high-performance drilling fluid lubricant to meet the requirements of environmental protection and drilling engineering, the effects of different types of drilling fluids, bentonite content and different treatment agents on the properties of oligosaccharide CQ01 in drilling fluid were studied in this paper. The results show that oligosaccharide CQ01 can increase viscosity, cut, reduce filtration and improve the lubrication of drilling fluid. Oligosaccharide CQ01 has good adaptability to drilling fluids with high or low bentonite content. Oligosaccharide CQ01 can be adsorbed on the surface of clay particles, and the hydrophilic group in oligosaccharide CQ01 molecules is adsorbed inside clay particles to form a lubricating film, which improves the lubricating performance of drilling fluid.

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