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RESEARCH ARTICLE

Effect of reservoir characteristics and chemicals on filtration property of water-based drilling fluid in unconventional reservoir and mechanism disclosure

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Abstract

The research objective of this investigation is to explore the influence of filtrate reducer and reservoir characteristics on the filtration reduction of drilling fluid during the drilling process, and the filtration reduction mechanism of drilling fluids is also revealed. The results obtained that a synthetic filtrate reducer can significantly reduce the filtration coefficient than that of the commercial filtrate reducer. Moreover, the filtration coefficient of drilling fluid constructed from synthetic filtrate reducer is reduced from 4.9×10^{-2} $m^3\cdot min^{1/2}$ to 2.4×10^{-2} $m^3\cdot min^{1/2}$ with an increase in the filtrate reducer content, which is much lower than that of the commercial filtrate reducer. The weaker filtration capacity of the drilling fluid containing the modified filtrate reducer is attributed to the combined action of the filtrate reducer containing multifunctional groups adsorbed on the sand surface and the hydration membrane adsorbed on the sand surface. Furthermore, the increase in reservoir temperature and shear rate increases the filtration coefficient of drilling fluid, indicating that low temperature and shear rate are conducive to improve the filtration capacity. Thus, the type and content of filtrate reducer are preferred during drilling in oilfield reservoir, but increasing reservoir temperature and shear rate are not recommended. It is necessary to confect the drilling mud with appropriate filtrate reducer such as the chemicals prepared herein during drilling operation.

Keywords Enhanced oil recovery · Unconventional shale reservoir · Oilfield Chemical Materials · Fluid filtration · Drilling efficiency

Introduction

Global energy demand is becoming more urgent due to economic development and climate change. As an important energy situation in the world, oil, and natural gas occupies an important position for economic development and human life (Li et al. 2018a, b; Li et al. 2022a). Drilling and exploration of deep reservoirs has been considered as an important way to ensure the supply of crude oil as crude oil reserves in shallow reservoirs plummet (Yao et al. 2021; Yao et al. 2022a; Yao et al. 2022b). Drilling fluid for shallow reservoir shall not apply to the drilling needs of deep reservoirs. Water-based drilling fluids and oil-based drilling fluids are regarded as effective working fluids for deep reservoir drilling (Cheraghian et al. 2018; Li et al. 2020a; Liu et al. 2020; Zhuang et al. 2019), and each drilling fluid is used in different oilfield reservoirs due to its own advantages. Although oil-based drilling fluid has high viscosity and excellent temperature resistance, the toxicity of drilling fluid and reservoir pollution hinder its application (Dejtaradon et al. 2019; Okoro et al. 2020). Water-based drilling fluids have been considered as a main body of drilling fluids for deep reservoirs due to the low cost, low reservoir pollution, and excellent salt tolerance (Kosynkin et al. 2012), but the huge fluid loss volume and fluid loss coefficient of the drilling fluid have become a difficult problem that cannot be solved in

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the current drilling process (Pereira et al. 2022). The larger fluid loss volume of drilling fluid can cause the following three hazards: (1) swelling and instability of the shaft wall (Cheraghian et al. 2018); (2) reservoir rock expansion and crack plugging (Liu et al. 2020); and (3) drilling tool damage caused by increased filter cake. Improving the fluid loss ability of drilling fluids was viewed as the focus of mitigating the drawbacks of drilling fluids.

As an important method to improve the filtration capacity of drilling fluids and drilling efficiency, filtrate reducer has been successfully used and promoted in reservoir drilling and production process of most oilfields due to these advantages such as glue protection, particle hydration promotion, high thickening of drilling fluid, and high sand-carrying capacity (Li et al. 2020b; Liu et al. 2020). Moreover, filtrate reducer is classified into four categories: Starch and cellulose, humic acids, resin polymer, and nanomaterial. Although starch and cellulose, humic acids and resin polymer are used as filtrate reducer with low cost and less environmental pollution, poor temperature resistance is an important obstacle to the improvement of drilling fluid performance. Traditionally, nanomaterials are regarded as an important material that can significantly improve the filtration reduction of drilling fluid (Li et al. 2023). Nanomaterials can significantly improve the phase stability, sand suspension, and rheology of drilling fluids due to their small size and large specific surface area (Li et al. 2018a, b; Wang et al. 2023). Nevertheless, the sufficiently large specific surface area of nanomaterials also initiated a low dispersion and agglomeration of drilling fluid particles, which showed a low drilling efficiency and sticking. Moreover, barren temperature resistance and large dosage have also become important factors that hinder the use of nanomaterials as a filtrate reducer in drilling fluids.

Herein, a modified nanomaterial was prepared to reduce the amount of nanomaterial and filtration volume. Furthermore, the effect of reservoir conditions on the filtration reduction ability of water-based drilling fluid has also been evaluated, and a model including filtration agents, solid particles and other molecules is proposed to reveal the filtration reduction mechanism of modified nanomaterials. The aim of this investigation is to provide a conference for efficient drilling efficiency and drilling fluid stability in deep oilfield reservoir.

Experimental section

Materials

All the chemicals were used without further purification, and more than 99.5% purity is present in all chemicals. γ-Methacryloyloxypropyl trimethoxysilane, N-allyl-p-toluenesulfonamide, and 2-acrylamido-2-methylpropanesulfonic acid was purchased from Aladdin Industrial Corporation, China, ethanol, tetrahydrofuran and isopropyl alcohol was presented by Xilong Chemical Co., Ltd. Other chemical reagents such as toluene, acetonitrile, ethyl acetate, and triethylenetetramine were obtained from Sinopharm Chemical Reagent Co., Ltd, China. Aqueous chloroplatinic acid was donated by Nanjing Chemical Reagent Co., Ltd. Low permeability core has a permeability of 1 mD and porosity of 0.1.

Preparation of drilling fluid and filtration reducer

To prepare the filtration reducer, the ethanol mixture mixed with nanosilica (15 g), γ-methacryloyloxypropyl trimethoxysilane (7.2 g), N-allyl-p-toluenesulfonamide (12.8 g), and 2-acrylamido-2-methylpropanesulfonic acid (21 g) was poured into a three-necked flask, and the chloroplatinic acid dissolved in tetrahydrofuran was added dropwise and stirred at 75 °C for 5 h (Fig. 1). In addition, the molecular weight of filtration reducer is 15,500. Then, deionized water (350 g), sodium bentonite (11 g), sodium bicarbonate (4.5 g), and sodium carboxymethyl cellulose (0.7 g) were poured into a pressure vessel (2 L) for constructing base slurry of drilling fluid, and drilling fluid was prepared by adding a certain quality of filtration reducer into base slurry of drilling fluid.

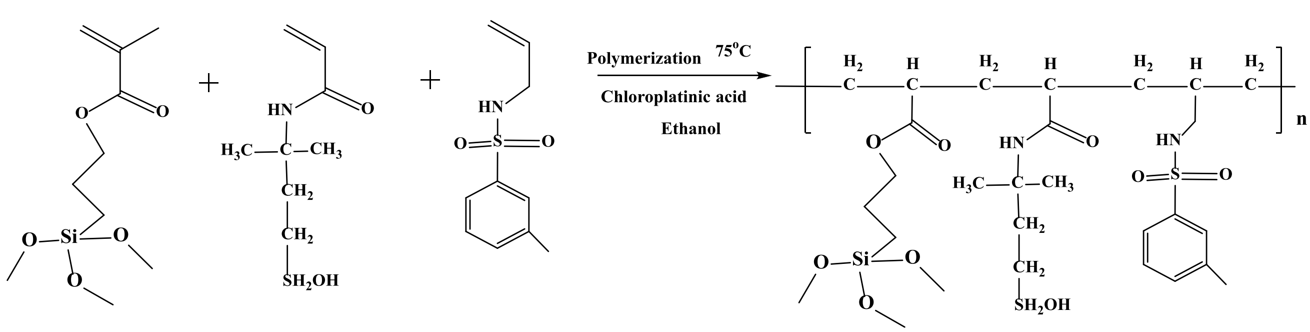

Fig. 1 Synthesis process of filtration reducer of water based drilling fluid

Device construction of drilling fluid filtration

The filtration capacity evaluation device for drilling fluids is similar to other measuring devices for oilfield working fluids. As shown in Fig. 2, the rheology and filtration evaluation sections are included in this device, as well as drilling fluid preparation part, drilling fluid behavior part, and temperature and pressure control part. The deionized water in the cylinder at the beginning is pressed into the pressure cylinder for temporary storage, and a constant-speed pump that connected to the bottom of the pressure-resistant cylinder can push the initially pressurized deionized water to the drilling fluid mixing equipment by boosting the piston inside the cylinder. Meanwhile, the filtration reducer is injected into the mixing equipment through the pipeline connected between the pressure cylinder and the drilling fluid mixing equipment. The drilling fluid after the phase behavior was treated at constant temperature and pressure and then pressed into the capillary viscosity device and the core holder for the study of fluid viscosity and fluid loss coefficient.

Rheology of drilling fluid

The capillary viscometer shown in Fig. 2 was used for the rheological study of drilling fluids, and Eq. (1) is used to study the rheology of the drilling fluid according to the properties of the drilling fluid and the characteristics of the capillary viscometer (Li and Wu 2022).

$$\eta = \frac{D\Delta p/_{4L}}{8v/_{D}} = \frac{\Delta p D^2}{32Lv} \tag{1}$$

where η was considered as the viscosity of drilling fluids, $Pa \cdot s$; Δp is the pressure difference of capillary, MPa; and L was indicated by the capillary length, m; v represented the flow velocity of drilling fluids in the capillary, $m \cdot s^{-1}$. D showed the capillary diameter, m.

Filtration reduction capacity

The prepared water-based drilling fluid containing filtration reducer was placed in a heating roller furnace for heating for 15 h. The heated water-based drilling fluid is placed in a filtration meter to evaluate the filtration capacity, and Eq. (2) was used to calculate the filtration coefficient of aged drilling fluid according to the filtration volume (Esmaeilirad et al. 2016; Dumabo et al. 2014).

$$C = 0.005\frac{m}{A} \tag{2}$$

where C is considered as the filtration coefficient, $m \cdot min^{0.5}$; m is the curve slope between V and $t^{1/2}$, $m^3 \cdot min^{1/2}$; A is the contact area between fracturing fluid and shale core, m^2. In addition, the absolute value of zeta potential is used to reveal

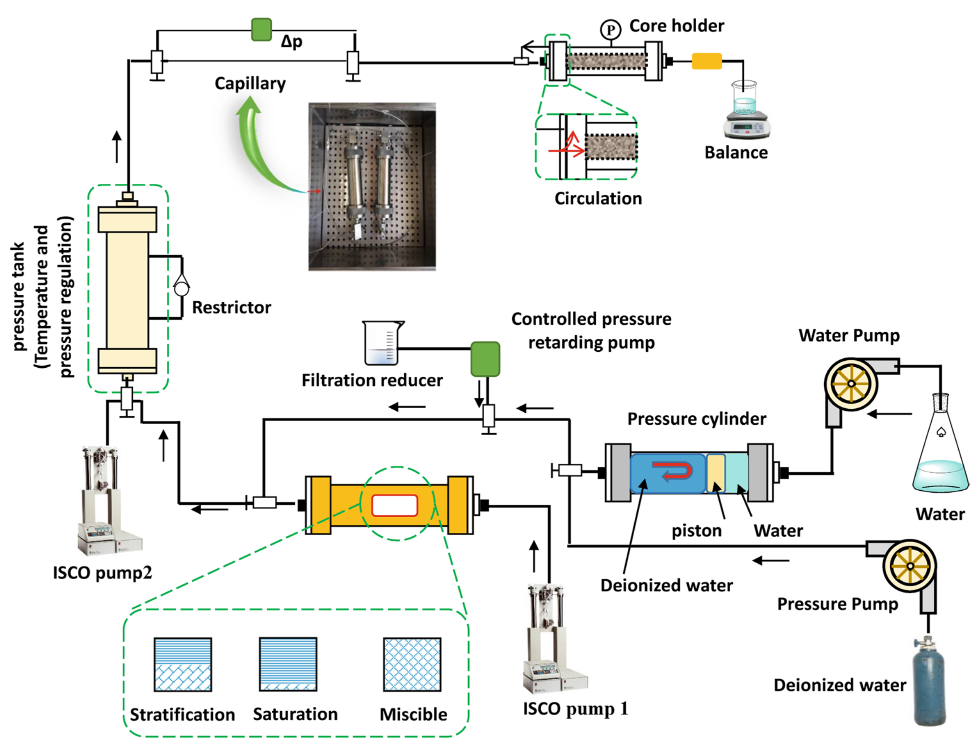

Fig. 2 Evaluation device for the rheology and filtration of drilling fluid

the mechanism of fluid loss reduction of drilling fluid by filtrate reducers in the oilfield reservoir.

Results and discussion

Chemical characterization of filtration reducer

Scanning electron microscope (SEM) and ^{1}H-NMR spectroscopy were used to characterize the microscopic three-dimensional structure and chemical structure of the filtration reducer, respectively. It can be seen from Fig. 3 that filtration reducer has been synthesized and adsorbed on a single nanosilica surface. In addition, ^{1}H-NMR spectroscopy demonstrated that an appropriate filtration reducer structure with a molecular weight of 3200 has been perfectly synthesized.

Effects of filtrate reducer on the viscosity and filtration capacity

As we all know, the drilling efficiency of drilling fluids in oilfield reservoirs was affected by the addition of filtrate reducer, but the excessive addition of filtrate reducer also affects the cost. Therefore, it is necessary to control the content of filtrate reducer and increase the filtrate capacity. Figure 4 a shows the effects of different filtrate reducer contents on drilling fluid viscosity and filtration coefficient. As shown in Fig. 4 a, an apparent viscosity of only 23 mPa·s is exhibited on the drilling fluid base slurry without any filtrate reducer. However, 0.5% of nanofiltrate reducer will increase the viscosity of drilling fluid to 26 mPa·s, indicating that, nanofiltrate reducer contributed to improve the apparent viscosity and rheology of drilling fluids (Mao et al. 2015a, b). Additionally, a gradually increasing viscosity of drilling fluid is displayed with increasing nanofiltrate reducer content; and commercially available filtrate reducer (Hydrocarbon polymer) also illustrated a positive correlation between filtrate reducer content and apparent viscosity (Chang et al. 2019). The gelation of hydrogen bonds and hydrogen bond cannot be put up due the remaining inorganic chemicals and sodium carboxymethyl cellulose in drilling fluid base mud (Zhao et al. 2019a). More and more hydrogen bonds are formed between the fluid loss reducer and sodium carboxymethyl cellulose water molecules with the addition of filtrate reducer. The increased hydrogen bonds make the drilling fluid system gradually form a whole, which increases the resistance of the capillary viscometer and causes the increase of apparent viscosity. The nanofiltrate reducer has

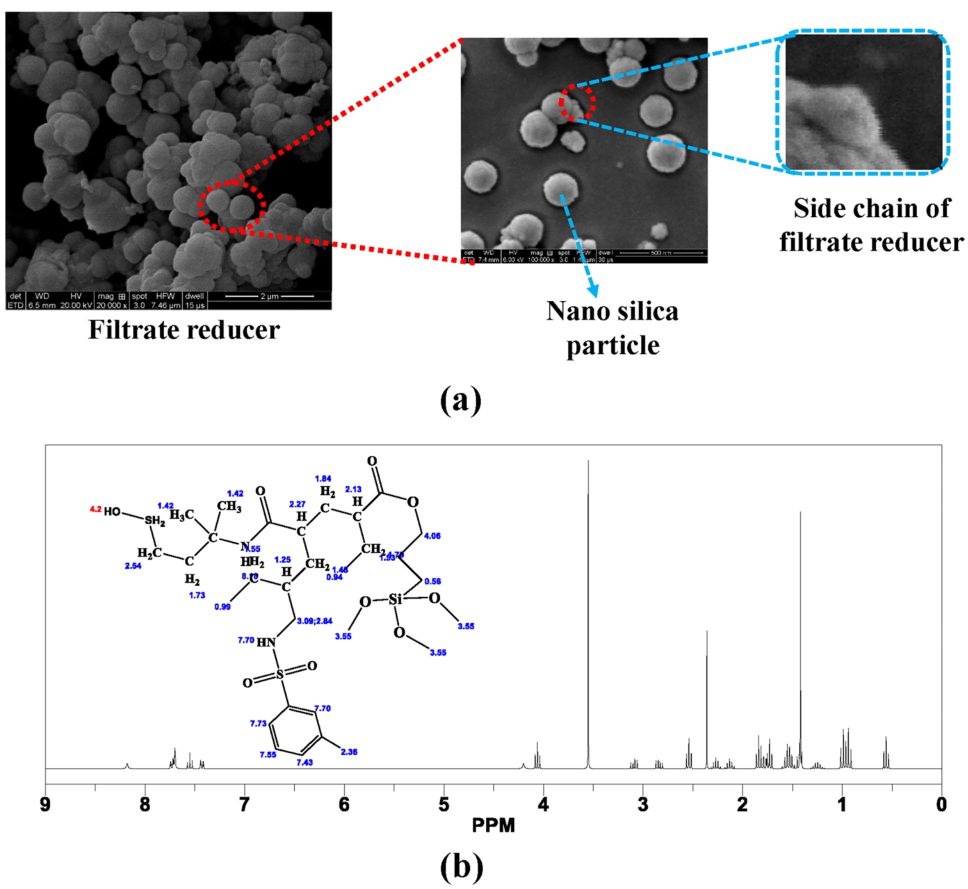

Fig. 3 Chemical structure characterization of filtration reducers

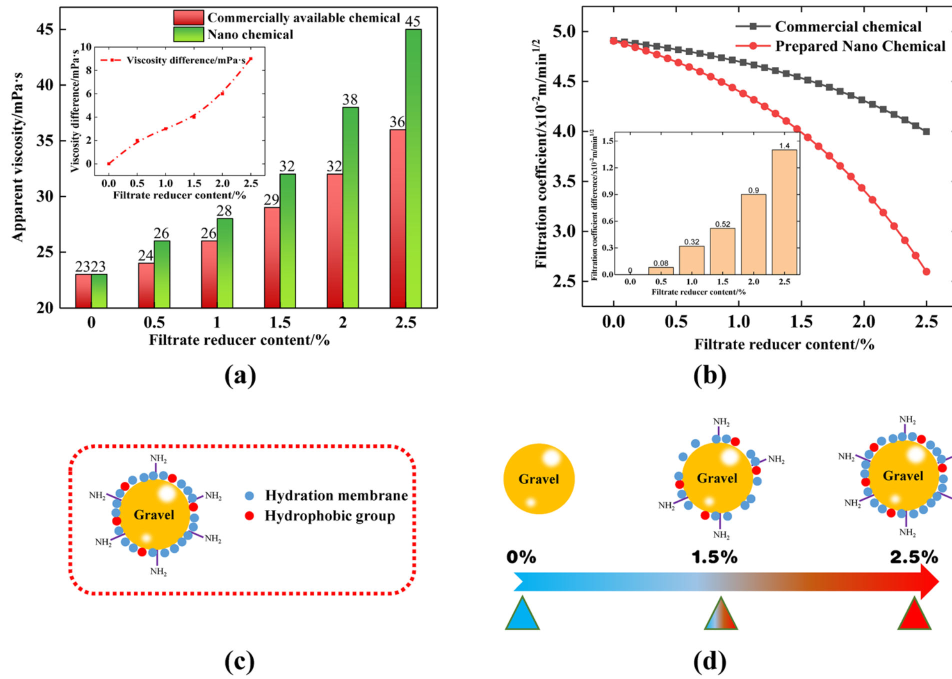

Fig. 4 Effect of filtrate reducer content on drilling fluid viscosity and filtration coefficient

more polar groups that can form hydrogen bonds than the commercially available filtrate reducer with the same dosage, which leads to a higher apparent viscosity of the drilling fluid caused by nanofiltrate reducer.

Figure 4 b shows an effect of filtration reducer content on filtration capacity of drilling fluid after aging temperature of 160 °C. The filtration coefficient of water-based drilling fluids is significantly improved with the addition of filtrate reducers, and a decreasing filtration coefficient of water-based drilling fluids is presented as filtrate reducer content increased from 0 to 2.5%. A functional relationship between the filtration reducer content and the filtration coefficient was shown in Eq. (3) (nanofiltration reducer) and Eq. (4) (commercially available).

$$y = 5.146 - 0.2395e^{-x/-1.592} \tag{3}$$

$$y = 5.417 - 0.5132e^{-x/-1.467} \tag{4}$$

In addition, the viscosity and filtration coefficient of drilling fluid without nanofiltrate reducer are only 23 mPa·s and 4.9×10^{-2} $m^3 \cdot min^{1/2}$, respectively, but a 26 mPa·s of drilling fluid viscosity and 4.7×10^{-2} $m^3 \cdot min^{1/2}$ of filtration coefficient were expressed, respectively, when nanofiltrate reducer content increased to 0.5%. Nevertheless, the weaker filtration capacity of the commercially available filtrate reducer is also shown in Fig. 4. The filtration coefficient of water-based drilling fluid was calculated to 4.82×10^{-2} $m^3 \cdot min^{1/2}$ when the content of commercially available filtrate reducer is 0.5%, which is much higher than that of the nanometer filtrate reducer at the same content. It can be obtained from the data analysis of Fig. 4 a and b that nanofiltrate reducer has better viscosity increase and filtration coefficient reduction in water-based drilling fluids than that of commercially available filtrate reducers, and an improving filtration reduction capacity of drilling fluid is shown with increasing the filtrate reducer content.

As given in Fig. 4 c and d, two microscopic reasons dictate the data analysis of Fig. 4 a and b as follows: (1) The amino group contained in the nanofiltration reducer can interact with water molecules and O in cellulose sodium to form a hydrogen bond, which are used to connect each particle in the drilling fluid. As a hydrophilic group, the amino group was beneficial to build a hydration layer around the gravel (3-mm diameter) in the drilling fluid (Zhao et al. 2019b). (2) As a hydrophobic group, a hydrophobic layer around the gravel surface could be constructed by the epoxy groups in filtration reducer (Saleh et al. 2020). Thus, the fine sand and gravel in the drilling fluid cannot only connect with each other under the action of hydrogen bonds, but also not agglomerate with each other due to the existence of hydration membrane and hydrophobic group.

In addition, the density of hydration film and the number of hydrogen bonds on the gravel surface increased with the content of filtration reducer, the increase of hydrogen bonds leads to the increase of drilling fluid viscosity. An increasing dispersion between the tiny sand and gravel was illustrated with increasing the density of hydration film on the surface of the sand and gravel. Drilling fluid with excellent dispersion can achieve high drilling efficiency in oilfield reservoirs (Li et al. 2020c). Compared with the commercially available filtrate reducer, the nanometer filtrate reducer molecule contains more amino groups and epoxy groups, which can achieve excellent dispersion and filtrate reduction capacity of drilling fluid at low content.

Effects of reservoir pressure on the viscosity and filtration capacity

The pressurization process from low-pressure shallow layers to high-pressure deep layers should be experienced in oilfield drilling. In addition, different oilfield reservoirs also allocate different reservoir pressures. Thus, it is necessary to study the rheology and filtration reduction capacity of drilling fluids containing nanofiltration reducers under different drilling pressures (Sadeghalvaad, and Sabbaghi 2015). Figure 5 a expresses the effect of different drilling pressures on the filtration and rheology of drilling fluids. It can be seen from Fig. 5 a that the filtration coefficient of the drilling fluid decreases moderately with the gradual increase of the reservoir pressure, and the viscosity of the drilling fluid also improves significantly. When the reservoir pressure increased from 10 to 30 MPa, the viscosity of drilling fluid increased from 45 to 60 mPa·s, and the fluid loss coefficient decreased from 2.5×10^{-2} $m^3 \cdot min^{1/2}$ to 1.3×10^{-2} $m^3 \cdot min^{1/2}$, and an obvious inverse trend between drilling fluid viscosity and filtration coefficient was illustrated with the change of reservoir pressure. The main reason why the reservoir pressure contributes to the improvement of the apparent viscosity of the drilling fluid is the change of the single bond length and bond energy of the hydrogen bond in the drilling fluid system (Fig. 5b). The gradually decreasing distance of each molecule in the drilling fluid is shown with an increase in the reservoir pressure, which causes the original hydrogen bond length to be continuously compressed. The compression of hydrogen bonds resulted in an increase in single bond energy and a shortening of single bond length. Additionally, free filtration reducer and water molecules also interacted and binded due to hydrogen bonding as the reservoir pressure increases (Li et al. 2020b). The hydrogen bond density in the drilling fluid system gradually increases due to the decreasing bond length and the increasing number of hydrogen bonds, which leads to the improvement of drilling fluid viscosity and rheology.

The filtration coefficient of the drilling fluid is mainly affected by the dispersion and viscosity of the drilling fluid. First, the higher viscosity of the drilling fluid can lock most of the water molecules to avoid filtration. In addition, the increased reservoir pressure promotes the ability of water molecules to be pressed against the gravel surface, which results in an increase in the thickness of the hydration film. The sand and gravel show a huge resistance due to the increase of the thickness of the hydration film when the external pressure is close to each other (Mao et al. 2015a, b). Nevertheless, the increase in reservoir pressure caused a rapid increase in the squeezing force (Fig. 5c) between the sand-gravel carrying the hydration film and filtration reducer on the surface, which can offset the resistance between the sand-gravel formed by the hydration film. Moreover, the resultant force between sand and gravel close to each other increases due to the increase of reservoir pressure, which improves the filtration reduction capacity of the drilling fluid due to the gap reduction between the sand and gravel.

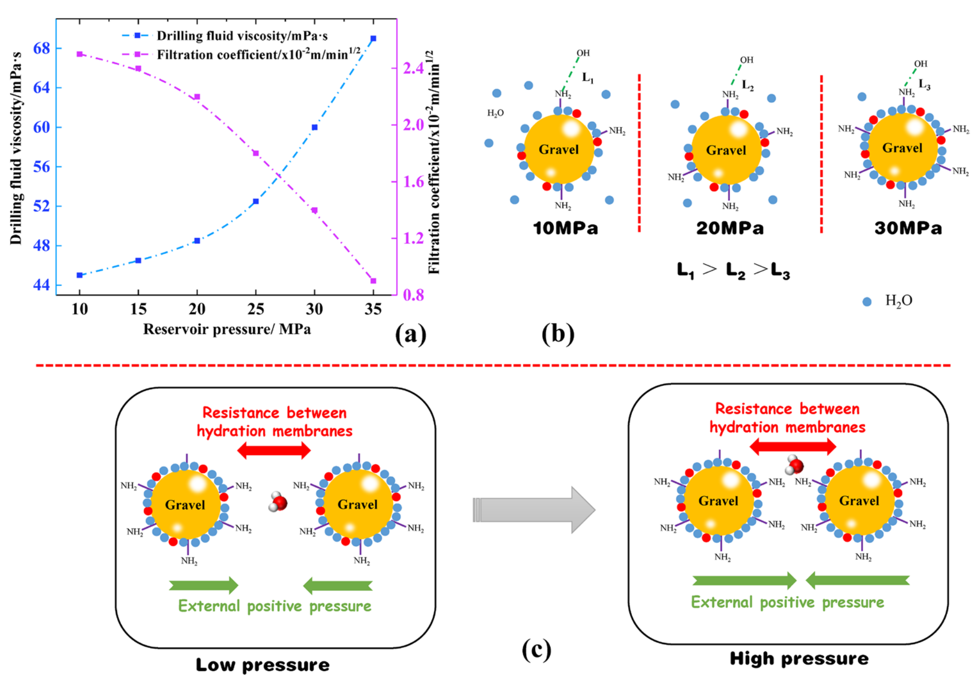

Fig. 5 Effect of reservoir pressure on drilling fluid viscosity and filtration coefficient

Effects of reservoir temperature on the viscosity and filtration capacity

The reservoir temperature also shows an increasing trend with the increase of reservoir depth in the oilfield. Thus, it is necessary to further investigate the effect of reservoir temperature on the filtration reduction ability of drilling fluid at different drilling depths. As can be illustrated in Fig. 6 a and b, a relatively higher reservoir temperature predicts lower drilling fluid apparent viscosity and higher filtration coefficient. That is, the apparent viscosity decreases significantly with the increase of the reservoir temperature, and an opposite trend was shown in filtration of drilling fluid. About 45 mPa·s of drilling fluid viscosity and 2.5×10^{-2} $m^3 \cdot min^{1/2}$ of filtration coefficient was evaluated at reservoir temperature of 160 °C, but they changed to 35 mPa·s of drilling fluid viscosity and 3.1×10^{-2} $m^3 \cdot min^{1/2}$ of filtration coefficient when reservoir temperature increased to 180 °C.

In other words, the increase in reservoir temperature results in a decrease in the viscosity of the drilling fluid, which also destroys its ability to reduce filtration. However, the temperature resistance and filtration capacity of the drilling fluid prepared by the commercially available filtrate reducer are significantly lower than those of the nanometer filtrate reducer. The viscosity of drilling fluid prepared by commercially available filtrate reducer decreased from 36 to 20 mPa·s under the same temperature change interval, while the fluid loss coefficient increased from 4.1×10^{-2} $m^3 \cdot min^{1/2}$ to 5.5×10^{-2} $m^3 \cdot min^{1/2}$.

The relationship between molecular activity and temperature in the Arrhenius equation can well reveal the changing trend among reservoir temperature, drilling fluid viscosity, and filtration coefficient (Tamm, and Mcconnell 1985; Li et al. 2022a, b).

$$\eta = A_v \exp\left({}^{E_f}\!/_{R_g T} \right) \tag{5}$$

where E_f is the molecular activation energy (kJ), and there is no correlation between E_f and reservoir temperature. The E_f, A_v, and R_g are considered as a constant.

The increase of reservoir temperature directly leads to the increase of molecular activity and intermolecular repulsion, which causes the hydrogen bonds formed between molecules to be elongated or broken. Decreased hydrogen bond density was supposed to a fatal factor for low drilling fluid viscosity. Moreover, the increasing temperature also triggers the desorption of the hydration membrane and filtration reducer adsorbed on the surface of the sand and gravel. The reduction in the thickness of the hydration film directly leads to the agglomeration between the sand and gravel, water molecules were easier to flow away around the agglomerated gravel to increase the filtration coefficient. The relationship between zeta potential and reservoir temperature in Fig. 6 c can prove the above mechanism (Huo et al. 2018). The hydrogen bond between the water molecules of the hydration film on the surface of the gravel is broken due to the rising reservoir temperature, and a large number of free polar water molecules are scattered. In addition, the lack of hydration

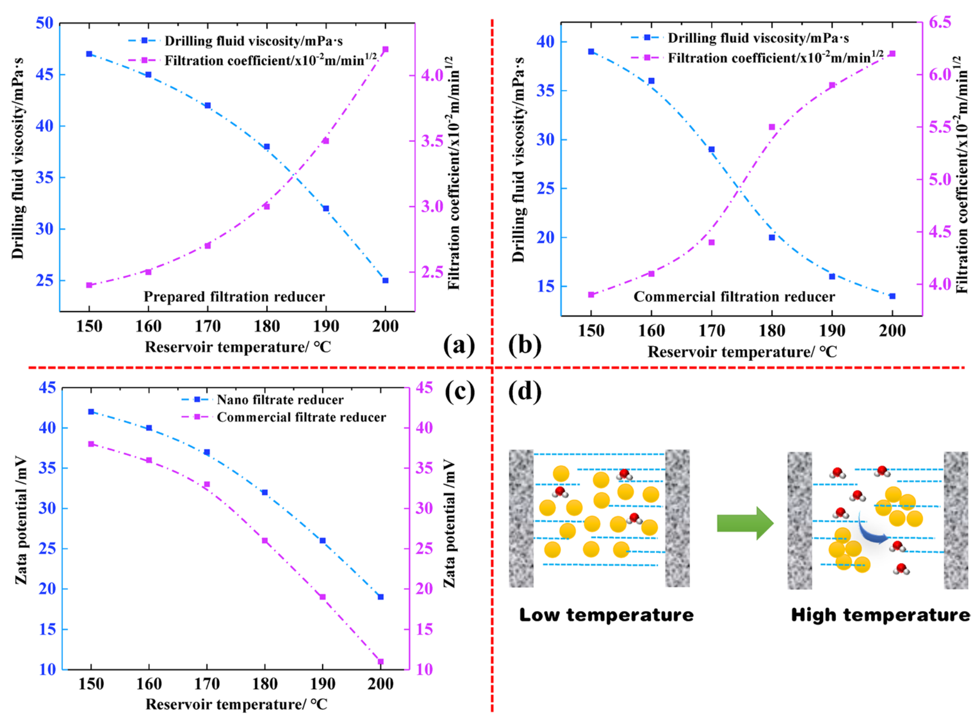

Fig. 6 Effect of reservoir temperature on drilling fluid viscosity and filtration coefficient

film also leaked out the polar surface of the gravel. Two reasons jointly led to the change of zeta point. Gravel is not uniformly aggregated due to the disappearance of hydration membrane and filtrate reducer, and free water molecules are filtered out from a distance from a distance (Fig. 6d).

Effects of shear rate on the viscosity and filtration capacity

The drilling fluid injected into the reservoir always has a certain shear rate due to the injection pressure, which can affect the viscosity and dispersibility of the drilling fluid, thereby affecting the filtration capacity of the drilling fluid (Iscan and Kok 2007). Figure 7 shows the variation of drilling fluid viscosity and filtration coefficient under different shear rates. As given in Fig. 7, the viscosity of drilling fluid containing nanofiltration reducer is 45 mPa·s when the shear rate is 160 s^{-1}, while the shear rate of 180 s^{-1} shows only 39 mPa·s of drilling fluid viscosity, the shear rate of the drilling fluid is not conducive to the improvement of the drilling fluid viscosity (Guria et al. 2013). In addition, the shear resistance of drilling fluids containing commercially available filtration reducers is much lower than that of nanofiltration reducers. The viscosity of drilling fluid containing commercial filtration reducer decreased from 36 to 27 mPa·s while changing the shear rate from 160 to 180 s^{-1}. Compared to commercially available filtration reducers, more functional groups in the nanofiltration reducer molecule can significantly increase the number and density of hydrogen bonds in the drilling fluid system.

It can also be seen from Fig. 7 that the increase of shear rate causes the hydration film adsorbed on the particle surface to be broken up, which leads to the aggregation of sand and the increase of free water molecules. More water molecules are filtered out due to the poor dispersion and freeness of the gravel. An obviously proportional relationship was demonstrated between the shear rate and filtration coefficient. Moreover, the viscosity decrease and filtration coefficient increase of nanofiltration reducer under the same shear rate are obviously better than those of commercial filtration reducer.

Furthermore, drilling fluids with different filtration reducers has different fluid viscosity and filtration coefficient; two microscopic reasons directly triggered the influence of different filtration reducers on drilling fluid parameters. In the same content of filtration reducers, the molecule of prepared nanofiltration reducers possesses more amide groups, which can construct more intermolecular hydrogen bonds, and a denser microscopic grid formed by intermolecular hydrogen bonds blocks the passage and filtration of free water molecules, while the commercially available filtration control agent has only one amide group (Jain et al. 2014; Li et al. 2022d). More and denser intermolecular hydrogen bonds and grid structure can be more resistant to hydrogen bond breakage at the same shear rate (Fig. 7c). In addition, the long side chains contained in the synthetic nanofluid loss reducer can also achieve spatial intertwining in the drilling fluid, which is more effective in resisting shearing. (Fig. 7d).

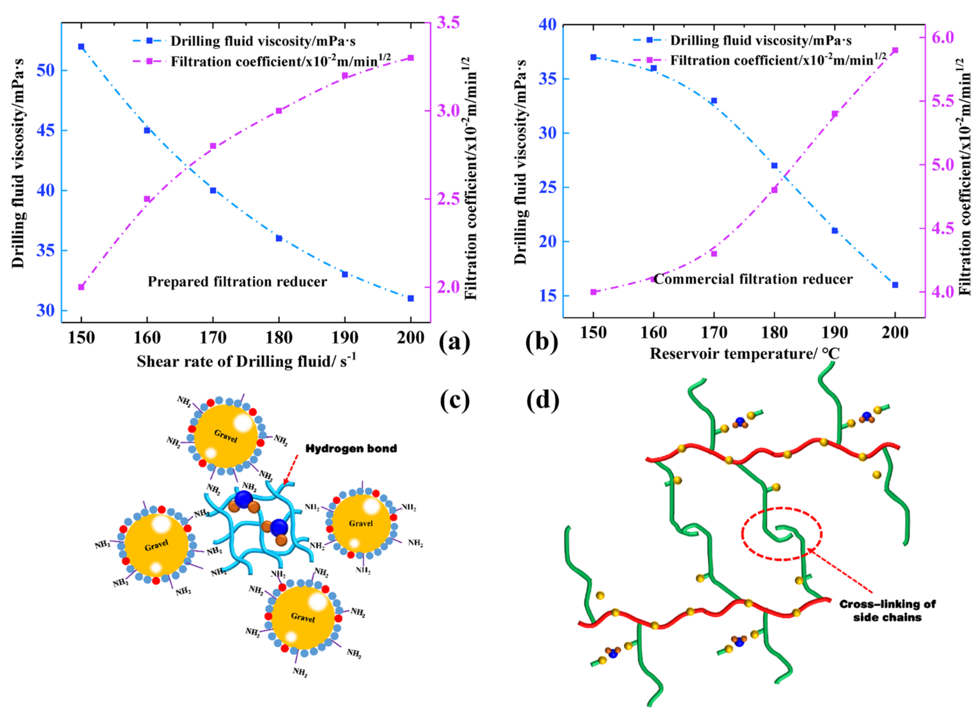

Fig. 7 Effect of shear rate on drilling fluid viscosity and filtration coefficient

Mechanism analysis of microscopic action

The amino group contained in the nanofiltration reducer could build more hydrogen bonds, which is conducive to connect the molecules in the drilling fluid. The molecules in the drilling fluid cannot be filtered out smoothly due to the involvement of micro-grid. In addition, the epoxy groups in the filtration reducer facilitated the hydrophobic layer of gravel surface, and the dispersion of larger sand and gravel will also increase. The above two reasons jointly lead to low filtration of drilling fluid.

Conclusion

Drilling fluid and reservoir properties endanger drilling efficiency during oilfield drilling. In this investigation, the influence of various factors such as reservoir temperature, pressure, shear rate, and filtration reducer content on the rheology and filtration of drilling fluid was analyzed with synthetic nanofiltration reducer, and the filtration mechanism of drilling fluid was also initially revealed. The investigation results demonstrate that all external factors mainly affect the filtration capacity of the drilling fluid by changing the number of intermolecular hydrogen bonds in the drilling fluid and the thickness of the hydration film on the surface of the sand and gravel. In drilling operation, nanofiltration reducer can significantly improve the filtration capacity of drilling fluids than commercial filtration reducers, and the increase in filtration reducer content and reservoir pressure is beneficial to improve drilling fluid rheology and filtration capacity. Thus, it is effective to increase filtration reducer content and reservoir pressure, and cooling the drilling fluid is also considered an effective measure to decrease the filtration capacity. Besides, replacing a type of high-efficiency fluid loss reducer is also a better method.

Author contribution Qiang Li, Yanling Wang, Fuling Wang, Jinyan Zhang, Jiashuo Chen, Yingjie Su, and Yulong Wang: testing, data analysis, and writing—original draft preparation. Longhao Tang, Chang Zhou, Jingyu Pang, Kobina Forson, and Rufeng Miao: reviewing and editing.

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Data availability Not applicable.

Declarations

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Competing interests Not applicable.

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