The Research of New Environment-Friendly Oil-based Drilling Fluid Base Oil

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The Research of New Environment-Friendly Oil-based Drilling Fluid Base Oil

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Abstract. In this paper, the heavy hydrocarbon of Daqing is used, and the desulfurization and de-aromatization experiments and refining process are carried out, a base oil suitable for oil-based drilling fluid was developed, and the performance of base oil was evaluated, we can know the aromatics content of oil base is low, less toxic, less pollution and it can meet the requirement of environmental protection.

Key Words. Se oil; desulfurization experiment; de-aromatization experiment

1. Introduction
The base oil used in oil-based drilling fluid directly decide the pollution extent of drilling fluid to environment. At present, it mostly use the diesel oil that the content of aromatic hydrocarbon is over 20 percent as the base oil in drilling, the high aromatic hydrocarbon content can make the strong toxic of drilling fluid, and it can hardly degradation that will create serious environment pollution, the use of diesel oil has more and more limitation in existing conditions. At present, the international gas to liquid instead of the traditional diesel fuel, environmental protection has made progress, because the reaction process is more complex, and also need to separate process, so the price is higher. What’s more, natural gal technology is not realistic for our country, because nature gas is shortage in our country, and the price is higher than abroad. Recently, cosmetic white oil is used instead of traditional diesel in our country, but white oil has high viscosity, it will influence other parameters in drilling.

The unique heavy hydrocarbon of Daqing oil field is used in this paper, researching the new environment-friendly oil-based drilling fluid base oil (MC oil) through a series of methods.

2. Method for preparing MC oil
(1) Materials
The heavy hydrocarbon of Daqing which physical and chemical indicators are:
1) distillation: 80～280℃;2) condensation point: -20～-40℃;3) flash point: 30～50℃;4)sulphur content:250ppm;5) aromatic hydrocarbon content: 6～8%;6) olefin content: 2～3%

(2) Production equipment’s
1) raw material buffer tank;2) heating furnace;3) fractionation tower;4) first order hydrogenation reactor;5) medium temperature Zinc oxide desulfurization tank A;6) medium temperature Zinc oxide desulfurization tank B;7) second order hydrogenation reactor;8) cooling reactor;9) raw material oil
pump; 10) the third heat exchanger; 11) supercharge oil pump; 12) the second heat exchanger; 13) the first heat exchanger; 14) condenser

(3) Preparation process

raw materials \[\xrightarrow{200\# \text{ solvent oil}}\] generated H\(_2\)S \[\xrightarrow{}\] Hydrodearomatization

\[\xrightarrow{\text{distillation}}\] first order hydrogenization \[\xrightarrow{\text{zinc oxide desulfurization}}\] second order hydrogenization \[\xrightarrow{\text{cooling and splitting the finished}}\]

**Fig. 1** MC Oil preparation route

3. Desulfurization experiment of raw oil
First, the organic sulfide in stock oil is converted to hydrogen sulphide by catalytic cracking, and finally escaping in a gas form. After catalytic oxidation, the performance of raw oil is improved, performance meets international standards [1-2]. Desulfurization process flow chart is as follows:

**Fig. 2** The desulfurization process flow diagram

| Number | Reaction temperature /°C | Sulfur W/% | Desulfurization degree /% | Alkene/% |
|--------|---------------------------|------------|---------------------------|---------|
|        |                           | Raw oil    | 70.00                     | 7.60    |
|        |                           | After desulfurization | 67.60 | 4.00 |
|        |                           | 70.00 | 67.60 | 4.00 |
|        |                           | 50.50 | 41.20 | —    |
|        |                           | 50.50 | 41.20 | —    |
|        |                           | 1.12 | 41.20 | —    |

**Tab. 1** After desulfurization raw oil properties
After catalytic desulfurization, raw oil is not only high in gas content, but also high in carbon content [3-4], therefore, we used catalytic oxidation experiments to remove more Thiel in the sulfur [5-6].

The hydrogenation of aromatic compounds was reversible. The reaction was as follows:

$$A + n/2H_2 = AH$$

Type: $A$ —— Aromatic compounds; $AH$ —— the product after hydrogenation, Naphthenic hydrocarbon.

The liquid activity factor of aromatic compounds $A$ and naphthenic hydrocarbons $AH$ is equal to their fugacity[7-8], Hydrogen activity coefficient and total pressure ratio is 1, Hydrogen fugacity and total pressure ratio is 1, The equilibrium concentration of aromatic compounds is expressed as follows:

$$\frac{y_A}{y_A + y_{AH}} = \frac{1}{1 + K_e \times \left(\frac{P_{H_2}}{P_0}\right)^n}$$

Type: $y_A$ —— Aromatics molar ratio; $y_{AH}$ —— Naphthenic hydrocarbons molar ratio; $K_e$ —— Equilibrium constant; $P_{H_2}$ —— Partial pressure of hydrogen.

4. Performance evaluation of MC oil base oil

MC oil features: MC oil is mainly mixed from C12～C22 hydrocarbons. The impurities are low in content, small in proportion, less in water content, easy to volatilize and easy to degrade.

The viscosity of the MC oil is low and the viscosity of the MC oil drops as the temperature rises, as shown in figure 3.

![Fig.3 MC Oil viscosity with temperature under atmospheric pressure change curve](image)

At room temperature, the viscosity of different base oils varies greatly, which influences drilling fluid preparation differently. The viscosity of base oil should not be too high, which is beneficial to control the rheology of drilling fluid.
Fig. 4 The influence of temperature and pressure on the viscosity

The data of density, viscosity and flash point of various base oils were compared and evaluated after desulfurization and aromatics removal, as shown in Table 2.

Tab. 2 The performance of the base oil data sheet

| Property                  | Mentor26 | Gtl  | MC oil | White oil | BP8313 | Diesel oil |
|---------------------------|----------|------|--------|-----------|--------|-----------|
| Appearance                | colorless liquid | colorless liquid | Canary yellow liquid | colorless liquid | colorless liquid | Brownish yellow liquid |
| Chroma                    | <1.8     | <1.8 | <1.8   | <1.8      | <1.8   | <1.8      |
| Density ρ/(kg·m⁻³)        | 827      | 851  | 783    | 810       | 796    | 831       |
| Flash point /°C           | 92       | 111  | 134    | 161       | 74     | 83        |
| Aniline point /°C         | 71       | 81   | 75     | 63        | 78     | 57        |
| Pour point /°C            | 26       | 15   | 55     | 77        | 41     | 47        |
| Final boiling point /°C   | 318      | 321  | 331    | 316       | 250    | 335       |
| Aromatic Hydrocar / quality % | 14.3   | 18.2 | 0.8    | 13.0      | 2.1    | 46.0      |
| Sulfur content /%         | <0.1     | <0.1 | <0.1   | <0.1      | <0.1   | 0.5       |
| Viscosity / (mPa·s)       | 2.5      | 4.0  | 1.5    | 1.8       | 1.7    | 2.9       |
| LC50 value / (mg·l⁻¹·WSF) | >1000000 | >1000000 | >1000000 | >1000000 | >1000000 | 80000     |
| Freezing point /°C        | -1       | 0    | 0      | 0         | 0      | 0         |
| Mechanical impurities     | /        | /    | /      | /         | /      | /         |
| Water content             | /        | /    | /      | /         | /      | /         |
| Water soluble acid        | /        | /    | /      | /         | /      | /         |
| Alkaline corrosion        | qualified| qualified| qualified| qualified| qualified| qualified |
| Rotary reading            | Φ600/Φ300 | 15/8 | 6/3    | 9/5       | 4/3    |            |
| viscometer reading        | Φ200/Φ100 | 5/3  | 2/1    | 4/3       |        |            |

As can be seen from above table, the permeability recovery value of drilling fluid system using MC oil as base oil is greater than 90%, higher than other two kinds of drilling fluid, low filtration loss, good effect on reservoir protection and little pollution.
5. Conclusion
(1) With the shortage of ordinary base oil, using the unique oil in Daqing fields, through desulfurization and de-aromatization experiments and refining technology, MC oil as the base oil in oil-based drilling fluid is worked. MC oil is superior to other base oils such as diesel oil, with low aromatic hydrocarbon content, low toxicity, and low pollution, it is the preferred base oil for the preparation of shale formation drilling fluids.

(2) MC oil was system evaluated in the lab, the result is MC oil is superior to other base oils such as diesel oil, with low toxicity, and low pollution, it is the preferred base oil for the preparation of environment-friendly drilling fluid system.

(3) The drilling fluid prepared with MC oil is applied in the field, which has good protection effect on the reservoir and little pollution to the environment.

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