Development of the Basic Oil for Environmental Protection

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Abstract. In this paper a base oil applicable for oil-based drilling fluid is put up , which refined by Daqing's special heavy hydrocarbon’s desulphurization and de-aromatization. Performance of this base oil is also evaluated and results in low aromatics content, toxicity and pollution, which meets the requirement of environmental protection.

1. Introduction
Diesel oil is often used as a base oil of oil-based drilling fluid in the oil industry, but too high aromatics content of it makes drilling fluid have strong toxicity, and it is difficult to degrade which causes environment problem. As China attaches great importance to environmental protection, the restrictions on diesel fuel are becoming more and more stringent. At present, gas-to-liquid instead of conventional diesel oil in many countries,but its price is too high because of the complex reaction process and separate technology. In recent years, cosmetic-grade white oil has also been used in place of common diesel in China. However, the white oil has a certain influence on other process parameters in the drilling process owing to higher viscosity. In this paper, a unique heavy hydrocarbon in Daqing Oilfield was used for developing new environmental drilling liquid oil (TC oil) through a series of methods.

2. Method for preparing TC oil
2.1 materials and preparation rout
(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 hydricarbon content: 6~8%;  6)olefincontent: 2~3%
(2) Production equipment
  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
2.2 Desulfurization experiment of raw oil

First, organic sulfides in stock oil were transformed into hydrogen sulfide by catalytic cracking, which escaped in form of gas. Then, through catalytic oxidation to improve performances of stock oil, in order to meet the international standard [1, 2]. Desulfurization process flow chart is as follows:

- 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 thiol in the sulfur [5, 6].

| Number | Reaction temperature /°C | Sulfur W/ % | Desulfurization degree /% | Alkene /% |
|--------|--------------------------|-------------|---------------------------|-----------|
| 1      | 530                      | 1.68        | 0.50                      | 70.00     | 7.60     |
| 2      | 530                      | 1.18        | 0.38                      | 67.60     | 4.00     |
| 3      | 480                      | 1.44        | 0.55                      | 61.70     | 4.80     |
| 4      | 490                      | 1.91        | 0.95                      | 50.50     | —        |
| 5      | 440                      | 1.91        | 1.12                      | 41.20     | —        |
3. Performance evaluation of TC oil

The influence of TC oil carbon atom distribution, temperature and pressure on the viscosity of TC oil, the change of TC oil density with the temperature, and the compressibility of TC oil are discussed.

3.1 Carbon number distribution

Fig. 3 shows that carbochain from C12 to C22 take 92% of TC oil’s total mass, which can be inferred:

(a) TC oil is mainly composed by carbochain from C12 to C22.
(b) Impurity content of TC oil is low.
(c) TC oil is easy to volatilize and degrade.

3.2 The relationship between viscosity with temperature and pressure

As the viscosity of each type of base oil is different, the viscosity of the drilling fluid made from different base oils is different at normal temperature. In order to make the rheology of drilling fluid easy to control, the viscosity of the base oil should not be too high.

Figure 4 shows the viscosity of TC oil decreases with the increase of temperature, and increases with the increase of pressure.
3.3 The relationship between density with temperature
The density of TC oil is significantly affected by temperature, and when the temperature is raised, the density of TC oil drops as shown in figure 5.

![TC oil density changing with temperature curve](image)

3.4 Performance comparison of base oil
The comparison results of some basic oil properties after desulfurization and dearomatization are shown in table 2.

| Property                  | T C oil | White oil | BP8313  | diesel oil |
|---------------------------|---------|-----------|---------|------------|
| Density/(kg·m⁻³)          | 783     | 810       | 796     | 831        |
| Flash point/°C            | 134     | 161       | 74      | 83         |
| Aniline point /°C         | 75      | 63        | 78      | 57         |
| Pour point/°C             | 55      | 77        | 41      | 47         |
| Boiling point/°C          | 331     | 316       | 250     | 335        |
| Aromatic content /mass%   | 0.8     | 13.0      | 2.1     | 46.0       |
| Sulfur content /%         | <0.1    | 0.5       |         |            |
| Viscosity/(mPa·s)         | 1.5     | 1.8       | 1.7     | 2.9        |
| LC50/(mg/l WSFs)          | >1000000| >1000000  | >1000000| 80000      |

It can be seen that LC50 value of TC oil is more than 1 million mg/l WSFs, and LC50 value of diesel oil is only 80 000 mg/l WSFs, which indicates that TC oil is much less toxic than diesel oil. Flash point of TC oil are higher than 110 °C which is more safety. And aromatic hydrocarbon content of TC oil is much lower than other base oil, so its toxicity was the lowest.

TC oil is superior to other base oils such as diesel oil, which is low aromatic hydrocarbon content, low toxicity, low pollution, so it is very suitable for preparation of environment-friendly drilling fluid system.

4. Conclusions
(1) With the shortage of conventional base oil, TC oil has been developed as the base oil of oil base drilling fluid by using the unique crude oil of Daqing oilfield through desulfurization and dearomatization.

(2) TC oil was system evaluated in the lab, results show that TC oil is obviously superior to other base oils such as diesel oil, with low toxicity, and low pollution, which is the preferred base oil for the preparation of environment-friendly drilling fluid system.
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