FRICTIONAL AND WEAR BEHAVIORS OF IONIC LIQUID ADDITIVES FOR DRILLING FLUIDS

TRACK OR CATEGORY
Lubrication Fundamentals

AUTHORS AND INSTITUTIONS
Min Ji[1]; Shuhai Liu[1*]; Huaping Xiao[1]

[1]College of Mechanical and Transportation Engineering, China University of Petroleum-Beijing, Beijing, 102249, China

*Corresponding author: Email: liu_shu_hai@163.com; Tel: 086-010-89733835.

INTRODUCTION
With the development of oil/gas industry, increasing drilling depth has caused many problems in drilling operations. High torque is easy to occur by friction between drilling tools [1-2]. This would bring big challenges in reducing friction and using efficient drilling fluids is a simple and significant method. Water-based drilling fluids have been paid much attention in the few decades for its good cooling capacity and environmental friendly [3-4]. However, it is necessary to overcome some shortcomings of water-based drilling fluids such as poor lubrication property for application in actual drilling operation.

As all known, multiple researches on ionic liquid are growing because of its unique properties of customization [5]. Among massive type of ionic liquids, imidazolium- and phosphonium-based ionic liquids (ILs) are most commercially available and commonly used [6]. Many researches on the tribological behavior of imidazolium- and phosphonium-based ILs have been made. Previous studies illustrate that imidazolium- and phosphonium-based ILs shows great lubrication performance as lubricant additives both in oil- and water-based fluids [7]. Besides load is also a significant impact factor influencing tribological performance. Thus tribological properties of five kinds of imidazolium- and two kinds of phosphonium-based ILs as additives in drilling mud under various load conditions were investigated in this study.

Experimental
Drilling mud was prepared by gradually adding bentonite into deionized water with a glass rod stirring. Then other ingredients were added in turn, and the formulation of mud is listed in table 1. The frictional tests were carried out using a pin-on-disc tribometer in a rotary motion. A SAE52100 steel ball with diameter of 3mm purchased from Changzhou Huari Steel Ball Co., Ltd. and an ASTM201 steel disc with diameter of 30mm supplied by a metal factory were mated on the flat. The experiment was conducted with the applied load ranging from 1N to 5N and a fixed speed at 150rpm/min. Each experiment lasted for 15min and repeated 3 times to reduce error. A scanning electron microscope (SEM, FEI Quanta 200F) was employed to wear tracks on the steel balls.

Table 1. Based formulation of drilling mud

Ingredient	Mass fraction
H_2O	95.85%
Bentonite	3%
CMC	1%
Na_2CO_3	0.15%

Results and Discussion

Measured COF varies with applied load under the lubrication of various IL additives is displayed in Fig.2. It is found in Fig.2 that COF decreased slightly with increasing load for all types of ILs. This result demonstrates that IL as lubricant additives is effective in sustaining the load. Among these ILs, [Im1,8] Br shows an excellent friction reduction property. As seen in Fig.2, COF value under the lubrication of [Im1,8] Br is nearly half of that of other ILs. After the experiment, wear scar SEM of the worn balls under load of 2N and 5N are displayed in Fig. 3. When the applied load is 2N, the surfaces are destroyed seriously with cracks and scratches appearing under the effect of normal load for ILs additives. While at 5N, the degree is similar to that under 2N, which indicates a good load capacity.

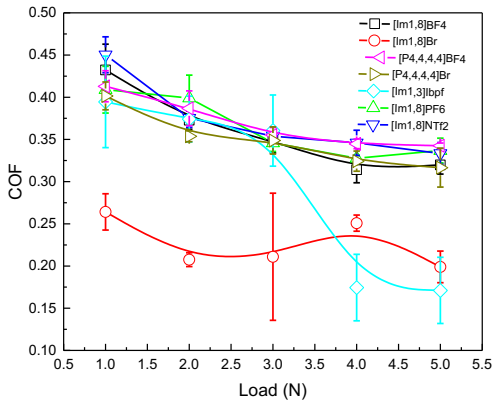

Figure 1. Measures COF of different ILs additives varies with load at speed of 150 rpm/min.

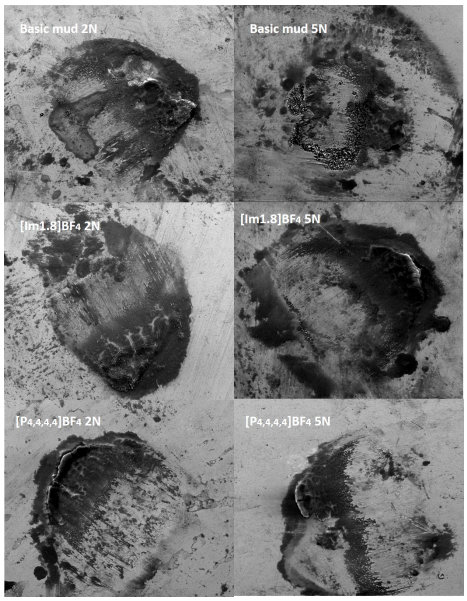

Figure 2. SEM micrographs of worn steel balls for different types of IL additives at load of 2N (left column) and 5N (right column).

CONCLUSIONS

The tribological properties of 4% IL drilling muds under different load were investigated in this study. Results demonstrate that ILs show good performance in friction reduction especially for [Im1,8] Br. Regarding wear, some cracks take place on the worn surface after the experiment, and the addition of IL is beneficial in sustain the load.

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KEYWORDS

Drilling mud; lubrication; ionic liquid additive