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Study on Tribo-chemistry Properties of Some Additives on Base Oils of Friendly Environmentally Lubricants

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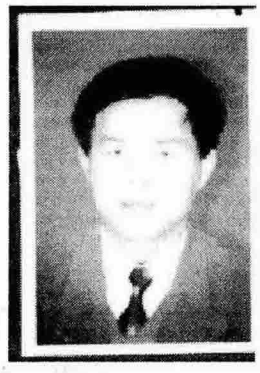

Abstract: The tribological characteristic of several environmentally friendly lubricating base stocks was examined, and the effect of some commonly used additives on the tribological behavior of the lubricating oils was comparatively investigated on a four-ball machine. It has been found that the commercial additives including butene sulfide, wax chloride, zinc dialkyldithiophosphate and ashless P-N type agent helped to improve the friction-reducing and antiwear properties as well as the extreme pressure behavior. Non-toxic nanoscale $(CF)_x$ showed the best friction-reducing ability, though it registered relatively poor extreme pressure properties. The mechanism on friction of nano-scale material is discussed.

Key words: green lubricants; additives; friction-reducing and antiwear behavior

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1. Introduction

With the development of economy and the improver of human being's environmental protection, the mineral oil is being limited because of bad biodegradability. The environmentally friendly(green) lubricants are rapidly being researched and developed by the large petrifaction company all over the world because of excellent environmentally compatible and harmless capability, the demand of which is increasing year after year.

The tribological properties of green harmless lubricants have been investigated including typical diesters, natural plant oils. The tribo-chemistry properties of environmentally compatible base fluids with antiwear and extremepressure additives such as poly-sulfurized isobutylene(T321), chloroparaffins(T301), ZDDP(T202) and non-toxic nano-scaled $(CF)_x$(diameter:560nm) have been examined on Fig 1. The tests show the chemical structures of environmentally Friendly base stocks effect antiwear and friction[1].

2. The Rheology and Chem-physics Character of Some Friendly Environmentally Base Fluids

Some friendly environmentally base fluids are tested on the laboratory. The result is shown on table 1. The test method of biodegradability is refered to [2], [3].

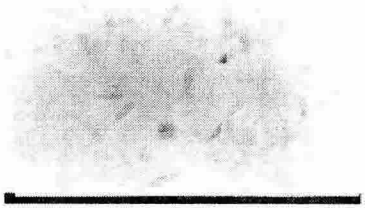

Fig 1 TEM Photo of Nano-scale $(CF)_x$ (x 50000 times)

Table 1. the rheology and chem-physics character of some friendly environmentally base fluids

Types of base fluids	viscosity 40 ℃	viscosity 100 ℃	VI	Pour point ℃	biodegradability % CEC-L-33-T-93
Castor oil	233	17.4	70	-19	100
Rapeseed oil	35	8	210	-10	99
Bean oil	27.5	6	75		81
Pentaerythritol esters (C_{7-9} acidate)	24.4	5.2	160	≤-35	98.8
Dioctyl adipate	8.32	2.84	212		100
Di-n-butyl sebacate	6.2	2.3	159	-10	100
Di-iso-capryl sebacate e	11.7	3.11	153	≤-70	100
Methyl oleate	5.5	2.1		-15	100
Ethyl oleate	5.2	2.3	218	-17.5	100
n-Buthyl oleate	6.3	2.5	216	-21	100

3. Testing Method

The antiwear and EP additives are used to do compared test on tribological charateristic in the paper. The additives: poly-sulfurized isobutylene(T321), chloroparaffins(T301), ZDTP(T202), TAW and nano-scaled $(CF)_x$(diameter:560nm) are selected and used.

The antiwear $D_{30\,min}^{196N}$ is determined in four-ball machine. The determining time of P_B is used by 10s.The indexes of tribological charateristic are shown : ①antiwear;

②capacity of load P_B; ③ anti-friction friction coefficient(f)

4. The Testing Result and Discussion

3.1 Tribological behavior of Some Friendly Environmentally Base Fluids with some additives

some friendly environmentally base fluids and ones with some additives are tested with tribologyical charateristic on steel pair.

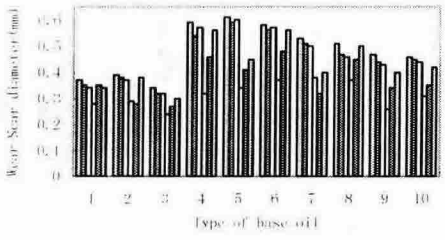

Fig1. Compared wear scar diameter of different friendly environmentally base fluids and ones with 1%T301、1% nano-scale $(CF)_X$、1%TAW-4、1%T202 and 1%T321

1) castor oil 2) Rapeseed oil 3) Bean oil 4) pentaerythritol esters(C_{7-9}Acidate) 5) Dioctyl adipate 6) Di-n-butyl sebacate 7) Di-iso-capryl sebacate 8) Methyl oleate 9) Ethyl oleate 10) n-Buthyl oleate

The tribologyical charateristic on different base fluids and ones with 1%T301、1% Nano-scale $(CF)_X$、1%TAW-4、1%T202 and 1%T321 are shown on Fig 1. Nano-scale $(CF)_X$ have antiwear effect on friendly environmentally base fluids, but effect not enough TAW and ZDTP which form chemical films.

Capacity of load different base fluids and ones with 1% Nano-scale $(CF)_X$ are shown on Fig 2. The P_B base fluids with $(CF)_X$ are little higher than ones.but less than S-system.Cl-system. ZDTP additives.

Friction coefficient on different friendly environmentally base fluids and ones with 1%T301、1% nano-scale $(CF)_X$、1%TAW-4、1%T202 and 1%T321 under 98N. 196N. 294N.392N are shown on table 2. The antifriction effect on nano-scale $(CF)_X$ is better than S-system.Cl-system. ZDTP or non-ashed antiwear agent TAW. This is outstanding characteristic of new nano- material.

5. Conclusion

The friendly environmentally base fluids with nano-scale $(CF)_X$ additive have definite antiwear and capacity, but less than chemical antiwear EP agent. Antifriction capacity of The friendly environmentally base fluids with nano-scale $(CF)_X$ is better than used EP additives.

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