LUBRICANT COMPOSITION FOR HYDRAULIC OIL

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a lubricant composition, and more particularly to a lubricant composition, which has superior oxidation stability and friction characteristics even under harsh conditions of high temperature and high pressure and is thus suitable for use in hydraulic oil.

2. Description of the Related Art

A lubricant is an oily material used to reduce the generation of frictional force on the friction surface of a machine or to dissipate frictional heat generated from the friction surface. Because of the wide variety of machinery that requires lubrication and the wide variety of conditions under which such machinery works, lubricants vary in type and quality. Depending on the application thereof, different types of base oil must be used. In particular, when a lubricant is used for an airplane or an advanced hydraulic system, hydraulic oil having a strong flame-retarding effect is required.

Any type of hydraulic oil used in industrial fields is a medium of power transmission and plays roles in lubrication, rust prevention, sealing and cooling of respective parts of hydraulic equipment. The hydraulic oil is manufactured by adding additives to base oil, and is largely classified into mineral hydraulic oil

(petroleum-based hydraulic oil) and synthetic hydraulic oil depending on the type of base oil, synthetic hydraulic oil being classified into polyalphaolefin-based hydraulic oil and ester-based hydraulic oil.

Meanwhile, the operating temperature range of hydraulic oil varies, and especially in the summer, may be 75 to 85˚C or higher. At such temperatures, however, mineral hydraulic oil and polyalphaolefin-based hydraulic oil generate a lot of oil vapor. The occurrence of such oil vapor causes a problem of increasing the evaporation loss of hydraulic oil, and also promotes the oxidation of hydraulic oil. Hence, it is necessary to minimize the generation of oil vapor. In particular, mineral hydraulic oil, which accounts for most hydraulic oil, requires additional measures to improve oxidation stability due to the characteristics of the base feedstock oil. Moreover, since hydraulic systems are recently becoming more and more sophisticated, hydraulic oil is required to have superior friction characteristics.

Therefore, the present inventors have developed a lubricant composition for hydraulic oil, which has superior thermal and oxidation stability and is capable of reducing mechanical wear of hydraulic equipment.

[Citation List]

[Patent Literature]

(Patent Document 0001) Korean Patent No. 10-0201759

(Patent Document 0002) Korean Patent Application Publication No. 10-2008-0109015

SUMMARY OF THE INVENTION

Accordingly, the present invention has been made keeping in mind the problems encountered in the related art, and an objective of the present invention is to provide a lubricant composition, in which a functional additive for friction reduction and an ethylene-alphaolefin liquid random copolymer having a high viscosity index are mixed, thereby exhibiting superior friction characteristics, thermal stability and oxidation stability.

Another objective of the present invention is to provide a lubricant composition for hydraulic oil, which is capable of reducing the mechanical wear of hydraulic equipment and energy consumption when applied to hydraulic equipment and of decreasing evaporation loss due to low changes in the physical properties of hydraulic oil, and thus may be used for a long period of time.

In order to accomplish the above objectives, the present invention provides a lubricant composition, comprising a base oil, a liquid olefin copolymer, a phosphorothioate compound, and phosphonium phosphate.

The base oil may be at least one selected from the group consisting of mineral oil, polyalphaolefin (PAO) and ester.

The liquid olefin copolymer may be prepared by copolymerizing ethylene and alphaolefin in the presence of a single-site catalyst system, and the single-site catalyst system preferably includes a metallocene catalyst, an organometallic

compound and an ionic compound.

The liquid olefin copolymer may have a coefficient of thermal expansion of 3.0 to 4.0.

The liquid olefin copolymer may be included in an amount of 0.5 to 30 wt%, and preferably 0.5 to 25 wt%, in the lubricant composition of the present invention.

The phosphorothioate compound may be included in an amount of 0.1 to 5.0 wt%, and preferably 0.1 to 3.0 wt%, in the lubricant composition.

The phosphonium phosphate may be included in an amount of 0.05 to 3.0 wt%, and preferably 0.1 to 1.5 wt%, in the lubricant composition.

The lubricant composition may have an SRV friction coefficient of 0.1 to 0.35 and a traction coefficient of 0.15 to 0.3.

According to the present invention, a lubricant composition includes phosphorothioate, phosphonium phosphate, and an ethylene-alphaolefin liquid random copolymer having a high viscosity index, which are mixed together, thereby improving friction characteristics and thermal and oxidation stability, and is capable of reducing the mechanical wear of hydraulic equipment and energy consumption when applied to hydraulic equipment, thereby maximizing energy-saving effects.

Also, according to the present invention, the lubricant composition has low changes in the physical properties of hydraulic oil, thus decreasing evaporation loss, and can endure 1000 min or more, and preferably 1200 min or more, in an RBOT

oxidation stability test (ASTM D2271), thereby enabling the long-term use thereof as hydraulic oil.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Hereinafter, a detailed description will be given of the present invention.

The present invention relates to a lubricant composition, which has superior oxidation stability and friction characteristics and is thus suitable for use in hydraulic oil. Hence, the lubricant composition of the present invention includes a base oil, a liquid olefin copolymer, a phosphorothioate compound, and phosphonium phosphate.

Here, the base oil varies from the aspects of viscosity, heat resistance, oxidation stability and the like depending on the manufacturing method or refining method, but is generally classified into mineral oil and synthetic oil. The API (American Petroleum Institute) classifies base oil into five types, namely Group I, II, III, IV and V. These types, based on API ranges, are defined in API Publication 1509, 15th Edition, Appendix E, April 2002, and are shown in Table 1 below.

[Table 1]

	Saturated hydrocarbon (%)	Sulfur (%)	Viscosity index
Group I	< 90	> 0.03	80 ≤ VI < 120
Group II	≥ 90	≤ 0.03	80 ≤ VI < 120
Group III	≥ 90	≤ 0.03	VI ≥ 120
Group IV	PAO (Poly Alpha Olefin)		
Group V	Ester & Others		

In the lubricant composition of the present invention, the base oil may be at least one selected from the group consisting

of mineral oil, polyalphaolefin (PAO) and ester, and may be any type among Groups I to V based on the API ranges.

More specifically, mineral oil belongs to Groups I to III based on the API ranges, and mineral oil may include oil resulting from subjecting a lubricant distillate fraction, obtained through atmospheric distillation and/or vacuum distillation of crude oil, to at least one refining process of solvent deasphalting, solvent extraction, hydrogenolysis, solvent dewaxing, catalytic dewaxing, hydrorefining, sulfuric acid cleaning, and white clay treatment; wax isomerized mineral oil; or a gas-to-liquid (GLT) oil obtained via the Fischer-Tropsch process.

The synthetic oil belongs to Group IV or V based on the API ranges, and polyalphaolefin belonging to Group IV may be obtained through oligomerization of a higher alphaolefin using an acid catalyst, as disclosed in U.S. Patent No. 3,780,128, U.S. Patent No. 4,032,591, Japanese Patent Application Publication No. Hei. 1-163136, and the like, but the present invention is not limited thereto.

Examples of the synthetic oil belonging to Group V include alkyl benzenes, alkyl naphthalenes, isobutene oligomers or hydrides thereof, paraffins, polyoxy alkylene glycol, dialkyl diphenyl ether, polyphenyl ether, ester, and the like.

Here, the alkyl benzenes and alkyl naphthalenes are usually dialkylbenzene or dialkylnaphthalene having an alkyl chain length of 6 to 14 carbon atoms, and the alkyl benzenes or alkyl naphthalenes are prepared through Friedel-Crafts alkylation of benzene or naphthalene with olefin. The alkylated olefin used in

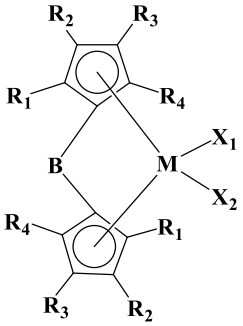
the preparation of alkyl benzenes or alkyl naphthalenes may be linear or branched olefins or combinations thereof.

Also, examples of the ester include, but are not limited to, ditridecyl glutarate, di-2-ethylhexyl adipate, diisodecyl adipate, ditridecyl adipate, di-2-ethylhexyl sebacate, tridecyl pelargonate, di-2-ethylhexyl adipate, di-2-ethylhexyl azelate, trimethylolpropane caprylate, trimethylolpropane pelargonate, trimethylolpropane triheptanoate, pentaerythritol 2-ethylhexanoate, pentaerythritol pelargonate, pentaerythritol tetraheptanoate, and the like.

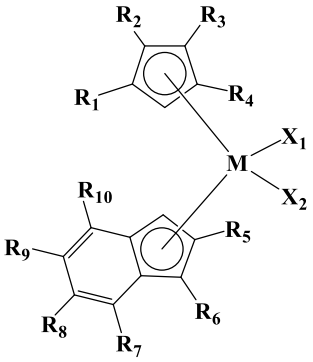
In the lubricant composition of the present invention, the liquid olefin copolymer is prepared by copolymerizing ethylene and alphaolefin monomers in the presence of a single-site catalyst system in order to uniformly distribute alphaolefin units in the copolymer chain. Preferably, the liquid olefin copolymer is prepared by reacting ethylene and alphaolefin monomers in the presence of a single-site catalyst system including a crosslinked metallocene compound, an organometallic compound, and an ionic compound for forming an ion pair through reaction with the crosslinked metallocene compound.

Here, the metallocene compound included in the single-site catalyst system may be at least one selected from the group consisting of Chemical Formulas 1 to 6 below.

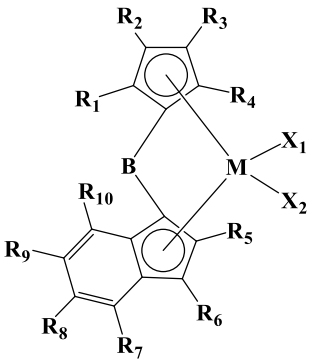
[Chemical Formula 1]



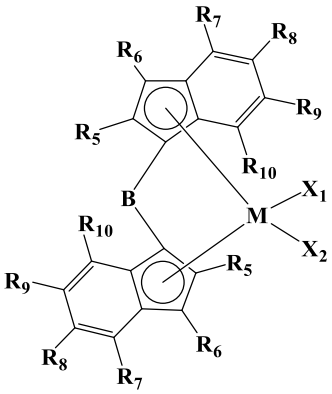
[Chemical Formula 2]



[Chemical Formula 3]



[Chemical Formula 4]



In Chemical Formulas 1 to 4,

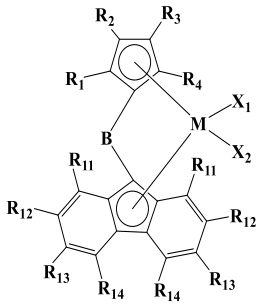
M is a transition metal selected from the group consisting of titanium, zirconium, and hafnium,

B is absent or is a linking group including a C1-C20 alkylene group, a C6-C20 arylene group, C1-C20 dialkyl silicon, C1-C20 dialkyl germanium, a C1-C20 alkylphosphine group or a C1-C20 alkylamine group,

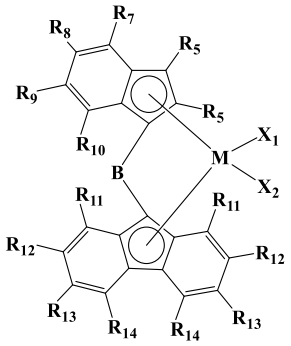
X_1 and X_2, which are the same as or different from each other, are each independently a halogen atom, a C1-C20 alkyl group, a C2-C20 alkenyl group, a C2-C20 alkynyl group, a C6-C20 aryl group, a C7-C40 alkylaryl group, a C7-C40 arylalkyl group, a C1-C20 alkylamido group, a C6-C20 arylamido group, a C1-C20 alkylidene group or a C1-C20 alkoxy group, and

R_1 to R_{10}, which are the same as or different from each other, are each independently hydrogen, a C1-C20 alkyl group, a C2-C20 alkenyl group, a C6-C20 aryl group, a C7-C20 alkylaryl group, a C7-C20 arylalkyl group, a C5-C60 cycloalkyl group, a C4-C20 heterocyclic group, a C1-C20 alkynyl group, a C6-C20-aryl-containing hetero group or a silyl group.

[Chemical Formula 5]



[Chemical Formula 6]



In Chemical Formulas 5 and 6,

M is a transition metal selected from the group consisting of titanium, zirconium, and hafnium,

B is absent or is a linking group including a C1-C20 alkylene group, a C6-C20 arylene group, a C1-C20 dialkyl silicon, a C1-C20 dialkyl germanium, a C1-C20 alkylphosphine group or a C1-C20 alkylamine group,

X_1 and X_2, which are the same as or different from each other, are each independently a halogen atom, a C1-C20 alkyl group, a C2-C20 alkenyl group, a C2-C20 alkynyl group, a C6-C20 aryl group, a C7-C40 alkylaryl group, a C7-C40 arylalkyl group, a C1-C20 alkylamido group, a C6-C20 arylamido group, a C1-C20 alkylidene group or a C1-C20 alkoxy group, and

R_1 to R_{10}, which are the same as or different from each other, are each independently hydrogen, a C1-C20 alkyl group, a C2-C20 alkenyl group, a C6-C20 aryl group, a C7-C20 alkylaryl group, a C7-C20 arylalkyl group, a C5-C60 cycloalkyl group, a C4-C20 heterocyclic group, a C1-C20 alkynyl group, a C6-C20-aryl-containing hetero group or a silyl group.

Furthermore, all of R_{11}, R_{13} and R_{14} are hydrogen, and each of R_{12} radicals, which are the same as or different from each other,

may independently be hydrogen, a C1-C20 alkyl group, a C2-C20 alkenyl group, a C6-C20 aryl group, a C7-C20 alkylaryl group, a C7-C20 arylalkyl group, a C5-C60 cycloalkyl group, a C4-C20 heterocyclic group, a C1-C20 alkynyl group, a C6-C20-aryl-containing hetero group or a silyl group.

Also, the metallocene compound of Chemical Formulas 2 to 6 may include a compound substituted through a hydroaddition reaction, and a preferred example thereof includes dimethylsilyl bis(tetrahydroindenyl) zirconium dichloride.

The organometallic compound included in the single-site catalyst system may be at least one selected from the group consisting of an organoaluminum compound, an organomagnesium compound, an organozinc compound and an organolithium compound, and is preferably an organoaluminum compound. The organoaluminum compound may be at least one selected from the group consisting of, for example, trimethylaluminum, triethylaluminum, triisobutylaluminum, tripropylaluminum, tributylaluminum, dimethylchloroaluminum, dimethylisobutylaluminum, dimethylethylaluminum, diethylchloroaluminum, triisopropylaluminum, triisobutylaluminum, tricyclopentylaluminum, tripentylaluminum, triisopentylaluminum, ethyldimethylaluminum, methyldiethylaluminum, triphenylaluminum, methylaluminoxane, ethylaluminoxane, isobutylaluminoxane and butylaluminoxane, and is preferably triisobutylaluminum.

The ionic compound included in the single-site catalyst system may be at least one selected from the group consisting of organoboron compounds such as dimethylanilinium tetrakis(perfluorophenyl)borate, triphenylcarbenium

tetrakis(perfluorophenyl)borate, and the like.

The component ratio of the single-site catalyst system may be determined in consideration of catalytic activity, and the molar ratio of metallocene catalyst : ionic compound : organometallic compound is preferably adjusted in the range of 1 : 1 : 5 to 1 : 10 : 1000 in order to ensure desired catalytic activity.

Furthermore, the components of the single-site catalyst system may be added at the same time or in any sequence to an appropriate solvent and may thus function as an active catalyst system. Here, the solvent may include, but is not limited to, a hydrocarbon solvent such as pentane, hexane, heptane, etc., or an aromatic solvent such as benzene, toluene, xylene, etc., and any solvent usable in the preparation may be used.

Also, the alphaolefin monomer used in the preparation of the liquid olefin copolymer includes a C2-C20 aliphatic olefin, and may specifically be at least one selected from the group consisting of ethylene, propylene, 1-butene, 1-pentene, 3-methyl-1-butene, 1-hexene, 4-methyl-1-pentene, 3-methyl-1-pentene, 1-heptene, 1-octene, 1-decene, 1-dodecene and 1-tetradecene, and may include isomeric forms, but the present invention is not limited thereto. In the copolymerization, the monomer content is 1 to 95 mol%, preferably 5 to 90 mol%.

The liquid olefin copolymer required in the present invention has a coefficient of thermal expansion of 3.0 to 4.0 and a bromine number of 0.1 or less.

The liquid olefin copolymer may be included in an amount of 0.5 to 30 wt%, and preferably 0.5 to 25 wt%, based on 100 wt% of

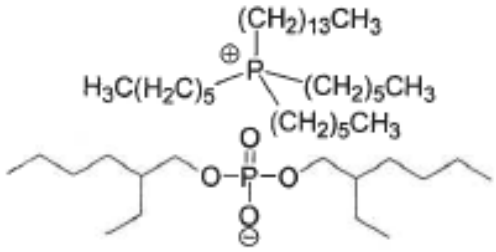
the lubricant composition. If the amount of the liquid olefin copolymer is less than 0.5 wt% based on 100 wt% of the lubricant composition, stability may deteriorate. On the other hand, if the amount thereof exceeds 30 wt%, application of the resulting composition to hydraulic oil becomes difficult, which is undesirable.

The phosphorothioate compound, serving as a friction-reducing agent, may be at least one selected from the group consisting of monophosphorothioate, diphosphorothioate, triphosphorothioate, methylphosphorothioate, ethylphosphorothioate and sulfonylphosphorothioate. When the phosphorothioate compound is included in the lubricant composition, it may exhibit synergistic effects with an existing wear-resistant agent and friction reduction effects, and additionally, energy-saving effects may be achieved through friction reduction.

The phosphorothioate compound may be included in an amount of 0.1 to 5.0 wt%, and preferably 0.1 to 3.0 wt%, based on 100 wt% of the lubricant composition. If the amount of the phosphorothioate compound is less than 0.1 wt% based on 100 wt% of the lubricant composition, the friction reduction effect is insignificant. On the other hand, if the amount thereof exceeds 5.0 wt%, the additional reduction effect is insignificant despite the excessive addition thereof, which is undesirable.

The phosphonium phosphate is a material having the structure of Chemical Formula 7 below, and is used as a friction/wear-reducing agent. In particular, when it is used together with the phosphorothioate compound, the effects thereof may be maximized.

[Chemical Formula 7]



The phosphonium phosphate exists in the form of an ionic liquid having both a phosphonium anion and a phosphate cation, and, among various phosphonium compounds, exhibits a characteristic friction/wear reduction effect.

Also, the phosphonium phosphate may be included in an amount of 0.05 to 3.0 wt%, and preferably 0.1 to 1.5 wt%, based on 100 wt% of the lubricant composition. If the amount of the phosphonium phosphate is less than 0.05 wt% based on 100 wt% of the lubricant composition, the friction/wear reduction effect may be insignificant. On the other hand, if the amount thereof exceeds 3.0 wt%, there is no synergistic effect thereof with the phosphorothioate compound, and wear may increase, which is undesirable.

The lubricant composition of the present invention may further include an additive selected from the group consisting of an antioxidant, a metal cleaner, an anticorrosive agent, a foam inhibitor, a pour-point depressant, a viscosity modifier, a wear-resistant agent and combinations thereof.

The antioxidant may be included in an amount of 0.01 to 5.0 wt% based on 100 wt% of the lubricant composition, and is preferably used in the form of a mixture of a phenolic antioxidant and an aminic antioxidant, more preferably a mixture

of 0.01 to 3.0 wt% of the phenolic antioxidant and 0.01 to 3.0 wt% of the aminic antioxidant.

The phenolic antioxidant may be any one selected from the group consisting of 2,6-dibutylphenol, hindered bisphenol, high-molecular-weight hindered phenol, and hindered phenol with thioether.

The aminic antioxidant may be any one selected from the group consisting of diphenylamine, alkylated diphenylamine and naphthylamine, and preferably, the alkylated diphenylamine is dioctyldiphenylamine, octylated diphenylamine, or butylated diphenylamine.

The metal cleaner may be at least one selected from the group consisting of metallic phenate, metallic sulfonate, and metallic salicylate, and preferably, the metal cleaner is included in an amount of 0.1 to 10.0 wt% based on 100 wt% of the lubricant composition.

The anticorrosive agent may be a benzotriazole derivative, and is preferably any one selected from the group consisting of benzotriazole, 2-methylbenzotriazole, 2-phenylbenzotriazole, 2-ethylbenzotriazole and 2-propylbenzotriazole. The anticorrosive agent may be included in an amount of 0 to 4.0 wt% based on 100 wt% of the lubricant composition.

The foam inhibitor may be polyoxyalkylene polyol, and preferably, the foam inhibitor is included in an amount of 0 to 4.0 wt% based on 100 wt% of the lubricant composition.

The pour-point depressant may be poly(methacrylate), and preferably, the pour-point depressant is included in an amount of 0.01 to 5.0 wt% based on 100 wt% of the lubricant composition.

The viscosity modifier may be polyisobutylene or polymethacrylate, and preferably, the viscosity modifier is included in an amount of 0 to 15 wt% based on 100 wt% of the lubricant composition.

The wear-resistant agent may be at least one selected from the group consisting of organic borates, organic phosphites, organic sulfur-containing compounds, zinc dialkyl dithiophosphate, zinc diaryl dithiophosphate and phosphosulfurized hydrocarbon, and preferably, the wear-resistant agent is included in an amount of 0.01 to 3.0 wt%.

The lubricant composition of the present invention has an SRV friction coefficient of 0.1 to 0.35. Moreover, the lubricant composition has a traction coefficient of 0.15 to 0.3.

A better understanding of the present invention through the following examples. However, the present invention is not limited to these examples, but may be embodied in other forms. These examples are provided to thoroughly explain the invention and to sufficiently transfer the spirit of the present invention to those skilled in the art.

1. Preparation of additive composition

An additive composition for use in the lubricant composition of the present invention was prepared as shown in Table 2 below.

[Table 2]

Additive composition		Composition A	Composition B
Antioxidant	2,6-dibutylphenol	1	1.5
	Diphenylamine	0.8	1
Metal cleaner	Metallic phenate	0.2	0.6
Anticorrosive agent	Benzotriazole	0.3	1.0

Foam inhibitor	Polyoxyalkylene polyol	0.01	0.02
Pour-point depressant	Polymethacrylate	0.2	0.5
Viscosity modifier	Polyisobutylene	-	1.0
Wear-resistant agent	Zinc dialkyl dithiophosphate	0.2	1.1

2. Preparation of liquid olefin copolymer

A liquid olefin copolymer was prepared using an oligomerization method through a catalytic reaction process. Depending on the reaction time and conditions, which follow, liquid olefin copolymers having different molecular weights were prepared, and the properties thereof are shown in Table 3 below.

The reaction time and conditions were increased by 4 hr each from 20 hr. Here, the amounts of hydrogen and comonomer C3, which were added thereto, were increased by 10% each, and polymerization was performed under individual conditions, and the resulting polymers were classified depending on the molecular weight thereof.

[Table 3]

Alphaolefin copolymer	Main properties		
	Evaporation Loss (%)	Thickening Power (10 wt% in 150N)	CoE of Thermal Expansion
Copolymer I	1.28	6	3.00 to 3.20
Copolymer II	0.54	7	3.20 to 3.40
Copolymer III	0.10	8	3.40 to 3.50
Copolymer IV	0.001	10	3.50 to 3.60
Copolymer V	0.0001	12	3.60 to 3.70
Copolymer VI	0.00001	14	3.70 to 3.80

3. Preparation of lubricant composition for hydraulic oil

A lubricant composition was prepared by mixing a base oil, the liquid olefin copolymer, a phosphorothioate compound,

phosphonium phosphate and the additive prepared above, as shown in Tables 4 and 5 below. Here, the base oil was polyalphaolefin (PAO 4 cSt, available from Chevron Philips) having kinematic viscosity of 4 cSt at 100˚C, and the phosphorothioate compound was monophosphorothioate.

Preparation Examples 1 to 67 and Comparative Examples 1 to 14. Lubricant composition for hydraulic oil including additive A

[Table 4]

Composition	Base oil	Alphaolefin copolymer	Phosphorothioate Compound	Phosphonium phosphate	Additive A
			Monophosphorothioate		
Preparation Example 1	97.135	Copolymer I 0.05	0.1	0.005	2.71
Preparation Example 2	96.735	Copolymer I 0.05	0.5	0.005	2.71
Preparation Example 3	95.74	Copolymer I 0.05	1.0	0.5	2.71
Preparation Example 4	93.74	Copolymer I 0.05	3.0	0.5	2.71
Preparation Example 5	88.74	Copolymer I 0.05	5.0	3.5	2.71
Preparation Example 6	96.64	Copolymer I 0.5	0.1	0.05	2.71
Preparation Example 7	95.74	Copolymer I 0.5	1.0	0.05	2.71
Preparation Example 8	93.69	Copolymer I 0.5	3.0	0.1	2.71
Preparation Example 9	92.09	Copolymer I 5	0.1	0.1	2.71
Preparation Example 10	91.69	Copolymer I 5	0.5	0.1	2.71
Preparation Example 11	89.19	Copolymer I 5	3.0	0.1	2.71
Preparation Example 12	38.29	Copolymer I 5	5.0	4.0	2.71
Preparation Example 13	86.89	Copolymer I 10	0.1	0.3	2.71
Preparation Example 14	86.49	Copolymer I 10	0.5	0.3	2.71
Preparation Example 15	85.99	Copolymer I 10	1.0	0.3	2.71
Preparation Example 16	78.79	Copolymer I 10	5.0	3.5	2.71
Preparation Example 17	76.69	Copolymer I 20	0.1	0.5	2.71
Preparation Example 18	76.29	Copolymer I 20	0.5	0.5	2.71
Preparation	70.29	Copolymer I	5.0	2.0	2.71

Example 19		20			
Preparation Example 20	66.29	Copolymer I 30	0.5	0.5	2.71
Preparation Example 21	60.79	Copolymer I 30	5.0	1.5	2.71
Preparation Example 22	60.79	Copolymer I 35	0.5	1.0	2.71
Preparation Example 23	61.19	Copolymer I 35	1.0	0.1	2.71
Preparation Example 24	56.79	Copolymer I 35	3.0	2.5	2.71
Preparation Example 25	53.79	Copolymer I 35	5.0	3.5	2.71
Preparation Example 26	47.29	Copolymer I 35	10.0	5.0	2.71
Preparation Example 27	47.235	Copolymer I 50	0.05	0.005	2.71
Preparation Example 28	46.285	Copolymer I 50	1.0	0.005	2.71
Preparation Example 29	38.79	Copolymer I 50	5.0	3.5	2.71
Preparation Example 30	96.64	Copolymer II 0.05	0.1	0.5	2.71
Preparation Example 31	95.24	Copolymer II 0.05	0.5	1.5	2.71
Preparation Example 32	94.24	Copolymer II 0.05	1.0	2.0	2.71
Preparation Example 33	92.24	Copolymer II 0.05	3.0	2.0	2.71
Preparation Example 34	90.24	Copolymer II 0.05	5.0	2.0	2.71
Preparation Example 35	96.19	Copolymer II 0.5	0.1	0.5	2.71
Preparation Example 36	93.29	Copolymer II 0.5	3.0	0.5	2.71
Preparation Example 37	83.79	Copolymer II 5	5.0	3.5	2.71
Preparation Example 38	78.79	Copolymer II 10	5.0	3.5	2.71
Preparation Example 39	72.285	Copolymer II 20	5.0	0.005	2.71
Preparation Example 40	97.139	Copolymer III 0.05	0.1	0.001	2.71
Preparation Example 41	95.24	Copolymer III 0.05	0.5	1.5	2.71
Preparation Example 42	94.24	Copolymer III 0.05	1.0	2.0	2.71
Preparation Example 43	92.24	Copolymer III 0.05	3.0	2.0	2.71
Preparation Example 44	91.69	Copolymer III 5	0.1	0.5	2.71
Preparation Example 45	91.29	Copolymer III 5	0.5	0.5	2.71
Preparation Example 46	76.29	Copolymer III 20	0.5	0.5	2.71
Preparation Example 47	75.29	Copolymer III 20	1.0	1.0	2.71

Preparation Example 48	91.19	Copolymer IV 5	0.1	1.0	2.71
Preparation Example 49	88.29	Copolymer IV 5	3.0	1.0	2.71
Preparation Example 50	76.69	Copolymer IV 20	0.5	0.1	2.71
Preparation Example 51	73.29	Copolymer IV 20	3.0	1.0	2.71
Preparation Example 52	92.09	Copolymer V 5	0.1	0.1	2.71
Preparation Example 53	91.69	Copolymer V 5	0.5	0.1	2.71
Preparation Example 54	78.79	Copolymer V 10	5.0	3.5	2.71
Preparation Example 55	77.14	Copolymer V 20	0.1	0.05	2.71
Preparation Example 56	76.69	Copolymer V 20	0.5	0.1	2.71
Preparation Example 57	68.79	Copolymer V 20	5.0	3.5	2.71
Preparation Example 58	45.79	Copolymer V 50	1.0	0.5	2.71
Preparation Example 59	43.79	Copolymer V 50	3.0	0.5	2.71
Preparation Example 60	42.289	Copolymer V 50	5.0	0.001	2.71
Preparation Example 61	93.64	Copolymer VI 0.05	0.1	3.5	2.71
Preparation Example 62	93.24	Copolymer VI 0.05	0.5	3.5	2.71
Preparation Example 63	92.74	Copolymer VI 0.05	1.0	3.5	2.71
Preparation Example 64	92.14	Copolymer VI 5	0.1	0.05	2.71
Preparation Example 65	91.69	Copolymer VI 5	0.5	0.1	2.71
Preparation Example 66	77.09	Copolymer VI 20	0.1	0.1	2.71
Preparation Example 67	76.29	Copolymer VI 20	0.5	0.5	2.71
Comparative Example 1	97.24	Copolymer I 0.05	-	-	2.71
Comparative Example 2	93.74	Copolymer II 0.05	-	3.5	2.71
Comparative Example 3	87.29	Copolymer II 10	-	-	2.71
Comparative Example 4	73.29	Copolymer II 20	-	4.0	2.71
Comparative Example 5	67.29	Copolymer II 30	-	-	2.71
Comparative Example 6	87.29	Copolymer III 5	5.0	-	2.71
Comparative Example 7	82.29	Copolymer III 10	5.0	-	2.71
Comparative Example 8	72.29	Copolymer III 20	5.0	-	2.71
Comparative Example 9	88.79	Copolymer IV 5	-	3.5	2.71

Comparative Example 10	87.29	Copolymer IV 5	5.0	-	2.71
Comparative Example 11	82.29	Copolymer IV 5	10.0	-	2.71
Comparative Example 12	63.79	Copolymer V 30	-	3.5	2.71
Comparative Example 13	58.79	Copolymer V 35	-	3.5	2.71
Comparative Example 14	93.74	Copolymer VI 0.05	-	3.5	2.71

Preparation Examples 68 to 116 and Comparative Examples 15 to 53. Lubricant composition for hydraulic oil including additive B

[Table 5]

Composition	Base oil	Alphaolefin copolymer	Phosphorothioate compound	Phosphonium phosphate	Additive B
			Monophosphorothioate		
Preparation Example 68	92.58	Copolymer I 0.5	0.1	0.1	6.72
Preparation Example 69	92.18	Copolymer I 0.5	0.5	0.1	6.72
Preparation Example 70	91.68	Copolymer I 0.5	1.0	0.1	6.72
Preparation Example 71	88.08	Copolymer I 5	0.1	0.1	6.72
Preparation Example 72	87.28	Copolymer I 5	0.5	0.5	6.72
Preparation Example 73	86.78	Copolymer I 5	1.0	0.5	6.72
Preparation Example 74	82.68	Copolymer I 10	0.1	0.5	6.72
Preparation Example 75	81.78	Copolymer I 10	1.0	0.5	6.72
Preparation Example 76	79.78	Copolymer I 10	3.0	0.5	6.72
Preparation Example 77	73.08	Copolymer I 20	0.1	0.1	6.72
Preparation Example 78	72.28	Copolymer I 20	0.5	0.5	6.72
Preparation Example 79	71.78	Copolymer I 20	1.0	0.5	6.72
Preparation Example 80	92.18	Copolymer II 0.5	0.1	0.5	6.72
Preparation Example 81	88.78	Copolymer II 0.5	3.0	1.0	6.72
Preparation Example 82	54.78	Copolymer II 30	5.0	3.5	6.72
Preparation Example 83	93.08	Copolymer III 0.05	0.1	0.05	6.72
Preparation	91.73	Copolymer III	0.5	1.0	6.72

Example 84		0.05			
Preparation Example 85	91.23	Copolymer III 0.05	1.0	1.0	6.72
Preparation Example 86	89.23	Copolymer III 0.05	3.0	1.0	6.72
Preparation Example 87	86.68	Copolymer III 5	0.1	1.5	6.72
Preparation Example 88	86.28	Copolymer III 5	0.5	1.5	6.72
Preparation Example 89	79.78	Copolymer III 5	5.0	3.5	6.72
Preparation Example 90	74.78	Copolymer III 10	5.0	3.5	6.72
Preparation Example 91	71.28	Copolymer III 20	0.5	1.5	6.72
Preparation Example 92	70.78	Copolymer III 20	1.0	1.5	6.72
Preparation Example 93	34.78	Copolymer III 50	5.0	3.5	6.72
Preparation Example 94	89.63	Copolymer IV 0.05	0.1	3.5	6.72
Preparation Example 95	89.23	Copolymer IV 0.05	0.5	3.5	6.72
Preparation Example 96	86.68	Copolymer IV 5	0.1	1.5	6.72
Preparation Example 97	83.28	Copolymer IV 5	3.0	2.0	6.72
Preparation Example 98	79.78	Copolymer IV 5	5.0	3.5	6.72
Preparation Example 99	68.28	Copolymer IV 20	3.0	2.0	6.72
Preparation Example 100	72.68	Copolymer IV 20	0.5	0.1	6.72
Preparation Example 101	42.68	Copolymer IV 50	0.1	0.5	6.72
Preparation Example 102	88.13	Copolymer V 5	0.1	0.05	6.72
Preparation Example 103	87.73	Copolymer V 5	0.5	0.05	6.72
Preparation Example 104	79.78	Copolymer V 5	5.0	3.5	6.72
Preparation Example 105	74.78	Copolymer V 10	5.0	3.5	6.72
Preparation Example 106	73.08	Copolymer V 20	0.1	0.1	6.72
Preparation Example 107	71.78	Copolymer V 20	1.0	0.5	6.72
Preparation Example 108	86.73	Copolymer VI 0.05	3.0	3.5	6.72
Preparation Example 109	84.73	Copolymer VI 0.05	5.0	3.5	6.72
Preparation Example 110	87.68	Copolymer VI 5	0.5	0.1	6.72
Preparation Example 111	84.28	Copolymer VI 5	3.0	1.0	6.72
Preparation Example 112	68.28	Copolymer VI 20	3.0	2.0	6.72

Preparation Example 113	61.28	Copolymer VI 30	1.0	1.0	6.72
Preparation Example 114	39.73	Copolymer VI 50	0.05	3.5	6.72
Preparation Example 115	42.28	Copolymer VI 50	0.5	0.5	6.72
Preparation Example 116	38.279	Copolymer VI 50	5.0	0.001	6.72
Comparative Example 16	68.28	Copolymer III 20	5.0	-	6.72
Comparative Example 17	58.28	Copolymer III 30	5.0	-	6.72
Comparative Example 18	58.18	Copolymer III 35	0.1	-	6.72
Comparative Example 19	57.78	Copolymer III 35	0.5	-	6.72
Comparative Example 20	57.28	Copolymer III 35	1.0	-	6.72
Comparative Example 21	55.28	Copolymer III 35	3.0	-	6.72
Comparative Example 22	43.18	Copolymer III 50	0.1	-	6.72
Comparative Example 23	42.78	Copolymer III 50	0.5	-	6.72
Comparative Example 24	42.28	Copolymer III 50	1.0	-	6.72
Comparative Example 25	89.73	Copolymer IV 0.05	-	3.5	6.72
Comparative Example 26	92.23	Copolymer IV 0.05	1.0	-	6.72
Comparative Example 27	90.23	Copolymer IV 0.05	3.0	-	6.72
Comparative Example 28	88.23	Copolymer IV 0.05	5.0	-	6.72
Comparative Example 29	87.78	Copolymer IV 5	-	0.5	6.72
Comparative Example 30	78.28	Copolymer IV 5	10.0	-	6.72
Comparative Example 31	83.28	Copolymer IV 10	-	-	6.72
Comparative Example 32	78.28	Copolymer IV 10	5.0	-	6.72
Comparative Example 33	39.78	Copolymer IV 50	-	3.5	6.72
Comparative Example 34	42.78	Copolymer IV 50	0.5	-	6.72
Comparative Example 35	42.28	Copolymer IV 50	1.0	-	6.72
Comparative Example 36	40.28	Copolymer IV 50	3.0	-	6.72
Comparative Example 37	38.28	Copolymer IV 50	5.0	-	6.72
Comparative Example 38	93.23	Copolymer V 0.05	-	-	6.72
Comparative Example 39	93.13	Copolymer V 0.05	0.1	-	6.72
Comparative Example 40	92.73	Copolymer V 0.05	0.5	-	6.72

Comparative Example 41	92.23	Copolymer V 0.05	1.0	-	6.72
Comparative Example 42	90.23	Copolymer V 0.05	3.0	-	6.72
Comparative Example 43	88.23	Copolymer V 0.05	5.0	-	6.72
Comparative Example 44	84.78	Copolymer V 5	-	3.5	6.72
Comparative Example 45	69.78	Copolymer V 20	-	3.5	6.72
Comparative Example 46	63.28	Copolymer V 30	-	-	6.72
Comparative Example 47	88.28	Copolymer VI 5	-	-	6.72
Comparative Example 48	78.28	Copolymer VI 10	5.0	-	6.72
Comparative Example 49	58.18	Copolymer VI 35	0.1	-	6.72
Comparative Example 50	57.78	Copolymer VI 35	0.5	-	6.72
Comparative Example 51	57.28	Copolymer VI 35	1.0	-	6.72
Comparative Example 52	55.28	Copolymer VI 35	3.0	-	6.72
Comparative Example 53	53.28	Copolymer VI 35	5.0	-	6.72

4. Evaluation of properties

The properties of the lubricant compositions prepared in Preparation Examples and Comparative Examples were measured as follows. The results are shown in Tables 6 and 7 below.

Friction Coefficient

In the ball-on-disc mode, friction performance was evaluated by sequentially elevating the temperature in increments of 10˚C from 40 to 120˚C at 50 Hz and comparing the average friction coefficients at individual temperatures. Here, the friction coefficient value decreases with an increase in effectiveness.

Traction Coefficient

The traction coefficient was measured using an MTM instrument made by PCS Instruments. Here, the measurement conditions were fixed at 50N and SRR 50%, and friction and

traction were observed depending on changes in temperature. The temperature was varied from 40 to 120˚C, and the average values were compared.

Wear resistance

Four steel balls were subjected to friction with the lubricant composition for 60 min under conditions of 20 kg load, 1200 rpm, and 54˚C, the sizes of wear scars were compared, and evaluation was carried out in accordance with ASTM D4172. Here, the wear scar (average wear scar diameter, ㎛) value decreases with an increase in effectiveness.

Oxidation stability

Oxidation stability was measured using an RBOT (Rotational Bomb Oxidation Test) meter in accordance with ASTM D2271.

[Table 6]

	SRV Friction Coefficient	MTM Traction Coefficient	4 Ball Wear (㎛)	Oxidation stability (RBOT, min)
Preparation Example 1	0.701	0.598	496	610
Preparation Example 2	0.732	0.569	477	654
Preparation Example 3	0.734	0.587	432	523
Preparation Example 4	0.735	0.544	501	320
Preparation Example 5	0.712	0.523	665	249
Preparation Example 6	0.288	0.221	142	1580
Preparation Example 7	0.285	0.200	152	1650
Preparation Example 8	0.265	0.236	133	1600
Preparation Example 9	0.264	0.219	121	1480
Preparation	0.267	0.211	110	2000

Example 10				
Preparation Example 11	0.240	0.236	106	2110
Preparation Example 12	0.736	0.569	511	333
Preparation Example 13	0.246	0.222	116	2420
Preparation Example 14	0.239	0.207	123	1840
Preparation Example 15	0.257	0.217	140	1680
Preparation Example 16	0.745	0.564	522	285
Preparation Example 17	0.258	0.213	146	1590
Preparation Example 18	0.259	0.243	147	1510
Preparation Example 19	0.754	0.555	536	278
Preparation Example 20	0.264	0.222	149	1540
Preparation Example 21	0.768	0.561	555	269
Preparation Example 22	0.769	0.532	622	298
Preparation Example 23	0.774	0.512	654	277
Preparation Example 24	0.744	0.533	635	279
Preparation Example 25	0.730	0.612	598	311
Preparation Example 26	0.741	0.633	590	312
Preparation Example 27	0.745	0.654	455	322
Preparation Example 28	0.756	0.687	478	388
Preparation Example 29	0.725	0.698	497	368
Preparation Example 30	0.76	0.685	518	384
Preparation Example 31	0.769	0.696	523	368
Preparation Example 32	0.778	0.641	537	321
Preparation Example 33	0.792	0.621	556	325
Preparation Example 34	0.791	0.632	631	387
Preparation Example 35	0.269	0.219	106	1650
Preparation Example 36	0.279	0.245	108	1440
Preparation Example 37	0.793	0.612	623	345
Preparation Example 38	0.797	0.587	647	388

Preparation Example 39	0.755	0.555	612	321
Preparation Example 40	0.702	0.665	678	654
Preparation Example 41	0.682	0.610	598	523
Preparation Example 42	0.713	0.587	599	320
Preparation Example 43	0.715	0.588	587	333
Preparation Example 44	0.257	0.219	185	1490
Preparation Example 45	0.259	0.236	168	2110
Preparation Example 46	0.278	0.217	135	1580
Preparation Example 47	0.279	0.213	108	1490
Preparation Example 48	0.284	0.222	154	1480
Preparation Example 49	0.231	0.247	163	2456
Preparation Example 50	0.247	0.278	169	2122
Preparation Example 51	0.264	0.248	185	2020
Preparation Example 52	0.255	0.256	154	1854
Preparation Example 53	0.254	0.219	165	1681
Preparation Example 54	0.678	0.512	655	279
Preparation Example 55	0.269	0.213	116	1610
Preparation Example 56	0.278	0.243	123	1440
Preparation Example 57	0.744	0.587	478	347
Preparation Example 58	0.623	0.588	676	348
Preparation Example 59	0.634	0.521	618	384
Preparation Example 60	0.709	0.569	589	368
Preparation Example 61	0.745	0.587	599	348
Preparation Example 62	0.725	0.555	568	384
Preparation Example 63	0.756	0.548	534	368
Preparation Example 64	0.284	0.236	147	2410
Preparation Example 65	0.291	0.245	149	1810
Preparation Example 66	0.264	0.247	108	1560
Preparation Example 67	0.284	0.256	110	1540

Comparative Example 1	0.721	0.589	454	510
Comparative Example 2	0.759	0.674	505	348
Comparative Example 3	0.775	0.555	436	258
Comparative Example 4	0.811	0.588	698	412
Comparative Example 5	0.766	0.672	664	510
Comparative Example 6	0.716	0.521	499	285
Comparative Example 7	0.717	0.569	580	278
Comparative Example 8	0.726	0.587	590	269
Comparative Example 9	0.725	0.611	510	465
Comparative Example 10	0.691	0.587	651	419
Comparative Example 11	0.711	0.547	587	322
Comparative Example 12	0.68	0.563	636	249
Comparative Example 13	0.7	0.587	597	321
Comparative Example 14	0.716	0.539	498	396

[Table 7]

	SRV Friction Coefficient	MTM Traction Coefficient	4 Ball Wear (μm)	Oxidation stability (RBOT, min)
Preparation Example 68	0.291	0.219	121	1660
Preparation Example 69	0.268	0.209	122	1640
Preparation Example 70	0.269	0.236	132	1490
Preparation Example 71	0.264	0.221	159	2020
Preparation Example 72	0.247	0.200	164	2110
Preparation Example 73	0.231	0.236	176	2030
Preparation Example 74	0.255	0.219	157	1650
Preparation Example 75	0.254	0.211	161	1580
Preparation Example 76	0.251	0.236	196	1490
Preparation Example 77	0.260	0.222	186	1910

Preparation Example 78	0.269	0.207	193	1480
Preparation Example 79	0.278	0.222	190	1650
Preparation Example 80	0.279	0.219	176	1680
Preparation Example 81	0.284	0.245	189	2020
Preparation Example 82	0.755	0.587	458	249
Preparation Example 83	0.798	0.639	655	346
Preparation Example 84	0.768	0.589	636	347
Preparation Example 85	0.736	0.598	664	258
Preparation Example 86	0.747	0.569	673	269
Preparation Example 87	0.231	0.219	152	1790
Preparation Example 88	0.255	0.211	169	1560
Preparation Example 89	0.822	0.587	676	287
Preparation Example 90	0.813	0.544	618	288
Preparation Example 91	0.279	0.236	147	2110
Preparation Example 92	0.278	0.219	146	2020
Preparation Example 93	0.713	0.555	591	412
Preparation Example 94	0.693	0.548	587	322
Preparation Example 95	0.704	0.512	541	368
Preparation Example 96	0.277	0.245	149	2030
Preparation Example 97	0.284	0.209	198	1650
Preparation Example 98	0.715	0.555	612	345
Preparation Example 99	0.269	0.256	110	1910
Preparation Example 100	0.264	0.219	121	1480
Preparation Example 101	0.722	0.589	676	610
Preparation Example 102	0.291	0.236	132	1680
Preparation Example 103	0.268	0.221	158	1480
Preparation Example 104	0.713	0.532	580	365
Preparation Example 105	0.645	0.555	589	285
Preparation Example 106	0.255	0.236	194	1610

Preparation Example 107	0.231	0.211	169	1854
Preparation Example 108	0.758	0.512	578	321
Preparation Example 109	0.759	0.563	579	325
Preparation Example 110	0.251	0.207	154	2080
Preparation Example 111	0.260	0.234	169	2130
Preparation Example 112	0.261	0.226	226	1780
Preparation Example 113	0.275	0.217	169	1790
Preparation Example 114	0.813	0.613	501	415
Preparation Example 115	0.734	0.580	512	369
Preparation Example 116	0.784	0.571	523	358
Comparative Example 16	0.702	0.569	589	299
Comparative Example 17	0.682	0.564	597	388
Comparative Example 18	0.726	0.512	478	347
Comparative Example 19	0.735	0.533	436	321
Comparative Example 20	0.749	0.523	505	247
Comparative Example 21	0.748	0.532	518	258
Comparative Example 22	0.725	0.621	556	401
Comparative Example 23	0.704	0.633	623	369
Comparative Example 24	0.779	0.666	655	358
Comparative Example 25	0.725	0.555	651	269
Comparative Example 26	0.779	0.563	523	388
Comparative Example 27	0.77	0.611	498	396
Comparative Example 28	0.691	0.587	599	348
Comparative Example 29	0.711	0.588	568	384
Comparative Example 30	0.716	0.672	647	346
Comparative Example 31	0.717	0.499	698	347
Comparative Example 32	0.745	0.623	612	299
Comparative Example 33	0.711	0.639	673	519
Comparative Example 34	0.702	0.598	618	654

Comparative Example 35	0.632	0.569	589	523
Comparative Example 36	0.612	0.587	597	320
Comparative Example 37	0.643	0.547	591	333
Comparative Example 38	0.756	0.610	698	412
Comparative Example 39	0.758	0.600	678	415
Comparative Example 40	0.759	0.588	598	369
Comparative Example 41	0.76	0.541	599	358
Comparative Example 42	0.769	0.563	587	347
Comparative Example 43	0.778	0.522	499	321
Comparative Example 44	0.715	0.543	590	399
Comparative Example 45	0.749	0.555	587	321
Comparative Example 46	0.646	0.569	523	278
Comparative Example 47	0.76	0.611	624	387
Comparative Example 48	0.822	0.601	444	412
Comparative Example 49	0.769	0.587	584	345
Comparative Example 50	0.778	0.588	562	346
Comparative Example 51	0.792	0.541	532	347
Comparative Example 52	0.791	0.513	521	258
Comparative Example 53	0.793	0.555	511	269

As is apparent from Tables 6 and 7, the lubricant compositions including the liquid ethylene alphaolefin copolymer, the phosphorothioate compound and the phosphonium phosphate within the amount ranges of the present invention were significantly reduced in wear scar and friction coefficient compared to the lubricant compositions of Comparative Examples, and also exhibited superior oxidation stability. Therefore, it is concluded that the lubricant composition of the present invention is improved from the aspects of friction

characteristics and stability and thus is suitable for use in hydraulic oil.

Although the embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

WHAT IS CLAIMED IS:

1. A lubricant composition, comprising, based on 100% by weight of the lubricant composition:

61.28~96.64% by weight of a base oil;

0.5~30% by weight of a liquid olefin copolymer;

0.1~3.0% by weight of a phosphorothioate compound; and

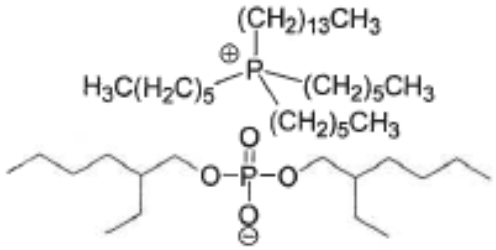
0.05~3.0% by weight of phosphonium phosphate, wherein the lubricant composition has a SRV friction coefficient of 0.1 to 0.35.

2. The lubricant composition of claim 1, wherein the liquid olefin copolymer is prepared by copolymerizing ethylene and alphaolefin using a single-site catalyst system.

3. The lubricant composition of claim 1, wherein the phosphorothioate compound is at least one selected from the group consisting of monophosphorothioate, diphosphorothioate, triphosphorothioate, methylphosphorothioate, ethylphosphorothioate, and sulfonylphosphorothioate.

4. The lubricant composition of claim 1, wherein the phosphonium phosphate has a structure of Chemical Formula 7 below.

[Chemical Formula 7]



5. The lubricant composition of claim 2, wherein the single-site catalyst system includes a metallocene catalyst, an organometallic compound and an ionic compound.

6. The lubricant composition of claim 1, wherein the liquid olefin copolymer has a coefficient of thermal expansion of 3.0 to 4.0.

7. The lubricant composition of claim 1, wherein the liquid olefin copolymer has a bromine number of 0.1 or less.

8. The lubricant composition of claim 1, wherein the base oil is at least one selected from the group consisting of mineral oil, polyalphaolefin (PAO), and ester.

9. The lubricant composition of claim 1, further comprising an additive selected from the group consisting of an antioxidant, a metal cleaner, an anticorrosive agent, a foam inhibitor, a pour-point depressant, a viscosity modifier, a wear-resistant agent, and combinations thereof.

10. The lubricant composition of claim 1, wherein the lubricant composition has a traction coefficient of 0.15 to 0.3.

11. The lubricant composition of claim 1, wherein the lubricant composition endures 1000 min or more in an oxidation stability evaluation (RBOT, ASTM D2271).

12. The lubricant composition of claim 1, wherein the lubricant composition is used as hydraulic oil.