

Specification

Lubricating Oil Composition

Technological Fields of the Invention

The present invention relates to novel lubricating oil compositions. More specifically, it relates to lubricating oil compositions suitably usable as a lubricating oil composition for internal combustion engines, automatic transmissions, shock absorbers, and power steering, and specifically as a lubricating oil composition for internal combustion engines, having excellent low-wear properties and low-friction properties, and also retaining low-friction properties for a long period, which do not deteriorate even in an air atmosphere containing nitrogen oxide gases.

Background of the Invention

Lubricating oils are used in internal combustion engines, drive-type apparatuses such as automatic transmissions, shock absorbers, and power steering, gears, etc., to lubricate their operations. Especially, lubricating oils for internal combustion engines serve functions such as to cool engines, provide a detergent-dispersion action for combustion products, and prevent rust and corrosion, besides lubricating various sliding parts such as valve mechanisms, mainly including piston rings and cylinder liners, bearings for crankshafts and connecting rods, and valve-operating mechanisms, including cams and valve lifters.

Thus versatile performances have been required for lubricating oils for internal combustion engines. Moreover, lubricating oils having a high performance are now required due to the recent tendency to high performances of internal combustion engines such as a lower fuel consumption, higher output, and ability to operate under severe operating conditions. On the other hand, combustion gas generated in

an internal combustion engine partially leaks from the parts between a piston and cylinder into a crankcase, as a blowby gas. Such combustion gas contains nitrogen oxide gases in a relatively high concentration. The nitrogen oxide gases together with oxygen in the blowby gas deteriorate a lubricating oil. Due to the high performances of internal combustion engines in recent years, the concentrations of nitrogen oxide gases that leak into crankcases have tended to increase. Thus to satisfy the above-required performances and to not deteriorate a lubricating oil even in an air atmosphere containing nitrogen oxide gases, various additives such as an antiwear agent, a metal-based detergent, an ashless dispersant, and an anti-oxidant, are added to a lubricating oil.

For fundamental functions of lubricating oils, it is especially important under all conditions to lubricate engines that are operating to prevent engine wear and seizing. Although most of the lubricated parts of engines are in a fluid lubrication state, valve-operating systems, the top and bottom dead spots of pistons, etc., tend to be in a boundary lubrication state. Anti-wear properties in such a boundary lubrication state are generally imparted by the addition of zinc dithiophosphate.

In internal combustion engines, due to a great loss of energy in parts subject to friction where a lubricating oil is involved, as measures to reduce friction loss and fuel consumption, a friction modifier is added to lubricating oils. As the friction modifiers, for example, organic molybdenum compounds, fatty acid esters, alkylamines, etc., are generally used.

Summary of the Invention

Under these circumstances, as a result of the extensive study by the inventors of the present invention, they achieved the present invention, which aims at providing lubricating oil compositions by which, without undergoing the effect of nitrogen oxide gases, the

effect of decreasing engine friction can be retained for a long period. This was based on their finding that although a friction modifier exhibits its addition effect at the beginning of its use, the effect is decreased when it undergoes oxidative deterioration by oxygen contained in air, with a significant decrease especially occurring in the presence of nitrogen oxide gases.

As a result of extensive research by the inventors to develop lubricating oil compositions having these desired properties, they found that a lubricating oil composition attains the above object in which to a lubricating oil a sulfurized oxymolybdenum dithiocarbamate having a certain alkyl group, a zinc dialkyl dithiophosphate having a certain alkyl group, a certain sulfur compound, a certain metal-based detergent, and a boron-containing compound, are added in their respective specified ratios. Based on this finding they accomplished the present invention.

That is, the present invention provides (1) lubricating oil compositions characterized in that they are obtained by adding to a lubricating base oil (A) a sulfurized oxymolybdenum dithiocarbamate having an alkyl group with 8 - 18 carbon atoms, (B) a zinc dialkyl dithiophosphate having a primary alkyl group with 1 - 18 carbon atoms, (C) one or more kinds of sulfur compounds selected from the group consisting of zinc dialkyldithiocarbamates, copper dialkyldithiocarbamates, or nickel dialkyldithiocarbamates, each having an alkyl group with 2 - 18 carbon atoms, tetraalkylthiuram disulfides of which the carbon numbers of the alkyl group are 2 - 18, disulfides having an alkyl group with 2 - 18 carbon atoms, disulfides having an aryl group, an alkyl aryl group, or aryl alkyl group, with 6 - 18 carbon atoms, thiadiazole compounds having a substituent with 3 - 24 carbon atoms and a sulfur atom, sulfurized olefins, sulfurized fish oils, and sulfurized whale oils, (D) one or more kinds of metal-based detergents selected from the group consisting of calcium salicylates, magnesium salicylates, calcium sulfonates, magnesium

sulfonates, and calcium phenates, and (E) a boron-containing compound, are added, and in that based on the total weight of the composition the amount of the sulfurized oxymolybdenum dithiocarbamate-derived molybdenum is 200 - 2,000 ppm (weight ratio), the amount of the zinc dialkyl dithiophosphate-derived phosphorus is 0.02 - 0.15% by weight, the amount of the sulfur compound(s)-derived sulfur is 0.02 - 0.30 % by weight, the content of the metal-based detergent(s) is 1 - 10 % by weight, and the amount of boron-containing compound-derived boron is 0.005 - 0.06 % by weight.

Further, as a preferable embodiment of the present invention, (2) lubricating oil compositions of (1) are exemplified in which (A) the carbon numbers of the alkyl group of the sulfurized oxymolybdenum dithiocarbamate are 8 - 13, (B) the carbon numbers of the primary alkyl group of the zinc dialkyl dithiophosphate are 3 - 12, and (E) the boron-containing compound is a boron-containing succinimide, and lubricating oil compositions (3) of (1) or (2) are exemplified in which based on the total weight of the composition, the amount of the sulfurized oxymolybdenum dithiocarbamate-derived molybdenum is 300 - 800 ppm (weight ratio), the amount of the zinc dialkyl dithiophosphate-derived phosphorus is 0.04 - 0.12% by weight, and the amount of the boron-containing compound-derived boron is 0.01 - 0.04% by weight.

Detailed Explanation of the Embodiment

Below, the present invention is described in detail.

The lubricating base oils used in the lubricating oil compositions of the present invention are not specifically limited, and the base oils conventionally and usually used in lubricating oils, for example, mineral oils and synthetic oils, can be used.

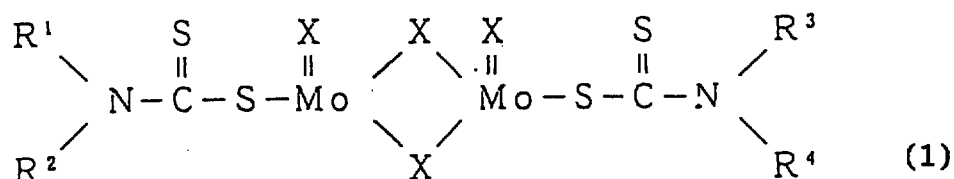
As the mineral oils, raffinates obtained by solvent-refining raw materials of lubricating oils with an aromatic extraction solvent such as phenol or furfural, hydrogenated oils obtained by a hydrogenation with a hydrogenation catalyst such as cobalt or

molybdenum, all supported on silica-alumina as a carrier, mineral oils such as lubricating oil distillates obtained by the isomerization of a wax, as, for example, 60 Neutral oil, 100 Neutral oil, 150 Neutral oil, 300 Neutral oil, 500 Neutral oil, and bright stocks, are exemplified.

As the synthetic oils, poly- α -olefin oligomers, polybutene, alkylbenzenes, polyol esters, polyglycol esters, dibasic esters, phosphoric esters, and silicone oils, are exemplified. Such a base oil can be used alone, or a combination of two or more such base oils can be used. Also, a mixture of a mineral oil and a synthetic oil can be used.

As the base oils used in the lubricating oil compositions of the present invention, those of which the viscosity at 100 °C is in a range of 3 - 20 mm²/sec. are preferable. Among them, hydrocracked oils and wax-isomerized oils, containing aromatic components of 3% by weight or less, and having a sulfur content of 50 ppm or less, and a nitrogen content of 50 ppm or less, are especially preferable.

As the sulfurized oxymolybdenum dithiocarbamates that are incorporated in the lubricating oil compositions of the present invention, the compounds represented by the following general formula (1) are used:



wherein R¹, R², R³, and R⁴, which may be the same or different, are each an alkyl group having 8 - 18 carbon atoms, and X is S or O.

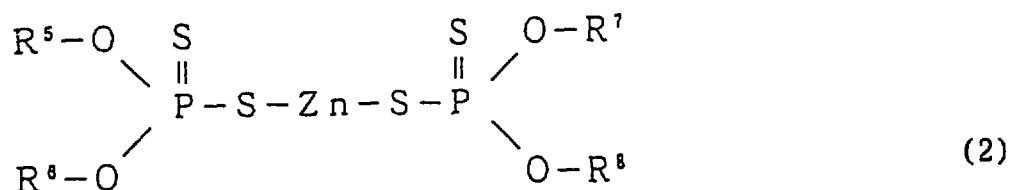
The alkyl groups having 8 - 18 carbon atoms, represented by R¹, R², R³, and R⁴, may be linear or branched. In the lubricating oil compositions of the present invention, the especially preferred carbon number of each of the alkyl groups represented by R¹, R², R³,

and R⁴, is 8 - 13.

As the alkyl groups represented by R¹, R², R³, and R⁴, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl groups, are exemplified.

In the lubricating oil compositions of the present invention, a sulfurized oxymolybdenum dithiocarbamate can be used alone or a combination of two or more kinds of it can be used. The sulfurized oxymolybdenum dithiocarbamate is incorporated in the composition in an amount such that, based on the total weight of the composition, the amount of sulfurized oxymolybdenum dithiocarbamate-derived molybdenum is 200 - 2,000 ppm (weight ratio), preferably 300 - 800 ppm (weight ratio). When the compounding amount of the sulfurized oxymolybdenum dithiocarbamate is one such that, based on the total weight of the composition, the amount of the sulfurized oxymolybdenum dithiocarbamate-derived molybdenum is less than 200 ppm (weight ratio), the effect of improving friction properties (low-friction properties) is not sufficiently exhibited. When the compounding amount of the sulfurized oxymolybdenum dithiocarbamate is one such that, based on the total weight of the composition, the amount of the sulfurized molybdenum dithiocarbamate-derived molybdenum exceeds 2,000 ppm (weight ratio), the improving effects are not enhanced proportionately to the amount, and it tends to cause sludge.

As the zinc dialkyl dithiophosphates that are incorporated in the lubricating oil compositions of the present invention, the compounds represented by the following general formula (2) are used:

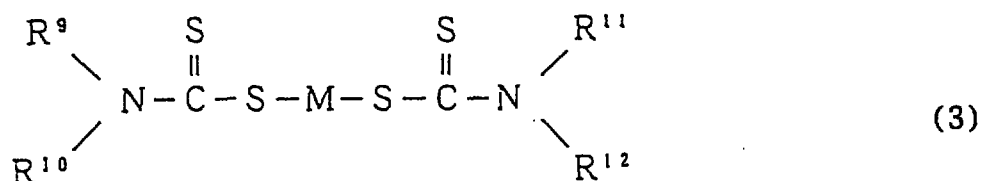


wherein R⁵, R⁶, R⁷, and R⁸, which may be the same or different, are each a primary alkyl group having 1 - 18 carbon atoms.

The primary alkyl groups represented by R^5 , R^6 , R^7 , and R^8 , in general formula (2), may be linear or branched. For example, they are methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl groups. It is preferred to use in the lubricating oil compositions of the present invention a zinc dialkyl dithiophosphate having a primary alkyl group with 3 - 12 carbon atoms.

In the lubricating oil compositions of the present invention, the zinc dialkyl dithiophosphate is incorporated in the composition in an amount such that, based on the total weight of the composition, the amount of the zinc dialkyl dithiophosphate-derived phosphorus is 0.02 - 0.15 % by weight, preferably 0.04 - 0.12% by weight. When the compounding amount of the zinc dialkyl dithiophosphate is one such that based on the total weight of the composition, the amount of the zinc dialkyl dithiophosphate-derived phosphorus is less than 0.02% by weight, besides the wear-resistant properties being insufficient, a sufficiently low coefficient of friction is not obtained under the operating conditions of high oil temperatures and low revolution rates. When the compounding amount of the zinc dialkyl dithiophosphate is one such that, based on the total weight of the composition, the amount of the zinc dialkyl dithiophosphate-derived phosphorus exceeds 0.15% by weight, the improving effect is not enhanced proportionately to the amount.

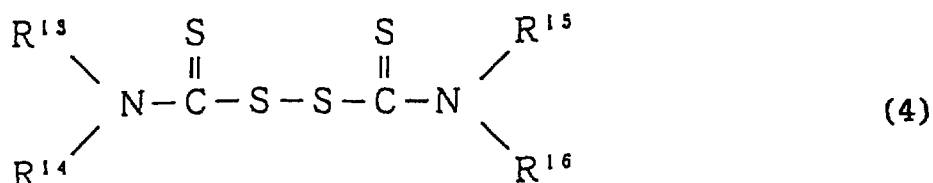
As the salts of dialkyldithiocarbamic acids that are incorporated in the lubricating oil compositions of the present invention, the compounds represented by the following general formula (3) are used:



wherein M is zinc, copper, or nickel, and R^9 , R^{10} , R^{11} , and R^{12} , which may be the same or different, are each an alkyl group having 2 - 18 carbon atoms.

The alkyl groups having 2 - 18 carbon atoms, represented by R^9 , R^{10} , R^{11} , and R^{12} , in general formula (3), may be linear or branched. As the alkyl groups, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl groups, are exemplified.

As the tetraalkylthiuram disulfides that are incorporated in the lubricating oil compositions of the present invention, the compounds represented by the following general formula (4) are used:



wherein R^{13} , R^{14} , R^{15} , and R^{16} , which may be the same or different, are each an alkyl group having 2 - 18 carbon atoms.

The alkyl groups having 2 - 18 carbon atoms, represented by R^{13} , R^{14} , R^{15} , and R^{16} , in general formula (4), may be linear or branched. As the alkyl groups, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl groups, are exemplified.

As the disulfides that are incorporated in the lubricating oil compositions of the present invention, the compounds represented by the following general formula (5) are used:



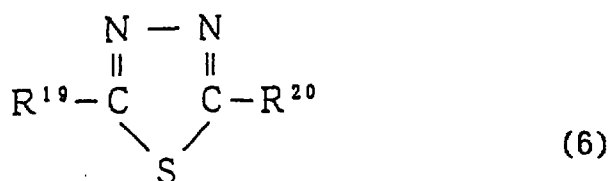
wherein R^{17} and R^{18} , which may be the same or different, are

each an alkyl group having 2 - 18 carbon atoms, or an aryl group, or an alkyl aryl group, or an aryl alkyl group, each having 6 - 18 carbon atoms.

The alkyl groups having 2 - 18 carbon atoms, represented by R^{17} and R^{18} , in general formula (5), may be linear or branched.

As the alkyl groups, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, and octadecyl groups, are exemplified. As the aryl groups, alkyl aryl groups, and aryl alkyl groups, having 6 - 18 carbon atoms, represented by R^{17} and R^{18} , phenyl, benzyl, phenethyl, methylbenzyl, and diphenylmethyl groups, are exemplified.

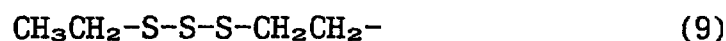
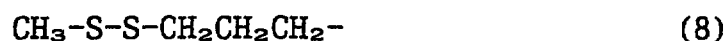
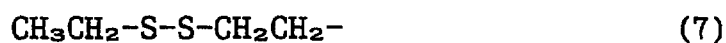
As the thiadiazole compounds having a substituent with sulfur atom(s) that are incorporated in the lubricating oil compositions of the present invention, the compounds represented by the general formula (6) are used:



wherein R^{19} and R^{20} , which may be the same or different, are each a monovalent group having 3 - 24 carbon atoms and one or more sulfur atoms.

As the monovalent groups having 3 - 24 carbon atoms and one or more sulfur atoms, represented by R^{19} and R^{20} in the general formula (6), 5-thianonyl, 2,5-dithiahexyl, 3,4-dithiahexyl, 4,5-dithiahexyl, 3,4,5-trithiaheptyl, 3,4,5,6-tetrathiaoctyl, 5-thia-2-heptenyl, 4-thiacyclohexyl, 1,4-dithianaphthyl, 5-(methylthio)octyl, 4-(ethylthio)-2-pentenyl, 4-(methylthio)cyclohexyl, 4-mercaptophenyl, 4-(methylthio)phenyl, and 4-(hexylthio)benzyl groups, are exemplified. Among them, those groups are especially preferable in which in the chain of each group 2 - 4 sulfur atoms are continuously

combined, such as 3,4-dithiahexyl group represented by the following formula (7), 4,5-dithiahexyl group represented by the following formula (8), 3,4,5-trithiaheptyl group represented by the following formula (9), and 3,4,5,6-tetrathiaoctyl group represented by the following formula (10).



The sulfurized olefins that are incorporated in the lubricating oil compositions of the present invention are sulfurized olefins obtained by sulfurizing a polymer of isobutylene etc., of which the sulfur content is 25 - 40% by weight (polysulfide products). The sulfurized fish oils and the sulfurized whale oils are those obtained by similarly sulfurizing fish oils and whale oils, respectively.

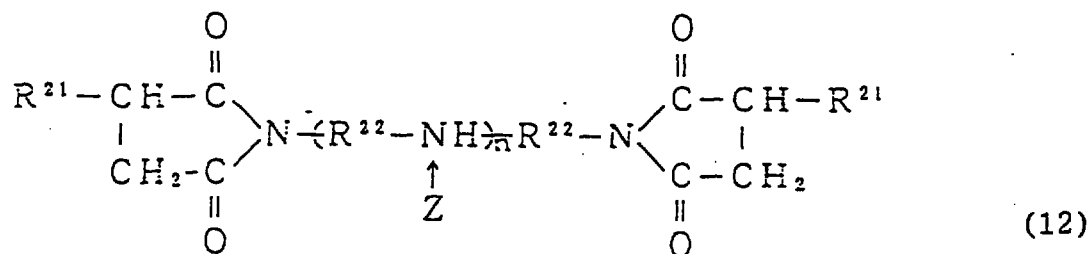
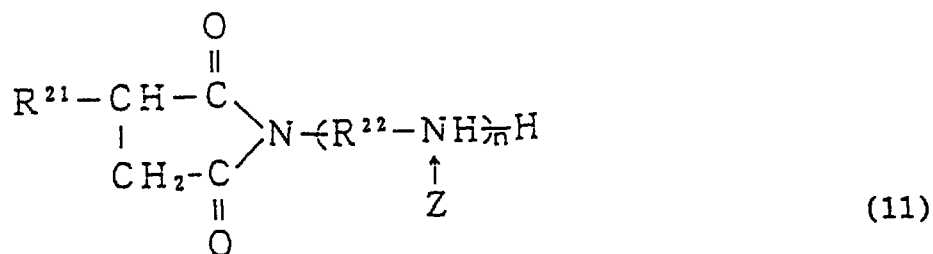
In the lubricating oil compositions of the present invention, either the salt of the dialkyldithiocarbamic acid represented by general formula (3), the tetraalkylthiuram disulfide represented by general formula (4), the disulfide represented by general formula (5), the thiadiazole compound represented by general formula (6), the sulfurized olefin, the sulfurized fish oil, or the sulfurized whale oil, can be used alone, or a mixture of two or more kinds of them can also be used. Such a sulfur compound is incorporated in the composition in an amount such that, based on the total weight of the composition, the amount of the sulfur compound(s)-derived sulfur is 0.02 - 0.30% by weight. When the compounding amount is one such that, based on the total weight of the composition, the amount of the sulfur compound(s)-derived sulfur is less than 0.02% by weight, the

retained effect of the decreased friction properties over a long period is insufficient. When the compounding amount is one such that, based on the total weight of the composition, the amount of the sulfur compound(s)-derived sulfur exceeds 0.30% by weight, the improving effect is not enhanced proportionately to the amount.

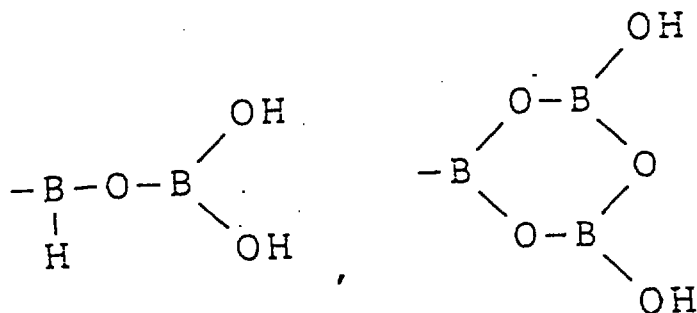
In the lubricating oil compositions of the present invention, one or more kinds of metal-based detergents selected from the group consisting of calcium salicylates, magnesium salicylates, calcium sulphonates, magnesium sulphonates, and calcium phenates, are incorporated. The metal-based detergent(s) is incorporated in an amount of 1 - 10% by weight based on the total weight of the composition. When the compounding amount of the metal-based detergent(s) is less than 1% by weight based on the total weight of the composition, the detergent effect is insufficient. When the compounding amount of the metal-based detergent(s) exceeds 10% by weight based on the total weight of the composition, the effect is not enhanced proportionately to the amount, and the ash content increases.

In the lubricating oil compositions of the present invention, the total base number of the composition is preferably 3 - 10, with 4 - 7 being more preferable. The total base number can be determined in accordance with JIS K2501. The total base number can be suitably adjusted by selecting a metal-based detergent having a suitable base number.

As the boron-containing compounds in the lubricating oil compositions of the present invention, boron-containing succinimides and boron-containing succinic esters are exemplified. As the boron-containing succinimides, the compounds represented by the following formula (11) and (12) are exemplified:



wherein R^{21} is a hydrocarbon group having 1 - 50 carbon atoms, R^{22} is an alkylene group having 2 - 5 carbon atoms, "n" is a number of 1 - 10, provided that in formula (12) two R^{21} s may be the same or different, and that in formula (11) n R^{22} s may be the same or different and in formula (12) n+1 R^{22} s may be the same or different, and Z is a boron-containing substituent. As Z, the following formulas are exemplified:



As the succinimides, ECA 5025 (produced by Exxon Chemical Company) and LUBRIZOL 935 (produced by Lubrizol Co. Ltd.) are specifically exemplified.

As the boron-containing succinic esters, the compounds represented by the following general formula (13) are exemplified:

a viscosity-index improver, a pour point depressant, an anti-foamant, a rust inhibitor, and a corrosion inhibitor, can be optionally incorporated in a range such that the object of the invention will be attained without fail.

As other friction modifiers, partial esters of polyhydroxy alcohols, amines, amides, and sulfurized esters, are exemplified.

As other metal-based detergents, barium sulfonates and barium phenates are exemplified. They can be usually used in a ratio of 0.1 - 5 % by weight.

As other wear-resistant agents, metal salts of thiophosphoric acids, sulfur compounds, phosphoric esters, and phosphorous esters, are exemplified. They can be usually used in a ratio of 0.05 - 5.0% by weight.

As other ashless dispersants, succinimide-type, succinamide-type, benzylamine-type, and ester-type compounds, are exemplified. They are usually used in a ratio of 0.5 - 7% by weight.

As the anti-oxidants, amine-type anti-oxidants such as alkylated diphenylamines, phenyl- α -naphthyl amine, alkylated α -naphthyl amines, and phenolic anti-oxidants such as 2,6-di-t-butyl-4-methylphenol and 4,4'-methylene-bis(2,6-di-t-butylphenol), are exemplified. They are usually used in a ratio of 0.05 - 4% by weight.

As the viscosity-index improvers, polymethacrylate-type, polyisobutylene-type, ethylene-propylene copolymer-type, and hydrogenated styrene-butadiene copolymer-type compounds, are exemplified. They are usually used in a ratio of 0.5 - 35% by weight.

As the pour point depressants, polyalkylmethacrylates, chlorinated paraffin-naphthalene condensates, and alkylated polystyrenes, are exemplified.

As the anti-foamants, dimethyl polysiloxane and polyacrylic acid are exemplified.

As the rust inhibitors, fatty acids, partial esters of alkenyl succinic acids, fatty acid soaps, alkyl sulphonates, fatty acid esters of polyhydric alcohols, fatty amides, oxidized paraffins, and polyoxyethylene alkyl ethers, are exemplified.

As the corrosion-inhibitors, benzotriazole and benzoimidazole are exemplified.

Examples

Below the present invention is illustrated in more detail by the following Examples, but is not limited to them.

The coefficients of friction of the lubricating oil compositions were determined with a reciprocating sliding friction tester (SRV Friction Tester) under the conditions of a frequency of 50 Hz, an amplitude of 3 mm, a load of 25 N, a temperature of 80 °C, and a test time of 25 minutes.

The test for oxidization by air containing nitrogen oxide gases was carried out for 150 ml of a test oil under the conditions of a temperature of 130 °C, a concentration of nitrogen oxides (NO_x) of 1% by volume, a flow velocity of 2 l /hour, and a test time of 8 hours.

Examples 1 - 10 and Comparative Examples 1 and 2

The lubricating oil compositions of Examples 1 - 10 are those in which (A) a sulfurized oxymolybdenum dithiocarbamate, (B) a zinc dialkyl dithiophosphate, (C) zinc diamyldithiocarbamate, copper dibutyldithiocarbamate, tetrabutylthiuram disulfide, dibenzyl disulfide, or di(thianonyl)thiadiazole, (D) a calcium salicylate, and (E) a boron-containing compound, were incorporated.

The lubricating oil compositions of Comparative Examples 1 and 2 are those in which although components (A), (B), (D), and (E), are contained, component (C) is not contained.

Lubricating oil compositions were prepared in which to a base oil (100 Neutral oil: the viscosity at 100 °C is 4.4 mm²/s)

compounding components, the kinds and amounts of which are listed in Table 1, were added. The coefficients of friction were determined immediately after preparation of the composition and after oxidizing the composition by keeping the composition in the presence of nitrogen oxide gases at 130 °C for 8 hours. The results are shown in Table 1.

Table 1

	Example										Comparative	
	1	2	3	4	5	6	7	8	9	10	Example	
											1	2
Molybdenum Content of C ₈ -MoDTC(ppm)	600	600	400	---	600	600	600	600	600	600	600	---
Molybdenum Content of C ₁₃ -MoDTC(ppm)	---	---	---	600	---	---	---	---	---	---	---	600
Phosphorus Content of C ₈ -ZnDTP (Primary) (% by Weight)	0.10	0.10	0.10	0.10	0.06	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Sulfur Content of C ₈ -ZnDTC (% by Weight)	0.15	0.05	0.10	0.10	0.10	---	---	---	---	---	---	---
Sulfur Content of C ₄ -CuDTC (% by Weight)	---	---	---	---	---	0.05	---	---	---	---	---	---
Sulfur Content of Tetrabutylthiuram Disulfide (% by Weight)	---	---	---	---	---	---	0.10	---	---	---	---	---
Sulfur Content of Dibenzyl Disulfide (% by Weight)	---	---	---	---	---	---	---	0.10	0.05	---	---	---
Sulfur Content of 2,5-di(4,5- dithianonyl)-1,3,4-thiadiazole (% by Weight)	---	---	---	---	---	---	---	---	---	0.10	---	---
Calcium Salicylate (% by Weight)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Boron Content of Boron-Containing Succinimide (% by Weight)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Coefficient of Friction Immediately After Preparation	0.087	0.087	0.090	0.090	0.089	0.094	0.092	0.085	0.086	0.090	0.086	0.091
Coefficient of Friction After Oxidi- zation with NOx (130°C x 8 hours)	0.090	0.091	0.094	0.095	0.097	0.101	0.095	0.087	0.094	0.086	0.167	0.175

Note: C₈-MoDTC: Sulfurized Oxymolybdenum-N,N-dioctyldithiocarbamate
C₁₃-MoDTC: Sulfurized Oxymolybdenum-N,N-ditridecyldithiocarbamate
C₈-ZnDTP (Primary): Zinc di-2-ethylhexyldithiophosphate
C₈-ZnDTC: Zinc diamyldithiocarbamate
C₄-CuDTC: Copper dibutyldithiocarbamate

Every lubricating oil composition of the present invention as shown in Examples 1 - 10 is found to have good friction properties with a low coefficient of friction and a good resistance to oxidation with little change in the coefficient of friction after oxidization by heating it in the presence of nitrogen oxide gases at 130 °C for 8 hours. In contrast, although every lubricating oil composition of Comparative Examples 1 - 2, in which the sulfur compound that is component (C) is not contained, has a low coefficient of friction immediately after the composition is prepared, it has an increased coefficient of friction after oxidization by heating it in the presence of nitrogen oxide gases at 130 °C for 8 hours. Thus it is found to have an inferior resistance to oxidation.

The lubricating oil compositions of the present invention, which are obtained by adding to a base oil a sulfurized oxymolybdenum dithiocarbamate, a zinc dialkyl dithiophosphate, and a sulfur compound, each having a certain structure, a metal-based detergent, and a boron-containing compound, have, besides excellent low-friction properties, a resistance to oxidation even at high temperatures and in the presence of nitrogen oxide gases and thus retain good friction properties (low-friction properties). Accordingly, they can be suitably used as a lubricating oil for internal combustion engines, automatic transmissions, shock absorbers, and power steering, especially as a lubricating oil for internal combustion engines.



Claim:

Claim 1: A lubricating oil composition characterized in that it is obtained by adding to a lubricating base oil (A) a sulfurized oxymolybdenum dithiocarbamate having an alkyl group with 8 - 18 carbon atoms, (B) a zinc dialkyl dithiophosphate having a primary alkyl group with 1 - 18 carbon atoms, (C) one or more kinds of sulfur compounds selected from the group consisting of zinc dialkyldithiocarbamates, copper dialkyldithiocarbamates, or nickel dialkyldithiocarbamates, each having an alkyl group with 2 - 18 carbon atoms, tetraalkylthiuram disulfides of which the carbon numbers of the alkyl group are 2 - 18, disulfides having an alkyl group with 2 - 18 carbon atoms, disulfides having an aryl group, an alkyl aryl group, or aryl alkyl group, with 6 - 18 carbon atoms, and thiadiazole compounds having a substituent with 3 - 24 carbon atoms and sulfur atom(s), sulfurized olefins, sulfurized fish oils, and sulfurized whale oils, (D) one or more kinds of metal-based detergents selected from the group consisting of calcium salicylates, magnesium salicylates, calcium sulfonates, magnesium sulfonates, and calcium phenates, and (E) a boron-containing compound, and in that based on the total amount of the composition the amount of the sulfurized oxymolybdenum dithiocarbamate-derived molybdenum is 200 - 2,000 ppm (weight ratio), the amount of the zinc dialkyl dithiophosphate-derived phosphorus is 0.02 - 0.15% by weight, the amount of the sulfur compound(s)-derived sulfur is 0.02 - 0.30 % by weight, the content of the metal-based detergent(s) is 1 - 10 % by weight, and the amount of the boron-containing compound-derived boron is 0.005 - 0.06 % by weight.