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(54) **LUBRICANT COMPOSITION**

(57) A lubricant oil composition which is excellent in wear resistance, high temperature detergency and base number retaining property, despite its low phosphorus content, low sulfur content and low sulfuric acid ash con-

tent, is provided at a low cost by compounding a sulfonamide compound having a specific structure in a base oil.

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Description

[Technical Field]

5 **[0001]** The present invention relates to a lubricant oil composition and, more specifically, to a lubricant oil composition which is excellent in wear resistance, high temperature detergency and base number retaining property, despite its low phosphorus content, low sulfur content and low sulfuric acid ash content.

[Background Art]

10 **[0002]** A zinc dithiophosphate (Zn-DTP) has been conventionally used over the years as a wear resisting and antioxidant agent for a lubricant oil for use in an internal combustion engine such as a gasoline engine, a diesel engine or a gas engine and is now still accepted as an important essential additive for such a lubricant oil for internal combustion engines.

15 The zinc dithiophosphate which contains, in the molecule thereof, a large amount of phosphorus and sulfur components in addition to a metal component (zinc), however, generates sulfuric acid and phosphoric acid upon being decomposed. Therefore, the zinc dithiophosphate may consume basic compounds contained in the engine oil and accelerate the deterioration of the lubricant oil with the result that oil change intervals are extremely short (this phenomenon indicates that the so-called base number retaining property of the dithiophosphate is insufficient). Additionally, the fact that the zinc dithiophosphate tends to be changed into sludge at high temperatures, causing deterioration of the property to clean the inside of an engine is perceived as being problematic.

20 In this circumstance, there is a need for a wear resisting additive that can be used in place of the zinc dithiophosphate in a lubricant oil for internal combustion engines.

25 **[0003]** Current automobile engines use an oxidation catalyst, a three way catalyst, an NOx occlusion reduction catalyst, a diesel particulate filter (DPF), etc. for purification of exhaust gases. The exhaust gas purification devices are known to be adversely affected by metal components, phosphorus components and sulfur components contained in the engine oil. Thus, it is known to be necessary to reduce these components in order to prevent the deterioration of these devices. Accordingly, there is a strong need for a lubricant oil that has a low metal content (namely low sulfuric acid ash content), a low phosphorus content and a low sulfur content and, yet, which can exhibit basic performances (such as wear resistance, detergency and base number retaining property).

30 **[0004]** With a view toward solving the above problems, a variety of lubricant oil additives and lubricant oil compositions have been hitherto proposed. For example, Patent Document 1 proposes a lubricant oil composition containing a specific phosphorus-containing phenol-based antioxidant. However, since the solubility of the phosphorus-containing phenol-based antioxidant in a base oil is insufficient, there is still a room for improvement in solving the above-mentioned problems.

35 **[0005]** In Patent Document 2, there is disclosed a technique for improving dispersibility of a base oil with a view toward extending the oil change interval, in which the base oil is directly modified by molecularly bonding specific aromatic groups to the base oil through a sulfonamide linkage.

[0006]

40 Patent Document 1: JP-A-11-35962
Patent Document 2: JP-A-6-220473

[Disclosure of the Invention]

45 [Problems to be Solved by the Invention]

[0007] Although the known lubricant oil additives and lubricant oil compositions can achieve a certain degree of extension of the oil change interval, it is not possible to improve, sufficiently and in a well-balanced manner, the basic properties, such as wear resistance, detergency and base number retaining property, required for lubricant oils for internal combustion engines.

50 **[0008]** In this circumstance, it is an object of the present invention to provide, at a low cost, a lubricant oil composition which is excellent in wear resistance, high temperature detergency and base number retaining property, despite its low phosphorus content, low sulfur content and low metal content (low sulfuric acid ash content).

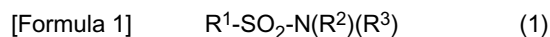
55 [Means for Solving the Problem]

[0009] The present inventors have made an earnest study with a view toward developing a lubricant oil composition

having the afore-mentioned preferred properties and found that the object can be achieved by compounding a specific sulfonamide compound. Namely, the present invention provides:

<1> A lubricant oil composition comprising a base oil and a sulfonamide compound represented by the following general formula (1).

[0010]



(In the formula, R¹ represents one selected from substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups, and R² and R³ each independently represent one selected from a hydrogen atom, substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted alkenyl groups, substituted or unsubstituted alkynyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups, with the proviso that R² and R³ may be taken together to form a ring structure or a condensed ring structure.)

[0011] <2> The lubricant oil composition according to <1>, wherein at least one of R² and R³ in the general formula (1) represents one selected from substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted alkenyl groups, substituted or unsubstituted alkynyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups.

[0012] <3> The lubricant oil composition according to <1> or <2>, wherein, when at least one of R² and R³ in the general formula (1) has a substituent or substituents, the substituents of R² and R³ independently represent a C₁ to C₂₀ hydrocarbon group.

[0013] <4> The lubricant oil composition according to <1> or <2>, wherein at least one of R² and R³ in the general formula (1) represents one selected from unsubstituted alkyl groups, unsubstituted cycloalkyl groups, unsubstituted alkenyl groups, unsubstituted alkynyl groups, unsubstituted aryl groups and unsubstituted heteroaryl groups.

[0014] <5> The lubricant oil composition according to any one of <1> to <4>, wherein R¹ in the general formula (1) represents one selected from unsubstituted alkyl groups, unsubstituted cycloalkyl groups, unsubstituted alkenyl groups, unsubstituted alkynyl groups, unsubstituted aryl groups and unsubstituted heteroaryl groups.

[0015] <6> The lubricant oil composition according to any one of <1> to <5>, wherein the lubricant oil composition has a phosphorus content of 0.12% by mass or less and a sulfuric acid ash content of 1.2% by mass or less, each based on the mass of the composition.

[0016] <7> The lubricant oil composition according to any one of <1> to <6>, wherein the lubricant oil composition is used for an internal combustion engine.

[Effect of the Invention]

[0017] According to the present invention, it is possible to provide at a low cost a lubricant oil composition which is excellent in wear resistance, high temperature detergency and base number retaining property, despite its low phosphorus content, low sulfur content and a low metal content (low sulfuric acid ash content).

[Best Mode for Carrying out the Invention]

[0018] Embodiments of the present invention will be described below.

The lubricant oil composition of the present embodiment is **characterized in that** a sulfonamide compound represented by the above general formula (1) is compounded in a base oil.

Base oil:

[0019] The base oil used in the present embodiment is not specifically limited and may be appropriately selected from mineral oils and synthetic oils that are conventionally used as a base oil for internal combustion engine lubricant oils. Examples of the mineral oils include those which are obtained by subjecting a lube-oil distillate (which is obtained by vacuum distillation of an atmospheric residue produced by atmospheric distillation of a crude oil) to one or more refining treatments such as solvent deasphalting, solvent extraction, hydrocracking, solvent dewaxing, catalytic dewaxing and hydrotreating, and those which are produced by isomerizing waxes or GTL waxes.

[0020] Examples of the synthetic oils include polybutene, polyolefins (α -olefin homopolymers and copolymers (such as ethylene- α -olefin copolymers)), various esters (such as polyol esters, dibasic acid esters and phosphoric acid esters), various ethers (such as polyphenyl ethers), polyglycols, alkyl benzenes and alkyl naphthalenes. Among these synthetic

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oils, particularly preferred are polyolefins and polyol esters.

In the present embodiment, the above mineral oils may be used singly or in combination of two or more thereof as the base oil. Also, the above synthetic oils may be used singly or in combination of two or more thereof. Further, one or more mineral oils may be used in combination with one or more synthetic oils.

[0021] The viscosity of the base oil is not specifically limited. However, it is preferred that the base oil has a kinematic viscosity at 100°C of 2 mm²/s or more and 30 mm²/s or less, more preferably 3 mm²/s or more and 15 mm²/s or less, still more preferably 4 mm²/s or more and 10 mm²/s or less.

When the kinematic viscosity at 100°C is 2 mm²/s or more, an evaporation loss is small. When the kinematic viscosity at 100°C is 30 mm²/s or less, a power loss by viscosity resistance can be suppressed so that a fuel consumption improving effect is obtainable.

[0022] It is also preferred that the base oil has a %C_A value of 3.0 or less as measured by ring analysis and a sulfur content of 50 ppm by mass or less. As used herein, the term "%C_A value as measured by ring analysis" means a proportion (percentage) of an aromatic component in the base oil which is calculated by the n-d-M ring analysis method. The sulfur content as used herein means a value as measured according to JIS K 2541.

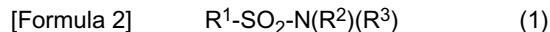
The base oil having a %C_A value of 3.0 or less and a sulfur content of 50 ppm by mass or less exhibits good oxidation stability and can give a lubricant oil composition that can suppress an increase of the acid value and formation of a sludge. The %C_A value of the base oil is more preferably 1.0 or less, still more preferably 0.5 or less. The sulfur content is more preferably 30 ppm by mass or less.

[0023] It is further preferred that the base oil has a viscosity index of 70 or more, more preferably 100 or more, still more preferably 120 or more. When the viscosity index of the base oil is 70 or more, a change in viscosity of the base oil by a change in temperature is small.

Sulfonamide compound:

[0024] The lubricant oil composition of the present embodiment is compounded with a sulfonamide compound represented by the general formula (1) shown below. By using the sulfonamide compound as a component of the lubricant oil composition, it is possible to improve the wear resistance, high temperature detergency and base number retaining property notwithstanding the fact that the phosphorus content, sulfur content and metal content thereof are low.

[0025]



[0026] In the formula, R¹ represents one selected from substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups, and R² and R³ each independently represent one selected from a hydrogen atom, substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted alkenyl groups, substituted or unsubstituted alkynyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups, with the proviso that R² and R³ may be taken together to form a ring structure or a condensed ring structure.

[0027] The above-mentioned alkyl groups include straight-chained and branched alkyl groups. The preferred alkyl groups have 1 to 20 carbon atoms and may include a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, an isobutyl group, a tert-butyl group and similar alkyl groups. The alkyl groups may be substituted with a substituent or substituents. The alkyl groups more preferably have 4 to 18 carbon atoms.

As the above-mentioned substituent, there may be specifically mentioned a halogen atom, a hydroxyl group, an amino group, a nitro group, a cyano group, an alkyl group, an alkenyl group, a cycloalkyl group, an alkoxy group, an aromatic hydrocarbon group, an aromatic heterocyclic group, an aralkyl group, an aryloxy group, an alkoxy carbonyl group, a fluorinated alkyl group, a fluorinated aryl group, a carboxyl group, an isocyanate group, a thioisocyanate group, an imino group, a sulfone group, a thiocarboxyl group, a carbonyl group, a thiocarbonyl group, a formyl group, a thioformyl group, a silanol group, a hydrocarbyloxy group, a nitrile group, a pyridyl group, an amide group, an imide group, an imidazolyl group, an ammonium group, a hydrazo group, an azo group, a diazo group, a ketimine group, an epoxy group, a thioepoxy group, an oxycarbonyl group (ester bond), a carbonylthio group (thioester bond), an oxy group (ether bond), a glycidoxy group, a sulfide group (thioether bond), a disulfide group, a mercapto group, a hydrocarbylthio group, a sulfonyl group, a sulfanyl group, an imine residue, a hydrocarbyloxysilyl group and an organic tin group.

As the halogen group, there may be mentioned, for example, fluorine, chlorine, bromine and iodine.

[0028] Specific examples of the substituted or unsubstituted alkyl group include a methyl group, an ethyl group, a propyl group, an isopropyl group, an n-butyl group, an s-butyl, an isobutyl group, a t-butyl group, an n-pentyl group, an n-hexyl group, an n-heptyl group, an n-octyl group, a hydroxymethyl group, a 1-hydroxyethyl group, a 2-hydroxyethyl group, a 2-hydroxyisobutyl group, a 1,2-dihydroxyethyl group, a 1,3-dihydroxyisopropyl group, a 1,1-di(hydroxymethyl) ethyl group, a 1,2,3-hydroxypropyl group, a chloromethyl group, a 1-chloroethyl group, a 2-chloroethyl group, a 2-

chloroisobutyl group, a 1,2-dichloroethyl group, a 1,3-dichloroisopropyl group, a 1,1-di(chloromethyl)ethyl group, a 1,2,3-trichloropropyl group, a bromomethyl group, a 1-bromoethyl group, a 2-bromoethyl group, a 2-bromoisobutyl group, a 1,2-dibromoethyl group, a 1,3-dibromoisopropyl group, a 1,1-di(bromomethyl)ethyl group, a 1,2,3-tribromopropyl group, an iodomethyl group, a 1-iodoethyl group, a 2-iodoethyl group, a 2-iodoisobutyl group, a 1,2-diiodoethyl group, a 1,3-diiodoisopropyl group, a 1,1-di(iodomethyl)ethyl group, a 1,2,3-triiodopropyl group, an aminomethyl group, a 1-aminoethyl group, a 2-aminoethyl group, a 2-aminoisobutyl group, a 1,2-diaminoethyl group, a 1,3-diaminoisopropyl group, a 1,1-di(aminomethyl)ethyl group, a 1,2,3-triaminopropyl group, a cyanomethyl group, a 1-cyanoethyl group, a 2-cyanoethyl group, a 2-cyanoisobutyl group, a 1,2-dicyanoethyl group, a 1,3-dicyanoisopropyl group, a 1,1-di(cyanomethyl)ethyl group, a 1,2,3-tricyanopropyl group, a nitromethyl group, a 1-nitroethyl group, a 2-nitroethyl group, a 2-nitroisobutyl group, a 1,2-dinitroethyl group, a 1,3-dinitroisopropyl group, a 1,1-di(nitromethyl)ethyl group and a 1,2,3-trinitropropyl group.

[0029] The above-mentioned cycloalkyl groups include polycyclic alkyl groups. The preferred cycloalkyl groups include those which have a ring structure constituted of 3 to 7 carbon atoms and may include a cyclopropyl group, a cyclopentyl group, a cyclohexyl group and similar cycloalkyl groups. The cycloalkyl groups may be substituted with a substituent or substituents which are similar to those which have been described above with reference to the alkyl groups.

[0030] Specific examples of the substituted or unsubstituted cycloalkyl group include C₆ to C₁₁ alkylcycloalkyl groups (wherein the alkyl group may be substituted at any position of the cycloalkyl ring), such as a methylcyclopentyl group, a dimethylcyclopentyl group, a methylethylcyclopentyl group, a diethylcyclopentyl group, a phenylcyclopentyl group, a methylcyclohexyl group, a dimethylcyclohexyl group, a methylethylcyclohexyl group, a diethylcyclohexyl group, a phenylcyclohexyl group, a methylcycloheptyl group, a dimethylcycloheptyl group, a methylethylcycloheptyl group and a diethylcycloheptyl group; a bicyclo[2,2,1]heptyl group; and a decahydronaphthyl group.

[0031] The above-mentioned alkenyl groups include straight-chained and branched alkenyl groups. The preferred alkenyl groups have 2 to 20 carbon atoms. The alkenyl groups may be substituted with a substituent or substituents which are similar to those which have been described above with reference to the alkyl groups. The alkenyl groups more preferably have 4 to 18 carbon atoms.

[0032] Specific examples of the substituted or unsubstituted alkenyl group include a vinyl group, an allyl group, a 1-butenyl group, a 2-butenyl group, a 3-butenyl group, a 1,3-butanediethyl group, a 1-methylvinyl group, a styryl group, a 2,2-diphenylvinyl group, a 1,2-diphenylvinyl group, a 1-methylallyl group, a 1,1-dimethylallyl group, a 2-methylallyl group, a 1-phenylallyl group, a 2-phenylallyl group, a 3-phenylallyl group, a 3,3-diphenylallyl group, a 1,2-dimethylallyl group, a 1-phenyl-1-butenyl group and a 3-phenyl-1-butenyl group.

[0033] The above-mentioned alkynyl groups include straight-chained and branched alkynyl groups. The preferred alkynyl groups have 2 to 40 carbon atoms. The alkynyl groups may be substituted with a substituent or substituents which are similar to those which have been described above with reference to the alkyl groups. The alkynyl groups more preferably have 4 to 18 carbon atoms.

[0034] Specific examples of the substituted or unsubstituted alkynyl group include an ethynyl group, a methylethynyl group, a 2-propynyl group, a 3-butynyl group, a 1-methyl-2-propynyl group and a phenylethynyl group.

[0035] The above-mentioned aryl groups include monocyclic and polycyclic aryl groups. In the polycyclic aryl group, two carbon atoms are shared by two adjacent rings (these rings are condensed) at least one of which is an aromatic ring. The other ring may be, for example, a cycloalkyl ring, a cycloalkenyl ring, an aryl ring, a heteroring or a heteroaromatic ring. The aryl groups may be substituted with a substituent or substituents which are similar to those which have been described above with reference to the alkyl groups.

[0036] Specific examples of the unsubstituted aryl group include a phenyl group, a 1-naphthyl group, a 2-naphthyl group, a 1-anthryl group, a 2-anthryl group, a 9-anthryl group, a 1-phenanthryl group, a 2-phenanthryl group, a 3-phenanthryl group, a 4-phenanthryl group, a 9-phenanthryl group, a 1-naphthacenyl group, a 2-naphthacenyl group, a 9-naphthacenyl group, a 1-pyrenyl group, a 2-pyrenyl group and a 4-pyrenyl group.

As the substituted aryl group, there may be mentioned, for example, C₇ to C₁₈ alkylaryl groups (wherein the alkyl group may be straight-chained or branched and may be substituted at any position of the aryl group) such as a tolyl group, a xylyl group, an ethylphenyl group, a propylphenyl group, a butylphenyl group, a pentylphenyl group, a hexylphenyl group, a heptylphenyl group, an octylphenyl group, a nonylphenyl group, a decylphenyl group, an undecylphenyl group, and a dodecylphenyl group.

As the unsubstituted aryl group, there may also be mentioned, for example, a 2-biphenyl group, a 3-biphenyl group, a 4-biphenyl group, a p-terphenyl-4-yl group, a p-terphenyl-3-yl group, a p-terphenyl-2-yl group, a m-terphenyl-4-yl group, a m-terphenyl-3-yl group, a m-terphenyl-2-yl group, an o-tolyl group, a m-tolyl group, a p-tolyl group, a p-t-butylphenyl group, a p-(2-phenylpropyl)phenyl group, a 3-methyl-2-naphthyl group, a 4-methyl-1-naphthyl group, a 4-methyl-1-anthryl group, a 4'-methylbiphenyl group and a 4"-t-butyl-p-terphenyl-4-yl group.

[0037] As the above-mentioned heteroaryl group, there may be mentioned, for example, a monocyclic heteroaromatic group which may contain 1 to 3 hetero atoms. Specific examples of the heteroaryl group include groups of a pyrrol group, a furan group, a thiophene group, an imidazol group, an oxazol group, a thiazol group, a triazol group, a pyrazol group,

a pyridine group, a pyrazine group and a pyrimidine group. The heteroaryl group may also include polycyclic heteroaromatic groups having two or more rings and containing two atoms which are shared by two adjacent rings (these rings are condensed). At least one of the two adjacent rings is a heteroaryl group, while the other ring may be, for example, a cycloalkyl ring, a cycloalkenyl ring, an aryl ring, a heteroring and/or a heteroaromatic ring. The heteroaryl groups may be substituted with a substituent or substituents which are similar to those which have been described above with reference to the alkyl groups.

[0038] Specific examples of the substituted or unsubstituted heteroaryl group include a 1-pyrrolyl group, a 2-pyrrolyl group, a 3-pyrrolyl group, a pyrazinyl group, a 2-pyridinyl group, a 3-pyridinyl group, a 4-pyridinyl group, a 1-indolyl group, a 2-indolyl group, a 3-indolyl group, a 4-indolyl group, a 5-indolyl group, a 6-indolyl group, a 7-indolyl group, a 1-isoindolyl group, a 2-isoindolyl group, a 3-isoindolyl group, a 4-isoindolyl group, a 5-isoindolyl group, a 6-isoindolyl group, a 7-isoindolyl group, a 2-furyl group, a 3-furyl group, a 2-benzofuranyl group, a 3-benzofuranyl group, a 4-benzofuranyl group, a 5-benzofuranyl group, a 6-benzofuranyl group, a 7-benzofuranyl group, a 1-isobenzofuranyl group, a 3-isobenzofuranyl group, a 4-isobenzofuranyl group, a 5-isobenzofuranyl group, a 6-isobenzofuranyl group, a 7-isobenzofuranyl group, a 2-quinolyl group, a 3-quinolyl group, a 4-quinolyl group, a 5-quinolyl group, a 6-quinolyl group, a 7-quinolyl group, a 8-quinolyl group, a 1-isoquinolyl group, a 3-isoquinolyl group, a 4-isoquinolyl group, a 5-isoquinolyl group, a 6-isoquinolyl group, a 7-isoquinolyl group, a 8-isoquinolyl group, a 2-quinoxalanyl group, a 5-quinoxalanyl group, a 6-quinoxalanyl group, a 1-carbazolyl group, a 2-carbazolyl group, a 3-carbazolyl group, a 4-carbazolyl group, a 9-carbazolyl group, a 1-phenanthridinyl group, a 2-phenanthridinyl group, a 3-phenanthridinyl group, a 4-phenanthridinyl group, a 6-phenanthridinyl group, a 7-phenanthridinyl group, a 8-phenanthridinyl group, a 9-phenanthridinyl group, a 10-phenanthridinyl group, a 1-acridinyl group, a 2-acridinyl group, a 3-acridinyl group, a 4-acridinyl group, a 9-acridinyl group, a 1,7-phenanthroline-2-yl group, a 1,7-phenanthroline-3-yl group, a 1,7-phenanthroline-4-yl group, a 1,7-phenanthroline-5-yl group, a 1,7-phenanthroline-6-yl group, a 1,7-phenanthroline-8-yl group, a 1,7-phenanthroline-9-yl group, a 1,7-phenanthroline-10-yl group, a 1,8-phenanthroline-2-yl group, a 1,8-phenanthroline-3-yl group, a 1,8-phenanthroline-4-yl group, a 1,8-phenanthroline-5-yl group, a 1,8-phenanthroline-6-yl group, a 1,8-phenanthroline-7-yl group, a 1,8-phenanthroline-9-yl group, a 1,8-phenanthroline-10-yl group, a 1,9-phenanthroline-2-yl group, a 1,9-phenanthroline-3-yl group, a 1,9-phenanthroline-4-yl group, a 1,9-phenanthroline-5-yl group, a 1,9-phenanthroline-6-yl group, a 1,9-phenanthroline-7-yl group, a 1,9-phenanthroline-8-yl group, a 1,9-phenanthroline-10-yl group, a 1,10-phenanthroline-2-yl group, a 1,10-phenanthroline-3-yl group, a 1,10-phenanthroline-4-yl group, a 1,10-phenanthroline-5-yl group, a 2,9-phenanthroline-1-yl group, a 2,9-phenanthroline-3-yl group, a 2,9-phenanthroline-4-yl group, a 2,9-phenanthroline-5-yl group, a 2,9-phenanthroline-6-yl group, a 2,9-phenanthroline-7-yl group, a 2,9-phenanthroline-8-yl group, a 2,9-phenanthroline-10-yl group, a 2,8-phenanthroline-1-yl group, a 2,8-phenanthroline-3-yl group, a 2,8-phenanthroline-4-yl group, a 2,8-phenanthroline-5-yl group, a 2,8-phenanthroline-6-yl group, a 2,8-phenanthroline-7-yl group, a 2,8-phenanthroline-9-yl group, a 2,8-phenanthroline-10-yl group, a 2,7-phenanthroline-1-yl group, a 2,7-phenanthroline-3-yl group, a 2,7-phenanthroline-4-yl group, a 2,7-phenanthroline-5-yl group, a 2,7-phenanthroline-6-yl group, a 2,7-phenanthroline-8-yl group, a 2,7-phenanthroline-9-yl group, a 2,7-phenanthroline-10-yl group, a 1-phenazinyl group, a 2-phenazinyl group, a 1-phenothiazinyl group, a 2-phenothiazinyl group, a 3-phenothiazinyl group, a 4-phenothiazinyl group, a 10-phenothiazinyl group, a 1-phenoxazinyl group, a 2-phenoxazinyl group, a 3-phenoxazinyl group, a 4-phenoxazinyl group, a 10-phenoxazinyl group, a 2-oxazolyl group, a 4-oxazolyl group, a 5-oxazolyl group, a 2-oxadiazolyl group, a 5-oxadiazolyl group, a 3-furazanyl group, a 2-thienyl group, a 3-thienyl group, a 2-methylpyrrol-1-yl group, a 2-methylpyrrol-3-yl group, a 2-methylpyrrol-4-yl group, a 2-methylpyrrol-5-yl group, a 3-methylpyrrol-1-yl group, a 3-methylpyrrol-2-yl group, a 3-methylpyrrol-4-yl group, a 3-methylpyrrol-5-yl group, a 2-t-butylpyrrol-4-yl group, a 3-(2-phenylpropyl)pyrrol-1-yl group, a 2-methyl-1-indolyl group, a 4-methyl-1-indolyl group, a 2-methyl-3-indolyl group, a 4-methyl-3-indolyl group, a 2-t-butyl-1-indolyl group, a 4-t-butyl-1-indolyl group, a 2-t-butyl-3-indolyl group and a 4-t-butyl-3-indolyl group.

[0039] Incidentally, R^2 and R^3 may be taken together to form a ring structure or a condensed ring structure when the above-mentioned groups are represented by R^2 and R^3 . The ring of such a ring structure may be, for example, a cyclohexane ring or a cyclopentane ring, while the ring of such a condensed ring structure may be, for example, a naphthalene ring, a fluorene ring, an acenaphthene ring, a quinoline ring, a purine ring or a quinuclidine ring.

[0040] In the present embodiment, when the above-mentioned groups are represented by R^2 and R^3 , it is preferred that at least one of R^2 and R^3 represents one selected from substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted alkenyl groups, substituted or unsubstituted alkynyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups. As a specific example, there may be mentioned a case where one of R^2 and R^3 represents a hydrogen atom and the other one represents the above-specified group.

A sulfonamide compound in which R^2 and R^3 each represent a hydrogen atom is considered to have a relatively large polarity and, therefore, may occasionally cause a disadvantage that the dispersibility or solubility of the compound in the base oil is deteriorated.

[0041] When, in the present embodiment, the above-mentioned groups represented by R^2 and R^3 have a substituent or substituents, it is preferred that the substituents of R^2 and R^3 independently represent a C_1 to C_{20} hydrocarbon group.

As used herein, the term "hydrocarbon group" is intended to mean an alkyl group, an alkenyl group, an alkynyl group, a cycloalkyl group, an aromatic hydrocarbon group or an aralkyl group.

When the substituent of R^2 and R^3 is not the above specified hydrocarbon group but is one which contains an atom other than carbon and hydrogen, the structure of the substituent becomes complicated so that there is a possibility that not only the production process and production cost become problematic but also the stability of the compound itself is deteriorated.

The hydrocarbon group preferably has 4 to 18 carbon atoms, more preferably 4 to 8 carbon atoms.

[0042] In the present embodiment, when the above-mentioned groups are represented by R^2 and R^3 , it is preferred that at least one of R^2 and R^3 represents one selected from unsubstituted alkyl groups, unsubstituted cycloalkyl groups, unsubstituted alkenyl groups, unsubstituted alkynyl groups, unsubstituted aryl groups and unsubstituted heteroaryl groups.

It is preferred that R^2 and R^3 represent alkyl groups, cycloalkyl groups, alkenyl groups, alkynyl groups, aryl groups or heteroaryl groups for reasons of improved dispersibility of the sulfonamide compound in the base oil. When these groups have a substituent or substituents, however, there is caused a disadvantage in production of the sulfonamide compound and, moreover, there is a possibility that the effect of addition of the compound is deteriorated because the molecule thereof becomes large as a whole.

[0043] In the above case, it is further preferred that the unsubstituted groups be aryl group, heteroaryl groups or alkyl groups, still more preferably alkyl groups.

[0044] In the present embodiment, it is preferred that the above-described group of R^1 represent one selected from unsubstituted alkyl groups, unsubstituted cycloalkyl groups, unsubstituted aryl groups and unsubstituted heteroaryl groups.

When R^1 has a substituent or substituents, there is caused a disadvantage in production of the sulfonamide compound and, moreover, there is a possibility that the effect of addition of the compound is deteriorated because the molecule thereof becomes large as a whole.

In the above case, it is further preferred that the unsubstituted groups be aryl groups or heteroaryl groups for reasons of production costs.

[0045] Specific examples of the sulfonamide compound that may be used in the present embodiment are given below.

As the sulfonamide compound, there may be mentioned, for example, benzenesulfonamide, 2-methylbenzenesulfonamide, 4-methylbenzenesulfonamide, 2-chlorobenzenesulfonamide, 4-chlorobenzenesulfonamide, 2,5-dichlorobenzenesulfonamide, 3,5-dichlorobenzenesulfonamide, 2-bromobenzenesulfonamide, 4-bromobenzenesulfonamide, 2-nitrobenzenesulfonamide, 3-nitrobenzenesulfonamide, 4-nitrobenzenesulfonamide, 4-hydroxybenzenesulfonamide, naphthalenesulfonamide, 5-hydroxynaphthalenesulfonamide, N-methylbenzenesulfonamide, N-ethylbenzenesulfonamide, benzenesulfonanilide, benzenesulfon-4-chloroanilide, N-methyl-4-methylbenzenesulfonamide, N-ethyl-4-methylbenzenesulfonamide, 4-methylbenzenesulfonanilide, 4-methylbenzenesulfon-4-chloroanilide, N-methyl-2-nitrobenzenesulfonamide, N-ethyl-2-nitrobenzenesulfonamide, 2-nitrobenzenesulfonanilide, 2-nitrobenzenesulfon-4-chloroanilide, methanesulfonanilide, ethanesulfonanilide, trichloromethanesulfonanilide, trifluoromethanesulfonanilide, methanesulfon-4-chloroanilide, ethanesulfon-4-chloroanilide, trichloromethanesulfon-4-chloroanilide, trifluoromethanesulfon-4-chloroanilide, N-naphthylmethanesulfonamide, N-naphthylethanesulfonamide, N-naphthyltrichloromethanesulfonamide, N-naphthyltrifluoromethanesulfonamide, p-toluenesulfonamide, N-butylbenzenesulfonamide, N-butyl-4-methylbenzenesulfonamide, N-phenyl-4-hydroxybenzenesulfonamide, 5-dimethylamino-1-naphthalenesulfonamide, N-cyclohexyl-N-methyl-2-aminobenzenesulfonamide, N-(4-aminophenyl)-4-methylbenzenesulfonamide, 4-(2-aminoethyl)benzenesulfonamide, N-(3-aminophenyl)methanesulfonamide, N,N-dioctylmethanesulfonamide, N,N-dioctylethanesulfonamide and N,N-dibutenylmethanesulfonamide.

[0046] Among the above exemplified sulfonamide compounds, compounds of the above general formula (1) in which at least one of R^1 , R^2 and R^3 is an aromatic group are preferred. From the standpoint of performance and cost, particularly preferred are N-butylbenzenesulfonamide and N-butyl-4-methylbenzenesulfonamide.

[0047] In the present embodiment, the sulfonamide compounds represented by the general formula (1) may be used singly or as a mixture of two or more thereof. The compounding amount of the sulfonamide compound represented by the general formula (1) is preferably 0.01% by mass or more and 5% by mass or less, more preferably 0.05% by mass or more and 3% by mass or less, particularly preferably 0.1% by mass or more and 2% by mass or less, based on the mass of the composition.

When the compounding amount of the sulfonamide compound represented by the general formula (1) is less than 0.01% by mass, there is a possibility that the performance such as wear resistance, high temperature detergency and base number retaining property are not sufficiently exhibited. When the compounding amount exceeds 5% by mass, there may cause a case where corrosion of automobile exhaust gas purification catalysts cannot be suppressed due to an increase of the sulfur content in the composition.

[0048] In the lubricant oil composition of the present embodiment, it is preferred that at least one additive selected from an antioxidant, an ashless dispersant, a metallic detergent, a viscosity index improver, a pour point depressant, a

metal deactivator, a rust inhibitor and a defoaming agent be further compounded therein.

[0049] The above-mentioned antioxidant is preferably a phosphorus-free antioxidant. Examples of the phosphorus-free antioxidant include a phenol-based antioxidant, an amino-based antioxidant, a molybdenum/amine complex-based antioxidant and a sulfur-based antioxidant.

Specific examples of the phenol-based antioxidant include 4,4'-methylenebis(2,6-di-t-butylphenol), 4,4'-bis(2,6-di-t-butylphenol), 4,4'-bis(2-methyl-6-t-butylphenol), 2,2'-methylenebis(4-ethyl-6-t-butylphenol), 2,2'-methylenebis(4-methyl-6-t-butylphenol), 4,4'-butylidenebis(3-methyl-6-t-butylphenol), 4,4'-isopropylidenebis(2,6-di-t-butylphenol), 2,2'-methylenebis(4-methyl-6-nonylphenol), 2,2'-isobutylidenebis(4,6-dimethylphenol), 2,2'-methylenebis(4-methyl-6-cyclohexylphenol), 2,6-di-t-butyl-4-methylphenol, 2,6-di-t-butyl-4-ethylphenol, 2,4-dimethyl-6-t-butylphenol, 2,6-di-t-amyl-p-cresol, 2,6-di-t-butyl-4-(N,N'-dimethylaminomethylphenol), 4,4'-thiobis(2-methyl-6-t-butylphenol), 4,4'-thiobis(3-methyl-6-t-butylphenol), 2,2'-thiobis(4-methyl-6-t-butylphenol), bis(3-methyl-4-hydroxy-5-t-butylbenzyl)sulfide, bis(3,5-di-t-butyl-4-hydroxybenzyl)sulfide, n-octyl 3-(4-hydroxy-3,5-di-t-butylphenyl)propionate, n-octadecyl 3-(4-hydroxy-3,5-di-t-butylphenyl)propionate, and 2,2'-thio[diethyl-bis-3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate].

Above all, especially preferred are bisphenol-based antioxidants and ester group-containing phenol-based antioxidants.

[0050] Specific examples of the amine-based antioxidant include monoalkyldiphenylamines such as monoctyldiphenylamine and monononyldiphenylamine; dialkyldiphenylamines such as 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine and 4,4'-dinonyldiphenylamine; polyalkyldiphenylamines such as tetrabutylidiphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine and tetranonyldiphenylamine; α -naphthylamine; phenyl- α -naphthylamine; and alkyl-substituted phenyl- α -naphthylamines such as butylphenyl- α -naphthylamine, pentylphenyl- α -naphthylamine, hexylphenyl- α -naphthylamine, heptylphenyl- α -naphthylamine, octylphenyl- α -naphthylamine and nonylphenyl- α -naphthylamine.

Above all, the dialkyldiphenylamine-based and naphthylamines-based antioxidants are preferred.

[0051] As the molybdenum/amine complex-based antioxidants, there may be mentioned, for example, hexavalent molybdenum compounds. Specific examples of such compounds include those which are obtained by reacting molybdenum trioxide and/or molybdic acid with an amine compound and those which are obtained by the production method described in JP-A-2003-252887.

The amine compound to be reacted with the hexavalent molybdenum compound is not particularly limited, and there may be mentioned monoamines, diamines, polyamines and alkanol amines. Specific examples of the amine compound include alkyl amines having an C₁ to C₃₀ alkyl group or groups (the alkyl group may be either linear or branched) such as methylamine, ethylamine, dimethylamine, diethylamine, methylethylamine and methylpropylamine; alkenyl amines containing a C₂ to C₃₀ alkenyl group or groups (the alkenyl group may be linear or branched) such as ethenyl amine, propenyl amine, butenyl amine, octenyl amine and oleyl amine; alkanol amines containing a C₁ to C₃₀ alkanol group or groups (the alkanol group may be linear or branched) such as methanol amine, ethanol amine, methanol ethanol amine and methanol propanol amine; alkylene diamines containing a C₁ to C₃₀ alkylene group or groups such as methylenediamine, ethylenediamine, propylenediamine and butylenediamine; polyamines such as diethylenetriamine, triethylenetetramine, tetraethylenepentamine and pentaethylenehexamine; compounds, such as undeoyldiethylamine, undecyldiethanol amine, dodecyldipropanol amine, oleyldiethanol amine, oleylpropylenediamine and stearyltertraethylenepentamine, which are obtained by further introducing a C₈ to C₂₀ alkyl or alkenyl group into the above monoamines, diamines or polyamines; heterocyclic compounds such as imidazoline; alkyleneoxide adducts of these compounds; and mixtures of these compounds.

In addition, as the molybdenum/amine complex-based antioxidants, there may be mentioned, for example, sulfur-containing molybdenum complexes of succinic imide as described in JP-B-3-22438 and JP-A-2004-2866.

[0052] As the sulfur-based antioxidant, there may be mentioned, for example, phenothiazine, pentaerythritol-tetrakis-(3-lauryl thiopropionate), didodecyl sulfide, dioctadecyl sulfide, didodecyl thiodipropionate, dioctadecyl thiodipropionate, dimyristyl thiodipropionate, dodecyl octadecyl thiodipropionate and 2-mercaptobenzimidazole.

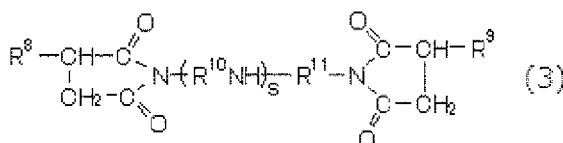
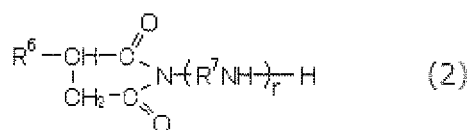
[0053] Among these antioxidants, from the standpoint of reducing a metal content and a sulfur content, phenol-based antioxidants and amine-based antioxidants are preferred. The above antioxidants may be used singly or as a mixture of two or more thereof. From the standpoint of improved oxidation stability, a mixture of one or more kinds of phenol-based antioxidants and one or more kinds of amine-based oxidants is preferably used.

The compounding amount of the antioxidant is generally 0.1% by mass or more and 5% by mass or less, more preferably from 0.1% by mass or more and 3% by mass or less, based on the total mass of the composition.

[0054] As the above-mentioned ashless dispersant, there may be used any ashless dispersant which is generally used for lubricant oils. Examples of the ashless dispersant include a mono-type succinimide compound represented by the following general formula (2) or a bis-type succinimide compound represented by the following general formula (3):

[0055]

[Chemical Formula 3]



[0056] In the above general formulas (2) and (3), R⁶, R⁸ and R⁹ each represent an alkenyl or alkyl group having a number-average molecular weight of 500 to 4,000. The groups R⁸ and R⁹ may be the same or different. The number-average molecular weight of R⁶, R⁸ and R⁹ is preferably from 1,000 to 4,000. When the number-average molecular weight of R⁶, R⁸ and R⁹ is 500 or more, the solubility of the compound in the base oil is good. When the number-average molecular weight is 4,000 or less, there is no fear of deterioration of the detergency.

[0057] In the formulas, R⁷, R¹⁰ and R¹¹ each represent a C₂ to C₅ alkylene group. The groups R¹⁰ and R¹¹ may be the same or different. The symbol r is an integer of 1 to 10, s is 0 or an integer of 1 to 10. The symbol r is preferably 2 to 5, more preferably 3 or 4. When r is 1 or more, good detergency may be obtained. When r is 10 or less, the compound exhibits good solubility in the base oil.

Further, in the general formula (3), s is preferably 1 to 4, more preferably 2 or 3. The symbol s that lies within the above-specified range is preferred for reasons of the detergency and solubility in the base oil.

[0058] Examples of the alkenyl group include a polybutenyl group, a polyisobutenyl group and an ethylene-propylene copolymer group. Examples of the alkyl group include those which are obtained by hydrogenating these alkenyl groups. Typical examples of the suitable alkenyl group include a polybutenyl group and a polyisobutenyl group. The polybutenyl group may be obtained by polymerizing a mixture of 1-butene and isobutene, or high-purity isobutene.

Typical examples of the suitable alkyl group include those which are obtained by hydrogenating a polybutenyl group and a polyisobutenyl group.

[0059] The above alkenylsuccinimide compound or alkylsuccinimide compound may be generally produced by reacting a polyamine with an alkenylsuccinic anhydride obtained by reaction of a polyolefin with maleic anhydride, or with an alkylsuccinic anhydride, obtained by hydrogenating the alkenylsuccinic anhydride. Also, the above mono-type succinimide compound or bis-type succinimide compound may be produced by varying a proportion between the alkenylsuccinic anhydride or alkylsuccinic anhydride and the polyamide to be reacted.

[0060] As an olefin monomer constituting the above polyolefin, there may be used a C₂ to C₈ α-olefin or a mixture of two or more thereof. Among them, a mixture of isobutene and butene-1 may be suitably used.

Examples of the polyamine include primary diamines such as ethylenediamine, propylenediamine, butylenediamine and pentylenediamine; polyalkylene polyamines such as diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenhexamine, di(methylethylene)triamine, dibutylenetriamine, tributyltetramine and pentapentylenhexamine; and piperazine derivatives such as aminoethylpiperazine.

[0061] In addition to the above alkenyl or alkylsuccinimide compound, there may also be used boron derivatives thereof and/or organic acid-modified products thereof as the ashless dispersant.

The boron derivatives of the alkenyl- or alkylsuccinimide compound may be produced by an ordinary method. For example, the boron derivatives may be produced by first reacting the above polyolefin with maleic anhydride to obtain an alkenylsuccinic anhydride, and then reacting the resulting alkenylsuccinic anhydride with an intermediate product obtained by reacting the above polyamine with a boron compound such as boron oxide, a boron halide, boric acid, boric anhydride, a boric acid ester and an ammonium salt of orthoboric acid to imidize the alkenylsuccinic anhydride.

The content of boron in the boron derivatives is not particularly limited, and is preferably in the range of 0.05 to 5% by mass, more preferably 0.1 to 3% by mass, in terms of boron element.

[0062] The compounding amount of the ashless dispersant is preferably 0.5 to 15% by mass, more preferably 1 to 10% by mass, still more preferably 3 to 7% by mass, based on a total amount of the lubricant oil composition.

When the compounding amount is less than 0.5% by mass, the effect on base number retaining property at high temperatures is small. When the compounding amount exceeds 15% by mass, the fluidity at low temperatures of the lubricant

oil composition is considerably deteriorated. Thus, either case is not preferable.

[0063] As the above-mentioned metallic detergent, there may be used any alkaline earth metal-based detergents which are employed for ordinary lubricant oils. Examples of the alkaline earth metal-based detergent include alkaline earth metal sulfonates, alkaline earth metal phenates, alkaline earth metal salicylates and mixtures of two or more thereof.

[0064] As the alkaline earth metal sulfonates, there may be mentioned alkaline earth metal salts of an alkyl aromatic sulfonic acid obtained by sulfonating an alkyl aromatic compound having a molecular weight of 300 to 1,500, preferably 400 to 700. Among them, magnesium salts and/or calcium salts, especially calcium salts are preferred.

[0065] As the alkaline earth metal phenates, there may be mentioned alkaline earth metal salts of alkylphenols, alkylphenol sulfides and Mannich reaction products of alkylphenols. Among them, magnesium salts and/or calcium salts, especially calcium salts are preferred.

[0066] As the alkaline earth metal salicylates, there may be mentioned alkaline earth metal salts of alkyl salicylic acids. Among them magnesium salts and/or calcium salts, especially calcium salts are preferred.

[0067] The alkyl group contained in the compounds constituting the above alkaline earth metal-based detergents is preferably a C₄ to C₃₀ alkyl group which may be linear or branched. More preferred is a C₆ to C₁₈ linear or branched alkyl group.

These alkyl groups may be primary alkyl groups, secondary alkyl groups or tertiary alkyl groups.

[0068] As the alkaline earth metal sulfonates, alkaline earth metal phenates and alkaline earth metal salicylates, there may be mentioned neutral alkaline earth metal sulfonates, neutral alkaline earth metal phenates and neutral alkaline earth metal salicylates which may be produced by directly reacting the above alkyl aromatic sulfonic acids, alkylphenols, alkylphenol sulfides, Mannich reaction products of alkylphenols, alkyl salicylic acids or the like with an alkaline earth metal base such as an oxide or a hydroxide of an alkaline earth metal such as magnesium and/or calcium or which may be produced by once forming an alkali metal salt thereof and then converting the alkali metal salt into an alkaline earth metal salt. Further, there may also be used basic alkaline earth metal sulfonates, basic alkaline earth metal phenates and basic alkaline earth metal salicylates which may be produced by heating neutral alkaline earth metal sulfonates, neutral alkaline earth metal phenates and neutral alkaline earth metal salicylates together with an excess amount of an alkaline earth metal salt or an alkaline earth metal base in the presence of water. Further, there may also be used perbasic alkaline earth metal sulfonates, perbasic alkaline earth metal phenates and perbasic alkaline earth metal salicylates which may be produced by reacting neutral alkaline earth metal sulfonates, neutral alkaline earth metal phenates and neutral alkaline earth metal salicylates with an alkaline earth metal carbonate or an alkaline earth metal borate in the presence of carbon dioxide.

[0069] The metallic detergent used in the present embodiment is preferably an alkaline earth metal salicylate or alkaline earth phenate, especially a perbasic salicylate or perbasic phenate, for reasons of reducing a sulfur content of the composition.

[0070] The total base number of the metallic detergent used in the present embodiment is preferably 10 mg KOH/g or more and 500 mg KOH/g or less, more preferably 15 mg KOH/g or more and 450 mg KOH/g or less. The metallic detergent may be selected from these detergents and used singly or in combination of two or more thereof.

The term "total base number" as used herein means the value as measured by a potentiometric titration method (base number/perchlorate method) according to the Item 7 of JIS K 2501 "Petroleum Products and Lubricants-Neutralization Number Testing Method."

[0071] The metal ratio of the metallic detergent used in the present embodiment is not specifically limited. The metallic detergent having a metal ratio of 20 or less may be generally used singly or as a mixture of two or more thereof. The metallic detergent having a metal ratio of preferably 3 or less, more preferably 1.5 or less, still more preferably 1.2 or less, is particularly suitably used for reasons of further improved oxidation stability, base number retention property, high-temperature detergency, etc.

Meanwhile, the term "metal ratio" as used herein means a ratio represented by the formula: (valence of a metal element) x (content (mol%) of the metal element)/(content (mol%) of a soap group) wherein the metal element is calcium, magnesium, etc., and the soap group is a sulfonic group, a phenol group, a salicylic group, etc.

[0072] The amount of the metallic detergent is preferably 0.01% by mass or more and 20% by mass or less, more preferably 0.1% by mass or more and 10% by mass or less, still more preferably 0.5% by mass or more and 5% by mass or less, based on the total amount of the lubricant oil composition.

A compounding amount of the metallic detergent less than 0.01% by mass is not preferable because performances such as high temperature detergency are not easily obtainable. When the amount of the metallic detergent compounded is 20% by mass or less, an effect proportional to the compounding amount of the metallic detergent may be generally obtained. In spite of the above specified range, however, it is important that the upper limit of the compounding amount of the metallic detergent should be as low as possible, since the metal content, namely sulfuric acid ash content, of the lubricant oil composition is reduced, with the result that the exhaust gas purification device of automobiles is prevented from being deteriorated.

The metallic detergent may be used singly or in combination of two or more thereof as long as the content thereof lies

within the above-specified range.

[0073] In the present embodiment, it is effective to homogeneously disperse or dissolve the sulfonamide compound in the base oil for the purpose of achieving the above-described effects. From this standpoint, the above-mentioned metallic detergent and ashless dispersant may be used in the present embodiment as a dispersion improving agent of the sulfonamide compound.

More specifically, among the above-mentioned metallic detergents, perbasic calcium salicylate and perbasic calcium phenate are particularly preferred. Among the above-mentioned ashless dispersants, the above-mentioned polybutenylsuccinic bisimide is particularly preferred. Meanwhile, it is preferred that perbasic calcium salicylate and perbasic calcium phenate each have a total base number of 100mgKOH/g or more and 500mgKOH/g or less, more preferably 200mgKOH/g or more and 500mgKOH/g or less.

[0074] As the above-mentioned viscosity index improver, there may be mentioned, for example, polymethacrylates, dispersion type polymethacrylates, olefin-based copolymers (such as ethylene-propylene copolymers), dispersion type olefin-based copolymers and styrene-based copolymers (such as styrene-diene copolymers and styrene-isoprene copolymers).

The compounding amount of the viscosity index improver is preferably 0.5 to 15% by mass, more preferably 1 to 10% by mass, based on the total amount of the lubricant oil composition from the standpoint of effects attained by addition thereof.

[0075] As the above-mentioned pour point depressant, there may be mentioned, for example, polymethacrylates having a weight-average molecular weight of about 5,000 or more and about 50,000 or less.

The compounding amount of the pour point depressant is generally 0.1% by mass or more and 2% by mass or less, more preferably 0.1% by mass or more and 1% by mass or less, based on the total amount of the lubricant oil composition from the standpoint of effects attained by addition thereof.

[0076] As the metal deactivator, there may be mentioned, for example, benzotriazole-based compounds, tolyl triazole-based compounds, thiadiazole-based compounds and imidazole-based compounds.

The compounding amount of the metal deactivator is preferably 0.01% by mass or more and 3% by mass or less, more preferably 0.01% by mass or more and 1% by mass or less, based on the total amount of the lubricant oil composition.

[0077] As the rust inhibitor, there may be mentioned, for example, petroleum sulfonates, alkylbenzene sulfonates, dinonylnaphthalene sulfonates, alkenylsuccinic acid esters and polyhydric alcohol esters.

The compounding amount of the rust inhibitor is preferably 0.01% by mass or more and 1% by mass or less, more preferably 0.05% by mass or more and 0.5% by mass or less, based on the total amount of the lubricant oil composition from the standpoint of effects attained by addition thereof.

[0078] As the above-mentioned defoaming agent, there may be mentioned, for example, silicone oils, fluorosilicone oils, and fluoroalkyl ethers. The compounding amount of the defoaming agent is preferably 0.005% by mass or less and 0.5% by mass or less, more preferably 0.01% by mass or more and 0.2% by mass or less, based on the total amount of the lubricant oil composition from the standpoint of a balance between the defoaming effect and economy.

[0079] The lubricant oil composition of the present embodiment may further contain a friction modifier, an anti-wear agent and an extreme pressure agent, if necessary.

As the friction modifier, there may be used any compound generally used as a friction reducing agent for lubricant oils. Examples of the friction reducing agent include ashless friction reducing agents such as compounds containing at least one C₆ to C₃₀ alkyl or alkenyl group in the molecule thereof, e.g. fatty acid esters, fatty acid amides, fatty acids, aliphatic alcohols, aliphatic amines and aliphatic ethers.

The compounding amount of the friction reducing agent is preferably 0.01% by mass or more and 2% by mass or less, more preferably 0.01% by mass or more and 1% by mass or less, based on the total amount of the lubricant oil composition.

[0080] As the anti-wear agent or the extreme-pressure agent, there may be mentioned sulfur containing compounds such as zinc dithiophosphate, zinc phosphate, zinc dithiocarbamate, molybdenum dithiocarbamate, molybdenum dithiophosphate, disulfides, sulfurized olefins, sulfurized oils and fats, sulfurized esters, thiocarbonates, thiocarbamates and polysulfides; phosphorus containing compounds such as phosphorous acid esters, phosphoric acid esters, phosphonic acid esters and amine salts or metal salts of these esters; and sulfur and phosphorus containing anti-wear agents such as thiophosphorous acid esters, thiophosphoric acid esters, thiophosphonic acid esters and amine salts or metal salts of these esters.

[0081] The compounding amount of the anti-wear agent or the extreme-pressure agent to be compounded should be such that the phosphorus content, sulfur content and metal content of the lubricant oil are not excessively large.

[0082] The lubricant oil composition of the present embodiment may be formulated as described in the foregoing and preferably has the following properties:

- (1) the sulfuric acid ash content (JIS K 2272) is 1.2% by mass or less, more preferably 1.0% by mass or less, particularly preferably 0.8% by mass or less;
- (2) the phosphorus content (JPI-5S-38-92) is 0.12% by mass or less, preferably 0.10% by mass or less, particularly

preferably 0.09% by mass or less; and

(3) the sulfur content (JIS K 2541) is 0.12% by mass or less, preferably 0.10% by mass or less, particularly preferably 0.08% by mass or less.

5 Owing to the above properties, the lubricant oil composition of the present embodiment can suppress deterioration of an oxidation catalyst, a three way catalyst, an NOx occlusion reduction catalyst, a diesel particulate filter (DPF), etc. which are used in automobile engines. Further, in addition to the above-mentioned properties, the lubricant oil composition of the present embodiment can also exhibit enhanced basic properties, such as wear resistance, high-temperature

10 **[0083]** The lubricant oil composition of the present embodiment exhibits excellent wear resistance, base number retaining property and high-temperature detergency and, therefore, can extend an oil change interval. Therefore, the lubricant oil composition of the present embodiment can be suitably used as a lubricant oil for use in an internal combustion engine, such as a gasoline engine, a diesel engine or a gas engine, for two-wheeled vehicles, four-wheeled vehicles, power generators, ships or the like, and particularly suited for internal combustion engines equipped with an exhaust gas post treatment device.

15 **[0084]** The lubricant oil composition of the present embodiment is also suitably used as lubricant oils that are required to have oxidation stability, for example, lubricant oils for drive systems such as automatic or manual transmission systems; and other lubricant oils such as grease, wet brake oils, hydraulic fluids, turbine oils, compressor oils, bearing oils and refrigerator oils.

20

[Examples]

[0085] The present invention will be described below in more detail by way of Examples and Comparative Examples. The scope of the present invention, however, is not limited to these examples in any way.

25 Methods for measuring properties and performances:

The properties and performances of the lubricant oil compositions obtained in the following Example and Comparative Example are measured by the methods shown below.

(1) Kinematic viscosity:

30 Measured according to JIS K 2283.

(2) Calcium content and phosphorus content:

Measured according to JPI-5S-38-92.

(3) Zinc content:

Measured according to JPI-5S-38-92.

35 (4) Sulfur content:

Measured according to JIS K 2541.

(5) Sulfuric acid ash content:

Measured according to JIS K 2272.

(6) Amount of eluted copper:

40 Measured according to JPI-5S-38-92.

(7) Base number:

Measured according to JIS K 2501.

(8) Reciprocating Friction Test

45

[0086] Using a SUJ-2 plate, as a test plate, having a hardness (HRC) of 61, a ten-point average surface roughness (Rz) of 0.004 μm and a size of 3.9 mm x 38 mm x 58 mm and an SUJ-2 ball, as a test ball, having a diameter of 10 mm, an abrasion test was carried out with a reciprocating friction tester under the conditions shown below. After completion of the abrasion test, the wear track size of the test ball was measured. The smaller the wear track size of the test ball

50 after completion of the abrasion test, the better is the wear resistance.

-Test Conditions-

[0087]

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Testing temperature: 100°C

Load: 200 N

Amplitude: 15 mm

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Frequency: 10 Hz
Testing time: 30 min

(9) Hot Tube Test

[0088] The hot tube test was carried out at a set temperature of 300°C under the conditions according to JPI-5S-55-99 except for the temperature. The test results were evaluated according to JPI-5S-55-99, i.e., a lacquer deposited on a test tube was evaluated according to 11 ratings from 0 point (black) to 10 point (colorless). The larger the number of the score, the smaller is the amount of the lacquer deposited, namely the better is the high-temperature detergency.

(10) Oxidation Stability Test

[0089] According to JIS K 2514-1996, an oxidation stability test for lubricant oils for internal combustion engines (Indiana Stirring Oxidation Test) was carried out under the following test conditions.

-Test Conditions-

[0090]

Testing temperature: 165.5°C
Rotating speed: 1,300 rpm
Testing time: 96 hours
Catalyst: Copper plate and iron plate

After completion of the oxidation stability test, a base number of the lubricant oil and an amount of copper (amount of eluted copper) were measured. A residual percentage of base number of the oil was calculated according to the formula shown below. Meanwhile, the larger the residual percentage of base number, the better is the long drain property, i.e. the replacement interval is long. Further, the larger the amount of the eluted copper, the larger is the influence on copper-containing metal materials, i.e., the metal materials are apt to be corroded.

Residual percentage of base number (%) = (Base number of lubricant oil composition after the test)/(Base number of lubricant oil composition before the test) x 100

Example 1 and Comparative Example 1:

[0091] The base oil and additives shown in Table 1 were blended in the proportion shown in Table 1 to prepare lubricant oil compositions for internal combustion engines. The properties, formulations and performances of the compositions are also shown in Table 1.

[0092]

[Table 1]

| | | Example 1 | Comparative Example 1 |
|-----------------------------------|---|-----------|-----------------------|
| Compounding amount (% by mass) | Base oil ¹⁾ | 84.65 | 84.15 |
| | Viscosity index improver ²⁾ | 6.50 | 6.50 |
| | Pour point depressant ³⁾ | 0.30 | 0.30 |
| | Metallic detergent ⁴⁾ | 2.35 | 2.35 |
| | Ashless dispersant ⁵⁾ | 5.00 | 5.00 |
| | Phenol-based antioxidant ⁶⁾ | 0.50 | 0.50 |
| | Amine-based antioxidant ⁷⁾ | 0.50 | 0.50 |
| | Zinc dialkyldithiophosphate ⁸⁾ | - | 0.60 |
| | Sulfonamide compound A ⁹⁾ | 0.10 | - |
| Defoaming agent ¹⁰⁾ | 0.10 | 0.10 | |

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(continued)

| | | Example 1 | Comparative Example 1 | | |
|----------|-------------------------|--|---------------------------------------|------|------|
| 5 10 | Properties of fresh oil | Base number (mgKOH/g) | 5.22 | 5.32 | |
| | | Calcium content (% by mass) | 0.19 | 0.19 | |
| | | Phosphorus content (% by mass) | - | 0.05 | |
| | | Zinc content (% by mass) | - | 0.06 | |
| | | Sulfur content (% by mass) | 0.06 | 0.15 | |
| | | Sulfuric acid ash content (% by mass) | 0.61 | 0.71 | |
| 15 20 | Evaluation results | Reciprocating friction test | Wear track size of test ball (mm) | 0.44 | 0.43 |
| | | Hot tube test (300°C) | Evaluation score | 9.5 | 0 |
| | | Oxidation stability test (165.5°C, 96 h) | Base number (mgKOH/g) | 2.34 | 1.57 |
| | | | Base number residual percentage (%) | 44.8 | 29.5 |
| | | | Amount of eluted copper (ppm by mass) | 11 | 180 |

Note:

[0093]

- 1) Hydrogenated refined base oil (kinematic viscosity at 40°C: 21 mm²/s; kinematic viscosity at 100°C: 4.5 mm²/s; viscosity index: 127; %C_A: 0; sulfur content: less than 20 ppm by mass; NOACK test evaporation amount: 13.3% by mass)
- 2) Polymethacrylate (weight average molecular weight: 420,000; resin content: 39% by mass)
- 3) Polyalkyl methacrylate (weight average molecular weight: 6,000)
- 4) Perbasic calcium salicylate (base number (perchlorate method): 225 mg KOH/g; Ca content: 7.8% by mass; sulfur content: 0.3% by mass)
- 5) Bis-polybutenylsuccinimide (average molecular weight of polybutenyl group: 2,000; nitrogen content: 0.99% by mass)
- 6) n-octadecyl 3-(4-hydroxy-3,5-di-t-butylphenyl)propionate
- 7) Dialkyldiphenylamine (nitrogen content: 4.62% by mass)
- 8) Zinc content: 9.0% by mass; phosphorus content: 8.2% by mass; sulfur content: 17.1% by mass; alkyl group: mixture of sec-butyl group and sec-hexyl group
- 9) N-butylbenzenesulfonamide (Trade name: BM-4, manufactured by Daihachi Chemical Industry Co., Ltd.)
- 10) Silicone-based defoaming agent

In Table 1, the symbol - in phosphorous content and zinc content indicates that the content is below detection sensitivity.

[0094] From Table 1, it will be understood that the lubricant oil composition of the Example in which the sulfonamide compound A is compounded shows excellent wear resistance, high-temperature detergency and residual percentage of base number even though it has a low phosphorus content and a low sulfuric acid ash content (Example 1).

In contrast, it is seen that the lubricant oil composition of Comparative Example 1, in which zinc dialkyl dithiophosphate is used in place of the sulfonamide compound A and the compounding amount of the metal-based detergent is changed, shows considerably inferior high-temperature detergency and residual percentage of base number as compared with the lubricant oil composition for internal engines obtained in Example 1, although the wear resistance is comparable. It is also appreciated that the lubricant oil composition of Comparative Example 1 has a higher sulfur content as compared with the composition of the Example.

[Industrial Applicability]

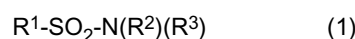
[0095] The present invention is able to provide, at a low cost, a lubricant oil composition which is excellent in wear

resistance, high temperature detergency and base number retaining property, despite its low phosphorus content, low sulfur content and low metal content (sulfuric acid ash content). The present invention can also provide a lubricant oil composition having excellent performances without using zinc dithiophosphate that has been conventionally used as an indispensable additive. The lubricant oil composition according to the present invention, therefore, can be widely and effectively used as a lubricant oil composition for internal combustion engines such as gasoline engines, diesel engines and gas engines.

Claims

1. A lubricant oil composition comprising a base oil and a sulfonamide compound represented by the following general formula (1):

[Formula 1]



wherein R^1 represents one selected from substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups, and R^2 and R^3 each independently represent one selected from a hydrogen atom, substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted alkenyl groups, substituted or unsubstituted alkynyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups, with the proviso that R^2 and R^3 may be taken together to form a ring structure or a condensed ring structure.

2. The lubricant oil composition according to claim 1, wherein at least one of R^2 and R^3 in the general formula (1) represents one selected from substituted or unsubstituted alkyl groups, substituted or unsubstituted cycloalkyl groups, substituted or unsubstituted alkenyl groups, substituted or unsubstituted alkynyl groups, substituted or unsubstituted aryl groups and substituted or unsubstituted heteroaryl groups.
3. The lubricant oil composition according to claim 1 or 2, wherein, when at least one of R^2 and R^3 in the general formula (1) has a substituent or substituents, the substituents of R^2 and R^3 independently represent a C_1 to C_{20} hydrocarbon group.
4. The lubricant oil composition according to claim 1 or 2, wherein at least one of R^2 and R^3 in the general formula (1) represents one selected from unsubstituted alkyl groups, unsubstituted cycloalkyl groups, unsubstituted alkenyl groups, unsubstituted alkynyl groups, unsubstituted aryl groups and unsubstituted heteroaryl groups.
5. The lubricant oil composition according to any one of claims 1 to 4, wherein R^1 in the general formula (1) represents one selected from unsubstituted alkyl groups, unsubstituted cycloalkyl groups, unsubstituted aryl groups and unsubstituted heteroaryl groups.
6. The lubricant oil composition according to any one of claims 1 to 5, wherein the lubricant oil composition has a phosphorus content of 0.12% by mass or less and a sulfuric acid ash content of 1.2% by mass or less, each based on the mass of the composition.
7. The lubricant oil composition according to any one of claims 1 to 6, wherein the lubricant oil composition is used for an internal combustion engine.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/059623

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|--|---|--|
| A. CLASSIFICATION OF SUBJECT MATTER <i>C10M135/10</i> (2006.01) i, <i>C10M101/02</i> (2006.01) i, <i>C10N20/00</i> (2006.01) n, <i>C10N30/00</i> (2006.01) n, <i>C10N30/06</i> (2006.01) n, <i>C10N30/08</i> (2006.01) n, <i>C10N40/25</i> (2006.01) n According to International Patent Classification (IPC) or to both national classification and IPC | | |
| B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) <i>C10M135/10</i> , <i>C10M101/02</i> , <i>C10N20/00</i> , <i>C10N30/00</i> , <i>C10N30/06</i> , <i>C10N30/08</i> , <i>C10N40/25</i> | | |
| Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2010 Kokai Jitsuyo Shinan Koho 1971-2010 Toroku Jitsuyo Shinan Koho 1994-2010 | | |
| Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) | | |
| C. DOCUMENTS CONSIDERED TO BE RELEVANT | | |
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| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex. | | |
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| Date of the actual completion of the international search 29 June, 2010 (29.06.10) | | Date of mailing of the international search report 13 July, 2010 (13.07.10) |
| Name and mailing address of the ISA/ Japanese Patent Office | | Authorized officer |
| Facsimile No. | | Telephone No. |

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2010/059623

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