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(54) LUBRICANT OIL COMPOSITION

(57) The object of the invention is to provide a lubricant oil composition, particularly a lubricant oil composition capable of maximizing the friction reducing effect. The lubricant oil composition of the invention contains a base oil (A) wherein the sulfur content is not less than 0.03 mass%, and the mass ratio [$\%C_A$ (mass%)/sulfur content (mass%)] between the aromatic content ($\%C_A$) and the sulfur content is not more than 30, and a metal salicylate-based detergent (B) in not more than 3 mass% as an alkali metal or alkali earth metal amount based on the total amount of the composition.

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Description

TECHNICAL FIELD

[0001] This invention relates to a lubricant oil composition, more specifically to a lubricant oil composition preferably used in an application such as a lubricant oil composition for an internal combustion engine.

BACKGROUND ART

[0002] To a lubricant oil composition for internal combustion engines, in order to improve fuel saving property, an organic molybdenum compound, particularly molybdenum dithiocarbamate (MoDTC) is often added as a friction modifier (e.g., see Patent Documents 1 to 3 below). However, since MoDTC is poor at maintaining effect and is likely to poison an exhaust gas treatment catalyst with the metal content, a friction modifier to replace MoDTC has been sought.

[0003] Thus, in particular, as a friction modifier having no influence on an exhaust gas treatment catalyst, development of an amphipathic molecule having a polar portion and an oil soluble portion, more specifically an oil soluble surfactant type ashless friction modifier has been attempted. However, while ashless friction modifiers which have been developed so far have an effect to some extent, one with a similar or better performance than MoDTC has not yet been discovered.

[0004] On the other hand, to a lubricant oil composition for internal combustion engines, in order to improve high temperature detergency and acid neutralizing property, various additives are added (e.g., see Patent Documents 4 to 5 below). However, these additives generally act in the direction of increasing friction, and inhibit the fuel saving effect.

PRIOR ART DOCUMENTS

Patent Documents

[0005]

Patent Document 1: JP-A-H06-336592

Patent Document 2: JP-A-H06-336593

Patent Document 3: WO-A-2009/104682

Patent Document 4: JP-A-2004-067808

Patent Document 5: JP-A-2003-277782

SUMMARY OF INVENTION

(Technical Problem)

[0006] Under such circumstances, the object of the invention is to provide a lubricant oil composition capable of maximizing the friction reducing effect by optimizing a base oil and an additive other than a friction modifier used in a lubricant oil composition, particularly a lubricant oil composition for an internal combustion engine.

(Solution to Problem)

[0007] The inventors have, as a result of devoted studies for achieving the above object, found that a lubricant oil composition capable of maximizing the friction reducing effect can be obtained by optimizing the sulfur content and the aromatic content of a base oil, and a certain metal-based detergent, and completed the invention.

[0008] Thus, the invention is a lubricant oil composition containing:

a base oil (A), wherein the sulfur content is not less than 0.03 mass%, and the mass ratio [$\%C_A$ (mass%)/sulfur content (mass%)] between the aromatic content ($\%C_A$) and the sulfur content is not more than 30, and;
a metal salicylate-based detergent (B) in not more than 3 mass% as an alkali metal or alkali earth metal amount based on the total amount of the composition.

[0009] In a preferred example of the lubricant oil composition of the invention, the carbon number of an alkyl chain of

a soap group of the metal salicylate-based detergent (B) is not less than 10 as an average.

[0010] In another preferred example of the lubricant oil composition of the invention, the metal salicylate-based detergent (B) is an overbased calcium carbonate salicylate.

[0011] The lubricant oil composition of the invention is preferable to be a lubricant oil composition for an internal combustion engine.

[0012] Also, the invention is a method for improving the fuel saving property of an internal combustion engine by using the above lubricant oil composition.

(Advantageous Effect of Invention)

[0013] According to the invention, it is possible to provide a lubricant oil composition, particularly a lubricant oil composition for an internal combustion engine, excellent in fuel saving property and capable of sufficiently reducing friction under boundary lubrication conditions and under mixed lubrication conditions even without a friction modifier.

DESCRIPTION OF EMBODIMENTS

[0014] Preferred embodiments of the invention will be described in detail below. The lubricant oil composition of the invention contains a base oil (A) wherein the sulfur content is not less than 0.03 mass%, and the mass ratio [$\%C_A$ (mass%)/sulfur content (mass%)] between the aromatic content ($\%C_A$) and the sulfur content is not more than 30, and a metal salicylate-based detergent (B) in not more than 3 mass% as an alkali metal or alkali earth metal amount based on the total amount of the composition.

[0015] In the base oil (A) of the lubricant oil composition of the invention, the sulfur content is not less than 0.03 mass%, preferably not less than 0.1 mass%, further preferably not less than 0.2 mass%, further more preferably not less than 0.3 mass%, particularly preferably not less than 0.4 mass%, most preferably not less than 0.5 mass%. Also, in the based oil (A), the sulfur content is preferably not more than 1.2 mass%, further preferably not more than 1 mass%, further more preferably not more than 0.8 mass%, particularly preferably not more than 0.7 mass%. With the sulfur content of the base oil (A) of not less than 0.03 mass%, friction is reduced, and when it is used as a lubricant oil for an internal combustion engine, a lubricant oil composition excellent in fuel saving property can be obtained. However, with the sulfur content of the base oil (A) of more than 1.2 mass%, oxidation stability of the lubricant oil composition deteriorates, sludge and the like easily occur, which are not preferable.

[0016] It should be noted that the "sulfur content" herein refers to a value measured according to JIS K 2541-4 "Energy Dispersive X-ray Fluorescence Method" (normally, within a range of 0.01 to 5 mass%) or JIS K 2541-5 "General Bomb Method, Supplementary Notes (Rules), Inductively Coupled Plasma Atomic Emission Spectrometry" (normally, not less than 0.05 mass%).

[0017] In the base oil (A) of the lubricant oil composition of the invention, the mass ratio [$\%C_A$ (mass%)/sulfur content (mass%)] between the aromatic content ($\%C_A$) and the sulfur content is not more than 30, preferably not more than 15, more preferably not more than 12, and also, preferably not less than 5, more preferably not less than 7. With the $\%C_A$/sulfur content of the base oil (A) of not more than 30, the friction reducing effect increases, while with that of less than 5, the influence of sulfur becomes too much, and the friction coefficient is concerned to be large conversely.

[0018] Moreover, although the $\%C_A$ of the above base oil (A) is not particularly limited as long as it meets the ranges of the mass ratio [$\%C_A$ (mass%)/sulfur content (mass%)] between the aromatic content ($\%C_A$) and the sulfur content as described above, it is preferably not more than 20, more preferably not more than 15, particularly preferably not more than 10, in terms of oxidation stability. It should be noted that the $\%C_A$ is obtained by a method according to ASTM D 3238 (n-d-M ring analysis).

[0019] The base oil (A) of the lubricant oil composition of the invention is not limited as long as the sulfur content is not less than 0.03 mass% and the mass ratio [$\%C_A$ (mass%)/sulfur content (mass%)] between the aromatic content ($\%C_A$) and the sulfur content is not more than 30. Therefore, the base oil (A) may contain at least one kind of sulfur containing mineral base oils shown below, alone or in combination with one kind or two or more kinds of other mineral base oils or synthetic base oils.

[0020] The above mineral base oil specifically includes one formed by vacuum distilling an atmospheric residue obtained by atmospheric distilling a crude oil to obtain a lubricant oil fraction, and refining it in one or more treatments such as solvent deasphalting, solvent extraction, hydrogenolysis, solvent dewaxing and hydrogenation refining.

[0021] Also, as an example of a base oil hardly containing sulfur, a wax isomerized mineral oil, a base oil produced by a method of isomerizing GTL WAX (gas-to-liquid wax), a synthetic base oil, and the like can be exemplified.

[0022] As the above synthetic base oil, specifically, polybutene or hydride thereof; poly-α-olefin such as 1-octene oligomer and 1-decene oligomer or hydride thereof; diester such as ditridecyl glutarate, di-2-ethylhexyl adipate, diisodecyl adipate, ditridecyl adipate, di-2-ethylhexyl sebacate; polyol ester such as neopentyl glycol ester, trimethylol propane caprylate, trimethylol propane pelargonate, pentaerythritol-2-ethylhexanoate and pentaerythritol pelargonate; aromatic

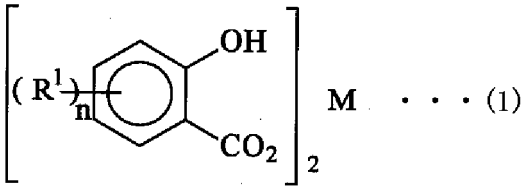
synthetic oil such as alkylnaphthalene, alkylbenzene, and aromatic ester or mixture thereof, and the like can be exemplified.

[0023] Moreover, although the kinematic viscosity of the above base oil (A) is not particularly limited, its kinematic viscosity at 100°C is preferably not more than 20 mm^2/s, more preferably not more than 15 mm^2/s, particularly preferably not more than 10 mm^2/s. On the other hand, the kinematic viscosity at 100°C of the base oil (A) is preferably not less than 1 mm^2/s, more preferably not less than 2 mm^2/s. With the kinematic viscosity at 100°C of the base oil (A) of more than 20 mm^2/s, low temperature viscosity property deteriorates, while with the kinematic viscosity at 100°C of less than 1 mm^2/s, lubricity is poor due to insufficient oil film formation at a lubrication point, and also the evaporation loss of a lubricant base oil is large, which are both not preferable.

[0024] Furthermore, although the viscosity index of the above base oil (A) is not particularly limited and is normally not more than 200, its viscosity index is preferably not less than 80, further preferably not less than 100, particularly preferably not less than 120, so that excellent viscosity property can be obtained from a low temperature to a high temperature. When the viscosity index of the base oil (A) is less than 80, low temperature viscosity property tends to deteriorate. Also, the viscosity index of the base oil (A) is preferable to be not more than 160.

[0025] The lubricant oil composition of the invention contains a metal salicylate-based detergent (B). Here, as the metal salicylate-based detergent (B), a metal salicylate represented by the following general formula (1), and/or its (over)basic salt are preferable.

[Chem. 1]



[0026] In the above general formula (1), R^1 is an alkyl group or alkenyl group, M represents an alkali metal or alkali earth metal, preferably calcium or magnesium, particularly preferably calcium, and n is 1 or 2.

[0027] Moreover, as the above metal salicylate-based detergent (B), alkali metal or alkali earth metal salicylate preferably having one alkyl group or alkenyl group within a molecule, and/or its (over)basic salt are preferable.

[0028] The method for producing the above alkali metal or alkali earth metal salicylate is not particularly limited, and a publicly known method for producing monoalkyl salicylate and the like can be used. For example, the above alkali earth metal salicylate can be obtained by subjecting a monoalkylsalicylic acid obtained by using a phenol as a starting raw material, alkylating it using olefin and carboxylating it with a carbon dioxide gas and the like, a monoalkylsalicylic acid obtained by using a salicylic acid as a starting raw material and alkylating it using an equivalent of the above olefin, or the like, to a reaction with a metal base such as an oxide and hydroxide of an alkali metal or alkali earth metal, conversion to an alkali metal salt such as a sodium salt and potassium salt once, then substitution it with an alkali earth metal salt, or the like.

[0029] The metal salicylate-based detergent (B) for use in the lubricant oil composition of the invention includes, not only a neutral salt as obtained above, but also a basic salt obtained by heating the neutral salt and an additional excessive alkali metal or alkali earth metal salt or alkali metal or alkali earth metal base (hydroxide or oxide of alkali metal or alkali earth metal) in the presence of water, or an overbased salt obtained by reacting the neutral salt with a base such as hydroxide of alkali metal or alkali earth metal in the presence of a carbon dioxide gas, or boric acid or borate.

[0030] In the lubricant oil composition of the invention, the content of the metal salicylate-based detergent (B) is not more than 3 mass%, preferably 0.05 to 2 mass%, further preferably 0.05 to 1.5 mass%, further more preferably 0.05 to 0.8 mass%, particularly preferably 0.05 to 0.5 mass%, most preferably 0.05 to 0.25 mass% as an alkali metal or alkali earth metal amount based on the total amount of the composition. With the content of the metal salicylate-based detergent (B) based on the total amount of the composition of less than 0.05 mass% as an alkali metal or alkali earth metal amount, a friction reducing effect is not sufficiently exerted, which is not preferable, while with that of more 3 mass%, a friction reducing effect is decreased.

[0031] As the metal salicylate-based detergent (B) for use in the lubricant oil composition of the invention, it is preferable to use one with a metal ratio of normally 1.0 to 30. A metal salicylate-based detergent with a metal ratio of less than 1.0 has an acid remained and is likely to have corrosive property, while a metal salicylate-based detergent with a metal ratio of not less than 30 is unstable and is likely to generate a precipitate, which are not preferable. Here, the metal ratio of the metal salicylate-based detergent (B) is represented by the valence number of a metal-based element in a salicylate-based detergent x metal element content (mol%) / soap group content (mol%), the metal element means calcium, magnesium and the like, and the soap group means a salicylic acid group and the like.

[0032] In the above general formula (1), the carbon number of R^1 is preferably 10 to 40, more preferably 14 to 30, further preferably not less than 20. Also, R^1 is preferably an alkyl group, more preferably a secondary alkyl group. With the carbon number of R^1 of less than 10, a sufficient friction reducing effect cannot be obtained, while with the carbon number of R^1 of more than 40, the low temperature flow property as a lubricant oil composition deteriorates, which is not preferable.

[0033] In the metal salicylate-based detergent (B) for use in the lubricant oil composition of the invention, the carbon number of an alkyl chain of a soap group is preferable to be not less than 10 as an average. When the carbon number of an alkyl chain of a soap group is not less than 10 as an average, a sufficient friction reducing effect can be obtained.

[0034] As the metal salicylate-based detergent (B) for use in the lubricant oil composition of the invention, an overbased calcium carbonate salicylate is preferable. The overbased calcium carbonate salicylate is one obtained by overbasing with calcium carbonate a neutral calcium salicylate which is obtained by a method of neutralizing a hydrocarbon group substituted salicylic acid with an equivalent of a calcium base such as calcium hydroxide and calcium oxide, and the like.

[0035] To the lubricant oil composition of the invention, other than the metal salicylate-based detergent (B) describe above, in order to further improve its acid neutralizing property, high temperature detergency and anti-wear property, a metal-based detergent such as a sulfonate-based detergent, phenate-based detergent and carboxylate-based detergent can be added. Here, the metal-based detergent other than the metal salicylate-based detergent (B) includes, for example, alkali metal sulfonate or alkali earth metal sulfonate, alkali metal phenate or alkali earth metal phenate, alkali metal carboxylate or alkali earth metal carboxylate, mixture thereof, or the like.

[0036] As the above alkali metal or alkali earth metal sulfonate, more specifically, for example an alkali metal salt or alkali earth metal salt, particularly a magnesium salt and/or calcium salt of an alkyl aromatic sulfonic acid obtained by sulfonating an alkyl aromatic compound with a molecular weight of 100 to 1500, preferably 200 to 700 is preferably used, and as the alkyl aromatic sulfonic acid, a so-called petroleum sulfonic acid, synthetic sulfonic acid and the like are specifically included.

[0037] As the above alkali metal or alkali earth metal phenate, more specifically, an alkali metal salt or alkali earth metal salt, particularly a magnesium salt and/or calcium salt of alkylphenol having at least one linear or branched alkyl group with a carbon number of 4 to 30, preferably 6 to 18, alkylphenol sulfide obtained by reacting this alkylphenol with an elemental sulfur, or a Mannich reaction product of alkylphenol obtained by reacting this alkylphenol with formaldehyde, and the like are preferably used.

[0038] As the above alkali metal or alkali earth metal carboxylate, more specifically, an alkali metal salt or alkali earth metal salt, particularly a magnesium salt and/or calcium salt of an alkyl benzoic acid having at least one linear or branched alkyl group with a carbon number of 4 to 30, preferably 6 to 18, and the like are preferably used.

[0039] Moreover, metal-based detergents are normally on market and also available in a state of being diluted by a light lubricant base oil and the like. Generally, it is desirable to use one with a metal content of 1.0 to 20 mass%, preferably 2.0 to 16 mass%. Furthermore, the total base number of the metal-based detergents is normally 0 to 500 mg KOH/g, preferably 20 to 450 mg KOH/g. It should be noted that the total base number herein refers to a total base number measured by a perchloric acid method according to 7. of JIS K2501 "Petroleum Products and Lubricants - Determination of Neutralization Number".

[0040] Also, the lubricant oil composition of the invention is preferable to further contain an ashless dispersant. As the ashless dispersant, an optional ashless dispersant for use in lubricant oils can be used, and for example, a nitrogen containing compound having at least one linear or branched alkyl group or alkenyl group with a carbon number of 40 to 400 within a molecule or its derivative, a modified product of alkenylsuccinimide, benzylamine, polyamine, or the like is included. To the lubricant oil composition of the invention, one kind or two or more kinds optionally selected from them can be formulated.

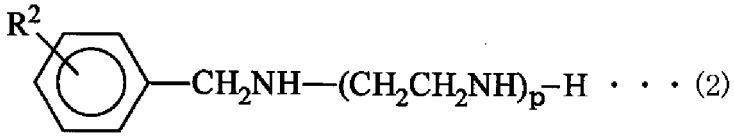
[0041] The carbon number of an alkyl group or alkenyl group of alkenylsuccinimide is preferably 40 to 400, more preferably 60 to 350. With the carbon number of an alkyl group or alkenyl group of less than 40, the solubility of a compound in a lubricant base oil tends to decrease, while with the carbon number of an alkyl group or alkenyl group of more than 400, the low temperature flow property of a lubricant oil composition tends to deteriorate. Although this alkyl group or alkenyl group may be linear or branched, specifically, a branched alkyl group or branched alkenyl group derived from an oligomer of olefin such as propylene, 1-butene and isobutylene or a cooligomer of ethylene and propylene, and the like are preferably included.

[0042] The lubricant oil composition of the invention may contain either or both of monotype or bistype succinimides.

[0043] The method for producing succinimide is not particularly limited, and it can be obtained by, for example reacting an alkylsuccinic acid or alkenylsuccinic acid obtained by reacting a compound having an alkyl group or alkenyl group with a carbon number of 40 to 400 with maleic anhydride at 100 to 200°C with a polyamine. As the polyamine, specifically, diethylene triamine, triethylene tetramine, tetraethylene pentamine, pentaethylene hexamine, and the like can be exemplified.

[0044] As the above benzylamine, more specifically, a compound represented by the following general formula (2), and the like can be exemplified.

[Chem. 2]



[0045] In the above general formula (2), R^2 represents an alkyl group or alkenyl group with a carbon number of 40 to 400, preferably 60 to 350, and p represents an integer of 1 to 5, preferably 2 to 4.

[0046] Although the method for producing the above benzylamine is not particularly limited, for example, it can be obtained by reacting a polyolefin such as a propylene oligomer, polybutene, and ethylene-α-olefin copolymer with a phenol into alkylphenol, and then reacting it with formaldehyde and polyamine such as diethylene triamine, triethylene tetramine, tetraethylene pentamine, and pentaethylene hexamine by a Mannich reaction.

[0047] As the above polyamine, more specifically, a compound represented by the following general formula (3), and the like can be exemplified.

$$R^3\text{-NH-}(CH_2CH_2NH)_q\text{-H} \qquad (3)$$

[0048] In the above general formula (3), R^3 represents an alkyl group or alkenyl group with a carbon number of 40 to 400, preferably 60 to 350, and q represents an integer of 1 to 5, preferably 2 to 4.

[0049] Although the method for producing the above polyamine is not particularly limited, for example, it can be obtained by chlorinating a polyolefin such as a propylene oligomer, polybutene, and ethylene-α-olefin copolymer, and then reacting it with ammonia and polyamine such as ethylene diamine, diethylene triamine, triethylene tetramine, tetraethylene pentamine and pentaethylene hexamine.

[0050] Moreover, the derivative of the nitrogen containing compound exemplified as one example of the ashless dispersant specifically includes, for example, a so-called acid modified compound formed by reacting the nitrogen containing compound described above with a monocarboxylic acid with a carbon number of 1 to 30 (fatty acid, etc.) and a polycarboxylic acid with a carbon number of 2 to 30 such as an oxalic acid, phthalic acid, trimellitic acid and pyromellitic acid to partially or totally neutralize, or amidate a remaining amino group and/or imino group; a so-called boron modified compound formed by reacting the nitrogen containing compound described above with a boric acid to partially or totally neutralize, or amidate a remaining amino group and/or imino group; a sulfur modified compound formed by reacting the nitrogen containing compound described above with a sulfur compound; a modified compound formed by subjecting the nitrogen containing compound described above to two or more kinds of modifications selected from acid modification, boron modification and sulfur modification in combination; and the like. Among these derivatives, a boron modified compound of alkenylsuccinimide is excellent in heat resistance property and anti-oxidizing property, and is also effective for improving base number maintaining property and high temperature detergency in the lubricant oil composition of the invention.

[0051] When an ashless dispersant is contained in the lubricant oil composition of the invention, its content is normally 0.01 to 20 mass%, preferably 0.1 to 10 mass% based on the total amount of the lubricant oil composition. With the content of the ashless dispersant in the lubricant oil composition of less than 0.01 mass%, an effect on base number maintaining property under a high temperature is small, while with that of more than 20 mass%, the low temperature flow property of the lubricant oil composition hugely deteriorates, which are both not preferable.

[0052] Also, the lubricant oil composition of the invention is preferable to further contain a radical scavenger type antioxidant. By containing a radical scavenger type antioxidant, anti-oxidizing property of a lubricant oil composition is further improved, and therefore base number maintaining property and high temperature detergency in the invention can further be improved.

[0053] As the above radical scavenger type antioxidant, a phenol-based antioxidant, amine-based antioxidant, metal-based antioxidant and the like which are generally used in lubricant oils can be used. Further, the above phenol-based antioxidant and amine-based antioxidant may be used in combination.

[0054] When the radical scavenger type antioxidant is contained in the lubricant oil composition of the invention, its content is normally not more than 5.0 mass%, preferably not more than 3.0 mass%, further preferably not more than 2.5 mass% based on the total amount of the lubricant oil composition. When the content of the radical scavenger type antioxidant is more than 5.0 mass%, a sufficient anti-oxidizing property corresponding to the content cannot be obtained, which is not preferable. On the other hand, the content of the radical scavenger type antioxidant is, in order to further improve the base number maintaining property and the high temperature detergency in a lubricant oil deterioration process, preferably not less than 0.1 mass%, more preferably not less than 1 mass% based on the total amount of the lubricant oil composition.

[0055] To the lubricant oil composition of the invention, in order to further improve its performance, an optional additive which is generally used in lubricant oils depending on its purpose can be added. Such an additive can include, for example, an additive such as anti-wear additive, friction modifier, viscosity index improver, anti-corrosive additive, anti-rust additive, anti-emulsifying additive, metal deactivating additive, anti-foaming additive and coloring additive, and the like.

[0056] As the above anti-wear additive, a phosphorous compound or sulfur compound can be used. Although zinc carbyldithiophosphate is a representative example as the phosphorous compound, other than that, a phosphate or phosphite containing no sulfur, and a metal salt thereof are also preferably used. Moreover, the sulfur compound includes, for example, a sulfur containing compound such as a disulfide, sulfurized olefin, sulfurized grease, metal dithiophosphate salt (zinc salt, molybdenum salt, etc.), metal dithiocarbamate salt (zinc salt, molybdenum salt, etc.), dithiophosphate ester and derivative thereof (reaction product with olefin cyclopentadiene, (methyl)methacrylic acid, propionic acid and the like; an addition product at a β position is preferable in the case of a propionic acid), trithiophosphate ester and dithiocarbamate ester, and the like. While they can normally be contained within a range of 0.005 to 5 mass% unless they largely deteriorate the performance of the lubricant oil composition of the invention, the content is preferably not more than 0.1 mass%, more preferably not more than 0.05 mass % as a sulfur conversion value, in terms of low sulfurization and long drain property.

[0057] As the above friction modifier, an optional compound which is normally used as a friction modifier for lubricant oils can be used, and for example, a molybdenum-based friction modifier such as molybdenum disulfide, molybdenum dithiocarbamate, molybdenum dithiophosphate and molybdenum amine complex can be used within a range having no influence on an exhaust gas treatment apparatus as a composition. Also, an ashless friction modifier such as an amine compound, fatty acid ester, fatty acid amide, fatty acid, aliphatic alcohol, aliphatic ether, hydrazide (oleyl hydrazide, etc.), semicarbazide, urea, ureide and biuret, having at least one alkyl group or alkenyl group with a carbon number of 6 to 30, particularly linear alkyl group or linear alkenyl group with a carbon number of 6 to 30 within a molecule, and the like are included. The content of these friction modifiers is normally 0.1 to 5 mass%.

[0058] The above viscosity index improver, specifically, includes a so-called non-dispersed type viscosity index improver such as a polymer or copolymer of one kind or two or more kinds of monomers selected from various methacrylate esters or hydrogenated product thereof, or a so-called dispersed type viscosity index improver having various methacrylate esters further containing a nitrogen compound copolymerized, a non-dispersed type or dispersed type ethylene-α-olefin copolymer (as α-olefin, propylene, 1-butene, 1-pentene, and the like can be exemplified) or hydride thereof, polyisobutylene or a hydrogenated product thereof, a hydride of a styrene-diene copolymer, a styrene-maleic anhydride ester copolymer, polyalkylstyrene, and the like.

[0059] The molecular weight of the above viscosity index improver is preferable to be selected by considering shear stability. Specifically, the number average molecular weight of the viscosity index improver is, for example, normally 5,000 to 1,000, 000, preferably 100,000 to 900,000 in the case of dispersed type and non-dispersed type polymethacrylates, normally 800 to 5,000, preferably 1,000 to 4,000 in the case of polyisobutylene or hydride thereof, normally 800 to 500,000, preferably 3,000 to 200,000 in the case of an ethylene-α-olefin copolymer or hydride thereof.

[0060] Moreover, among the above viscosity index improvers, when an ethylene-α-olefin copolymer or hydride thereof is used, a lubricant oil composition particularly excellent in shear stability can be obtained. In the lubricant oil composition of the invention, one kind or two or more kinds of compounds optionally selected from the above viscosity index improvers can be contained in an optional amount. The content of the viscosity index improver is normally 0.1 to 20 mass% based on the lubricant oil composition.

[0061] The above anti-corrosive additive includes, for example, benzotriazole-based, tolyltriazole-based, thiadiazole-based and imidazole-based compounds, and the like.

[0062] The above anti-rust additive includes, for example, petroleum sulfonate, alkylbenzene sulfonate, dinonylnaphthalene sulfonate, alkenylsuccinate ester, polyhydric alcohol ester, and the like.

[0063] The above anti-emulsifying additive includes, for example, a polyalkylene glycol-based nonionic surfactant such as a polyoxyethylene alkylether, polyoxyethylene alkylphenylether and polyoxyethylene alkylnaphthylether, and the like.

[0064] The above metal deactivating additive includes, for example, an imidazoline or pyrimidine derivative, alkylthiadiazole, mercaptobenzothiazole, benzotriazole or a derivative thereof, 1,3,4-thiadiazole polysulfide, 1,3,4-thiadiazolyl-2,5-bisdialkyldithiocarbamate, 2-(alkyldithio)benzoimidazole, β-(o-carboxybenzylthio)propionitrile, and the like.

[0065] The above anti-foaming additive includes, for example, silicone, fluorosilicone, fluoroalkylether, and the like.

[0066] When these additives are contained in the lubricant oil composition of the invention, the content is normally selected within a range of 0.005 to 5 mass% for the anti-corrosive additive, anti-rust additive and anti-emulsifying additive, 0.005 to 1 mass% for the metal deactivating additive, 0.0005 to 1 mass% for the anti-foaming additive.

EXAMPLES

[0067] Although the invention will be further specifically described based on Examples and Comparative Examples below, the invention is not limited to the following examples.

[0068] In the Examples and Comparative Examples below, the friction reducing effect was evaluated by using a TE77 reciprocating friction testing machine manufactured by Phoenix Tribology (here, the test plate has a material of BS4659 and a shape of 58 mm length x 38 mm width x 4 mm thickness, and the test cylinder pin has a material of EN1A and a shape of 6 mm diameter x 16 mm length), running in at a stroke of 15 mm, 20 Hz, an oil temperature of 150°C and a load of 300 N for 30 minutes, and then measuring the friction coefficient at a stroke of 15 mm, 1 Hz, an oil temperature of 150°C and a load of 200 N.

[0069] Characteristics of base oils used in the Examples and Comparative Examples are shown in Table 1, and characteristics of metal salicylate-based detergents used in the Examples and Comparative Examples are shown in Table 2. It should be noted that in Tables 3 to 6, the amount of a base oil is the content ratio in the base oil, while the amount of salicylate is the content based on the total amount of the composition.

[Table 1]

		Base Oil A-1	Base Oil A-2	Base Oil A-3	Base Oil A-4
Kinematic Viscosity (40°C)	mm^2/s	100.4	90.98	76.16	93.86
Kinematic Viscosity (100°C)	mm^2/s	11.18	10.50	9.793	10.76
Viscosity Index		96	97	108	98
Sulfur Content	mass%	0.61	less than 10 mass ppm	0.02	0.17
n-d-m Analysis					
$\%C_P$	%	66.1	66.3	71.2	67.3
$\%C_N$	%	27.1	33.7	25.9	27.0
$\%C_A$	%	6.8	0.0	2.9	5.7

[Table 2]

	Alkyl Chain Length (Carbon Number)	Base Number (BN) (mgKOH/g)	Metal Ratio	Ca Content (mass%)
Salicylate B-1	20-30	320	7.3	11.4
Salicylate B-2	14-18	280	14.9	10.0

[Examples 1 to 6 and Comparative Examples 1 to 2]

[0070] Lubricant oil compositions with formulations shown in Table 3 were prepared and measured for the friction coefficient.

[Table 3]

		Comp. Ex. 1	Comp. Ex. 2	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6
Base Oil A-1	mass%	-	-	5	15	25	50	75	100
Base Oil A-2	mass%	100	-	95	85	75	50	25	-
Base Oil A-3	mass%	-	100	-	-	-	-	-	-
Salicylate B-1	mass%	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
Base Number (BN)	mgKOH/g	5	5	5	5	5	5	5	5
Ca Amount	mass%	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18

(continued)

		Comp. Ex. 1	Comp. Ex. 2	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6
$\%C_A$ of Base Oil	mass%	0.00	2.90	0.34	1.02	1.70	3.40	5.10	6.80
Sulfur Content of Base Oil (S)	mass%	0	0.02	0.03	0.09	0.15	0.31	0.46	0.61
$\%C_A$/S of Base Oil	-	-	145	11	11	11	11	11	11
Friction Coefficient	200N 1Hz	0.079	0.070	0.067	0.066	0.064	0.064	0.061	0.056

[0071] Table 3 shows the influence of the sulfur content of a base oil in Examples 1 to 6 and Comparative Examples 1 to 2. From Table 3, it is clear that when the sulfur content of a base oil is not less than 0.03 mass%, the friction coefficient becomes small.

[Examples 3, 7 and 8, and Comparative Example 3]

[0072] Lubricant oil compositions with formulations shown in Table 4 were prepared and measured for the friction coefficient.

[Table 4]

		Ex. 3	Ex. 7	Ex. 8	Comp. Ex. 3
Base Oil A-1	mass%	25	22	10	-
Base Oil A-2	mass%	75	-	-	-
Base Oil A-3	mass%	-	78	90	14
Base Oil A-4	mass%	-	-	-	86
Salicylate B-1	mass%	1.56	1.56	1.56	1.56
Base Number (BN)	mgKOH/g	5	5	5	5
Ca Amount	mass%	0.18	0.18	0.18	0.18
$\%C_A$ of Base Oil	mass%	1.70	3.76	4.37	5.31
Sulfur Content of Base Oil (S)	mass%	0.15	0.15	0.15	0.15
$\%C_A$/S of Base Oil	-	11	25	29	36
Friction Coefficient	200N 1Hz	0.064	0.065	0.068	0.074

[0073] Table 4 shows the influence of the ratio between the aromatic content ($\%C_A$) and the sulfur content (S) of a base oil in Examples 3, 7 and 8, and Comparative Example 3. From Table 4, it is clear that when the $\%C_A$/S of a base oil is not more than 30, the friction coefficient becomes small.

[Examples 6, 9 and 10, and Comparative Examples 1 and 4 to 7]

[0074] Lubricant oil compositions with formulations shown in Table 5 were prepared and measured for the friction coefficient.

[Table 5]

		Ex. 6	Ex. 9	Ex. 10	Comp. Ex. 4	Comp. Ex. 1	Comp. Ex. 5	Comp. Ex. 6
Base Oil A-1	mass%	100	100	100	100	-	-	-
Base Oil A-2	mass%	-	-	-	-	100	100	100
Salicylate B-1	mass%	1.56	3.12	6.24	12.48	1.56	3.12	6.24
Base Number (BN)	mgKOH/g	5	10	20	40	5	10	20
Ca Amount	mass%	0.18	0.36	0.71	1.42	0.18	0.36	0.71
$\%C_A$ of Base Oil	mass%	6.80	3.76	4.37	5.31	0.00	0.00	0.00
Sulfur Content of Base Oil (S)	mass%	0.61	0.15	0.15	0.15	0	0	0
$\%C_A/S$ of Base Oil	-	11	25	29	36	-	-	-
Friction Coefficient	200N 1Hz	0.056	0.073	0.076	0.078	0.079	0.081	0.083

[0075] Table 5 shows the influence of the calcium amount of a lubricant oil composition in Examples 6, 9 and 10, and Comparative Examples 1 and 4 to 7. From Examples 6, 9 and 10, and Comparative Example 4 in Table 5, it is clear that when the sulfur content of a base oil is not less than 0.03 mass%, a lubricant oil composition with a smaller calcium

amount has a lower friction coefficient.

[Examples 6 and 11]

[0076] Lubricant oil compositions with formulations shown in Table 6 were prepared and measured for the friction coefficient.

[Table 6]

		Ex. 6	Ex. 11
Base Oil A-1	mass%	100	100
Salicylate B-1	mass%	1.56	-
Salicylate B-2	mass%	-	1.79
Base Number (BN)	mgKOH/g	5	5
Ca Amount	mass%	0.18	0.18
$\%C_A$ of Base Oil	mass%	6.80	3.76
Sulfur Content of Base Oil (S)	mass%	0.61	0.61
$\%C_A/S$ of Base Oil	-	11	11
Friction Coefficient	200N 1Hz	0.056	0.069

[0077] Table 6 shows the influence of the alkyl chain length of the metal salicylate based detergent (B) in Examples 6 and 11. From Table 6, it is clear that the metal salicylate-based detergent (B) has a higher friction reducing effect with a longer alkyl chain length.

INDUSTRIAL APPLICABILITY

[0078] The lubricant oil composition of the invention can be used as a general lubricant oil, can preferably be used in petrol engines, diesel engines, gas engines, and the like for two wheeled vehicles, four wheeled vehicles, power generation, cogeneration and the like, and is also useful in various engines for ships and outboard engines.

[0079] Moreover, the lubricant oil composition of the invention can also preferably be used as lubricant oils requiring friction reduction, for example, lubricant oils for drive systems such as automatic or manual transmissions, and lubricant oils such as grease, wet type brake oil, hydraulic oil, turbine oil, compressor oil, bearing oil and refrigerator oil.

Claims

1. A lubricant oil composition containing:

a base oil (A), wherein a sulfur content is not less than 0.03 mass%, and a mass ratio [$\%C_A$ (mass%)/sulfur content (mass%)] between an aromatic content ($\%C_A$) and the sulfur content is not more than 30, and;
a metal salicylate-based detergent (B) in not more than 3 mass% as an alkali metal or alkali earth metal amount based on the total amount of the composition.

2. A lubricant oil composition according to Claim 1, wherein a carbon number of an alkyl chain of a soap group of the metal salicylate-based detergent (B) is not less than 10 as an average.

3. A lubricant oil composition according to Claim 1 or 2, wherein the metal salicylate-based detergent (B) is an overbased calcium carbonate salicylate.

4. A lubricant oil composition according to any one of Claims 1 to 3, being a lubricant oil for an internal combustion engine.

5. A method for improving a fuel saving property of an internal combustion engine by using a lubricant oil composition according to any one of Claims 1 to 3.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/002139

A. CLASSIFICATION OF SUBJECT MATTER
See extra sheet.

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)
C10M101/00-177/00

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 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2000-53990 A (Showa Shell Sekiyu Kabushiki Kaisha), 22 February 2000 (22.02.2000), claims; paragraph [0025]; examples & CN 1243864 A	1-5
A	JP 11-189781 A (Japan Energy Corp.), 13 July 1999 (13.07.1999), claims; examples (Family: none)	1-5
A	JP 2008-120908 A (Nippon Oil Corp.), 29 May 2008 (29.05.2008), claims; examples (Family: none)	1-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
24 June, 2013 (24.06.13)	02 July, 2013 (02.07.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/002139

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	JP 2000-351984 A (Ciba Specialty Chemicals Holding Inc.), 19 December 2000 (19.12.2000), claims; examples & US 6410490 B1 & EP 1054052 A2 & CN 1274743 A	1-5
A	JP 2009-13355 A (Idemitsu Kosan Co., Ltd.), 22 January 2009 (22.01.2009), claims; examples (Family: none)	1-5
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/002139

Continuation of A. CLASSIFICATION OF SUBJECT MATTER
(International Patent Classification (IPC))

C10M169/04(2006.01)i, *C10M101/02*(2006.01)n, *C10M159/22*(2006.01)n, *C10N10/04*(2006.01)n, *C10N20/00*(2006.01)n, *C10N30/06*(2006.01)n, *C10N40/02*(2006.01)n, *C10N40/04*(2006.01)n, *C10N40/08*(2006.01)n, *C10N40/12*(2006.01)n, *C10N40/25*(2006.01)n, *C10N40/30*(2006.01)n, *C10N50/10*(2006.01)n

(According to International Patent Classification (IPC) or to both national classification and IPC)

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REFERENCES CITED IN THE DESCRIPTION

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- General Bomb Method, Supplementary Notes (Rules), Inductively Coupled Plasma Atomic Emission Spectrometry. *JIS K 2541-5* **[0016]**