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(71) Applicant: **Idemitsu Kosan Co., Ltd.**
Chiyoda-ku
Tokyo 100-8321 (JP)

(72) Inventor: **SAKANOUE, Shuichi**
Ichihara-shi
Chiba 299-0107 (JP)

(74) Representative: **HOFFMANN EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) LUBRICATING OIL COMPOSITION FOR BUFFER

(57) The invention provides a lubricating oil composition for a shock absorber, containing a base oil composed of a mineral oil and/or a synthetic oil, and (A) zinc dialkyldithiophosphate having a C7 to C12 alkyl group in an amount of 0.3 to 2 mass%, (B) a fatty acid amide in an amount of 0.05 to 2 mass%, and (C) a monocyclic phenol anti-oxidant in an amount of 0.1 to 1 mass%, and that the base oil contains an ester having a -COO- bond in an amount of 0.6 mass% or less as reduced to -COO-. The composition can increase the frictional force at a sliding part, such as between a piston rod and an oil seal or between a piston band and a cylinder in a shock absorber, while maintaining excellent wear resistance without impairing corrosion resistance or sludge formation resistance; and realizes both high-level handling/stability and high-level riding quality.

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Description

Technical Field

[0001] The present invention relates to a lubricating oil composition for buffer (hereinafter may be referred to as a "shock absorber") and, more particularly, to a lubricating oil composition for a shock absorber (hereinafter may be referred to as a "shock-absorber oil") which composition is mainly employed in four-wheel vehicles; can increase the frictional force at a sliding part, such as between a piston rod and an oil seal or between a piston band and a cylinder in a shock absorber, while maintaining excellent wear resistance without impairing corrosion resistance or sludge formation resistance; and realizes both high-level handling/stability and high-level riding quality.

Background Art

[0002] Lubricating oil for a shock absorber in automobiles is employed mainly for damping vibration in order to attain optimum attenuation force and maintain driving stability. Particularly, due to recent construction of high-way networks, automobile drivers more frequently have the opportunity for high-speed driving. Therefore, there is increasing demand for automobiles having excellent stability during high-speed driving and excellent accident-preventing performance. However, automobiles currently running in Japan have some problems. For example, when a driver turns the wheel for lane change at a driving speed of 100 to 200 km/h, unstable rolling of the vehicle occurs, impairing stable driving of the vehicle, and the distance required for preventing accidents is increased.

[0003] Recent studies have revealed that the stability of a vehicle running at high speed depends on the friction force at a sliding part between an oil seal and a piston rod, between a piston band and a cylinder, etc. in a shock absorber under micro-vibration conditions. During high-speed driving, vibration generated in a vehicle is transferred from tires sequentially to springs, shock absorbers, and the body of the vehicle, and a micro-vibration state is established. This micro-vibration generally involves a stroke of about 0.4 to about 2.0 mm and a frequency of about 1.5 to about 15.0 Hz. When such vibration occurs, a shock absorber encounters difficulty in generating damping force, thereby failing to attain satisfactory vibration damping effect. As a result, when the initial friction force at a sliding part between an oil seal and a piston rod, between a piston band and a cylinder, etc. is small, the body of the vehicle is easily tilted, impairing driving stability.

Thus, one conceivable approach to solve such a problem is an increase in the friction force provided by a lubricating oil for a shock absorber at a sliding part between an oil seal and a piston rod, between a piston band and a cylinder, etc.

[0004] Patent Document 1 discloses a lubricating oil composition for a shock absorber in an automobile, which composition contains a base oil, and (A) an acidic phosphate monoester amine salt (0.05 to 0.3 wt.%), (B) a polyalkenylsuccinimide (0.1 to 0.6 wt.%), and (C) an acidic phosphite diester (0.3 to 0.8 wt.%), the percentages being based on the total weight of the composition.

However, such a lubricating oil composition employing phosphorus-containing additives exhibits an anti-corrosion property (particularly in the presence of water) not higher than that of a high-friction oil employing a Zn-containing additive such as zinc dialkyldithiophosphate (hereinafter abbreviated as ZnDTP). On the other hand, such a high-friction oil employing a Zn-containing additive is known to exhibit sludge formation resistance inferior to that of a high-friction oil employing the aforementioned phosphorus-containing additive.

[0005] When sludge is formed in a shock absorber, plugging of a valve and adhesion of the sludge to a seal part occur, inhibiting smooth reciprocal motion. Meanwhile, a shock absorber employs a number of metallic parts such as tubes and valves (iron) and guide bushings (copper). Thus, when a vehicle runs on a slushy road, a large amount of water may enter the shock absorber. Therefore, a shock-absorber oil is required to have sludge formation resistance and anti-corrosion property.

There have been disclosed other oil compositions: a hydraulic control oil composition containing a $\%C_A$ 5 or less base oil, and (A) an amine anti-oxidant (0.01 to 5 wt.%), (B) a phenol anti-oxidant (0.01 to 5 wt.%), (C) a phosphate ester (0.01 to 5 wt.%), and (D) a fatty acid amide and/or a polyhydric alcohol ester (0.001 to 5 wt.%), the percentages being based on the total weight of the composition (see Patent Document 2); a lubricating oil composition containing a base oil, and (A) at least one species selected from a phenol anti-oxidant and an amine anti-oxidant and (B) an ester compound having a disulfide structure (see Patent Document 3); and a hydraulic control oil composition for a shock absorber, containing a base oil, and a specific nitrogen-containing compound and a specific phosphate ester (see Patent Document 4). These disclosed compositions contain no ZnDTP.

[0006]

Patent Document 1: Japanese Patent Application Laid-Open (*kokai*) No. 2003-147379
Patent Document 2: Japanese Patent Application Laid-Open (*kokai*) No. Hei 9-111277
Patent Document 3: Japanese Patent Application Laid-Open (*kokai*) No. 2007-63431

Patent Document 4: Japanese Patent Application Laid-Open (*kokai*) No. 2002-194376

Disclosure of the Invention

Problems to be Solved by the Invention

[0007] Under such circumstances, an object of the present invention is to provide a lubricating oil composition for a shock absorber which composition is mainly employed in four-wheel vehicles; can increase the frictional force at a sliding part, such as between a piston rod and an oil seal or between a piston band and a cylinder in a shock absorber, while maintaining excellent wear resistance without impairing corrosion resistance or sludge formation resistance; and realizes both high-level handling/stability and high-level riding quality.

Means for Solving the Problems

[0008] The present inventors have carried out extensive studies on the production of a lubricating oil composition for a shock absorber having the aforementioned preferred characteristic, and have found that the object can be attained by a lubricating oil composition containing, as a base oil, a mineral oil and/or a synthetic oil having a level of an ester compound having a -COO- bond not higher than a certain value, and ZnDTP having an alkyl group of the number of carbon atoms falling within a specific range, a fatty acid amide, and a monocyclic phenol anti-oxidant, at predetermined proportions. The present invention has been accomplished on the basis of this finding.
Accordingly, the present invention provides the following:

(1) a lubricating oil composition for a shock absorber, **characterized in that** the composition comprises a base oil composed of a mineral oil and/or a synthetic oil, and (A) zinc dialkyldithiophosphate having a C7 to C12 alkyl group in an amount of 0.3 to 2 mass%, (B) a fatty acid amide in an amount of 0.05 to 2 mass%, and (C) a monocyclic phenol anti-oxidant in an amount of 0.1 to 1 mass%, and that the base oil contains an ester having a -COO- bond in an amount of 0.6 mass% or less as reduced to -COO-;
(2) a lubricating oil composition for a shock absorber as described in (1) above, wherein the base oil is a mineral oil;
(3) a lubricating oil composition for a shock absorber as described in (1) above, wherein the base oil is a hydrocarbon synthetic oil and/or an ether synthetic oil;
(4) a lubricating oil composition for a shock absorber as described in (3) above, wherein the base oil is a hydrocarbon synthetic oil;
(5) a lubricating oil composition for a shock absorber as described in (1) above, which contains zinc dialkyldithiophosphate, serving as ingredient (A), in an amount of 0.5 to 1.5 mass%;
(6) a lubricating oil composition for a shock absorber as described in (1) above, which contains the fatty acid amide, serving as an ingredient (B), in an amount of 0.08 to 1 mass%;
(7) a lubricating oil composition for a shock absorber as described in (1) above, which contains the monocyclic phenol anti-oxidant, serving as an ingredient (C), in an amount of 0.1 to 0.8 mass%; and
(8) a lubricating oil composition for a shock absorber as described in (1) above, which is for use in a four-wheel vehicle.

Effects of the Invention

[0009] According to the present invention, there can be provided a lubricating oil composition for a shock absorber which composition is mainly employed in four-wheel vehicles; can increase the frictional force at a sliding part, such as between a piston rod and an oil seal or between a piston band and a cylinder in a shock absorber, while maintaining excellent wear resistance without impairing corrosion resistance or sludge formation resistance; and realizes both high-level handling/stability and high-level riding quality. Best Modes for Carrying Out the Invention
[0010] The shock-absorber oil of the present invention is a lubricating oil composition containing a base oil composed of a mineral oil and/or a synthetic oil, and (A) ZnDTP, (B) a fatty acid amide, and (C) a monocyclic phenol anti-oxidant.

[Base oil]

[0011] The shock-absorber oil of the present invention employs a base oil which is a mineral oil and/or a synthetic oil and which contains an ester having a -COO- in an amount of 0.6 mass% or less in terms of -COO-. When the ester content is in excess of 0.6 mass% as reduced to -COO-, the corrosion resistance of a metallic material of a shock absorber may decrease by water entering the shock absorber. The ester content is preferably 0.4 mass% or less as recued to -COO-, more preferably substantially 0.
Examples of the mineral oil contained in the base oil include paraffin-based mineral oil, intermediate mineral oil, and

naphthene-based mineral oil, which are produced through a routine refining method such as solvent refining or hydrogenation refining.

The synthetic oil is preferably a hydrocarbon synthetic oil or an ether synthetic oil. Examples of the hydrocarbon synthetic oil include polybutene, polyisobutylene, α-olefin oligomers such as 1-octene oligomer, 1-decene oligomer, and ethylene-propylene copolymer, hydrogenated products thereof, alkylbenzenes, and alkylnaphthalenes. Examples of the ether synthetic oil include polyoxyalkylene glycol and polyphenyl ether.

In the present invention, among them, a mineral oil and a hydrocarbon synthetic oil are preferred.

In the present invention, the mineral oil may be used, as the base oil, singly or in combination of two or more species. Alternatively, the synthetic oil may be used, as the base oil, singly or in combination of two or more species. Furthermore, one or more mineral oils may be combined with one or more synthetic oils.

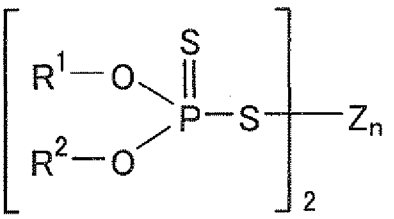
In the case of a shock-absorber oil for four-wheel vehicles for riding, the base oil preferably has a viscosity (40°C) of 2.0 to 15.0 mm^2/s, more preferably 4.0 to 9.0 mm^2/s.

[(A) ZnDTP]

[0012] The shock-absorber oil of the present invention employs, as ingredient (A), ZnDTP having a C7 to C12 alkyl group for improving the friction coefficient and wear resistance of a seal to which the oil is applied. Examples of ZnDTP include compounds represented by the following formula (I):

[0013]

[F1]



···(I)

[0014] (wherein each of R^1 and R^2 represents a C7 to C12 linear, branched, or cyclic alkyl group).

Specific examples of the alkyl group R^1 or R^2 in formula (I) include heptyl, isoheptyl, cyclohexylmethyl, octyl, 2-ethylhexyl, isooctyl, cyclooctyl, nonyl, isononyl, 3,5,5-trimethylhexyl, cyclooctylmethyl, decyl, 3,7-dimethyloctyl, 2-propylheptyl, isodecyl, undecyl, dodecyl, 2-butyloctyl, and isododecyl. Of these, C7 to C10 alkyl groups are preferred.

R^1 and R^2 may be identical to or different from each other. From the viewpoint of easiness of production of the compounds, R^1 and R^2 are preferably identical to each other.

From the viewpoints of improvement in friction coefficient and wear resistance of a seal, the shock-absorber oil of the present invention contains ZnDTP, serving as ingredient (A), in an amount of 0.3 to 2 mass, preferably 0.5 to 1.5 mass%.

[(B) Fatty acid amide]

[0015] The shock-absorber oil of the present invention employs a fatty acid amide as ingredient (B). The fatty acid amide provides the oil with anti-corrosion effect and sludge formation resistance.

Examples of the fatty acid amide which may be used in the invention include acid amides produced via reaction between, for example, a C7 to C31 linear or branched saturated or unsaturated monocarboxylic acid and a polyalkylenepolyamine represented by the following formula (II):

$$H_2N\text{-}(R^3\text{-}NH)_m\text{-}H \qquad (II)$$

(wherein R^3 represents a C2 to C4 alkylene group, and m is an integer of 2 to 6).

(Monocarboxylic acid)

[0016] Examples of the C7 to C31 monocarboxylic acid include saturated fatty acids (which may be linear or branched) such as heptanoic acid, octanoic acid, nonanoic acid, decanoic acid, undecanoic acid, dodecanoic acid, tridecanoic acid, tetradecanoic acid, pentadecanoic acid, hexadecanoic acid, heptadecanoic acid, octadecanoic acid, nonadecanoic acid, icosanoic acid, henicosanoic acid, docosanoic acid, tricosanoic acid, tetracosanoic acid, pentacosanoic acid, hexacosanoic acid, heptacosanoic acid, octacosanoic acid, nonacosanoic acid, and triacontanoic acid; and unsaturated fatty acids (which may be linear or branched and which has a double bond at any locant) such as heptenoic acid, octenoic acid, nonenoic acid, decenoic acid, undecenoic acid, dodecenoic acid, tridecenoic acid, tetradecenoic acid, pentadecenoic acid, hexadecenoic acid, heptadecenoic acid, octadecenoic acid (including oleic acid), nonadecenoic acid, icosenoic acid, henicosenoic acid, docosenoic acid, tricosenoic acid, tetracosenoic acid, pentacosenoic acid, hexacosenoic acid, heptacosenoic acid, octacosenoic acid, nonacosenoic acid, and triacontenoic acid. Of these, C10 to C24 such carboxylic acids, specifically, lauric acid, myristic acid, palmitic acid, stearic acid, isostearic acid, oleic acid, etc. are preferred.

(Polyalkylenepolyamine)

[0017] Examples of the polyalkylenepolyamine represented by formula (II) to be reacted with the monocarboxylic acid include diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenehexamine, hexaethyleneheptamine, tetrapropylenepentamine, and hexabutyleneheptamine.

[0018] The polyalkylenepolyamine is reacted with the monocarboxylic acid at about 200 to about 220°C for about 2 to about 3 hours, to thereby produce a fatty acid amide of interest. The amount of the monocarboxylic acid used is preferably (m + 1) mol or less with respect to 1 mol of polyalkylenepolyamine.

The shock-absorber oil of the present invention may employ, as ingredient (B), the thus-produced fatty acid amide singly or in combination of two or more species. The fatty acid amide content is 0.05 to 2 mass%, preferably 0.08 to 1 mass%, from the viewpoints of anti-corrosion effect and sludge formation resistance improvement.

[(C) Monocyclic phenol anti-oxidant]

[0019] The shock-absorber oil of the present invention employs, as ingredient (C), a monocyclic phenol anti-oxidant. The monocyclic phenol anti-oxidant provides the oil with sludge formation resistance improving effect.

Examples of the monocyclic phenol anti-oxidant include 2,6-di-tert-butyl-p-cresol, 2,6-di-tert-butyl-4-ethylphenol, n-hexyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, isohexyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, n-heptyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, isoheptyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, n-octyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, isooctyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, 2-ethylhexyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, n-nonyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, isononyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, n-decyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, isodecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, n-undecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, isoundecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, n-dodecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, isododecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)acetate, n-hexyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, isohexyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, n-heptyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, isoheptyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, n-octyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, isooctyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, 2-ethylhexyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, n-nonyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, isononyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, n-decyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, isodecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, n-undecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, isoundecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, n-dodecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, isododecyl (3-methyl-5-tert-butyl-4-hydroxyphenyl)propionate, n-hexyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, isohexyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, n-heptyl (3,5-di-tert-butyl-4-hydroxyphenyl) acetate, isoheptyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, n-octyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, isooctyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, 2-ethylhexyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, n-nonyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, isononyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, n-decyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, isodecyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, n-undecyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, isoundecyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, n-dodecyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, isododecyl (3,5-di-tert-butyl-4-hydroxyphenyl)acetate, n-hexyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, isohexyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, n-heptyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, isoheptyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, n-octyl (3,5-di-tert-butyl-4-hydroxyphenyl) propionate, isooctyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, 2-ethylhexyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, n-nonyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, isononyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, n-decyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, isodecyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, n-undecyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, isoundecyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, n-dodecyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate, and isododecyl (3,5-di-tert-butyl-4-hydroxyphenyl)propionate. These compounds may be used singly or in combination of two or more species.

[0020] The aforementioned monocyclic phenol anti-oxidant exhibits higher sludge formation resistance as compared with a polycyclic phenol anti-oxidant. Examples of preferred monocyclic phenol anti-oxidants include 2,6-di-tert-butyl-p-cresol and 2,6-di-tert-butyl-4-ethylphenol. Of these, 2,6-di-tert-butyl-p-cresol is particularly preferred, from the viewpoints of sludge formation resistance and availability.

From the viewpoint of sludge formation resistance, the shock-absorber oil of the present invention contains, as ingredient (C), a monocyclic phenol anti-oxidant in an amount of 0.1 to 1 mass%, preferably 0.1 to 0.8 mass%.

[Optional additives]

[0021] The shock-absorber oil of the present invention may appropriately contain, as an optional additive(s), at least one species selected from among an ashless detergent-dispersant, a metallic detergent, a lubrication improver (other than essential ingredients of the invention), and an anti-oxidant (other than essential ingredients of the invention), and a rust preventive, a metal deactivator, a viscosity index-improver, a pour point-depressant, and a deformer, so long as the object of the present invention is not impaired.

Examples of the ashless detergent-dispersant include dibasic carbamides such as succinimides, boron-containing succinimides, benzylamines, boron-containing benzylamines, and succinic acid. Examples of the metallic detergent include neutral metal sulfonates, neutral metal phenate, neutral metal salicylate, neutral metal phosphonate, basic sulfonates, basic phenates, basic salicylates, perbasic sulfonates, perbasic salicylate, and perbasic phosphonate.

[0022] Examples of the aforementioned lubrication improver include an extreme pressure agent, an anti-wear agent, and an oiliness agent, and specific examples include phosphate ester compounds such as phosphate esters, acidic phosphate monoester amine salts, and acidic phosphite diesters; and organometallic compounds such as zinc dithiocarbamate (ZnDTC), molybdenum oxysulfide organophosphorodithioate (MoDTP), and molybdenum oxysulfide dithiocarbamate (MoDTC).

The lubrication improver also includes sulfur-containing extreme pressure agents such as sulfidized fats and oils, sulfidized fatty acids, sulfidized esters, sulfidized olefins, dihydrocarbyl polysulfides, thiadiazole compounds, alkylthiocarbamoyl compounds, triazine compounds, thioterpene compounds, and dialkylthiodipropionate compounds.

The lubrication improver also includes oiliness agents such as aliphatic saturated and unsaturated monocarboxylic acids (e.g., stearic acid and oleic acid); polymerized fatty acids (e.g., dimeric acid and hydroganated dimeric acid); hydroxyfatty acids (e.g., ricinoleic acid and 12-hydroxystearic acid); aliphatic saturated and unsaturated monohydric alcohols (e.g., lauryl alcohol and oleyl alcohol); aliphatic saturated and unsaturated monoamines (e.g., stearylamine and oleylamine); and aliphatic saturated and unsaturated monocarbamides (e.g., lauric amide and oleamide).

[0023] Examples of the aforementioned anti-oxidant include polycyclic phenol anti-oxidants such as 4,4'-methylenebis (2,6-di-tert-butylphenol) and 2,2'-methylenebis(4-ethyl-6-tert-butylphenol); amine anti-oxidants such as monoalkyldiphenylamine compounds (e.g., monooctyldiphenylamine and monononyldiphenylamine), dialkyldiphenylamine compounds (e.g., 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine, and 4,4'-dinonyldiphenylamine), polyalkyldiphenylamine compounds (e.g., tetrabutyldiphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine, and tetranonyldiphenylamine), and naphthylamine compounds (e.g., α-naphthylamine, phenyl-α-naphthylamine, butylphenyl-α-naphthylamine, pentylphenyl-α-naphthylamine, hexylphenyl-α-naphthylamine, heptylphenyl-α-naphthylamine, octylphenyl-α-naphthylamine, and nonylphenyl-α-naphthylamine); and sulfur-containing anti-oxidants such as 2,6-di-tert-butyl-4-(4,6-bis(octylthio)-1,3,5-triazin-2-ylamino)phenol, thioterpene compounds (e.g., reaction products between phosphorus pentasulfide and pinene), and dialkylthiodipropionates (e.g., dilaurylthiodipropionate and distearylthiodipropionate).

[0024] Examples of the rust preventive include metal sulfonates and succinate esters. Examples of the metal deactivator include benzotriazole and thiadiazole.

Examples of the viscosity index-improver include polymethacrylates, dispersion-type polymethacrylates, olefin copolymers (e.g., ethylene-propylene copolymer), dispersion-type olefin copolymers, and styrene copolymers (e.g., hydrogenated styrene-diene copolymer).

Examples of the pour point-depressant which may be employed in the invention include polymethacrylates having a weight average molecular weight of about 50,000 to about 150,000.

The deformer is preferably a deformer of silicone polymer. Through incorporation of such a deformer into the composition, defoaming can be effectively attained, to thereby enhance riding quality.

Examples of the silicone-polymer deformer include organopolysiloxanes. Among them, fluorine-containing organopolysiloxanes (e.g., trifluoropropylmethylsilicone oil) are particularly preferred.

[0025] The shock-absorber oil of the present invention contains, as a base oil, a mineral oil and/or a synthetic oil having a predetermined amount of an ester compound having a -COO- bond, and ZnDTP having an alkyl group of the number of carbon atoms falling within a specific range, a fatty acid amide, and a monocyclic phenol anti-oxidant, at predetermined proportions. Therefore, the shock-absorber oil can increase the frictional force at a sliding part, such as between a piston rod and an oil seal or between a piston band and a cylinder in a shock absorber, without impairing corrosion resistance or sludge formation resistance; maintains excellent wear resistance; and realizes both high-level handling/stability and high-level riding quality.

The shock-absorber oil of the present invention can be employed in either a multi-cylinder-type shock absorber or a single-cylinder-type shock absorber. Also, the shock-absorber oil can be employed in either a four-wheel vehicle or a two-wheel vehicle, and is particularly suitably employed in a four-wheel vehicle.

[Examples]

[0026] The present invention will next be described in more detail by way of examples, which should not be construed as limiting the invention thereto.
Measurement of friction coefficient, an immersion test (iron and copper), and an oxidation stability test were performed through the following procedures.

(1) Measurement of friction coefficients of rubber samples Tester: Bounden-type reciprocal kinetic friction tester Test conditions:

load: 9.8 N
stroke: 10 mm
speed: 3.3 mm/s
temperature: 60°C
friction operation: 30 times
upper friction member: rubber (A727)
lower friction member: chromium-plated sheet (50 × 1000 × 5 mm).

The rubber member was made of a circular rubber piece (diameter: 15 mm). In the friction test, a few drops of a sample oil were fed onto the surface of the lower friction member, and the rubber piece was pressed against the lower friction member by means of a ball (diameter: 12.7 mm) under a friction load.
(2) Immersion test (iron and copper pieces) in water-containing oil
In a glass bottle (capacity: 500 mL), a sample oil (100 mL) and distilled water (2 mL) were placed. The mixture was stirred by means of a homogenizer for one minute at 2,000 rpm. Subsequently, a copper piece (pure copper for copper plate corrosion test) and an iron piece (bearing race: WS1730) were put into the oil sample. The bottle was capped with aluminum foil and left to stand in a thermostatic bath at 100°C for 48 hours.
At the end of the test, the copper piece and the iron piece were visually observed. The loss in mass of the copper piece was measured. Discoloration of the copper piece was measured in accordance with JIS 2513, with ratings of 1a (no discoloration) >1b ··· >4c (considerable discoloration).
Thereafter, the oil sample was left to stand at room temperature for 20 hours, and presence of sludge was checked before and after washing with hexane. In the washing with hexane, hexane (50 mL) was fed to the 500-mL glass bottle, and the oil sample was washed with hexane under slight stirring. Then, hexane was removed.
(3) Oxidation stability test
The oxidation stability test was performed in accordance with the method stipulated in CEC L-48-A-00/B.
Specifically, air was caused to blow through a test oil sample (100 mL) at 160°C and 5.0 L/h for 96 hours, and the inner wall of the glass bottle was checked for presence of deposits. The n-pentane-insoluble matter was determined through the method A.

Examples 1 to 3 and Comparative Examples 1 to 11

[0027] Lubricating oil compositions (shock-absorber oils) having compositional proportions shown in Table 1 were prepared. Each composition was subjected to friction coefficient measurement, the immersion test (copper and iron), and the oxidation stability test. Table 1 shows the results.

[Table 1]

[0028]

Table 1-1

			Examples			Comp. Exs.	
			1	2	3	1	2
Formulation (mass%)	Base oil	A1)	20.00	20.00	20.00	20.00	-
		B2)	61.78	61.58	61.78	56.87	-
		C3)	-	-	-	-	99.50
		D4)	-	-	-	5.00	-
	ZnDTP	A5)	0.70	0.90	0.70	0.70	-
		B6)	-	-	-	-	-
	Anti-oxidant	A7)	0.30	0.30	0.30	0.30	0.50
		B8)	-	-	-	-	-
	Fatty acid amide	A9)	0.20	0.20	-	0.20	-
		B10)	-	-	0.20	-	-
	Polybutenyl-succinimide	A11)	-	-	-	-	-
		B12)	-	-	-	-	-
	Ca sulfonate13)		-	-	-	-	-
	P-containing extreme pressure agent	A14)	-	-	-	-	-
		B15)	-	-	-	-	-
	Viscosity index-improver	A16)	14.00	14.00	14.00	14.00	-
		B17)	3.00	3.00	3.00	3.00	-
	Metal deactivator18)		-	-	-	-	-
	Deformer19)		0.02	0.02	0.02	0.02	-
Fe/Cu immersion test	Iron piece (corrosion)		no	no	no	no	no
	Copper piece		1b	1b	1b	1a	3a
	Percent Cu loss (mass%)		0.007	0.009	0.008	0.044	0.001
	Sludge	before hexane washing	pa	pa	pa	p1	p1
		after hexane washing	no	no	no	no	pa
Oxidation stability test	Deposit on glass container (sludge)		no	no	no	-	-
	Insoluble matter (mass%)		0.00	0.00	0.00	-	-
Friction coefficient [μ]			0.57	0.59	0.56	-	-
pa: particles remained p1: small amount of white precipitation p2: medium amount of white precipitation p3: large amount of white precipitation							

Table 1-2

			Comparative Examples				
			3	4	5	6	7
Formulation (mass%)	Base oil,	A1)	-	-	20.00	-	-
		S2)	-	-	61.53	-	-
		C3)	98.50	98.50	-	99.00	99.40
		D4)	-	-	-	-	-
	ZnDTP	A5)	-	-	-	-	-
		B6)	0.50	0.50	-	0.50	-
	Ants-oxidant	A7)	0.50	0.50	0.30	0.50	0.50
		B8)	-	-	0.20	-	-
	Fatty acid amide	A9)	0.50	-	-	-	-
		B10)				-	-
	Polybutenyl-succinimide	A11)	-	0.50	-	-	-
		B12)	-	-	0.30	-	-
	Ca sulfonate13)		-	-	-	-	-
	P-containing extreme pressure agent	A14)	-	-	0.10	-	0.10
		B15)	-	-	0.50	-	-
	Viscosity index-improver	A16)	-	-	14.00	-	-
		B17)	-	-	3.00	-	-
	Metal deactivator18)		-	-	0.05	-	-
	Deformer19)		-	-	0.02	-	-
Fe/Cu immersion test	Iron piece (corrosion)		no	no	heavy	heavy	heavy
	Copper piece		3b	3b	4a	3b	4a
	Percent Cu loss (mass%)		0.131	0.010	0.002	0.004	-
	Sludge	before hexane washing	p1	p3	p3	p2	p1
		after hexane wasting	no	no	no	pa	p1
Oxidation stability test	Deposit on glass container (sludge)		-	-	no	-	-
	Insoluble matter (mass%)		-	-	0.00	-	-
Friction coefficient [μ]			-	-	0.58	-	-
pa: particles remained p1: small amount of white precipitation p2: medium amount of white precipitation p3: large amount of white precipitation							

[Table 2]

[0029]

Table 1-3

			Comparative Examples			
			8	9	10	11
Formulation (mass%)	Base oil	A1)	-	-	-	20.00
		B2)	-	-	-	62.08
		C3)	99.00	98.90	98.00	-
		D4)	-	-	-	-
	ZnDTP	A5)	0.50	-	-	0.70
		B6)	-	0.50	0.50	-
	Anti-oxidant	A7)	0.50	0.50	0.50	-
		B8)	-	-	-	-
	Fatty acid amide	A9)	-	-	-	0.20
		B10)	-	-	-	-
	Polybutenyl-succinimide	A11)	-	-	-	-
		B12)	-	-	-	-
	Ca sulfonate13)		-	-	1.00	-
	P-containing extreme pressure agent	A14)	-	-	-	-
		B15)	-	-	-	-
	Viscosity index-improver	A16)	-	-	-	14.00
		B17)	-	-	-	3.00
	Metal deactivator18)		-	0.10	-	-
	Deformer19)		-	-	-	0.02
Fe/Cu immersion test	Iron piece (corrosion)		micro	light	no	no
	Copper piece		4c	4c	3b	1b
	Percent Cu loss (mass%)		-	-	-	-
	Sludge	before hexane washing	p1	p3	pa	pa
		after hexane washing	p1	p3	no	no
Oxidation stability test	Deposit on glass container (sludge)		-	-	-	light
	Insoluble matter (mass%)		-	-	-	0.09
Friction coefficient [μ]			-	-	-	0.56
pa: particles remained p1: small amount of white precipitation p2: medium amount of white precipitation p3: large amount of white precipitation						

[Note]

[0030]

1) Base oil A: mineral oil 35N
2) Base oil B: mineral oil 40N
3) Base oil C: mineral oil 60N
4) Base oil D: pentaerythritol dioleyl ester, intramolecular -COO- content = 13 mass%
5) ZnDTP-A: OLOA 5660 (product of Chevron Japan Ltd.), alkyl = 2-ethylhexyl, S = 12.6 mass%, P = 6.15 mass%,

Zn = 7.62 mass%

6) ZnDTP-B: OLOA 267 (product of Chevron Japan Ltd.), alkyl = = C3 to C6 alkyl mixture, S = 15.03 mass%, P = 7.50 mass%, Zn = 8.50 mass%

7) Anti-oxidant A: Sumilizer BHT (Sumitomo Chemical Co., ltd.), 2,6-di-tert-butyl-p-cresol

8) Anti-oxidant B: ANTI-OXIDANT 702ND (product of Albemarle Asano), 4,4'-methylenebis(2,6-di-tert-butylphenol)

9) Fatty acid amide A: OLOA 340D (product of Chevron Japan Ltd.), reaction product between isostearic acid and tetraethylenepentamine, N = 6.20 mass%, total base value = 81.0 mgKOH/g

10) Fatty acid amide B: reaction product between isostearic acid and triethylenetetramine

11) Polybutenylsuccinimide A: OLOA 1200N (product of Chevron Japan Ltd.), mono form, N = 1.85 mass%, total base value = 33.0 mgKOH/g

12) Polybutenylsuccinimide B: Hitec 646 (product of Ethyl Japan), mono form, N = 1.75 mass%, total base value = 40.0 mgKOH/g

13) Ca sulfonate: Bryton C-500 (product of Crompton Corporation), $(RC_6H_4SO_3)_2Ca$

14) Phosphorus-containing extreme pressure agent A: VANLUBE 672 (product of Vanderbilt), acidic phosphate ester amine salt (predominantly monoethylamine salt and monomethylamine salt), P = 9.5 mass%, N = 4.95 mass%

15) Phosphorus-containing extreme pressure agent B: JP-218-OR (product of Johoku Chemical Co., Ltd.), dioleyl hydrogenphosphite, P = 5.34 mass%

16) Viscosity index-improver A: Aqualube 806T (product of Sanyo Chemical Industries, Ltd.), polymethyl methacrylate having a wt. av. molecular weight of 61,000

17) Viscosity index-improver B: Aqualube 504 (product of Sanyo Chemical Industries, Ltd.), polymethyl methacrylate having a wt. av. molecular weight of 140,000

18) Metal deactivator: HiTEC4313 (product of Ethyl Japan), 2,5-bis(1,1,3,3-tetramethylbutyldithio)-1,3,4-thiadiazole

19) Deformer: FL100 (product of Shin-Etsu Chemical Co., Ltd.), fluorine-containing organopolysiloxane

The base oil employed in Comparative Example 1 had an ester content (as reduced to -COO-) of 0.79 mass%.

[0031] In comparison of Comparative Example 1 with Examples 1 to 3, the base oil of Comparative Example 1 had an ester content (as -COO-) of 0.79 mass% (i.e., greater than 0.6 mass%). Therefore, the percent loss of copper in the iron/copper immersion test was found to be greater, as compared with Examples 1 to 3.

In comparison of Comparative Example 3 with Examples 1 to 3, Comparative Example 3 employed a ZnDTP having C3 to C6 mixed alkyl groups (i.e., C<7). Therefore, the percent loss of copper and discoloration in the iron/copper immersion test were greater, as compared with Examples 1 to 3.

Comparative Examples 2, 4, to 11 did not contain at least one species selected from ZnDTP, a monocyclic phenol anti-oxidant, and a fatty acid amide, which are essential ingredients of the present invention. Therefore, in the iron/copper immersion test, rusting of iron pieces, discoloration of copper pieces, and formation of sludge occurred, and sludge formed in the oxidation stability test. Industrial Applicability

[0032] The shock-absorber oil of the present invention can increase the frictional force at a sliding part, such as between a piston rod and an oil seal or between a piston band and a cylinder in a shock absorber, without impairing corrosion resistance or sludge formation resistance; maintains excellent wear resistance; and realizes both high-level handling/stability and high-level riding quality.

The shock-absorber oil of the present invention is particularly suitably employed in a four-wheel vehicle.

Claims

1. A lubricating oil composition for a shock absorber, **characterized in that** the composition comprises a base oil composed of a mineral oil and/or a synthetic oil, and (A) zinc dialkyldithiophosphate having a C7 to C12 alkyl group in an amount of 0.3 to 2 mass%, (B) a fatty acid amide in an amount of 0.05 to 2 mass%, and (C) a monocyclic phenol anti-oxidant in an amount of 0.1 to 1 mass%, and that the base oil contains an ester having a -COO- bond in an amount of 0.6 mass% or less as reduced to -COO-.

2. A lubricating oil composition for a shock absorber according to claim 1, wherein the base oil is a mineral oil.

3. A lubricating oil composition for a shock absorber according to claim 1, wherein the base oil is a hydrocarbon synthetic oil and/or an ether synthetic oil.

4. A lubricating oil composition for a shock absorber according to claim 3, wherein the base oil is a hydrocarbon synthetic oil.

5. A lubricating oil composition for a shock absorber according to claim 1, which contains zinc dialkyldithiophosphate, serving as ingredient (A), in an amount of 0.5 to 1.5 mass%.

6. A lubricating oil composition for a shock absorber according to claim 1, which contains the fatty acid amide, serving as an ingredient (B), in an amount of 0.08 to 1 mass%.

7. A lubricating oil composition for a shock absorber according to claim 1, which contains the monocyclic phenol antioxidant, serving as an ingredient (C), in an amount of 0.1 to 0.8 mass%.

8. A lubricating oil composition for a shock absorber according to claim 1, which is for use in a four-wheel vehicle.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/062070

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)
C10M169/04, C10M101/02, C10M105/06, C10M105/18, C10M107/02, C10M107/06, C10M107/08, C10M107/10, C10M107/34, C10M129/10, C10M133/16, C10M137/10, C10N20/00, C10N30/04, C10N30/06, C10N30/12, C10N40/06

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	1996-2008
Kokai Jitsuyo Shinan Koho	1971-2008	Toroku Jitsuyo Shinan Koho	1994-2008

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

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Date of the actual completion of the international search 11 August, 2008 (11.08.08)	Date of mailing of the international search report 19 August, 2008 (19.08.08)
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/062070

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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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/062070

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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INTERNATIONAL SEARCH REPORT

International application No.
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Continuation of A. CLASSIFICATION OF SUBJECT MATTER
(International Patent Classification (IPC))

C10M169/04(2006.01)i, *C10M101/02*(2006.01)i, *C10M105/06*(2006.01)i, *C10M105/18*(2006.01)i, *C10M107/02*(2006.01)i, *C10M107/06*(2006.01)i, *C10M107/08*(2006.01)i, *C10M107/10*(2006.01)i, *C10M107/34*(2006.01)i, *C10M129/10*(2006.01)i, *C10M133/16*(2006.01)i, *C10M137/10*(2006.01)i, *C10N20/00*(2006.01)n, *C10N30/04*(2006.01)n, *C10N30/06*(2006.01)n, *C10N30/12*(2006.01)n, *C10N40/06*(2006.01)n

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