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(54) **LUBRICANT COMPOSITION**

SCHMIERMITTEL-ZUSAMMENSETZUNG

COMPOSITION LUBRIFIANTE

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The file contains technical information submitted after the application was filed and not included in this specification

EP 2 053 117 B1

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Description

Technical Field

5 **[0001]** The present invention relates to a lubricant composition, and more specifically, to a lubricant composition having low viscosity and has a long metal fatigue life, while being excellent in low-temperature fluidity and oxidation stability, thereby being particularly suitable as a lubricant for automobile transmissions or the like.

Background Art

10 **[0002]** Energy savings, that is, fuel savings in, for example, construction machines, agricultural machines and automobiles have recently become urgent matters with the advent of the need to cope with environmental issues, so an apparatus such as an engine, a transmission, a final reduction gear, a compressor, or a hydraulic system has been strongly requested to contribute to the energy savings. Accordingly, a lubricant to be used in any such apparatus has been requested to reduce the stirring resistance or frictional resistance of the apparatus to a larger extent than a conventional lubricant does.

15 **[0003]** For example, a reduction in viscosity of a lubricant is one method of achieving fuel savings in each of the transmissions and the final reduction gears. Of the transmissions, an automatic transmission or continuously variable transmission for automobiles has, for example, a torque converter, a wet clutch, a gear bearing mechanism, an oil pump, and a hydraulic control mechanism, and a manual transmission or final reduction gear has a gear bearing mechanism. A reduction in viscosity of a lubricant to be used in any such transmission reduces the stirring resistance and frictional resistance of, for example, each of the torque converter, the wet clutch, the gear bearing mechanism, and the oil pump, and improves the efficiency of power transmission, thereby enabling an improvement in fuel efficiency of an automobile.

20 **[0004]** However, a lubricant with its viscosity reduced is apt to be lost by evaporation particularly when used in a high-humidity environment. Moreover, a problem such as an increase in coefficient of friction of a film composed of the lubricant arises in association with the reduction in viscosity. As a result, the lubricant has a significantly reduced fatigue life to cause seizing or the like, so a transmission or the like may undergo malfunctions. In particular, when a phosphorus-based extreme pressure agent is blended for improving the extreme-pressure property of a low-viscosity oil, the fatigue life of the oil remarkably deteriorates, so it is generally difficult to reduce the viscosity of the oil.

25 **[0005]** However, a lubricant with its viscosity reduced is apt to be lost by evaporation particularly when used in a high-humidity environment. Moreover, a problem such as an increase in coefficient of friction of a film composed of the lubricant arises in association with the reduction in viscosity. As a result, the lubricant has a significantly reduced fatigue life to cause seizing or the like, so a transmission or the like may undergo malfunctions. In particular, when a phosphorus-based extreme pressure agent is blended for improving the extreme-pressure property of a low-viscosity oil, the fatigue life of the oil remarkably deteriorates, so it is generally difficult to reduce the viscosity of the oil.

30 **[0005]** For example, a composition obtained by the following procedure has been disclosed (see, for example, Patent Documents 1 and 2) : a conventional transmission oil for automobiles is blended with, for example, a synthetic oil-based lubricant base oil and/or a mineral oil-based lubricant base oil, an anti-wear agent, an extreme pressure agent, a metal-based detergent, an ashless dispersant, a friction adjustor, or a viscosity index improver with the amount of any such additive optimized so that the composition to be obtained may be able to maintain various properties such as a transmission characteristic for a long time period. However, no investigation has been conducted on an influence of any such composition on the fatigue life of a lubricant when the viscosity of the lubricant is reduced.

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Patent Document 1: JP 7-268375 A

Patent Document 2: JP 2000-63869 A

40 **[0006]** Patent document 3 is WO 02/083825 A1 and discloses a lubricating oil composition comprising an oil of lubricating viscosity and a total of from about 1 to about 50% by weight of copolymers comprising (A) at least one ethylene-aliphatic olefin copolymer wherein the aliphatic olefins contain from 3 to about 24 carbon atoms, said copolymer (A) having Mn ranging from about 600 to about 5000, and (B) at least one copolymer comprising units derived from alkyl acrylate ester monomers containing from 2 to about 25 carbon atoms in the ester group, and optionally, from about 0.1% to about 20% by weight of at least one member of the group consisting of vinyl aromatic monomers and nitrogen-containing vinyl monomers, said copolymer (B) having Mn ranging from about 10,000 to about 350,000, wherein the weight ratio of (A):(B) ranges from about 99:1 to about 1:99.

45 **[0007]** Patent document 4 is EP 0 291 006 A2 and discloses a lubricating oil composition having improved temperature characteristics, containing: (A) a base oil having a kinematic viscosity at 100°C of 1.5 to 50 cSt, a pour point of -25°C or lower and a viscosity index of at least 60; (B) an ethylene-alpha-olefin copolymer having a number average molecular weight of 1,000 to 8,000; and (C) at least one additive selected from an extreme pressure agent, an anti-wear agent, an oiliness agent and a detergent dispersant.

50 **[0008]** Patent document 5 is EP 1 950 277 A1 and provides a transmission fluid composition which has a kinematic viscosity as determined at 100°C of 2 to 10 mm²/s and a viscosity index of 150 or higher and which satisfies a specific relationship between kinematic viscosity and NOACK evaporation loss amount, and a transmission fluid composition containing, as a base oil, at least one species selected from among α -olefin oligomers produced through oligomerization of an α -olefin through a specific method and hydrogenation products of the oligomers.

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5 [0009] Patent document 6 JP 2006 117 854 A discloses lubricating oil compositions for transmissions comprising (A) a lubricating base oil with a kinematic viscosity at 100°C adjusted to 1.5 to 6 mm²/s, composed of (A1) a lubricating base oil with a kinematic viscosity at 100°C of 1.5 mm²/s or higher and lower than 7 mm²/s or (A1) the lubricating oil and (A2) a lubricating base oil with a kinematic viscosity at 100°C of 7 to 50 mm²/s, blended with (B) a poly(meth)acrylate-based additive, so that the composition has a kinematic viscosity at 100°C of 3 to 8 mm²/s and a viscosity index of 95 to 200.

[0010] Document 7 is Phillips 66: "Sales Specification of Ultra-S Base Oils", and was retrieved from [http://baseoil.phillip366.com/EN/spec_sheets/Documents/Ultra_S_Specs .pdf](http://baseoil.phillip366.com/EN/spec_sheets/Documents/Ultra_S_Specs.pdf). It discloses the properties of certain base oils.

10 Disclosure of the Invention

Problems to be solved by the Invention

15 [0011] The present invention has been made in view of such circumstances, and an object of the present invention is to provide a lubricant composition having low viscosity and a long metal fatigue life, while being excellent in low-temperature fluidity and oxidation stability, and hence is particularly suitable as a lubricant for automobile transmissions.

Means for solving the Problems

20 [0012] The inventors of the present invention have made extensive studies with a view to developing a lubricant composition having the foregoing excellent performance. As a result, the inventors have found that the object can be achieved by blending a base oil having specific properties with an ethylene/ α -olefin copolymer having a molecular weight in a specific range at a predetermined ratio and a specific amount of a thiadiazole extreme pressure agent. The present invention has been completed on the basis of such finding.

25 [0013] That is, the present invention provides:

1. A lubricant composition, comprising:

30 a lubricant base oil; and
0.5 to 10 mass% of (A) an ethylene/ α -olefin copolymer having a number average molecular weight of 2,800 to 8,000; and
0.05 to 2.0 mass% of component (B),
wherein component (B) is a sulfur-based extreme pressure agent optionally in combination with a phosphorus-based extreme pressure agent,
35 with the proviso that the composition comprises 0.05 to 2.0 mass% of a thiadiazole extreme pressure agent which is a sulfur-based extreme pressure agent;
wherein the lubricant base oil used here has a kinematic viscosity at 100°C of 1.5 to 40 mm²/s, a viscosity index of 100 or more, a pour point of -25°C or lower, and a sulfur content of 0.01 mass% or less.

40 2. The lubricant composition according to item 1, wherein the lubricant composition has a total sulfur content of 0.15 mass% or less.

45 3. The lubricant composition according to item 2, further comprising (C) at least one kind of an additive selected from the group consisting of: an antioxidant; another extreme pressure agent; a wear-resisting agent; an oiliness agent; a detergent dispersant; and a pour point depressant.

50 4. A lubricant composition according to item 3,
wherein the antioxidant is selected from amine-based antioxidants, phenol-based antioxidants, and sulfur-based antioxidants;
wherein the another extreme pressure agent, wear-resisting agent, and oiliness agent are selected from zinc dithiophosphate, zinc dithiocarbamate, oxymolybdenum organo phosphorodithioate sulfide, and oxymolybdenum dithiocarbamate sulfide;
wherein the oiliness agent is further selected from aliphatic saturated and unsaturated monocarboxylic acids, polymerized fatty acids, hydroxy fatty acids, aliphatic saturated and unsaturated monohydric alcohols, aliphatic saturated and unsaturated monoamines, and aliphatic saturated and unsaturated monocarboxylic acid amides;
55 wherein the detergent dispersant is selected from ashless dispersants and metal-based detergents; and
wherein the pour point depressant is a polymethacrylate having a weight average molecular weight of 50,000 to 150,000.

5. Use of a lubricant composition according to any one of items 1 to 4, as:

an oil for transmissions, power steering oil, shock absorber oil, or engine oil in automobiles; or
 a gear oil, hydraulic oil, or bearing oil for automobiles and industries; or
 an oil for transmissions including a manual transmission, a continuously variable transmission, or an automatic
 transmission in automobiles.

[0014] According to the present invention, there can be provided a lubricant composition having low viscosity and a long metal fatigue life, while being excellent in low-temperature fluidity and oxidation stability, and hence is particularly suitable as a lubricant for automobile transmissions or the like.

Best Mode for carrying out the Invention

[0015] In a lubricant composition of the present invention, there is used a base oil having the following properties.

[0016] The base oil must have a kinematic viscosity at 100°C in the range of 1.5 to 40 mm²/s. When the kinematic viscosity is 1.5 mm²/s or more, the evaporation loss of the lubricant composition is small, so an improving effect on fuel efficiency can be obtained. Meanwhile, when the kinematic viscosity is 40 mm²/s or less, a power loss due to the viscous resistance of the lubricant composition does not become very large, so the improving effect on fuel efficiency can be similarly obtained. The kinematic viscosity is preferably 2 to 25 mm²/s, or particularly preferably 2 to 10 mm²/s.

[0017] The base oil must have a viscosity index of 100 or more and a pour point of -25°C or lower. When the viscosity index is 100 or more, a change in viscosity of the lubricant composition due to a temperature change is small. The viscosity index is preferably 105 or more, or more preferably 110 or more. In addition, when the pour point is -25°C or lower, the lubricant composition to be obtained has sufficient fluidity even in a low-temperature environment. The pour point is preferably -30°C or lower, or more preferably -40°C or lower.

[0018] It should be noted that the kinematic viscosity and the viscosity index are each a value measured in accordance with JIS K 2283, and the pour point is a value measured in accordance with JIS K 2265.

[0019] In addition, the base oil must have a sulfur content of 0.01 mass% or less. When the sulfur content is 0.01 mass% or less, the oxidation stability of the lubricant composition to be obtained becomes good. It should be noted that the sulfur content is a value measured in accordance with JIS K 2541.

[0020] The kind of the base oil is not particularly limited, and each of a mineral oil and a synthetic oil can be used as the base oil. Here, any one of the various conventionally known mineral oils can be used as the mineral oil, and examples of the mineral oil include a paraffin base mineral oil, an intermediate base mineral oil, and a naphthene base mineral oil. Specific examples of the mineral oil include a light neutral oil, medium neutral oil, heavy neutral oil, or bright stock obtained by solvent refining, hydrogenation refining, or the like, and a mineral oil obtained by the isomerization of a wax.

[0021] In addition, any one of the various conventionally known synthetic oils can be also used as the synthetic oil, and examples of the synthetic oil include poly α -olefin, polybutene, polyol ester, dibasic acid ester, phosphate, polyphenyl ether, alkyl benzene, alkyl naphthalene, polyoxyalkylene glycol, neopentyl glycol, silicone oil, trimethylol propane, and pentaerythritol, and further include hindered ester. Those base oils may be used alone or in combination of two or more kinds. A mineral oil and a synthetic oil may be used in combination.

[0022] The lubricant composition of the present invention has the feature of containing the base oil having the foregoing properties and 0.5 to 10 mass% of (A) an ethylene/ α -olefin copolymer having a number average molecular weight of 2,800 to 8,000 and a specific amount of a thiadiazole extreme pressure agent.

[0023] The ethylene/ α -olefin copolymer to be used as the component (A) in the lubricant composition of the present invention has a number average molecular weight in the range of 2,800 to 8,000. When the number average molecular weight is 2,800 or more, an improving effect on the viscosity index of the lubricant composition to be obtained is exerted. Meanwhile, when the number average molecular weight is 8,000 or less, the shear stability of the lubricant composition to be obtained becomes good. The number average molecular weight is preferably 3,000 to 7,000 from the viewpoints of the improving effect on the viscosity index and the impartment of good shear stability.

[0024] It should be noted that the number average molecular weight is a value measured by vapor pressure osmometry.

[0025] As the α -olefin constituting the ethylene/ α -olefin copolymer, an ethylene/ α -olefin copolymer having carbon atoms of preferably 3 to 20, or more preferably 3 to 10 is used. Examples of the α -olefin include propylene, 1-butene, isobutene, 1-pentene, 1-hexene, 1-octene, and 1-decene. One kind of the α -olefin may be used or two or more kinds of the α -olefins may be used in combination. Particularly suitable is propylene in terms of the performance of the composition.

[0026] In addition, the content of an ethylene unit in the ethylene/ α -olefin copolymer is preferably 15 to 85 mol%, or more preferably 20 to 80 mol% in terms of the performance of the composition. The manner in which the ethylene unit and the α -olefin are copolymerized is not particularly limited, and the copolymer may be either a random copolymer or a block copolymer.

[0027] In the lubricant composition of the present invention, one kind of the ethylene/ α -olefin copolymer may be used as the component (A), or two or more kinds of the ethylene/ α -olefin copolymers may be used in combination as the component (A). The component (A) is a component to be blended into the base oil for providing the lubricant composition of the present invention with low viscosity, excellent low-temperature fluidity and oxidation stability, and a long metal fatigue life.

[0028] Therefore, the content of the component (A) is 0.5 to 10 mass%, preferably 0.5 to 6 mass%, or more preferably 0.5 to 4.5 mass% with respect to the total amount of the composition from the viewpoints of the foregoing properties.

[0029] The composition comprises 0.05 to 2.0 mass% of component (B). Component (B) is a sulfur-based extreme pressure agent optionally in combination with a phosphorus-based extreme pressure agent, with the proviso that the composition comprises 0.05 to 2.0 mass% of a thiadiazole extreme pressure agent which is a sulfur-based extreme pressure agent.

[0030] Examples of the phosphorus-based extreme pressure agent include phosphate, acidic phosphate, acidic phosphate amine salt, phosphite, acidic phosphite, and acidic phosphite amine salt.

[0031] As the triphosphate, there are given triaryl phosphate, trialkyl phosphate, trialkylaryl phosphate, triarylalkyl phosphate, and trialkenyl phosphate, and examples thereof include triphenyl phosphate, tricresyl phosphate, benzylidiphenyl phosphate, ethyldiphenyl phosphate, tributyl phosphate, ethyldibutyl phosphate, cresyldiphenyl phosphate, di-cresylphenyl phosphate, ethylphenyldiphenyl phosphate, di(ethylphenyl)phenyl phosphate, propylphenyldiphenyl phosphate, di(propylphenyl)phenyl phosphate, triethylphenyl phosphate, tripropylphenyl phosphate, butylphenyldiphenyl phosphate, di(butylphenyl)phenyl phosphate, tributylphenyl phosphate, trihexyl phosphate, tri(2-ethylhexyl)phosphate, tridecyl phosphate, trilauryl phosphate, trimyristyl phosphate, tripalmityl phosphate, tristearyl phosphate, and trioleyl phosphate.

[0032] Examples of the acidic phosphate include di-2-ethylhexyl acid phosphate, didecylacid phosphate, didodecyl acid phosphate (dilauryl acid phosphate), tridecyl acid phosphate, dioctadecyl acid phosphate (distearyl acid phosphate), and di-9-octadecenylacidphosphate (dioleylacidphosphate). Examples of the phosphite include triethyl phosphite, tributyl phosphite, triphenyl phosphite, tricresyl phosphite, tri(nonylphenyl)phosphite, tri(2-ethylhexyl)phosphite, tridecyl phosphite, trilauryl phosphite, triisooctyl phosphite, diphenylisodecyl phosphite, tristearyl phosphite, and trioleyl phosphite.

[0033] Examples of the acidic phosphite include di-2-ethylhexyl hydrogen phosphite, didecyl hydrogen phosphite, didodecyl hydrogen phosphite (dilauryl hydrogen phosphite), dioctadecyl hydrogen phosphite (distearyl hydrogen phosphite), di-9-octadecenyl hydrogen phosphite (dioleyl hydrogen phosphite), and diphenyl hydrogen phosphite.

[0034] As the acidic phosphate amine salt and the acidic phosphite amine salt, salts formed of the above-mentioned acidic phosphates and acidic phosphites and the following amines are exemplified. As the amines, a monosubstituted amine, a disubstituted amine, or a trisubstituted amine may be used.

[0035] Examples of the monosubstituted amine include butylamine, pentylamine, hexylamine, cyclohexylamine, octylamine, laurylamine, stearylamine, oleylamine, and benzylamine. Examples of the disubstituted amine include dibutylamine, dipentylamine, dihexylamine, dicyclohexylamine, dioctylamine, dilaurylamine, distearylamine, dioleylamine, dibenzylamine, stearyl monoethanolamine, decyl monoethanolamine, hexyl monopropylamine benzyl monoethanolamine, phenyl monoethanolamine, and tolyl monopropylamine. Examples of the trisubstituted amine include tributylamine, tripentylamine, trihexylamine, tricyclohexylamine, trioctylamine, trilaurylamine, tristearylamine, trioleylamine, tribenzylamine, dioleyl monoethanolamine, dilauryl monopropylamine, dioctyl monoethanolamine, dihexyl monopropylamine, dibutyl propanolamine, oleyl diethanolamine, stearyl dipropylamine, lauryl diethanolamine, octyl dipropylamine, butyl diethanolamine, benzyl diethanolamine, phenyl diethanolamine, tolyl dipropylamine, xylyl diethanolamine, triethanolamine, and tripropanolamine.

[0036] In addition, as the acidic phosphate amine salt, a salt formed of the acidic monophosphate and the above-mentioned amine such as monomethyl hydrogen phosphate, monoethyl hydrogen phosphate, monopropyl hydrogen phosphate, monobutyl hydrogen phosphate, or mono-2-ethylhexyl hydrogen phosphate can be used.

[0037] In the present invention, one kind of the phosphate-based compound may be used or two or more kinds of the phosphate-based compounds may be used in combination.

[0038] Meanwhile, any sulfur-based extreme pressure agent other than the mandatory thiadiazole has only to have the following characteristics: the agent has a sulfur atom in any one of its molecules, and is dissolved or uniformly dispersed in the lubricant base oil so as to be capable of exerting extreme-pressure property or an excellent friction characteristic. Examples of the sulfur-based extreme pressure agent having such characteristics include sulfurized fats and oils, a sulfurized fatty acid, a sulfurized ester, a sulfurized olefin, dihydrocarbyl polysulfide, the mandatory thiadiazole compound, a thiophosphoric acid ester (thiophosphite or thiophosphate), an alkylthiocarbonyl compound, a thiocarbamate compound, a thioterpene compound, and a dialkyl thiodipropionate compound. Here, the sulfurized fats and oils can be obtained by causing sulfur or a sulfur-containing compound and fats and oils (such as a lard oil, a whale oil, a vegetable oil, and a fish oil) to react with each other, and the sulfur content of each of the sulfurized fats and oils, which is not particularly limited, is suitably 5 to 30 mass% in ordinary cases. Specific examples of such fats and oils include a sulfurized lard, a sulfurized rapeseed oil, a sulfurized castor oil, a sulfurized soybean oil, and a sulfurized rice bran oil.

The sulfurized fatty acid is, for example, a sulfurized oleic acid. Examples of the sulfurized ester include sulfurized methyl oleate and sulfurized rice bran fatty acid octyl.

[0039] The sulfurized olefin is, for example, a compound represented by the following general formula (I):



where: R¹ represents an alkenyl group having 2 to 15 carbon atoms; R² represents an alkyl or alkenyl group having 2 to 15 carbon atoms; and q represents an integer of 1 to 8.

10 The compound is obtained by causing an olefin having 2 to 15 carbon atoms or a dimer, trimer, or tetramer of the olefin and a sulfurizing agent such as sulfur or sulfur chloride to react with each other, and the olefin is preferably, for example, propylene, isobutene, or diisobutene.

[0040] The dihydrocarbyl polysulfide is, for example, a compound represented by the following general formula (II):



where R³ and R⁴ each represent an alkyl group or a cyclic alkyl group having 1 to 20 carbon atoms, an aryl group having 6 to 20 carbon atoms, an alkyl aryl group having 7 to 20 carbon atoms, or an aryl alkyl group having 7 to 20 carbon atoms, which may be identical to or different from each other; and r represents an integer of 1 to 8.

when both R³ and R⁴ are alkyl groups, the compound is referred to as sulfurized alkyl.

20 Examples of the dihydrocarbyl polysulfide represented by the general formula (II) preferably include dibenzyl polysulfide, various dinonyl polysulfides, various didodecyl polysulfides, various dibutyl polysulfides, various dioctyl polysulfides, diphenyl polysulfide, and dicyclohexyl polysulfide.

[0041] Examples of the thiadiazole compound required by the invention preferably include

25 2,5-bis(n-hexyldithio)-1,3,4-thiadiazole,
2,5-bis(n-octyldithio)-1,3,4-thiadiazole,
2,5-bis(n-nonyldithio)-1,3,4-thiadiazole,
2,5-bis(1,1,3,3-tetramethylbutyldithio)-1,3,4-thiadiazole,
3,5-bis(n-hexyldithio)-1,2,4-thiadiazole,
30 3,6-bis(n-octyldithio)-1,2,4-thiadiazole,
3,5-bis(n-nonyldithio)-1,2,4-thiadiazole,
3,5-bis(1,1,3,3-tetramethylbutyldithio)-1,2,4-thiadiazole,
4,5-bis(n-octyldithio)-1,3,4-thiadiazole,
4,5-bis(n-nonyldithio)-1,2,3-thiadiazole, and
35 4,5-bis(1,1,3,3-tetramethylbutyldithio)-1,2,3-thiadiazole.

[0042] Examples of the thiophosphoric acid ester include alkyl trithiophosphite, aryl or alkyl aryl thiophosphate, and zinc dilauryl dithiophosphate. Particularly preferred are lauryl thiophosphite and triphenyl thiophosphate.

40 **[0043]** Examples of the alkyl thiocarbamoyl compound include bis(dimethyl thiocarbamoyl)monosulfide, bis(dibutyl thiocarbamoyl)monosulfide, bis(dimethyl thiocarbamoyl)disulfide, bis(dibutyl thiocarbamoyl)disulfide, bis(diamyl thiocarbamoyl)disulfide, and bis(dioctyl thiocarbamoyl)disulfide.

[0044] Further, the thiocarbamate compound is, for example, a zinc dialkyldithiocarbamate, the thioterpene compound is, for example, a product of a reaction between phosphorus pentasulfide and pinene, and examples of the dialkyl thiodipropionate compound include dilauryl thiodipropionate and distearyl thiodipropionate. Of those, the thiadiazole compound optionally together with benzyl sulfide is suitable in terms of, for example, extreme-pressure property, a friction characteristic, and thermal oxidation stability.

[0045] One kind of those sulfur-based extreme pressure agents may be used alone, or two or more kinds of them may be used in combination as long as the thiadiazole is present.

50 **[0046]** In the lubricant composition of the present invention, only the sulfur-based extreme pressure agent may be used as the component (B), or the phosphorus-based extreme pressure agent and the sulfur-based extreme pressure agent may be used in combination as the component (B).

[0047] The content of the component (B) is defined in the claims and achieves a balance between the effect and economical efficiency of the component as an extreme pressure agent.

55 **[0048]** It should be noted that, when the sulfur-based extreme pressure agent is used, from the viewpoint of corrosion prevention, the amount in which the agent is blended is preferably adjusted so that the total sulfur content in the composition may be preferably 0.15 mass% or less, or more preferably 0.10 mass% or less.

[0049] At least one kind of an additive selected from an antioxidant, another extreme pressure agent, a wear-resisting agent, an oiliness agent, a detergent dispersant, and a pour point depressant can be further incorporated as a component

(C) into the lubricant composition of the present invention.

[0050] Examples of the antioxidants include an amine-based antioxidants, phenol-based antioxidants, and a sulfur-based antioxidants.

[0051] Examples of the amine-based antioxidants include: monoalkyldiphenylamine-based compounds such as mono-octyldiphenylamine and monononyldiphenylamine; dialkyldiphenylamine-based compounds such as 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine, and 4,4'-dinonyldiphenylamine; polyalkyldiphenylamine-based compounds such as tetrabutyl-diphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine, and tetranonyldiphenylamine; and naphthylamine-based compounds such as α -naphthylamine, phenyl- α -naphthylamine, butylphenyl- α -naphthylamine, pentylphenyl- α -naphthylamine, hexylphenyl- α -naphthylamine, heptylphenyl- α -naphthylamine, octylphenyl- α -naphthylamine, and nonylphenyl- α -naphthylamine. Of those, dialkyldiphenylamine-based compounds are preferable.

[0052] Examples of the phenol-based antioxidant include monophenol-based compounds such as 2,6-di-tert-butyl-4-methylphenol and 2,6-di-tert-butyl-4-ethylphenol; and diphenol-based compounds such as 4,4'-methylenebis(2,6-di-tert-butylphenol) and 2,2'-methylenebis(4-ethyl-6-tert-butylphenol).

[0053] Examples of the sulfur-based antioxidant include phenothiazine, pentaerythritol-tetrakis(3-laurylthiopropionate), bis(3,5-tert-butyl-4-hydroxybenzyl)sulfide, thiodiethylenebis(3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate), and 2,6-di-tert-butyl-4-(4,6-bis(octylthio)-1,3,5-triazine-2-methylamino)phenol.

[0054] Each of these antioxidants may be used alone or two or more of them may be used in combination. Further, the blending amounts of those antioxidants are typically in the range of 0.01 to 10 mass%, or preferably in a range of 0.03 to 5 mass% on the basis of the total amount of the lubricant composition.

[0055] As other extreme pressure agents, the wear-resisting agents, and the oiliness agents, there are exemplified organic metal compounds such as zinc dithiophosphate (ZnDTP), zinc dithiocarbamate (ZnDTC), oxymolybdenum organo phosphorodithioate sulfide (MoDTP), and oxymolybdenum dithiocarbamate sulfide (MDTC). The blending amount of those is typically 0.05 to 5 mass%, or preferably 0.1 to 3 mass% based on the total amount of lubricant composition.

[0056] Further, mentioned are oiliness agents including aliphatic saturated and unsaturated monocarboxylic acids such as stearic acids and oleic acids; polymerized fatty acids such as dimer acids and hydrogenated dimer acids; hydroxy fatty acids such as ricinoleic acids and 12-hydroxystearic acids; aliphatic saturated and unsaturated monohydric alcohols, such as lauryl alcohol and oleyl alcohol; aliphatic saturated and unsaturated monoamines such as stearylamine and oleylamine; and aliphatic saturated and unsaturated monocarboxylic acid amides such as lauric acid amide and oleamide.

[0057] The preferable blending amount of those oiliness agents is typically in a range of 0.01 to 10 mass%, or particularly preferably in a range of 0.1 to 5 mass% based on the total amount of lubricant composition.

[0058] Examples of the detergents and the dispersants include: ashless dispersants such as succinimides, boron-containing succinimides, benzylamines, boron-containing benzylamines, succinates, and monovalent or bivalent carboxylic amides typified by fatty acids or succinic acids; and metal-based detergents such as neutral metal sulfonate, neutral metal phenate, neutral metal salicylate, neutral metal phosphonate, basic sulfonate, basic phenate, basic salicylate, over-based sulfonate, over-based salicylate, and over-based phosphonate. The blending amount of those detergent dispersants is typically 0.1 to 20 mass%, or preferably 0.5 to 10 mass% based on the total amount of lubricant composition.

[0059] For example, a polymethacrylate having a weight average molecular weight of about 50,000 to 150,000 can be used as the pour point depressant.

[0060] An additive except those described above such as a rust inhibitor, a metal deactivator, a defoaming agent, or a surfactant can be incorporated into the lubricant composition of the present invention as desired.

[0061] There are used, for example: as the rust inhibitor, alkenyl succinic acid and partial esters thereof; as the metal corrosion inhibitor, benzotriazole-based, benzimidazole-based, benzothiazole-based, and thiadiazole-based ones; and as the metal deactivator, benzotriazole, benzotriazole derivatives, benzothiazole, benzothiazole derivatives, triazole, triazole derivatives, dithiocarbamate, dithiocarbamate derivatives, imidazole, and imidazole derivatives. There are used, for example: as the defoaming agent, dimethyl polysiloxane and polyacrylate; and as the surfactant, polyoxyethylene alkylphenyl ether.

[0062] The lubricant composition of the present invention has, for example, the following characteristics: the lubricant composition has low viscosity, is excellent in low-temperature fluidity and oxidation stability, and has a long metal fatigue life. Accordingly, the lubricant composition is suitably used as, for example, an oil for transmissions, power steering oil, shock absorber oil, or engine oil in automobiles, or a gear oil, hydraulic oil, or bearing oil for automobiles and industries; the lubricant composition is particularly suitable as an oil for transmissions such as an automatic transmission, a manual transmission, and a continuously variable transmission in automobiles.

Examples

[0063] Hereinafter, the present invention will be described in more detail with reference to Examples and Comparative

EP 2 053 117 B1

Examples, but is not limited thereto.

[0064] It should be noted that the physical properties of a base oil and a lubricant composition were determined in accordance with the following methods.

5 <Base oil and lubricant composition>

(1) Kinematic viscosity (40°C, 100°C)

10 **[0065]** Measurement was performed in accordance with JIS K 2283.

(2) Viscosity index (VI)

[0066] Measurement was performed in accordance with JIS K 2283.

15 (3) Sulfur content

[0067] Measurement was performed in accordance with JIS K 2541.

<Base oil>

20

(4) Pour point

[0068] Measurement was performed in accordance with JIS K 2265.

25 <Lubricant composition>

(5) Low-temperature viscosity (-40°C)

30 **[0069]** A Brookfield viscosity at -40°C was measured in accordance with ASTM D 2983.

(6) Fatigue life

[0070] A fatigue life was measured with a four-ball rolling fatigue tester in the following manner.

35 (Bearing)

[0071]

40

Material:	bearing steel
Test piece:	φ60×5 mm thick
Steel ball dimensions:	φ3/8 inch (3/8×2.54 cm)
(Test conditions)	
Load:	147 N
Rotational speed:	2,200 rpm
Oil temperature:	120°C

45

[0072] A time period required for flaking to occur in the test piece was defined as a fatigue life, and an L50 (average) was calculated from the results of the test performed six times.

50

(7) Oxidation stability

[0073] A test oil was forcedly deteriorated in an ISOT test (150°C) in accordance with JIS K 2514. The percentage by which the viscosity changed (40°C, 100°C), an increase in total acid number, a base number, the amount of n-heptane insoluble matter, and an increase in copper element were measured 144 hours after the deterioration.

55

[0074] The kinds of the respective components used in the preparation of a lubricant composition are as shown below. Base oils A to F

EP 2 053 117 B1

[0075] Table 1 shows the properties of the base oils.

[Table 1]

5 **[0076]**

Table 1

	Kind	Properties					
		Kinematic viscosity (mm ² /s)		Viscosity index	Pour point (°C)	Sulfur content (mass%)	
		40°C	100°C				
Base oil	A	Hydrogenation-refined base oil	9.79	2.686	113	-42.5	0.01>
	B	Hydrogenation-refined base oil	7.976	2.252	83	-10.0	0.01>
	C	Hydrogenation-refined base oil	20.54	4.412	127	-22.5	0.01>
	D	Hydrogenation-refined base oil	408.8	30.86	107	-15.0	0.01>
	E	Solvent-refined base oil	458.6	30.65	96	12.5	0.43
	F	Solvent-refined base oil	745.8	42.52	98	15.0	0.51

Ethylene/ α -olefin copolymer I

30 **[0077]** A product available under the trade name "Lucant HC600" from Mitsui Chemicals, the product having a number average molecular weight of 2,600, a kinematic viscosity at 100°C of 600 mm²/s, a viscosity index of 240, and a sulfur content of less than 0.1 mass%

Ethylene/ α -olefin copolymer II

35 **[0078]** A product available under the trade name "Lucant HC2000" from Mitsui Chemicals, the product having a number average molecular weight of 3,700, a kinematic viscosity at 100°C of 2,000 mm²/s, a viscosity index of 300, and a sulfur content of less than 0.1 mass% Ethylene/ α -olefin copolymer III (including diluent oil having a concentration of 50 mass%)

40 **[0079]** A product available under the trade name "Lucant HS4010M" from Mitsui Chemicals, the product having a number average molecular weight of 6,600, a kinematic viscosity at 100°C of 2,000 mm²/s, a viscosity index of 335, and a sulfur content of less than 0.1 mass% Viscosity index improver I

[0080] A polymethacrylate-based product available under the trade name "VISCOPLEX 0-050" from Romax, the product having a number average molecular weight of 18,000 and a kinematic viscosity at 100°C of 450 mm²/s

45 Viscosity index improver II

[0081] A polymethacrylate-based product available under the trade name "ACLUBE C728" from Sanyo Chemical Industries, Ltd., the product having a number average molecular weight of 45,000 and a kinematic viscosity at 100°C of 852 mm²/s

50 Pour point depressant

[0082] A polymethacrylate-based product available under the trade name "ACLUBE C728" from Sanyo Chemical Industries, Ltd.

55

EP 2 053 117 B1

Extreme pressure agent: thiadiazole

ATF additive package

5 **[0083]** A product available under the trade name "Infineum T4261" from Infineum, the product containing a phosphorus-based extreme pressure agent, a sulfur-based extreme pressure agent, a detergent dispersant a friction adjustor, and an antioxidant

[0084] Examples 1 to 3 do not form part of the invention and are provided for information only

10 Examples 1 to 4 and Comparative Examples 1 to 6

[0085] Lubricant compositions each having the composition shown in Table 2 were prepared, and were each evaluated for physical properties except oxidation stability. Table 2 shows the results.

15 **[0086]** The lubricant compositions of Example 1 and Comparative Example 1 were each evaluated for oxidation stability. Table 3 shows the results.

[Table 2]

[0087]

Table 2-1

			Example				Comparative Example
			1*	2*	3*	4	1
Composition (mass%)	Base oil	Kind	A	A	A	A	B/C
		Content	84.2	84.2	83.5	84.1	35.7/44.2
		Sulfur content (mass%)	0.01>	0.01>	0.01>	0.01>	0.01>
	Ethylene/propylene copolymer	I	-	-	2.7	-	-
		II	4.0	-	2.0	4.0	-
		III	-	4.0	-	-	-
	Viscosity index improver	I	-	-	-	-	-
		II	-	-	-	-	8.3
	Pour point depressant		0.3	0.3	0.3	0.3	0.3
	Extreme pressure agent		-	-	-	0.1	-
ATF additive package		11.5	11.5	11.5	11.5	11.5	
Physical properties	Sulfur content (mass%)		0.06	0.06	0.06	0.06	0.06
	Kinematic viscosity (mm ² /s)	40°C	25	26.11	26.07	24.95	33.1
		100°C	5.64	5.806	5.775	5.63	7.37
	Viscosity index		176	176	174	176	198
	Low-temperature viscosity [-40°C] [Brookfield viscosity]		7,500	7,200	9,200	7,500	14,500
Fatigue life [L50] (minutes)		155	160	162	170	95	
*Examples 1 to 3 do not form part of the invention and are provided for information only							

[Table 3]

[0088]

5

Table 2-2

			Comparative Example				
			2	3	4	5	6
Composition (mass%)	Base oil	Kind	A/C	A/C/D	A/E	A/F	A
		Content	19.0/66.2	50.0/25.2 /10.0	69.2/17.0	73.5/14.0	82.4
		Sulfur content (mass%)	0.01>	0.01>	0.08	0.08	0.01>
	Ethylene/propylene copolymer	I	-	-	-	-	5.8
		II	-	-	-	-	-
		III	-	-	-	-	-
	Viscosity index improver	I	-	-	2.0	-	-
		.11	3.0	3.0	-	0.7	-
	Pour point depressant		0.3	0.3	0.3	0.3	0.3
	Extreme pressure agent		-	-	-	-	-
ATF additive package		11.5	11.5	11.5	11.5	11.5	
Physical properties	Sulfur content (mass%)		0.06	0.06	0.14	0.14	0.06
	Kinematic viscosity (mm ² /s)	40 °C	26.46	26.61	28.06	27.24	26.37
		100 °C	5.729	5.682	5.762	5.690	5.828
	Viscosity index		167	162	153	156	174
	Low-temperature viscosity [-40 °C] [Brookfield viscosity]		'8,100	9,900	17,200	19,200	11,000
	Fatigue life [L50] (minutes)		110	135	140	155	140

[Table 4]

40

[0089]

Table 3

			Example 1*	Comparative Example 5
Oxidation stability [ISOT test 150°C, 144h]	Percentage by which kinematic viscosity changed (%)	40 °C	3.0	8.2
		100 °C	1.5	4.5
	Increase in total acid number (mgKOH/g)		-0.05	0.12
	Base number (mgKOH/g)		0.36	0.05
	Amount of n-pentane insoluble matter (mass%)		0.01>	0.05
Increase in Cu element (ppm)		26	35	
*Example 1 does not form part of the invention				

55

[0090] As can be seen from Table 2, each of the lubricant compositions of Examples 1 to 3 and composition of the

invention example 4 has a low-temperature viscosity (-40°C) of less than 10,000 and a fatigue life [L50] in excess of 150 minutes, so each of them has good low-temperature fluidity and a long metal fatigue life. In contrast, each of the lubricant compositions of Comparative Examples 1 to 4 and Comparative Example 6 has a fatigue life [L50] of less than 150 minutes, so each of them has a short metal fatigue life. Moreover, each of the lubricant compositions of Comparative Examples 1, 4, and 6 has a low-temperature viscosity (-40°C) in excess of 10,000, so each of them is poor in low-temperature fluidity.

[0091] Meanwhile, the lubricant composition of Comparative Example 5 has a fatigue life [L50] in excess of 150 minutes, so the lubricant composition has a long metal fatigue life. However, the lubricant composition has extremely bad low-temperature fluidity. In addition, as can be seen from Table 3, the lubricant composition is inferior in oxidation stability to the lubricant composition of the present disclosure, Example 1.

Industrial Applicability

[0092] The lubricant composition of the present invention has the following characteristics: the lubricant composition has low viscosity, is excellent in low-temperature fluidity and oxidation stability, and has a long metal fatigue life. Accordingly, the lubricant composition is suitably used as, for example, an oil for transmissions, power steering oil, shock absorber oil, or engine oil in automobiles, or a gear oil, hydraulic oil, or bearing oil for automobiles and industries.

Claims

1. A lubricant composition, comprising:

a lubricant base oil; and

0.5 to 10 mass% of (A) an ethylene/ α -olefin copolymer having a number average molecular weight of 2,800 to 8,000; and

0.05 to 2.0 mass% of component (B),

wherein component (B) is a sulfur-based extreme pressure agent optionally in combination with a phosphorus-based extreme pressure agent,

with the proviso that the composition comprises 0.05 to 2.0 mass% of a thiadiazole extreme pressure agent which is a sulfur-based extreme pressure agent;

wherein the lubricant base oil used here has a kinematic viscosity at 100°C of 1.5 to 40 mm²/s, a viscosity index of 100 or more, a pour point of -25°C or lower, and a sulfur content of 0.01 mass% or less.

2. The lubricant composition according to claim 1, wherein the lubricant composition has a total sulfur content of 0.15 mass% or less.

3. The lubricant composition according to claim 2, further comprising (C) at least one kind of an additive selected from the group consisting of: an antioxidant; another extreme pressure agent; a wear-resisting agent; an oiliness agent; a detergent dispersant; and a pour point depressant.

4. A lubricant composition according to claim 3,

wherein the antioxidant is selected from amine-based antioxidants, phenol-based antioxidants, and sulfur-based antioxidants;

wherein the another extreme pressure agent, wear-resisting agent, and oiliness agent are selected from zinc dithiophosphate, zinc dithiocarbamate, oxymolybdenum organo phosphorodithioate sulfide, and oxymolybdenum dithiocarbamate sulfide;

wherein the oiliness agent is further selected from aliphatic saturated and unsaturated monocarboxylic acids, polymerized fatty acids, hydroxy fatty acids, aliphatic saturated and unsaturated monohydric alcohols, aliphatic saturated and unsaturated monoamines, and aliphatic saturated and unsaturated monocarboxylic acid amides;

wherein the detergent dispersant is selected from ashless dispersants and metal-based detergents; and

wherein the pour point depressant is a polymethacrylate having a weight average molecular weight of 50,000 to 150,000.

5. Use of a lubricant composition according to any one of claims 1 to 4, as:

an oil for transmissions, power steering oil, shock absorber oil, or engine oil in automobiles; or a gear oil, hydraulic oil, or bearing oil for automobiles and industries; or

an oil for transmissions including a manual transmission, a continuously variable transmission, or an automatic transmission in automobiles.

5 **Patentansprüche**

1. Schmiermittelzusammensetzung, enthaltend:

10 ein Schmiermittel-Grundöl und
 0,5 bis 10 Masse-% eines (A) Ethylen/ α -Olefin-Copolymers mit einem Molekulargewicht im Zahlenmittel von 2.800 bis 8.000 und
 0,05 bis 2,0 Masse-% einer Komponente (B),
 worin die Komponente (B) ein Schwefel-basiertes extremes Druckmittel wahlweise in Kombination mit einem Phosphorbasierten extremen Druckmittel ist,
 15 mit dem Vorbehalt, dass die Zusammensetzung 0,05 bis 2,0 Masse-% eines extremen Thiadiazol-Druckmittels enthält, das ein Schwefel-basiertes extremes Druckmittel ist,
 worin das verwendete Schmiermittel-Grundöl eine kinematische Viskosität bei 100°C von 1,5 bis 40 mm²/s, einen Viskositätsindex von 100 oder mehr, einen Stockpunkt von -25°C oder weniger und einen Schwefelgehalt von 0,01 Masse-% oder weniger hat.

20 2. Schmiermittelzusammensetzung gemäß Anspruch 1, worin die Schmiermittelzusammensetzung einen gesamten Schwefelgehalt von 0,15 Masse-% oder weniger hat.

25 3. Schmiermittelzusammensetzung gemäß Anspruch 2, weiterhin enthaltend (C) zumindest eine Art eines Additivs, ausgewählt aus der Gruppe, bestehend aus: einem Antioxidans, einem anderen extremen Druckmittel, einem Abriebs-resistenten Mittel, einem Öligkeitsmittel, einem Reinigungsdispergiermittel und einem Stockpunktunterdrückungsmittel.

30 4. Schmiermittelzusammensetzung gemäß Anspruch 3, worin das Antioxidans ausgewählt ist aus Amin-basierten Antioxidantien, Phenol-basierten Antioxidantien und Schwefel-basierten Antioxidantien,
 worin das andere extreme Druckmittel, Abriebs-resistente Mittel und Öligkeitsmittel ausgewählt sind aus Zinkdithiophosphat, Zinkdithiocarbamat, Oxymolybdänorganophosphordithioatsulfid und Oxymolybdändithiocarbamatsulfid,
 worin das Öligkeitsmittel weiter ausgewählt ist aus aliphatischen gesättigten und ungesättigten Monocarbonsäuren,
 35 polymerisierten Fettsäuren, Hydroxyfettsäuren, aliphatischen gesättigten und ungesättigten einwertigen Alkoholen, aliphatischen gesättigten und ungesättigten Monoaminen und aliphatischen gesättigten und ungesättigten Monocarbonsäureamiden,
 worin das Reinigungsdispergiermittel ausgewählt ist aus aschelosen Dispersiermitteln und Metall-basierten Reinigungsmitteln und
 40 worin das Stockpunktunterdrückungsmittel ein Polymethacrylat mit einem Molekulargewicht im Gewichtsmittel von 50.000 bis 150.000 ist.

45 5. Verwendung einer Schmiermittelzusammensetzung gemäß einem der Ansprüche 1 bis 4 als Öl für Getriebe, Lenkhilfeöl, Schockabsorberöl oder Motoröl in Automobilen oder
 Getriebeöl, hydraulisches Öl oder Lageröl für Automobile und Industrien oder
 ein Öl für Getriebe einschließlich einem manuellen Getriebe, einem stufenlosen Getriebe oder einem Automatikgetriebe in Automobilen.

50 **Revendications**

1. Composition lubrifiante, comprenant :

55 une huile de base lubrifiante ; et
 0,5 à 10 % en masse de (A) un copolymère éthylène/ α -oléfine ayant un poids moléculaire moyen en nombre de 2 800 à 8 000 ; et
 0,05 à 2,0 % en masse de composant (B),
 dans laquelle le composant (B) est un agent de pression extrême à base de soufre éventuellement en combi-

EP 2 053 117 B1

naison avec un agent de pression extrême à base de phosphore,
à condition que la composition comprenne 0,05 à 2,0% en masse d'un agent extrême-pression thiadiazole qui
est un agent extrême-pression à base de soufre ;
dans laquelle l'huile de base lubrifiante utilisée ici a une viscosité cinématique à 100 °C de 1,5 à 40 mm²/s, un
indice de viscosité supérieur ou égal à 100, un point d'écoulement inférieur ou égal à -25 °C et une teneur en
soufre inférieure ou égale à 0,01 % en masse.

2. Composition lubrifiante selon la revendication 1, dans laquelle la composition lubrifiante a une teneur en soufre
totale inférieure ou égale à 0,15 % en masse.

3. Composition lubrifiante selon la revendication 2, comprenant en outre (C) au moins un type d'un additif choisi dans
le groupe constitué de : un antioxydant ; un autre agent extrême-pression ; un agent résistant à l'usure ; un agent
d'onctuosité ; un dispersant détergent et un abaisseur de point d'écoulement.

4. Composition lubrifiante selon la revendication 3,
dans laquelle l'antioxydant est choisi parmi les antioxydants à base d'amine, les antioxydants à base de phénol et
les antioxydants à base de soufre ;
dans laquelle l'autre agent extrême-pression, l'agent résistant à l'usure et l'agent d'onctuosité sont choisis parmi
dithiophosphate de zinc, dithiocarbamate de zinc, sulfure d'organophosphorodithioate d'oxymolybdène et sulfure
de dithiocarbamate d'oxymolybdène ;
dans laquelle l'agent d'onctuosité est en outre choisi parmi les acides monocarboxyliques saturés et insaturés
aliphatiques, les acides gras polymérisés, les acides gras d'hydroxy, les alcools monohydriques saturés et insaturés
aliphatiques, les monoamines saturées et insaturées aliphatiques et les amides d'acide monocarboxylique saturés
et insaturés ;
dans laquelle le dispersant détergent est choisi parmi les dispersants sans cendres et les détergents à base de
métal ; et
dans laquelle l'abaisseur de point d'écoulement est un polyméthacrylate ayant un poids moléculaire moyen en poids
de 50 000 à 150 000.

5. Utilisation d'une composition lubrifiante selon l'une quelconque des revendications 1 à 4, en tant que :

une huile pour transmissions, huile pour direction assistée, huile pour amortisseur, ou huile moteur dans des
automobiles ; ou

une huile pour engrenages, huile hydraulique ou huile pour roulements pour automobiles et industries ; ou

une huile pour transmissions incluant une transmission manuelle, une transmission à variation continue ou une
transmission automatique dans des automobiles.

REFERENCES CITED IN THE DESCRIPTION

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