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(54) **LUBRICATING-OIL COMPOSITION**

(57) The lubricating oil composition of the present invention comprises a base oil that contains at least one selected from the group consisting of a mineral oil and a synthetic oil, has a viscosity index of 120 or more, and has a paraffin content by ring analysis of 70% or more; (A) a dispersant containing one or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide; and (B) a metallic detergent containing one or more compounds selected from the group consisting of an alkali metal sulfonate, an alkali metal phenate, an alkali metal salicylate, an alkaline earth metal sulfonate, an alkaline earth metal phenate, and an alkaline earth metal salicylate; wherein the component (A) is contained in an amount of from 0.01% by mass to 0.10% by mass in terms of the nitrogen content thereof based on the total amount of the composition, the component (B) is contained in an amount of from 0.01% by mass to 0.3% by mass in terms of the metal

content thereof based on the total amount of the composition, at least one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained, the ratio by mass of boron to nitrogen B/N in the component (A) is 0.5 or more, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, and the sulfated ash content based on the total amount of the composition is 1.1% by mass or less. Accordingly, even when used in automobile internal combustion engines capable of increasing the thermal and mechanical durability temperature thereof more than before and capable of realizing power increase and fuel efficiency, the lubricating oil composition can prevent engine performance degradation and therefore can satisfy both the requirements of engine performance and engine durability.

Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a lubricating oil composition for use in internal combustion engines such as diesel engines, gasoline engines, gas engines, and hybrid vehicle engines.

BACKGROUND ART

10 **[0002]** In recent years, environmental regulations are becoming more and more severe on a global scale, and the circumstances surrounding automobiles, including fuel efficiency requirements and exhaust emission regulations, are becoming increasingly severe. Behind this, there are environmental issues, such as global warming, and resource protection arising from concerns about the depletion of petroleum resources. For these reasons, further reduction of fuel consumption in automobiles is desired.

15 **[0003]** Attempting power increase in automobile engines would tend to increase the combustion temperature and the pressure in engines. In particular, diesel engines are required to have high-temperature resistance and rigidity and thermal cracking resistance and the like, and therefore must be designed to be tough. However, for fuel consumption, reduction of engine weight is desired.

20 **[0004]** Given the situation, heretofore, an aluminum alloy such as JIS AC8A has been used for diesel engine pistons for weight reduction. In addition, a lubricating oil composition suitable for lubrication of diesel engines using an aluminum alloy is developed (for example, see Patent Document 1).

CITATION LIST

25 PATENT DOCUMENT

[0005] Patent Document 1: JP-A 2010-10070

SUMMARY OF INVENTION

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TECHNICAL PROBLEM

35 **[0006]** However, with respect to pistons formed of an aluminum alloy, the temperature at which they could still secure thermal and mechanical durability is about 350°C, and the thermal expansivity thereof at that temperature is high, and therefore, in the recent trend to improve automobile engines so as to meet the requirements of power increase and fuel efficiency, cast iron pistons having a thermal and mechanical durability temperature of up to about 400°C have become partly employed in place of aluminum alloy pistons.

40 **[0007]** As compared with aluminum alloy pistons, cast iron pistons could secure higher durability and, in addition, graphite contained in cast iron has self-lubricity, and therefore cast iron pistons could have good seizure resistance. However, there is a concern that the cast iron pistons readily cause engine performance degradation, since they may have a high temperature in the vicinity of the top dead center to cause significant abrasion and poor detergency as compared with that of aluminum alloy pistons.

45 **[0008]** Accordingly, an object of the present invention is to provide a lubricating oil composition which, even when used in automobile internal combustion engines capable of increasing the thermal and mechanical durability temperature thereof more than before and capable of realizing power increase and fuel efficiency, can prevent engine performance degradation and therefore can satisfy both the requirements of engine performance and engine durability.

SOLUTION TO PROBLEM

50 **[0009]** The inventors of the present invention conducted intensive studies and, as a result, found that the problem can be overcome by a lubricating oil composition containing a base oil, a dispersant and a metallic detergent in which these components are blended under a specific condition, and accomplished the present invention.

55 **[0010]** Specifically, the lubricating oil composition of the present invention comprises a base oil that contains at least one selected from the group consisting of a mineral oil and a synthetic oil, has a viscosity index of 120 or more, and has a paraffin content by ring analysis of 70% or more; a dispersant (A) containing one or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide; and a metallic detergent (B) containing one or more compounds selected from the group consisting of an alkali metal sulfonate, an alkali metal phenate, an alkali metal salicylate, an alkaline earth metal sulfonate, an

alkaline earth metal phenate, and an alkaline earth metal salicylate; wherein the component (A) is contained in an amount of from 0.01% by mass to 0.10% by mass in terms of the nitrogen content thereof based on the total amount of the composition, the component (B) is contained in an amount of from 0.01% by mass to 0.3% by mass in terms of the metal content thereof based on the total amount of the composition, one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained, the ratio by mass of boron to nitrogen B/N in the component (A) is 0.5 or more, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, and the sulfated ash content based on the total amount of the composition is 1.1% by mass or less.

[0011] A production method for the lubricating oil composition of the present invention is a production method for a lubricating oil composition for producing a lubricating oil composition by blending, with a base oil that contains at least one selected from the group consisting of a mineral oil and a synthetic oil, has a viscosity index of 120 or more, and has a paraffin content by ring analysis of 70% or more, a dispersant (A) containing one or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide, and a metallic detergent (B) containing one or more compounds selected from the group consisting of an alkali metal sulfonate, an alkali metal phenate, an alkali metal salicylate, an alkaline earth metal sulfonate, an alkaline earth metal phenate, and an alkaline earth metal salicylate, so that the component (A) is contained in an amount of from 0.01% by mass to 0.10% by mass in terms of the nitrogen content thereof based on the total amount of the composition, the component (B) is contained in an amount of from 0.01% by mass to 0.3% by mass in terms of the metal content thereof based on the total amount of the composition, one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained, the ratio by mass of boron to nitrogen B/N in the component (A) is 0.5 or more, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, and the sulfated ash content based on the total amount of the composition is 1.1% by mass or less.

ADVANTAGEOUS EFFECTS OF INVENTION

[0012] According to the present invention, it is possible to provide a lubricating oil composition which, even when used in automobile internal combustion engines capable of increasing the thermal and mechanical durability temperature thereof more than heretofore and then capable of realizing power increase and fuel efficiency, can prevent engine performance degradation and therefore can satisfy both the requirements of engine performance and engine durability.

DESCRIPTION OF EMBODIMENTS

[Lubricating Oil Composition]

[0013] The lubricating oil composition of the present invention comprises a base oil that contains at least one selected from the group consisting of a mineral oil and a synthetic oil, has a viscosity index of 120 or more, and has a paraffin content by ring analysis of 70% or more; a dispersant (A) containing one or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide; and a metallic detergent (B) containing one or more compounds selected from the group consisting of an alkali metal sulfonate, an alkali metal phenate, an alkali metal salicylate, an alkaline earth metal sulfonate, an alkaline earth metal phenate, and an alkaline earth metal salicylate.

[0014] The component (A) is contained in an amount of from 0.01% by mass to 0.10% by mass in terms of the nitrogen content thereof based on the total amount of the composition, the component (B) is contained in an amount of from 0.01% by mass to 0.3% by mass in terms of the metal content thereof based on the total amount of the composition.

[0015] One or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained, and the ratio by mass of boron to nitrogen B/N in the component (A) is 0.5 or more. In addition, in the lubricating oil composition, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, and the sulfated ash content based on the total amount of the composition is 1.1% by mass or less. The lubricating oil composition of the present invention may be hereinafter referred to simply as "the present composition".

[Base Oil]

[0016] The base oil in the present composition may be mineral oil or synthetic oil. The type of the mineral oil and the synthetic oil is not specifically limited, and for use herein, any one may be suitably selected from a mineral oil and a synthetic oil heretofore used as the base oil in lubricating oil compositions.

[0017] Examples of the mineral oil include a mineral oil refined by subjecting a lubricating oil distillate that is obtained

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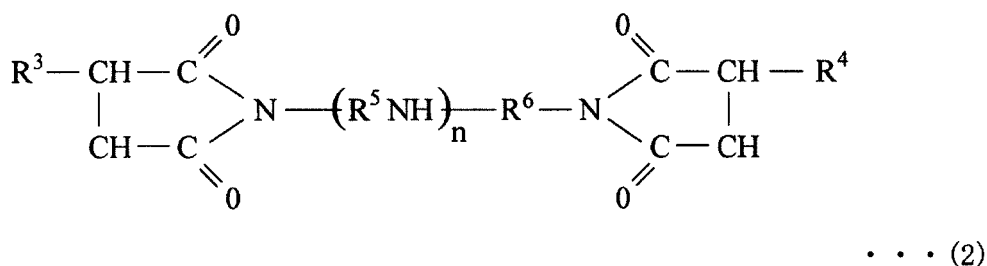
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[0028] In the above formulae (1) and (2), R^1 , R^3 and R^4 each represent an alkenyl group or an alkyl group, and the mass-average molecular weight of the group is preferably from 500 to 3,000, more preferably from 1,000 to 3,000, respectively.

[0029] When the mass-average molecular weight of R^1 , R^3 and R^4 is 500 or more, the solubility in the base oil is high and when 3,000 or less, the detergent effect can be expected. R^3 and R^4 may be the same or different.

[0030] R^2 , R^5 and R^6 each represent an alkylene group having from 2 to 5 carbon atoms, and R^5 and R^6 may be the same or different. m indicates an integer of from 1 to 10, and n indicates 0 or an integer of from 1 to 10. Here, m is preferably from 2 to 5, more preferably from 3 to 4. When m is 2 or more, the composition can realize further better high-temperature detergency, and when m is 5 or less, the solubility in the base oil can be further better.

[0031] In the above formula (2), n is preferably from 1 to 4, more preferably from 2 to 3. Different from that in the case of monoimide, when n is 1 or more, the high-temperature detergency of the composition is further better, and when n is 4 or less, the solubility in the base oil can be further better.

[0032] The alkenyl group includes, for example, a polybutenyl group, a polyisobutenyl group, and an ethylene-propylene copolymer. The alkyl group includes ones derived from hydrogenation of those groups. As a preferred alkenyl group, there is mentioned a polybutenyl group or a polyisobutenyl group. The polybutenyl group is favorably obtained as one produced from a mixture of 1-butene and isobutene or through polymerization of high-purity isobutene. Specific examples of a preferred alkyl group include those prepared through hydrogenation of a polybutenyl group or a polyisobutenyl group.

[0033] The above alkenyl or alkylsuccinimide may be produced generally through reaction of an alkenylsuccinic anhydride, which is obtained through reaction of a polyolefin and a maleic anhydride or an alkylsuccinic anhydride which is obtained through hydrogenation of the alkenylsuccinic anhydride, with a polyamine. The above succinic monoimide and succinic bisimide may be produced by varying the reaction ratio of the alkenylsuccinic anhydride or the alkylsuccinic anhydride and the polyamine.

[0034] As the olefin monomer to form the above polyolefin, usable is/are one alone or two or more of α -olefins having from 2 to 8 carbon atoms, either singly or as combined. Preferred is use of a mixture of isobutene and 1-butene.

[0035] On the other hand, the polyamine includes a simple diamine such as ethylenediamine, propylenediamine, butylenediamine, and pentylenediamine; a polyalkylenepolyamine such as diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenhexamine, di(methylethylene)triamine, dibutylenetriamine, tributylenetetramine, and pentapentylenhexamine; a piperazine derivative such as aminoethylpiperazine.

[0036] The boronated alkenyl or alkyl succinimide may be one produced according to a conventional method.

[0037] For example, the above polyolefin is reacted with a maleic anhydride to prepare an alkenylsuccinic anhydride, and then further reacted for imidization with an intermediate that is obtained through reaction of the above polyamine and a boron compound such as boron oxide, boron halide, boric acid, boric anhydride, borate, ammonium borate.

[0038] With respect to the component (A), the ratio by mass of the monoimide structure-derived nitrogen to the bisimide structure-derived nitrogen (N_m/N_b) is 0.5 or less, preferably 0.4 or less. The ratio by mass (N_m/N_b) of 0.5 or less could improve engine durability.

[0039] One or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained in an amount of from 0.01% by mass to 0.10% by mass in terms of the nitrogen content thereof based on the total amount of the composition. More preferably, the content is from 0.02% by mass to 0.09% by mass, and even more preferably from 0.03% by mass to 0.08% by mass. When the content of the compounds is less than 0.01% by mass in terms of the nitrogen content thereof, the high-temperature detergency of the composition would be poor, but when more than 0.10% by mass, the oxidation stability would worsen.

[0040] The ratio by mass of boron to nitrogen (B/N ratio) in the boronated alkenyl or alkylsuccinimide in the component (A) is 0.5 or more, preferably 0.6 or more, more preferably 0.8 or more. The B/N ratio of 0.5 or more could greatly improve the high-temperature detergency of the composition.

[0041] Presence of at least a predetermined amount of the boron content derived from the boronated alkenyl or alkylsuccinimide in the component (A) makes the composition exhibit high-temperature detergency. When the boron content derived from the boronated alkenyl or alkylsuccinimide in the component (A) is from 0.01% by mass to 0.06% by mass based on the total amount of the composition, the composition can realize sufficient high-temperature detergency. Preferably, the boron content is from 0.02% by mass to 0.05% by mass.

[Component (B)]

[0042] The component (B) in the lubricant oil composition of the present invention is a metallic detergent that contains one or more compounds selected from the group consisting of an alkali metal sulfonate, an alkali metal phenate, an alkali metal salicylate, an alkaline earth metal sulfonate, an alkaline earth metal phenate, and an alkaline earth metal salicylate. Among them, as the component (B), preferred is at least either alkali metal sulfonates or alkaline earth metal sulfonates.

[0043] The alkaline earth metal sulfonate includes an alkaline earth metal salt of an alkylaromatic sulfonic acid which is obtained through sulfonation of an alkylaromatic compound having a molecular weight of from 300 to 1,500, preferably from 400 to 700. In particular, there are mentioned magnesium salts, calcium salts and the like, and above all, preferred is use of calcium salts.

[0044] The alkaline earth metal phenate includes an alkaline earth metal salt of an alkylphenol, an alkylphenol sulfide, or a Mannich reaction product of an alkylphenol, especially a magnesium salt, a calcium salt or the like thereof; and above all, preferred is use of the calcium salts.

[0045] The alkaline earth metal salicylate includes an alkaline earth metal salts, especially a magnesium salt, a calcium salt or the like of an alkylsalicylic acid; and above all, preferred is use of the calcium salts.

[0046] The alkyl group constituting the alkaline earth metal detergent is preferably one having from 4 to 30 carbon atoms, and is more preferably an alkyl group having from 6 to 18 carbon atoms. The alkyl group may be either linear or branched. The group may be a primary alkyl group, a secondary alkyl group or a tertiary alkyl group.

[0047] The alkaline earth metal sulfonates, the alkaline earth metal phenates and the alkaline earth metal salicylates include neutral alkaline earth metal sulfonates, neutral alkaline earth metal phenates and neutral alkaline earth metal salicylates that are obtained through direction reaction of the above alkylaromatic sulfonic acid, alkylphenol, alkylphenol sulfide, a Mannich reaction product of an alkylphenol, alkylsalicylic acid or the like with an alkaline earth metal base such as an oxide and a hydroxide of one or more alkaline earth metals selected from magnesium and calcium.

[0048] In addition, the alkaline earth metal sulfonates, the alkaline earth metal phenates and the alkaline earth metal salicylates also include neutral alkaline earth metal sulfonates, neutral alkaline earth metal phenates and neutral alkaline earth metal salicylates that are obtained through conversion of the above alkylaromatic sulfonic acid, alkylphenol, alkylphenol sulfide, a Mannich reaction product of an alkylphenol, alkylsalicylic acid or the like into alkaline metal salts such as a sodium salts and potassium salts thereof followed by substitution thereof with an alkaline earth metal salt to give the intended salts.

[0049] Further, the alkaline earth metal sulfonates, the alkaline earth metal phenates and the alkaline earth metal salicylates include basic alkaline earth metal sulfonates, basic alkaline earth metal phenates and basic alkaline earth metal salicylates that are obtained by heating the neutral alkaline earth metal sulfonates, neutral alkaline earth metal phenates and neutral alkaline earth metal salicylates along with an excessive alkaline earth metal salt or alkaline earth metal base in the presence of water.

[0050] Still further, the alkaline earth metal sulfonates, the alkaline earth metal phenates and the alkaline earth metal salicylates include overbased alkaline earth metal sulfonates, overbased alkaline earth metal phenates and overbased alkaline earth metal salicylates that are obtained through reaction of the neutral alkaline earth metal sulfonates, neutral alkaline earth metal phenates and neutral alkaline earth metal salicylates with carbonate or borate of an alkaline earth metal in the presence of carbon dioxide.

[0051] One alone or two or more selected from the above alkaline earth metal sulfonates, alkaline earth metal phenates and the alkaline earth metal salicylates may be used here either alone or as combined.

[0052] As the metallic detergent, the above neutral salt, basic salt, overbased salt or a mixture thereof may be used, and in particular, a mixture of one or more of an overbased salicylate, an overbased phenate and an overbased sulfonate, and a neutral sulfonate is preferred, from the viewpoints of detergency for engine inside parts and in abrasion resistance. The metallic detergent is commercially sold generally in the form of being diluted with a light lubricant base oil or the like and is available as such. Preferably, the metal content of the metallic detergent for use herein is from 1.0% by mass to 20% by mass, more preferably from 2.0% by mass to 16% by mass.

[0053] The base number of the component (B) is preferably from 10 mg KOH/g to 600 mg KOH/g, more preferably from 20 mg KOH/g to 500 mg KOH/g. The total base number as referred to herein means the total base number according to potentiometric titration (base number - perchloric acid method) to be measured according to 7. "Petroleum Products and Lubricants - Neutralization Number Test Method" in JIS K 2501.

[0054] The metal ratio in the component (B) is not specifically limited. In general, one or more metallic detergents having a metal ratio of 20 or less may be used. It is especially desirable that a metallic detergent having a metal ratio of 3 or less, more preferably 1.5 or less, even more preferably 1.2 or less is used as the essential component from the viewpoint of being more excellent in oxidation stability, base number retention and high-temperature detergency and the like. The metal ratio as referred to herein is represented by (number of valences of metal element in metallic detergent) x (metal element content (mol%))/(soap group content (mol%)). The metal element means calcium, magnesium, etc.; and the soap group means a sulfonic acid group, a phenol group, a salicylic acid group, etc.

[0055] In the lubricating oil composition of the present invention, the amount of the component (B) is preferably 0.3% by mass or less in order that the sulfated ash content therein could be reduced to 1.1% by mass or less. The blending amount of the component (B) is from 0.01% by mass to 0.3% by mass in terms of the metal content thereof based on the total amount of the composition.

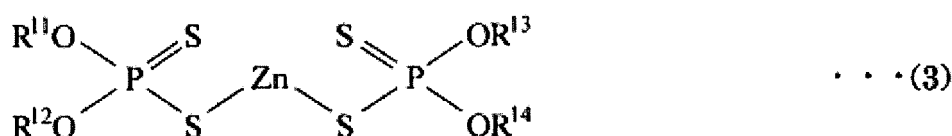
[0056] More preferably, the component (B) contains sodium sulfonate in an amount of 0.05% by mass or less as the metal amount thereof based on the total amount of the lubricating oil composition, for the purpose of reducing the sulfated

ash content in the lubricating oil composition to 1.1% by mass or less. Alternatively, magnesium sulfonate is contained in an amount of 0.05% by mass or less as the metal amount thereof based on the total amount of the lubricating oil composition.

[0057] In the lubricating oil composition of the present invention, the sulfur content is preferably 0.3% by mass or less based on the total amount of the composition, more preferably 0.2% by mass or less, even more preferably 0.1% by mass or less based on the total amount of the composition. The sulfur content of 0.3% by mass or less is preferred as capable of effectively preventing the exhaust gas purification catalyst performance from degrading.

[Component (C)]

[0058] Preferably, a zinc dialkyldithiophosphate (hereinafter this may be referred to as "ZnDTP") is further blended with the present composition as a component (C). The component (C) includes, for example, ZnDTP represented by the following formula (3).



[0059] In the above formula (3), R¹¹, R¹², R¹³ and R¹⁴ each represent a substituent selected from a primary or secondary alkyl group having from 3 to 22 carbon atoms or an alkaryl group substituted with an alkyl group having from 3 to 18 carbon atoms, and they may be the same or different each other.

[0060] In the present invention, one alone or two or more types of those ZnDTPs may be used either singly or as combined. Especially preferred is one that comprises, as the main ingredient, a zinc dithiophosphate with secondary alkyl groups for enhancing abrasion resistance.

[0061] Specific examples of ZnDTP include zinc dipropyldithiophosphate, zinc dibutyldithiophosphate, zinc dipentyldithiophosphate, zinc dihexyldithiophosphate, zinc diisopentyldithiophosphate, zinc diethylhexyldithiophosphate, zinc dioctyldithiophosphate, zinc dinonyldithiophosphate, zinc didecyldithiophosphate, zinc didodecyldithiophosphate, zinc dipropylphenyldithiophosphate, zinc dipentylphenyldithiophosphate, zinc dipropylmethylphenyldithiophosphate, zinc dinonylphenyldithiophosphate, zinc didodecylphenyldithiophosphate, zinc didodecylphenyldithiophosphate, etc.

[Other Components]

[0062] If desired, an antioxidant, a viscosity index improver, a pour-point depressant, a rust inhibitor, a metal deactivator, a defoaming agent, an anti-wear agent, an extreme-pressure agent and any other additives may be added to the lubricating oil composition of the present invention within a range not to impair the effects of the present invention.

<Antioxidant>

[0063] As the antioxidant, antioxidants such as phenol-based or amine-based may be used.

[0064] The phenol-based antioxidant includes, for example, octadecyl 3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate; 4,4'-methylenebis(2,6-di-t-butylphenol); 4,4'-bis(2,6-di-t-butylphenol); 4,4'-bis(2-methyl-6-t-butylphenol); 2,2'-methylenebis(4-ethyl-6-t-butylphenol); 2,2'-methylenebis(4-methyl-6-t-butylphenol); 4,4'-butylidenebis(3-methyl-6-t-butylphenol); 4,4'-isopropylidenebis(2,6-di-t-butylphenol); 2,2'-methylenebis(4-methyl-6-nonylphenol); 2,2'-isobutylidenebis(4,6-dimethylphenol); 2,2'-methylenebis(4-methyl-6-cyclohexylphenol); 2,6-di-t-butyl-4-methylphenol; 2,6-di-t-butyl-4-ethylphenol; 2,4-dimethyl-6-t-butylphenol; 2,6-di-t-amyl-p-cresol; 2,6-di-t-butyl-4-(N,N'-dimethylaminomethylphenol); 4,4'-thiobis(2-methyl-6-t-butylphenol); 4,4'-thiobis(3-methyl-6-t-butylphenol); 2,2'-thiobis(4-methyl-6-t-butylphenol); bis(3-methyl-4-hydroxy-5-t-butylbenzyl) sulfide; bis(3,5-di-t-butyl-4-hydroxybenzyl) sulfide; n-octyl 3-(4-hydroxy-3,5-di-t-butylphenyl)propionate; n-octadecyl 3-(4-hydroxy-3,5-di-t-butylphenyl)propionate; 2,2'-thio[diethyl-bis-3-(3,5-di-t-butyl-4-hydroxyphenyl) propionate], etc. Among them, especially preferred are bisphenol compounds and ester group-containing phenol compounds.

[0065] The amine-based antioxidant includes, for example, monoalkyldiphenylamines such as mono-octyldiphenylamine and monononyldiphenylamine; dialkyldiphenylamines such as 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine and 4,4'-dinonyldiphenylamine; polyalkyldiphenylamines such as tetrabutyldiphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine and tetranonyldiphenylamine; as well as naphthylamine-based antioxidants, in particular, α-naphthylamine, phenyl-α-naphthylamine, and further alkyl-substituted phenyl-α-naphthylamines such as butylphenyl-α-naphthylamine, pentylphenyl-

α -naphthylamine, hexylphenyl- α -naphthylamine, heptylphenyl- α -naphthylamine, octylphenyl- α -naphthylamine and nonylphenyl- α -naphthylamine. Among them, diphenylamine compounds are preferred to naphthylamine compounds from the viewpoint of the antioxidation effect thereof.

[0066] In the present invention, a molybdenumamine-based antioxidant may be further added. The molybdenumamine-based antioxidant usable here includes those prepared by the reaction of a hexavalent molybdenum compound, specifically molybdenum trioxide and/or molybdic acid, with an amine compound, for example, the compounds obtained according to the production method described in JP-A 2003-252887.

[0067] The amine compound to be reacted with a hexavalent molybdenum compound is not specifically limited. In particular, there are mentioned monoamines, diamine, polyamines and alkanolamines. More particularly, there are exemplified alkylamines having an alkyl group with from 1 to 30 carbon atoms (in which the alkyl group may be linear or branched) such as methylamine, ethylamine, dimethylamine, diethylamine, methylethylamine and methylpropylamine; alkenylamines having an alkenyl group with from 2 to 30 carbon atoms (in which the alkenyl group may be linear or branched) such as ethenylamine, propenylamine, butenylamine, octenylamine and oleylamine; alkanolamines having an alkanol group with from 1 to 30 carbon atoms (in which the alkanol group may be linear or branched) such as methanolamine, ethanolamine, methanolethanolamine and methanolpropanolamine; alkylenediamines having an alkylene group with from 1 to 30 carbon atoms such as methylenediamine, ethylenediamine, propylenediamine and butylenediamine; polyamines such as diethylenetriamine, triethylenetetramine, tetraethylenepentamine and pentaethylenhexamine; compounds derived from the above monoamines, diamines or polyamines by incorporating therein an alkyl group or alkenyl group having from 8 to 20 carbon atoms, such as undecyldiethylamine, undecyldiethanolamine, dodecyldipropylamine, oleyldiethanolamine, oleylpropylenediamine and stearyl tetraethylenepentamine; heterocyclic compounds such as imidazole; alkylene oxide adducts of those compounds; mixture of those compounds, etc. Also exemplified here are sulfur-containing molybdenum complexes with succinimide and the like described in JP-B 3-22438 and JP-A 2004-2866.

[0068] The blending amount of the above antioxidant is preferably from 0.3% by mass to 3% by mass based on the total amount of the composition, from the viewpoint of the miscibility thereof with the base oil. More preferably, the amount of the above antioxidant is from 0.4% by mass to 3% by mass, even more preferably from 0.4% by mass to 2% by mass, still more preferably from 0.5% by mass to 2% by mass. When the content of the antioxidant is 0.3% by mass or more based on the total amount of the composition, then the acid value of the composition can be prevented from increasing, and when 3% by mass or less, the solubility in the lubricant base oil can be secured.

<Viscosity Index Improver>

[0069] The viscosity index improver includes, for example, polymethacrylates, dispersant-type polymethacrylates, olefinic copolymers (for example, ethylene-propylene copolymers), dispersant-type olefinic copolymers, styrenic copolymers (for example, styrene-diene copolymers, styrene-isoprene copolymers), etc. The blending amount of the viscosity index improver may be from 0.5% by mass to 15% by mass, preferably from 1 % by mass to 10% by mass based on the total amount of the composition, from the viewpoint of the blending effect.

<Pour-Point Depressant>

[0070] The pour-point depressant includes ethylene-vinyl acetate copolymers, condensates of chlorinated paraffin and naphthalene, condensates of chlorinated paraffin and phenol, polymethacrylates, polyalkylstyrenes, etc. For example, preferred for use herein are polymethacrylates having a mass-average molecular weight of from 5,000 to 50,000. The pour-point depressant may be used in a ratio of from 0.1% by mass to 5% by mass based on the total amount of the composition.

<Rust Inhibitor>

[0071] The rust inhibitor includes petroleum sulfonates, alkylbenzene sulfonates, dinonylnaphthalene sulfonates, alkenylsuccinates, polyalcohol esters, etc. The blending amount of the rust inhibitor may be from 0.01% by mass to 1% by mass, preferably from 0.05 % by mass to 0.5% by mass based on the total amount of the composition, from the viewpoint of the blending effect.

<Metal Deactivator>

[0072] The metal deactivator (copper corrosion inhibitor) includes, for example, benzotriazole compounds, tolyltriazole compounds, thiadiazole compounds, imidazole compounds, pyrimidine compounds, etc. Among them, preferred are benzotriazole compounds. Incorporating the metal deactivator can protect engine parts from metal corrosion and oxidative

degradation. The blending amount of the metal deactivator is preferably from 0.01% by mass to 0.1% by mass, more preferably from 0.03 % by mass to 0.05% by mass based on the total amount of the composition, from the viewpoint of the blending effect.

[0073] <Defoaming Agent>

[0074] The defoaming agent includes silicone oil, fluorosilicone oil, fluoroalkyl ether, etc. From the viewpoint of the balance of the defoaming effect and the economic performance, the agent is blended preferably in an amount of from 0.005% by mass to 0.1% by mass based on the total amount of the composition.

<Anti-Wear Agent or Extreme-Pressure Agent>

[0075] The anti-wear agent or the extreme-pressure agent includes sulfur-containing compounds such as zinc dithiophosphate, zinc phosphate, zinc dithiocarbamate, molybdenum dithiocarbamate, molybdenum dithiophosphate, disulfides, olefin sulfides, sulfurized oils and fats, sulfurized esters, thiocarbonates, thiocarbamates and polysulfides; phosphorus-containing compounds such as phosphites, phosphates, phosphonates, and amine salts or metal salt of those compounds; sulfur and phosphorus-containing anti-wear agents such as thiophosphites, thiophosphates, thiophosphonates, and amine salts or metal salts of those compounds.

[0076] In case where the additional anti-wear agent or extreme-pressure agent is incorporated, if desired, the amount of the additional anti-wear agent or extreme-pressure agent to be blended may be 600 ppm by mass or less in terms of the element of zinc and based on the total amount of the lubricating oil composition. Preferably, the amount is from 0 ppm by mass to 500 ppm by mass, more preferably from 0 ppm by mass to 400 ppm by mass.

[0077] Also the amount of the additional anti-wear agent or extreme-pressure agent to be blended is 500 ppm by mass or less in terms of the element of phosphorus and based on the total amount of the lubricating oil composition. Preferably, the amount is from 0 ppm by mass to 400 ppm by mass, more preferably from 0 ppm by mass to 300 ppm by mass. When the zinc amount is 600 ppm by mass or less and the phosphorus amount is 500 ppm by mass or less, a problem of extremely shortening the period for oil change owing to consumption of the basic compound in the lubricating oil composition, for example, in the engine oil could be evaded.

<Phosphorus Content and Sulfated Ash Content in Lubricating Oil Composition>

[0078] In the lubricating oil composition of the present invention, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass. When the phosphorus amount is less than 100 ppm by mass, the wear resistance would be insufficient. On the other hand, when the phosphorus content is more than 1200 ppm by mass, purification catalyst poisoning by exhaust gas could not be sufficiently prevented.

[0079] The phosphorus content is preferably from 200 ppm by mass to 1100 ppm by mass, more preferably from 300 ppm by mass to 1000 ppm by mass, even more preferably from 400 ppm by mass to 900 ppm by mass.

[0080] In the lubricant oil composition of the present invention, the sulfated ash content is 1.1% by mass or less based on the total amount of the composition. When the sulfated ash content is more than 1.1% by mass, the amount of ash to deposit on the DPF filter in a diesel engine would increase whereby the DPF filter would be readily clogged by ash and the life of the DPF filter would be thereby shortened.

[0081] From the viewpoint of further increasing the oxidation stability, the base number retention and the high-temperature detergency of the lubricating oil composition, the sulfated ash content is more preferably 0.2% by mass or more, even more preferably 0.3% by mass or more. Falling within the range, the composition can maintain the base number and the high-temperature detergency for a longer period of time.

[0082] The sulfated ash content means the ash content which is determined by firing a sample of the composition, then adding sulfuric acid to the resultant carbonized residue and heating it to have a constant weight. In general, the sulfated ash content is used for identifying a rough amount of a metal additive in a lubricant oil composition. Specifically, it is determined according to the method prescribed in JIS K 2272 "5. Sulfated Ash Content Test Method".

[0083] The lubricating oil composition of the present invention is not only excellent in high-temperature detergency but also has good compatibility with fluoro-rubber seal much used inside engines, and therefore can be favorably used in internal combustion engines such as gasoline engines, diesel engines, gas engines and hybrid vehicle engines. As internal combustion engines, there are mentioned ordinary internal combustion engines that are produced using various materials such as aluminum alloy materials, nickel chromium alloy materials, carbon steel materials and chromium molybdenum steel materials. The lubricating oil composition of the present invention is especially favorable for use for lubricating internal combustion engines in which at least the piston head is formed of a cast iron material.

[Production Method for Lubricating Oil Composition]

[0084] The production method for a lubricating oil composition of this embodiment of the present invention is a pro-

duction method for a lubricating oil composition, which comprises blending, with a base oil that contains at least one selected from the group consisting of a mineral oil and a synthetic oil, has a viscosity index of 120 or more, and has a paraffin content by ring analysis of 70% or more, a dispersant (A) containing one or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide, and a metallic detergent (B) containing one or more compounds selected from the group consisting of an alkali metal sulfonate, an alkali metal phenate, an alkali metal salicylate, an alkaline earth metal sulfonate, an alkaline earth metal phenate, and an alkaline earth metal salicylate, so that the component (A) is contained in an amount of from 0.01% by mass to 0.10% by mass in terms of the nitrogen content thereof based on the total amount of the composition, the component (B) is contained in an amount of from 0.01% by mass to 0.3% by mass in terms of the metal content thereof based on the total amount of the composition, at least one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained, the ratio by mass of boron to nitrogen B/N in the component (A) is 0.5 or more, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, and the sulfated ash content based on the total amount of the composition is 1.1% by mass or less.

[0085] The production method for a lubricating oil composition of this embodiment of the present invention may further comprise blending, if desired, with the above base oil, any of an antioxidant, a viscosity index improver, a pour point depressant, a rust inhibitor, a metal deactivator, a defoaming agent, an anti-wear agent, an extreme-pressure agent and any other additive.

[0086] In addition, as described above, the lubricating oil composition produced by blending, with the base oil, the component (A) and the component (B) and, if desired, any of an antioxidant, a viscosity index improver, a pour point depressant, a rust inhibitor, a metal deactivator, a defoaming agent, an anti-wear agent, an extreme-pressure agent and any other additive contains those various additives blended therein. In the lubricating oil composition, at least a part of those various additives blended therein may react with each other to form any other compound therein in some cases.

EXAMPLES

[0087] The present invention is described in more detail with reference to Examples hereinunder. The present invention is not limited to the following Examples.

[Examples and Comparative Examples]

[0088] Using a base oil, a dispersant, a metallic detergent and any other additive mentioned below, samples of a lubricating oil composition were produced, and tested for the characteristics and the properties thereof according to the evaluation methods mentioned below. The results are shown in Table 1 and Table 2.

[0089] Base oil: hydrorefined oil, kinematic viscosity at 40°C; 21 mm²/s, kinematic viscosity at 100°C; 4.5 mm²/s, viscosity index; 127, %C_P; 83, %C_A; 0.0, sulfur content; less than 10 ppm by mass, NOACK value; 13.3% by mass.

[0090] Viscosity index improver A: polymethacrylate, weight-average molecular weight 420,000, resin amount 39% by mass.

[0091] Phenol-based antioxidant: octadecyl 3-(3,5-di-*t*-butyl-4-hydroxyphenyl)propionate

[0092] Amine-based antioxidant: dialkyldiphenylamines, nitrogen content 4.62% by mass.

[0093] Zinc dithiophosphate: Zn content 9.0% by mass, phosphorus content 8.2% by mass, sulfur content 17.1% by mass, alkyl group; mixture of secondary butyl group and secondary hexyl group.

[0094] Metallic detergent A: neutral calcium sulfonate, base number (perchloric acid method) 20 mg KOH/g, calcium content 1.8% by mass, sulfur content 1.8% by mass.

[0095] Metallic detergent B: neutral calcium sulfonate, base number (perchloric acid method) 22 mg KOH/g, calcium content 2.4% by mass, sulfur content 3.0% by mass.

[0096] Metallic detergent C: overbased calcium sulfonate, base number (perchloric acid method) 308 mg KOH/g, calcium content 12% by mass, sulfur content 1.1% by mass.

[0097] Metallic detergent D: overbased calcium sulfonate, base number (perchloric acid method) 320 mg KOH/g, calcium content 13% by mass, sulfur content 2.4% by mass.

[0098] Metallic detergent E: overbased calcium sulfonate, base number (perchloric acid method) 450 mg KOH/g, calcium content 15% by mass, sulfur content 1.2% by mass.

[0099] Metallic detergent F: overbased calcium sulfonate, base number (perchloric acid method) 500 mg KOH/g, calcium content 18.5% by mass.

[0100] Metallic detergent G: overbased calcium phenate, base number (perchloric acid method) 200 mg KOH/g, calcium content 7.2% by mass, sulfur content 2.0% by mass.

[0101] Metallic detergent H: overbased calcium phenate, base number (perchloric acid method) 255 mg KOH/g, calcium content 9.2% by mass, sulfur content 3.3% by mass.

EP 2 966 155 A1

[0102] Metallic detergent I: overbased calcium phenate, base number (perchloric acid method) 400 mg KOH/g, calcium content 14% by mass, sulfur content 2% by mass.

[0103] Metallic detergent J: neutral calcium salicylate, base number (perchloric acid method) 64 mg KOH/g, calcium content 2.3% by mass.

5 **[0104]** Metallic detergent K: overbased sodium sulfonate, base number (perchloric acid method) 450 mg KOH/g, sodium content 19.5% by mass, sulfur content 1.2% by mass.

[0105] Metallic detergent L: overbased magnesium sulfonate, base number (perchloric acid method) 410 mg KOH/g, magnesium content 9.4% by mass, sulfur content 2.0% by mass.

10 **[0106]** Metallic detergent M: overbased calcium salicylate, base number (perchloric acid method) 230 mg KOH/g, calcium content 7.9% by mass.

[0107] Metallic detergent N: overbased calcium salicylate, base number (perchloric acid method) 290 mg KOH/g, calcium content 7.8% by mass.

[0108] Ashless dispersant A: boron derivative of alkenylsuccinimide, number-average molecular weight of polybutenyl group 1000, nitrogen content 1.8% by mass, boron content 2.0% by mass.

15 **[0109]** Ashless dispersant B: alkenylsuccinimide, number-average molecular weight of polybutenyl group 2000, nitrogen content 1.0% by mass.

[0110] Methylbenzotriazole derivative: 1-[N,N-bis(2-ethylhexyl)aminomethyl]methylbenzotriazole

[0111] Other additives: pour-point depressant and defoaming agent

20 [Characteristics Evaluation of Base Oil and Lubricating Oil Composition]

(1) Kinematic Viscosity of Base Oil and Lubricating Oil Composition

25 **[0112]** Measured according to "Petroleum Product Kinematic Viscosity Test Method" prescribed in JIS K 2283.

(2) Viscosity Index of Base Oil

[0113] Measured according to "Petroleum Product Kinematic Viscosity Test Method" prescribed in JIS K 2283.

30 (3) Sulfur Content in Base Oil

[0114] Measured according to JIS K 2541.

(4) %C_A of Base Oil

35 **[0115]** The proportion (percentage) of the aromatic component is calculated through n-d-M ring analysis.

(5) %C_P of Base Oil

40 **[0116]** The proportion (percentage) of the paraffin component is calculated through n-d-M ring analysis.

(6) NOACK Value of Base Oil

45 **[0117]** Measured according to JPI-5S-41-2004.

(7) Boron Content

[0118] Measured according to JPI-5S-38-92.

50 (8) Nitrogen Content

[0119] Measured according to JIS K 2609.

(9) Molybdenum and Phosphorus Content

55 **[0120]** Measured according to JPI-5S-38-92.

(10) Sulfated Ash Content

[0121] Measured according to JIS K 2272.

5 [Evaluation Method]

<High-Temperature Detergency Evaluation Method (hot tube test)>

10 **[0122]** The high-temperature detergency was evaluated in a hot tube test according to JPI-5S-55-99. Specifically, a sample oil and an air were introduced into a glass tube having an inner diameter of 2 mm, at flow rates of 0.31 mL/h and 10 mL/min, respectively, for 16 hours. The glass tube was kept at 280°C. Subsequently, the mass of the deposit adhering to the glass tube was measured. The samples were evaluated in 10 ranks. The higher rank means that the mass of the deposit was small and the sample is excellent in high-temperature detergency.

15 <Initial Coating Film Formation Test>

[0123] Using a Soda four-ball machine and under the condition of an oil temperature of 80°C, a rotation number of 500 rpm and a load of 0.0480 MPa, the time in which the rotating ball and the fixed ball were electrically completely insulated by the lubricating oil film was evaluated as the film formation time within a test period of 180 seconds. The samples having taken a shorter film formation time are more excellent in the initial coating film formability and in the anti-wear performance.

<Load Carrying Performance Test>

25 **[0124]** Using a Soda four-ball machine and under the condition of an oil temperature of 80°C and a rotation number of 500 rpm, a load increasing from the initial load of 0.048 MPa up to 0.288 MPa at intervals of 0.196 MPa every 3 minutes was kept applied to the sample, and the load under which the rotating ball and the fixed ball electrically completely run through the sample was evaluated as the complete contact load. The samples for which the complete contact load was larger are more excellent in load carrying performance.

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Table 1

		Example																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Base Oil A	mass%	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance
Viscosity Index Improver A	mass%	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Phenol-based Antioxidant	mass%	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Amine-based Antioxidant	mass%	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Zinc Dithiophosphate	mass%	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Metallic Detergent A	mass%	5.00	5.00															
Metallic Detergent B	mass%			3.85														
Metallic Detergent C	mass%				0.78													
Metallic Detergent D	mass%					0.72												
Metallic Detergent E	mass%						0.59											
Metallic Detergent F	mass%							0.49									0.26	0.26
Metallic Detergent G	mass%								1.25									
Metallic Detergent H	mass%									0.98								
Metallic Detergent I	mass%										0.63							
Metallic Detergent J	mass%											3.89						

(continued)

		Example																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	mass%												0.56				0.26	
Metallic Detergent K	mass%													0.90				0.44
Metallic Detergent L	mass%														1.13			
Metallic Detergent M	mass%															1.15		
Metallic Detergent N	mass%																	
Ashless Dispersant A	mass%	1.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Ashless Dispersant B	mass%	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Methylbenzotriazole Derivative	mass%	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Other Additive	mass%	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calcium	mass%	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.09	0.09	0.05	0.05
Magnesium	mass%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.04
Sodium	mass%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.05	0.00
Phosphorus	mass%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Zinc	mass%	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Boron	mass%	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Nitrogen	mass%	0.06	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Nitrogen (derived from ashless dispersant)	mass%	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Sulfated Ash Content	mass%	0.37	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.37	0.37	0.38	0.38	0.38	0.38

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(continued)

		Example																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
High-Tempera- ture Detergency Test(hot tubetest score)	M.R.	8.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.0	8.0
Initial Coating Film Formation Test (coating film formation time)	sec	14	5	5	4	5	6	8	7	5	4	27	30	52	6	8	33	20
Load Carrying Performance Test (complete contact load)	MPa	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<

Table 2

		Comparative Example																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Base Oil A	mass%	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance
Viscosity Index Improver A	mass%	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Phenol-based Antioxidant	mass%	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Amine-based Antioxidant	mass%	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Zinc Dithiophosphate	mass%	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30		
Metallic Detergent A	mass%	5.00															5.00	
Metallic Detergent B	mass%		3.85															
Metallic Detergent C	mass%			0.78														
Metallic Detergent D	mass%				0.72													
Metallic Detergent E	mass%					0.59												
Metallic Detergent F	mass%						0.49											
Metallic Detergent G	mass%							1.25										
Metallic Detergent H	mass%								0.98									
Metallic Detergent I	mass%									0.63								
Metallic Detergent J	mass%										3.89							

(continued)

	Comparative Example																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Metallic Detergent K mass%											0.56						
Metallic Detergent L mass%												0.90					
Metallic Detergent M mass%													1.13				
Metallic Detergent N mass%														1.15			
Ashless Dispersant A mass%															1.00	1.00	1.00
Ashless Dispersant B mass%	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Methylbenzotriazole Derivative mass%	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Other Additive mass%	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Calcium mass%	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.90	0.09	0.00	0.09	0.00
Magnesium mass%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
Sodium mass%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00
Phosphorus mass%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00
Zinc mass%	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.00	0.00
Boron mass%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02
Nitrogen mass%	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.06
Nitrogen (derived from ashless dispersant) mass%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04	0.04
Sulfated Ash Content mass%	0.35	0.35	0.35	0.35	0.35	0.36	0.36	0.35	0.35	0.35	0.35	0.34	0.35	0.35	0.31	0.01	0.00

(continued)

		Comparative Example																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
High-Tempera- ture Detergency Test (hot tube test score)	M.R.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0
Initial Coating Film Formation Test (coating film formation time)	sec	156	152	25	121	51	58	58	72	41	180<	180<	180<	42	59	180<	180<	180<
Load Carrying Performance Test (complete contact load)	MPa	0.192	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.144	0.144	0.144	0.192	0.144	0.096	0.048

[Evaluation Results]

[0125] From the results in Table 1, it is known that, in Examples using the lubricating oil composition of the present invention, the deposit in the hot tube test is small, and this means that the lubricating oil composition of the present invention is excellent in hot-temperature detergency. In addition, the lubricating oil composition in Examples gave a good result in the initial coating film formation test, from which it is known that, in using the lubricating oil composition of the present invention, oil film shortage occurs little even at the top dead center of pistons, or that is, the lubricating oil composition has good anti-wear performance. Furthermore, the load-carrying performance is also excellent.

Claims

1. A lubricating oil composition comprising:

a base oil that contains at least one selected from the group consisting of a mineral oil and a synthetic oil, has a viscosity index of 120 or more, and has a paraffin content by ring analysis of 70% or more;

(A) a dispersant containing one or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide; and

(B) a metallic detergent containing one or more compounds selected from the group consisting of an alkali metal sulfonate, an alkali metal phenate, an alkali metal salicylate, an alkaline earth metal sulfonate, an alkaline earth metal phenate, and an alkaline earth metal salicylate;

wherein the component (A) is contained in an amount of from 0.01% by mass to 0.10% by mass in terms of the nitrogen content thereof based on the total amount of the composition,

the component (B) is contained in an amount of from 0.01% by mass to 0.3% by mass in terms of the metal content thereof based on the total amount of the composition,

at least one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimides in the component (A) are contained, the ratio by mass of boron to nitrogen B/N in the component (A) is 0.5 or more,

the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, and

the sulfated ash content based on the total amount of the composition is 1.1% by mass or less.

2. The lubricating oil composition according to claim 1, wherein:

the component (B) is at least either alkyl metal sulfonates or alkaline earth metal sulfonates, and the base number of the component (B) is from 10 mg KOH/g to 600 mg KOH/g.

3. The lubricating oil composition according to claim 1 or 2, comprising an antioxidant selected from the group consisting of an amine-based antioxidant, a phenol-based antioxidant and a molybdenumamine-based antioxidant, in an amount of from 0.3% by mass to 3% by mass based on the total amount of the lubricating oil composition.

4. The lubricating oil composition according to any of claims 1 to 3, wherein the phosphorus content is from 200 ppm by mass to 1100 ppm by mass.

5. The lubricating oil composition according to any of claims 1 to 4, wherein the B/N ratio is 0.6 or more.

6. The lubricating oil composition according to any of claims 1 to 5, wherein, as the component (B), sodium sulfonate is contained in an amount of 0.05% by mass or less in terms of the metal amount thereof based on the total amount of the lubricating oil composition.

7. The lubricating oil composition according to any of claims 1 to 5, wherein, as the component (B), magnesium sulfonate is contained in an amount of 0.05% by mass or less in terms of the metal amount thereof based on the total amount of the lubricating oil composition.

8. The lubricating oil composition according to any of claims 1 to 7, which is used for lubrication in internal combustion engines.

9. The lubricating oil composition according to claim 8, which is used for lubrication in internal combustion engines where at least a piston head thereof is formed of a cast iron material.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/056068

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)

C10M163/00, C10M129/10, C10M133/12, C10M133/16, C10M133/56, C10M139/00, C10M159/22, C10M159/24, C10N10/02, C10N10/04, C10N10/12, C10N20/00, C10N20/02, C10N30/04, C10N30/06, C10N30/10, C10N40/25

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 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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.
Y	JP 2003-041283 A (Nippon Oil Corp.), 13 February 2003 (13.02.2003), claims 1 to 9; paragraphs [0012], [0016], [0042], [0046] to [0047], [0058] to [0059], [0076], [0079], [0081], [0087] to [0088], [0090]; examples 10 to 14 & CN 1400295 A	1-9
Y	WO 2008/117776 A1 (Idemitsu Kosan Co., Ltd.), 02 October 2008 (02.10.2008), claims 1 to 6; paragraphs [0010], [0012], [0023] to [0030], [0038] to [0039], [0041] to [0044]; examples 1 to 4, 6 to 8 & US 2010/0113313 A1 & EP 2141220 A1 & CN 101646757 A & KR 10-2009-0125845 A	1-9

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
15 May, 2014 (15.05.14)

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/056068

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2012-233116 A (JX Nippon Oil & Energy Corp.), 29 November 2012 (29.11.2012), paragraphs [0031], [0034] & WO 2012/153548 A1	1-9
Y	JP 06-299276 A (Daido Steel Co., Ltd.), 25 October 1994 (25.10.1994), paragraphs [0002] to [0003] (Family: none)	9

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INTERNATIONAL SEARCH REPORT

International application No.

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Continuation of A. CLASSIFICATION OF SUBJECT MATTER
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C10M163/00(2006.01)i, C10M129/10(2006.01)n, C10M133/12(2006.01)n,
C10M133/16(2006.01)n, C10M133/56(2006.01)n, C10M139/00(2006.01)n,
C10M159/22(2006.01)n, C10M159/24(2006.01)n, C10N10/02(2006.01)n,
C10N10/04(2006.01)n, C10N10/12(2006.01)n, C10N20/00(2006.01)n,
C10N20/02(2006.01)n, C10N30/04(2006.01)n, C10N30/06(2006.01)n,
C10N30/10(2006.01)n, C10N40/25(2006.01)n

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

REFERENCES CITED IN THE DESCRIPTION

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