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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 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 molybdenum dithiocarbamate (B); 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, one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained in an amount of from 0.05% by mass to 3.5% by mass based on the total amount of the composition, the phosphorus content is from 100 ppm by mass to 1200 ppm by mass, the sulfated ash content is 1.2% by mass or less, and the molybdenum content is from 300 ppm by mass to 1000 ppm by mass. 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.

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Description

TECHNICAL FIELD

[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

[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.

[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, thermal cracking resistance and the like, and therefore must be designed to be tough. However, for fuel consumption, reduction of engine weight is desired.

[0004] Given the situation, heretofore, an aluminum alloy such as JIS AC8A or the like 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

PATENT DOCUMENT

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

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[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.

[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.

[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

[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 and a dispersant in which these components are blended under a specific condition, and accomplished the present invention.

[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 molybdenum dithiocarbamate (B); 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, one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained in an amount of from 0.05% by mass to 3.5% by mass based on the total amount of the composition, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, the sulfated ash content based on the total amount of the composition is 1.2% by mass or less, and the molybdenum content based on the total amount of the composition is from 300 ppm by mass to 1000 ppm by mass.

[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 molybdenum dithiocarbamate (B), 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, one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained in an amount of from 0.05% by mass to 3.5% by mass based on the total amount of the composition, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, the sulfated ash content based on the total amount of the composition is 1.2% by mass or less, and the molybdenum content based on the total amount of the composition is from 300 ppm by mass to 1000 ppm by mass.

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 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.

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 molybdenum dithiocarbamate (B).

[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 dispersant comprising one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) is contained in an amount of from 0.05% by mass to 3.5% by mass based on the total amount of the composition. The phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass.

[0015] The sulfated ash content based on the total amount of the composition in the lubricating oil composition is 1.2% by mass or less, and the molybdenum content based on the total amount of the composition is from 300 ppm by mass to 1000 ppm by mass.

[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 the group consisting of 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 by distilling under a reduced pressure the atmospheric residue given by atmospheric distillation of crude oil, to one or more treatments selected from the group consisting of solvent deasphalting, solvent extraction, hydro-cracking, solvent dewaxing, catalytic dewaxing, hydrorefining and the like, and a mineral oil produced by isomerization of wax or GTL WAX and the like.

[0018] Examples of the synthetic oil include polybutene, polyolefins [α-olefin homopolymers and copolymers (e.g., ethylene-α-olefin copolymers), etc.], various kinds of esters (for example, polyol esters, dibasic acid esters, phosphate esters), various kinds of ethers (for example, polyphenyl ethers), polyglycols, alkylbenzenes, alkylnaphthalenes, etc.

Among those synthetic oils, polyolefins and polyol esters are particularly preferred from the viewpoint of the viscosity characteristics thereof, the solubility of additives therein, and the compatibility thereof to seal rubber.

[0019] In the present invention, the above mineral oils may be used alone or in combination of two or more thereof. Alternatively, the above synthetic oils may be used alone or in combination of two or more thereof. Further, one or more of the mineral oils and one or more of the synthetic oils may be used in combination thereof.

[0020] Not specifically limited, the viscosity of the base oil may be selected in accordance with the use of the lubricating oil composition. Regarding the viscosity of the base oil, the kinematic viscosity thereof at 100°C is generally from 2 mm^2/s to 30 mm^2/s, preferably from 3 mm^2/s to 15 mm^2/s, more preferably from 4 mm^2/s to 10 mm^2/s. When the kinematic viscosity at 100°C is 2 mm^2/s or more, the evaporation loss is small, and when the kinematic viscosity at 100°C is 30 mm^2/s or less, the power loss owing to viscosity resistance could be prevented therefore realizing an effect of fuel efficiency improvement.

[0021] The paraffin content by ring analysis (hereinafter this may be referred to as $\%C_P$) of the base oil is 70% or more. When $\%C_P$ is less than 70%, then the oxidation stability of the composition is poor and the acid value thereof may increase and sludge may form in the composition. From the above viewpoints, $\%C_P$ is preferably 80% or more.

[0022] Further, the viscosity index of the base oil is 120 or more, and is preferably 125 or more, more preferably 130 or more. The base oil of which the viscosity index is less than 120 undergoes great viscosity change owing to temperature change therefore reducing the effect of fuel efficiency improvement at low temperatures.

[Component (A)]

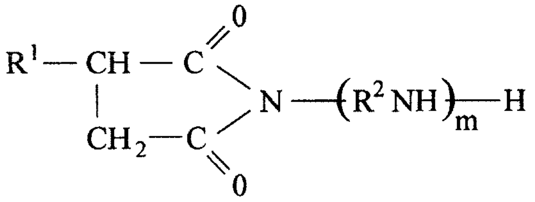
[0023] The component (A) is a dispersant that contains one or more compounds selected from the group consisting of an alkenylsuccinimide, a boronated alkenylsuccinimide, an alkylsuccinimide and a boronated alkylsuccinimide.

[0024] When the component (A) contains the boronated alkenylsuccinimide or the boronated alkylsuccinimide, the high-temperature detergency of the composition can be improved further.

[0025] In this embodiment, the succinimide includes a monoimide structure and a bisimide structure.

[0026] The monoimide structure includes both a structure based on an alkenyl or alkylsuccinic monoimide alone and a structure based on a boronated alkenyl or alkylsuccinic monoimide. The alkenyl or alkylsuccinic monoimide includes, for example, an alkenyl or alkylsuccinic monoimide represented by the following formula (1).

[0027] Similarly, the bisimide structure includes both a structure based on an alkenyl or alkylsuccinic bisimide alone and a structure based on a boronated alkenyl or alkylsuccinic bisimide. The alkenyl or alkylsuccinic bisimide includes, for example, an alkenyl or alkylsuccinic bisimide represented by the following formula (2).



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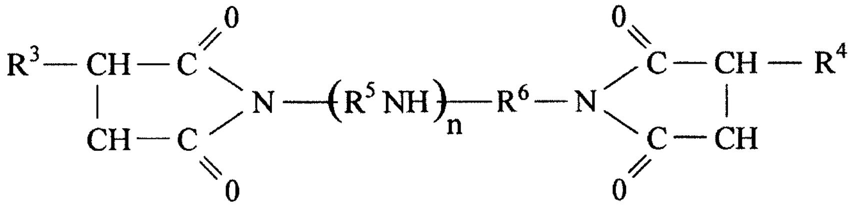


• • • (2)

[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.

[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 though 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, pentaethylenehexamine, di(methylethylene)triamine, dibutylenetriamine, tributylenetetramine, and pentapenthylenehexamine; a piperazine derivative such as aminoethylpiperazine.

[0036] The boronated alkenyl or alkyl succinimide may be one produced according to an ordinary 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, and ammonium borate.

[0038] With respect to component (A), the ratio by mass of the monoimide structure-derived nitrogen to the bisimide structure-derived nitrogen (Nm/Nb) is 0.5 or less, preferably 0.4 or less. The ratio by mass (Nm/Nb) 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. The compounds for the component (A) are contained preferably in an amount of from 0.02% by mass to 0.09% by mass, and more preferably from 0.03% by mass to 0.08% by mass, in terms of the nitrogen content thereof based on the total amount of the composition. 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.

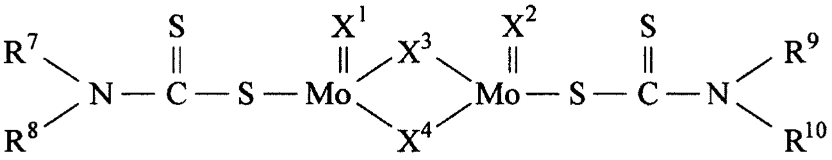
[0040] In the lubricating oil composition of this embodiment, one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained in an amount of from 0.05% by mass to 3.5% by mass, preferably in an amount of from 0.1% by mass to 3.0% by mass, more preferably in an amount of from 0.5% by mass to 2.5% by mass, based on the total amount of the composition. When the amount of one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) falls within the range, the high-temperature detergency of the composition can be improved further.

[0041] In case where at least either a boronated alkenylsuccinimide or a boronated alkylsuccinimides is contained in the component (A), 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.

[0042] 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 realizes sufficient high-temperature detergency. Preferably, the boron content is from 0.02% by mass to 0.05% by mass.

[Component (B)]

[0043] In the present composition, a molybdenum dithiocarbamate (hereinafter this may be also referred to as MoDTC) is blended as the component (B) therein. The component (B) includes, for example, MoDTC represented by the following formula (3).



· · · (3)

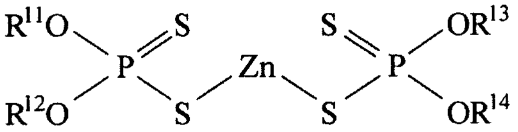
[0044] Here, in the above formula (3), R^7 to R^{10} each represent a hydrocarbon group preferably having from 4 to 22 carbon atoms, including, for example, an alkyl group, an alkenyl group, an alkylaryl group, a cycloalkyl group, and a cycloalkenyl group. Among them, preferably, R^7 to R^{10} each are a branched or linear alkyl or alkenyl group having from 4 to 18 carbon atoms, and from the viewpoint of the solubility of the compound in base oil and of the easy availability, more preferably, the substituents each are an alkyl group having from 8 to 13 carbon atoms. For example, there are mentioned an n-octyl group, a 2-ethylhexyl group, an isononyl group, a n-decyl group, an isodecyl group, a dodecyl group, a tridecyl group, and an isotridecyl group. R^7 to R^{10} may be the same as or different from each other. When R^7 and R^8, as well as R^9 and R^{10}, are different alkyl groups, the solubility in base oil, the storage stability and the sustainability of the ability to reduce friction could be improved.

[0045] In the above formula (3), X^1 to X^4 each represent a sulfur atom or an oxygen atom. All these X^1 to X^4 may be sulfur atoms or oxygen atoms. Here, the ratio of sulfur atom/oxygen atom is preferably from 1/3 to 3/1, more preferably from 1.5/2.5 to 3/1 from the viewpoint of improving the corrosion resistance and improving the solubility in base oil.

[0046] As the component (B), one alone or two or more of the above may be used either singly or as combined.

[Component (C)]

[0047] Preferably, a zinc dialkyldithiophosphate (hereinafter this maybe also referred to as "ZnDTP") is further blended in the present composition as a component (C) therein. The component (C) includes, for example, ZnDTP represented by the following formula (4).



· · · (4)

[0048] In the above formula (4), R^{11}, R^{12}, R^{13} and R^{14} each represent a substituent selected from the group consisting of a primary or secondary alkyl group having from 3 to 22 carbon atoms and an alkylaryl group substituted with an alkyl group having from 3 to 18 carbon atoms, and they may be the same or different.

[0049] 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 wear resistance.

[0050] 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 dipropylmethylphenyldithiophophate, zinc dinonylphenyldithiophosphate, zinc didodecylphenyldithiophosphate, zinc didodecylphenyldithiophosphate, etc.

[Other Components]

[0051] If desired, an antioxidant, a metallic detergent, 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>

[0052] As the antioxidant, antioxidants such as phenol-based or amine-based may be used.

[0053] 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.

[0054] The amine-based antioxidant includes, for example, monoalkyldiphenylamines such as monooctyldiphenylamine 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 naphtylamine-based antioxidants, in particular α-naphtylamine, 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 naphtylamine compounds from the viewpoint of the antioxidation effect thereof.

[0055] In the present invention, a molybdenumamine-based antioxidant may be further added. The molybdenumamine-based antioxidant usable here includes those prepared through reaction of a hexavalent molybdenum compound, in particular 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.

[0056] 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 specifically, there are exemplified alkylamines having an alkyl group with from 1 to 3 0 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 pentaethylenehexamine; compounds derived from the above monoamines, diamines or polyamines by incorporating thereinto an alkyl group or alkenyl group having from 8 to 20 carbon atoms, such as undecyldiethylamine, undecyldiethanolamine, dodecyldipropanolamine, oleyldiethanolamine, oleylpropylenediamine, and stearyltetraethylenepentamine; 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.

[0057] The blending amount of the above-mentioned 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 compatibility thereof with the base oil. More preferably, the amount 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 of the antioxidant in the lubricant base oil can be secured.

<Metallic Detergent>

[0058] The metallic detergent that may be added to the lubricating 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, preferred is at least any one of alkali metal sulfonates and alkaline earth metal sulfonates.

[0059] 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.

[0060] 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.

[0061] The alkaline earth metal salicylate includes an alkaline earth metal salts of an alkylsalicylic acid, especially a magnesium salt, a calcium salt or the like; and above all, preferred is use of the calcium salts.

[0062] 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 group may be either linear or branched. The group may be a primary alkyl group, a secondary alkyl group or a tertiary alkyl group.

[0063] 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 direct reaction of the above alkylaromatic sulfonic acid, alkylphenol, alkylphenol sulfide, alkylphenol Mannich reaction product, alkylsalicylic acid or the like and an alkaline earth metal base such as an oxide, a hydroxide or the like of one or more alkaline earth metals selected from magnesium and calcium.

[0064] 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, alkylphenol Mannich reaction product, alkylsalicylic acid or the like into alkaline metal salts such a sodium salts, potassium salts or the like thereof, followed by substitution thereof with an alkaline earth metal salt to give the intended salts.

[0065] 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.

[0066] 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 a carbonate or borate of alkaline earth metal in the presence of carbon dioxide.

[0067] 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.

[0068] As the metallic detergent, usable is the above neutral salt, basic salt, overbased salt or a mixture thereof, and in particular, preferred is a mixture of one or more of an overbased salicylate, an overbased phenate and an overbased sulfonate, and a neutral sulfonate, from the viewpoints of detergency for engine inside parts and wear 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.

[0069] The base number of the metallic detergent 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.

[0070] The metal ratio in the metallic detergents 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.

<Viscosity Index Improver>

[0071] 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, and 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 thereof.

<Pour-Point Depressant>

[0072] 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 agent 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>

[0073] 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 thereof.

<Metal Deactivator>

[0074] 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. Blending 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 thereof.

<Defoaming Agent>

[0075] 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>

[0076] 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.

[0077] In the case where the additional anti-wear agent or extreme-pressure agent is blended, 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.

[0078] 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, Sulfated Ash Content and Molybdenum Content in Lubricating Oil Composition>

[0079] 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 and, if so, MoDTC of the component (B) could not sufficiently secure the friction-reducing effect thereof. 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.

[0080] 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.

[0081] In the lubricant oil composition of the present invention, the sulfated ash content is 1.2% by mass or less based on the total amount of the composition. When the sulfated ash content is more than 1.2% 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.

[0082] 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.

[0083] The sulfated ash content means the ash content in the composition, 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".

[0084] In addition, in the lubricating oil composition of the present invention, the molybdenum content based on the total amount of the composition is from 300 ppm by mass to 1000 ppm by mass, preferably from 400 ppm by mass to 700 ppm by mass. When the content is less than 300 ppm by mass, then the composition could not secure a sufficient friction-reducing effect, but when more than 1000 ppm by mass, the solubility of the component in base oil would worsen so that metal material corrosion would be thereby accelerated.

[0085] 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]

[0086] The production method for a lubricating oil composition of this embodiment of the present invention is a production 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 molybdenum dithiocarbamate (B), 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, one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained in an amount of from 0.05% by mass to 3.5% by mass based on the total amount of the composition, the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass, the sulfated ash content based on the total amount of the composition is 1.2% by mass or less, and the molybdenum content based on the total amount of the composition is from 300 ppm by mass to 1000 ppm by mass.

[0087] 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 deactivatoar, a defoaming agent, an anti-wear agent, an extreme-pressure agent and any other additive.

[0088] 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 thereinto. 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

[0089] 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]

[0090] 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 characteristic data and the properties thereof according to the evaluation methods mentioned below. The results are shown in Table 1.

[0091] Base oil: hydrorefined oil, kinematic viscosity at 40°C; 21 mm^2/s, kinematic viscosity at 100°C; 4.5 mm^2/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.

[0092] Viscosity index improver A: polymethacrylate, weight-average molecular weight 420,000, resin amount 39%

by mass.

[0093] Phenol-based antioxidant: octadecyl 3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate

[0094] Amine-based antioxidant: dialkyldiphenylamines, nitrogen content 4.62% by mass.

[0095] Molybdenum-amine complex: Sakura-Lube S-710 (by Adeka Corporation), molybdenum content 10% by mass, nitrogen content 1.3% by mass.

[0096] 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.

[0097] Metallic detergent A: overbased calcium phenate, base number (perchloric acid method) 255 mg KOH/g, calcium content 9.3% by mass, sulfur content 3.0% by mass.

[0098] Metallic detergent B: overbased calcium salicylate, base number (perchloric acid method) 225 mg KOH/g, calcium content 7.8% by mass.

[0099] Metallic detergent C: calcium sulfonate, base number (perchloric acid method) 17 mg KOH/g, calcium content 2.4% by mass, sulfur content 2.8% by mass.

[0100] 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.

[0101] Ashless dispersant B: alkenylsuccinimide, number-average molecular weight of polybutenyl group 2000, nitrogen content 1.0% by mass.

[0102] Molybdenum dithiocarbamate: Sakura-Lube 515 (by Adeka Corporation), Mo content 10% by mass, sulfur content 11.5% by mass.

[0103] Methylbenzotriazole derivative: 1-[N,N-bis(2-ethylhexyl)-aminomethyl]methylbenzotriazole

[0104] Other additives: pour-point depressant and defoaming agent

[Characteristics Evaluation of Base Oil and Lubricating Oil Composition]

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

[0105] Measured according to "Petroleum Product Kinematic Viscosity Test Method" prescribed in JIS K 2283.

(2) Viscosity Index of Base Oil

[0106] Measured according to "Petroleum Product Kinematic Viscosity Test Method" prescribed in JIS K 2283.

(3) Sulfur Content in Base Oil

[0107] Measured according to JIS K 2541.

(4) $\%C_A$ of Base Oil

[0108] The proportion (percentage) of the aromatic component is calculated through n-d-M ring analysis.

(5) $\%C_P$ of Base Oil

[0109] The proportion (percentage) of the paraffin component is calculated through n-d-M ring analysis.

(6) NOACK Value of Base Oil

[0110] Measured according to JPI-5S-41-2004.

(7) Boron Content

[0111] Measured according to JPI-5S-38-92.

(8) Nitrogen Content

[0112] Measured according to JIS K 2609.

(9) Calcium, Phosphorus, Zinc, Molybdenum, Boron and Phosphorus Content

[0113] Measured according to JPI-5S-38-92.

(10) Sulfated Ash Content

[0114] Measured according to JIS K 2272.

[Evaluation Method]

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

[0115] The high-temperature detergency was evaluated in a hot tube test according to JPI-5S-55-99. In particular, 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 having a lower deposit mass are more excellent in high-temperature detergency.

<Initial Coating Film Formation Test>

[0116] 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>

[0117] 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.

<Friction Reduction Evaluation Test (SRV test)>

[0118] Using an SRV tester (by Optimol AG), the friction coefficient of a sample oil was measured under the condition mentioned below. The samples having a lower friction coefficient are more excellent in wear-reducing performance.

[0119] Test Piece: (a) disc: SUJ-2, (b) cylinder: SUJ-2
Amplitude: 1.5 mm
Frequency: 50 Hz
Load: 400 N
Temperature: 100°C

Table 1

		Example							Comparative Example							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
Base Oil A	mass%	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
Phenol-based Antioxidant	mass%	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
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
Molybdenum-Amine Complex	mass%	0.20	0.20	0.20	0.20	0.20	0.20	0.20		0.20	0.20		0.20	0.20	0.20	0.20
Zinc Dithiophosphate	mass%	0.60	0.60	0.60	0.60	0.60	0.60	1.20	0.60	0.60	0.60	0.60	0.60	0.00	2.40	0.60
Metallic Detergent A	mass%	2.50	2.50			1.00	1.00	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Metallic Detergent B	mass%			3.00	3.00											
Metallic Detergent C	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
Ashless Dispersant A	mass%	1.00	2.00	1.00	2.00	1.00	2.00	1.00	2.00		4.00	1.00	1.00	1.00	1.00	
Ashless Dispersant B	mass%	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	10.00	4.00	4.00	4.00	4.00	4.00	4.00
Molybdenum Dithiocarbamate	mass%	0.50	0.50	0.50	0.50	0.50	0.50	0.50		0.50	0.50	0.25		0.50	0.50	0.50
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
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
Calcium	mass%	0.24	0.24	0.25	0.25	0.11	0.11	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Phosphorus	mass%	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.05	0.05	0.05	0.05	0.05	0.00	0.20	0.05

(continued)

		Example							Comparative Example							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
Zinc	mass%	0.05	0.05	0.05	0.05	0.05	0.05	0.11	0.05	0.05	0.05	0.05	0.05	0.00	0.22	0.05
Molybdenum	ppm	700	700	700	700	700	700	700	0	700	700	250	200	700	700	700
Boron	mass%	0.02	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.00	0.08	0.02	0.02	0.02	0.02	0.00
Nitrogen	mass%	0.08	0.10	0.08	0.10	0.08	0.10	0.08	0.10	0.10	0.14	0.08	0.08	0.08	0.08	0.07
Nitrogen (derived from ashless dispersant)	mass%	0.06	0.08	0.06	0.08	0.06	0.08	0.06	0.08	0.10	0.11	0.06	0.06	0.06	0.06	0.04
Sulfur	mass%	0.25	0.25	0.17	0.17	0.20	0.20	0.35	0.19	0.25	0.25	0.25	0.19	0.15	0.56	0.25
Sulfated Ash Content	mass%	0.97	0.98	0.97	0.99	0.51	0.52	1.08	0.95	0.95	1.01	0.96	0.94	0.85	1.32	0.95
High-Temperature Detergency Test (hot tube test score)	M.R.	8.0	9.5	8.0	9.5	8.0	9.0	9.0	8.5	3.0	9.5	5.0	8.0	5.0	8.0	5.0
Initial Coating Film Formation Test (coating film formation time)	sec	15	6	13	4	18	6	1	180<	126	68	180<	180<	180<	180<	180<
Load Carrying Performance Test (complete contact load)	MPa	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.288<	0.048	0.096	0.048	0.048	0.048	0.048	0.048	0.048
Friction Reduction Evaluation Test (friction coefficient)		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.15	0.05	0.07	0.05	0.15	0.05	0.15	0.05

[Evaluation Results]

[0120] From the results in Table 1, it is known that, in Examples using the lubricating oil composition of the present invention that contains a specific amount of a molybdenum dithiocarbamate, the result in the initial coating film formation test is good, and therefore 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. In addition, 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 molybdenum dithiocarbamate;

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,
one or more compounds selected from the group consisting of a boronated alkenylsuccinimide and a boronated alkylsuccinimide in the component (A) are contained in an amount of from 0.05% by mass to 3.5% by mass based on the total amount of the composition,
the phosphorus content based on the total amount of the composition is from 100 ppm by mass to 1200 ppm by mass,
the sulfated ash content based on the total amount of the composition is 1.2% by mass or less, and
the molybdenum content based on the total amount of the composition is from 300 ppm by mass to 1000 ppm by mass.

2. The lubricating oil composition according to claim 1, wherein the component (A) contains a boron compound, and the ratio by mass of boron to nitrogen, B/N ratio in the component (A) is 0.5 or more.

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 2 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, which is used for lubrication in internal combustion engines.

7. The lubricating oil composition according to claim 6, which is used for lubrication in internal combustion engines where at least a piston head thereof is formed of a cast iron material.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/056071

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)
C10M141/12, C10M129/10, C10M133/12, C10M133/16, C10M133/56, C10M135/18, C10M139/00, C10N10/12, 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], [0076], [0081], [0087] to [0088], [0090]; examples 13 to 14 & CN 1400295 A	1-7
Y	JP 2012-233116 A (JX Nippon Oil & Energy Corp.), 29 November 2012 (29.11.2012), paragraphs [0031], [0034] & WO 2012/153548 A1	1-7
Y	JP 2009-292998 A (Idemitsu Kosan Co., Ltd.), 17 December 2009 (17.12.2009), paragraphs [0035] to [0037] & EP 2133406 A1	3

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

* Special categories of cited documents:
“A” document defining the general state of the art which is not considered to be of particular relevance
“E” earlier application or patent but published on or after the international filing date
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“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
“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
“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
“&” document member of the same patent family

Date of the actual completion of the international search 14 May, 2014 (14.05.14)	Date of mailing of the international search report 27 May, 2014 (27.05.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/056071

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 06-299276 A (Daido Steel Co., Ltd.), 25 October 1994 (25.10.1994), paragraphs [0002] to [0003] (Family: none)	7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/056071

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

C10M141/12(2006.01)i, *C10M129/10*(2006.01)n, *C10M133/12*(2006.01)n, *C10M133/16*(2006.01)n, *C10M133/56*(2006.01)n, *C10M135/18*(2006.01)n, *C10M139/00*(2006.01)n, *C10N10/12*(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

Patent documents cited in the description

- JP 2010010070 A **[0005]**
- JP 2003252887 A **[0055]**
- JP 3022438 B **[0056]**
- JP 2004002866 A **[0056]**