(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 636 725 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.09.2013 Bulletin 2013/37

(51) Int Cl.:
C10M 171/02 *(2006.01)* *C10N 30/06* *(2006.01)*
C10N 40/25 *(2006.01)*

(21) Application number: **13157940.1**

(22) Date of filing: **06.03.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **08.03.2012 JP 2012051849**

(71) Applicant: **Chevron Japan Ltd.**
Tokyo 101-0041 (JP)

(72) Inventors:
- **Hiroki, Andoh**
  Omaezaki-shi, Shizuoka (JP)
- **Nakazato, Morikuni**
  Omaezaki-shi, Shizuoka (JP)

(74) Representative: **Nash, David Allan**
Haseltine Lake LLP
Redcliff Quay
120 Redcliff Street
Bristol BS1 6HU (GB)

(54) **Lubricating oil composition for automobile engine lubrication**

(57) Provided is a lubricating oil composition that is highly fuel-efficient and has high wear resistance and is particularly suited for lubrication of a motorcycle four-cycle gasoline engine or a diesel engine vehicle having an exhaust gas after-treatment device. The lubricating oil composition, which is a lubricating oil composition having an SAE viscosity grade of 5W20, comprises a base oil and predetermined amounts of additive components comprising of a nitrogen-containing ash-free dispersant, an alkali earth metal-containing detergent, a phosphorus-containing anti-wear agent, an antioxidant, and a viscosity index-improving agent, wherein the viscosity index is within a range of 140 to 230, the high-shear viscosity at 150°C is 2.9 mPa·s or higher, and the NOACK evaporation loss is 13% or less.

EP 2 636 725 A1

Description

[0001] This application claims priority to Japanese Patent Application number JP 2012-51849 which was filed on March 8, 2012.

Field of Invention

[0002] The present invention relates to an excellent fuel-efficient, low-viscosity lubricating oil composition for an automobile engine, and in particular, relates to a lubricating oil composition for automobile engine lubrication that, while being an excellent fuel-efficient, low-viscosity lubricating oil composition for engine lubrication, also shows high wear resistance. The present invention relates to a low-viscosity lubricating oil composition that is particularly suitable for lubricating a motorcycle four-cycle gasoline engine or a diesel engine having an exhaust gas after-treatment device.

Background of Invention

[0003] There is an increasing demand for improved fuel efficiency in automobiles. Therefore, there is a need for an excellent fuel-efficient, low-viscosity engine oil as the lubricating oil composition (engine oil) that is used to lubricate the engine of a gasoline engine vehicle or a diesel engine vehicle. For instance, engine oils that have an SAE viscosity grade of 5W20 and a high-temperature high-shear viscosity (value measured at 150°C when the shear velocity or shear rate is 10^6 s^{-1}) of 2.6 mPa·s are already being used for practical purposes as fuel-efficient lubricating oil compositions for gasoline engines in four-wheel drive vehicles.

[0004] However, by means of four-cycle gasoline engines for motorcycles, the engine oil is also used to lubricate the transmission system and there is a chance that wear of the energy-transmission devices, such as the transmission gears, will increase (wear resistance will decrease) as a result of a reduction in viscosity of the engine oil. Taking this point into consideration, JASO T903-2006 stipulates that the engine oils for motorcycle four-cycle gasoline engines have a high-temperature, high-shear ($10^6 s^{-1}$) viscosity of 2.9 mPa·s or greater. Nevertheless, such a high high-temperature, high-shear viscosity can hardly been expected of the SAE5W20 engine oils known today and therefore, the engine oils used today in motorcycle four-cycle gasoline engines are all low-viscosity engine oils of SAEI viscosity grade 10W30, 5W30, or 0W30.

[0005] On the other hand, taking into consideration the need for wear resistance in engine oils, ACEA C1-08 and C2-08, which are the European standards for engine oils appropriate for lubrication of diesel engine vehicles having diesel particulate filters, set the lower limit of high-temperature, high-shear ($10^6 s^{-1}$) viscosity of engine oils at 2.9 mPa·s and, in order to limit evaporation loss of engine oils, the upper limit of NOACK evaporation loss at 13%.

[0006] Patent Document JP (Kokai) 6-306384 describes a fuel-efficient lubricating oil for an internal combustion engine wherein a predetermined amount of an organic molybdenum compound is added to a mineral oil base oil having a dynamic viscosity at 100°C of 3 to 5 cSt, a viscosity index of 135 or higher, and a paraffin to total carbon ratio (%Cp) of 90% or higher.

[0007] Patent Document JP (Kohyo) 2003-505533 describes a lubricating oil composition that, as a molybdenum additive-free, fuel-efficient, low-volatility lubricating oil composition having a NOACK volatility of 15 wt% or less, contains a predetermined amount of a calcium detergent and a predetermined amount of an oil-soluble organic wear-improving agent, as well as a base oil comprising at least 50 wt% of mineral oil; has a dynamic viscosity at 100°C of 4.0 to 5.5 mm^2/s; contains 95 wt% or more of saturated product and 25 wt% or less of naphthenes; has a viscosity index of at least 120; and has an NOACK volatility of 15.5 wt% or less.

[0008] Patent Document JP (Kokai) 2000-87070 describes an excellent fuel-efficient motorcycle four-cycle engine composition having an oil consumption-lowering effect that contains a hydrocarbon lubricating oil base oil having a dynamic viscosity at 100°C of 3 to 10 mm^2/s and a viscosity index of 120 or higher, or a mixed base oil containing at least 15 mass% of this base oil, a zinc dialkyl dithiophosphate, a metal detergent, an ash-free dispersant, a wear regulator, and a viscosity index-improving agent that brings dynamic viscosity at 100°C of this composition to 9.3 to 16.5 mm^2/s. Specifically, it describes a motorcycle four-cycle engine composition having an SAE viscosity grade of 10W30 or 10W40.

Summary of Invention

[0009] Improving engine structure is of course important as a method for improving fuel efficiency of automobile engines, but it is also known that lowering viscosity of lubricating oils is effective in improving fuel efficiency. Therefore, as previously mentioned, engine oils having an SAE viscosity grade of 5W20 and a high-temperature, high-shear ($10^6 s^{-1}$) viscosity of 2.6 mPa·s are already being used as fuel-efficient gasoline engine oils for four-wheel drive vehicles. Nevertheless, fuel-efficient gasoline engine oils for four-wheel drive vehicles having an SAE viscosity grade of 5W20 cannot be expected to have a high-temperature, high-shear viscosity that is as high as 2.6 mPa·s and therefore, there is a problem in that when used as the engine oil of a motorcycle four-cycle gasoline engine that uses engine oil for lubrication of the transmission system, there is a problem in that wear resistance is insufficient.

[0010] The inventors completed the present invention upon discovering that it is possible to produce a lubricating oil composition that has an SAE viscosity grade of 5W20 and yet a viscosity index within a range of 140 to 230, a high-shear ($10^6 s^{-1}$) viscosity at 150°C of 2.9 mPa·s or higher, a NOACK evaporation loss of 13% or less, and excellent wear resistance by using a base oil such as has been recently supplied to the market and is primarily isoparaffin, has an ultrahigh viscosity index wherein the viscosity index is within a range of approximately 133 to 160, and is obtained by hydrogenation and isomerization of a slack wax or a synthetic wax produced by the Fischer-Tropsch method and distillation and dewaxing treatment, and by optimizing the combination of additive components added to the base oil and the amount of each lubricant component. Note that lubricating oil compositions of SAE viscosity grade 5W20 are already known to have excellent fuel efficiency because they have a relatively low dynamic viscosity under temperature conditions of both low temperatures and high temperatures.

[0011] Consequently, the present invention is a lubricating oil composition for automobile engine lubrication, which is a lubricating oil composition comprising a base oil and the following additive components and having an SAE viscosity grade of 5W20, wherein the viscosity index is within a range of 140 to 230, the high-shear viscosity at 150°C is 2.9 mPa·s or higher, and the NOACK evaporation loss is 13% or less, further comprising:

a) a nitrogen-containing ash-free dispersant at 0.01 to 0.3 mass% in terms of the nitrogen content,
b) an alkaline earth metal-containing detergent at 0.08 to 0.4 mass% in terms of alkaline earth metal content,
c) a phosphorus-containing anti-wear agent at 0.05 to 0.12 wt% in terms of phosphorus content,
d) an antioxidant selected from the group consisting of amine compounds, phenol compounds, and molybdenum compounds at 0.1 to 7 mass%,
e) a viscosity index-improving agent at 0.5 to 20 mass%, and further wherein

the amount of each additive component is the mass% in terms of the total amount of lubricating oil composition.

[0012] It should be noted that the phrase "lubricating oil composition having an SAE viscosity grade of 5W20 of the present invention" refers to a lubricating oil composition that satisfies the viscosity property of "5 W20" described in "SAE viscosity grades for engine oils" of the American Petroleum Institute (revised in 2007). Moreover, the phrase "high-shear viscosity" refers to the measured value (shear viscosity) when the shear speed or shear rate is $10^6 s^{-1}$.

[0013] The present invention also is a method for lubricating a motorcycle four-cycle gasoline engine or a diesel engine having an exhaust gas after-treatment device.

Detailed Description of the Invention

[0014] The lubricating oil composition for lubricating an automobile engine provided by the present invention is a lubricating oil composition having an SAE viscosity grade that is low at 5W20, while having a high-temperature, high-shear viscosity of 2.9 mPa·s or higher, and shows excellent fuel efficiency and wear resistance. The lubricating oil compositor of the present invention therefore is an excellent fuel-efficient, wear-resistant lubricating oil that is particularly suitable for lubricating a motorcycle four-cycle gasoline engine or a diesel engine having an exhaust gas after-treatment device.

[0015] The following are preferred modes of the lubricating oil composition for lubricating an automobile engine of the present invention.

(1) Dynamic viscosity at 100°C is within a range of 8.5 mm^2/s or greater, but less than 9.3 mm^2/s.
(2) The base oil comprises as a base oil component at least 80 mass% of a mineral oil base oil having a dynamic viscosity at 100°C that is within a range of 2 to 9 mm^2/s (particularly preferably 4.5 to 9 mm^2/s, further preferably 5 to 8.5 mm^2/s) and a viscosity index of 133 to 160.
(3) The base oil is a mineral oil having a dynamic viscosity at 100°C that is within a range of 2 to 9 mm^2/s (particularly preferably 4.5 to 9 mm^2/s, further preferably 5 to 8.5 mm^2/s) and a viscosity index of 133 to 160.
(4) The base oil is a base oil having a viscosity index of 133 to 160 that is obtained by hydrogenation and isomerization of either a slack wax or a synthetic wax produced by the Fischer-Tropsch method and then distillation and dewaxing treatment.
(5) The lubricating oil comprises two or more base oil components having different viscosities, but both having a viscosity index of 130 or higher.
(6) The viscosity index-improving agent is a polymethacrylate polymer having a shear stability index (SSI, as defined by ASTM D6022) of 30 or less.
(7) An organic sulfur compound is further added as an additive component.
(8) The nitrogen-containing ash-free dispersant is a succinimide compound having a bis structure.

(9) The alkaline earth metal-containing component is a perbasic calcium-containing compound selected from the group consisting of perbasic calcium sulfonate and perbasic calcium phenate.
(10) The phosphorus-containing anti-wear agent is a phosphorus-containing compound selected from zinc dihydrocarbyl dithiophosphate and zinc dihydrocarbyl phosphate.
(11) The viscosity index-improving agent is a polymethacrylate viscosity index-improving agent.
(12) The lubricating oil composition is for lubrication of a motorcycle four-cycle gasoline engine.
(13) The lubricating oil composition is for lubricating the engine of a diesel engine vehicle having an exhaust gas post-purification device.

[0016] The base oil and additive components that are contained in the lubricating oil composition of the present invention will now be described.

Base oil

[0017] Taking into consideration economics, the base oil of the lubricating oil composition of the present invention is preferably a mineral oil. It can also be a mixture of a relatively large amount (at least 50 mass%) of a mineral oil and a relatively small amount (less than 50 mass%) of a synthetic oil.

[0018] Preferably the base oil used in the lubricating oil composition of the present invention is a base oil that is primarily an isoparaffin and has a dynamic viscosity at 100°C of 2 to 9 mm^2/s, a saturated component content of 95 mass% or higher (particularly 98 mass% or higher), and a viscosity index of 133 or higher (particularly 135 or higher, further 145 or higher). A base oil having such properties and composition can be used alone, or a combination of two or more types can be used. Moreover, it is also possible to use a mixture of a base oil having such properties and composition and a relatively small amount of a base oil having other properties and composition. Preferably the base oil composition after mixing will still have the above-mentioned properties and composition.

[0019] The base oil having the above-mentioned properties and composition preferably has an evaporation loss (ASTM D5800) of 16% or less (particularly 15% or less, further 13% or less). When evaporation loss of the base oil is high, oil consumption with long-term use of an engine oil that uses this base oil (lubricating oil composition) under high temperatures increases, and the rise in viscosity increases. This leads to a reduction in fuel efficiency.

[0020] There are no particular restrictions to the type of base oil showing the above-mentioned properties and composition, but when the base oil is a mineral oil, preferably it is a high-viscosity index base oil (base oil having a viscosity index between 133 and 160) the primary component of which is isoparaffin obtained by subjecting the slack wax that is the by-product of dewaxing during the production of mineral oil lubricating base oils, or synthetic wax synthesized using natural gas as the starting material (by the Fischer-Tropsche method), to hydrogenation and isomerization and then distillation and dewaxing. Such a high viscosity index base oil has a relatively high dynamic viscosity at 100°C, but has good low-temperature viscosity properties and therefore, can have a reduced evaporation loss and is ideal as the base oil of the lubricating oil composition of the present invention.

[0021] It should be noted that, as described above, the high-viscosity-index base oil, which is the above-mentioned mineral oil, can be used together with a synthetic oil. Preferably the synthetic oil has the above-mentioned properties and composition. The preferred synthetic oil can be selected from a variety of conventional synthetic oils, and examples of such synthetic oils are various esters, alkylbenzenes, and polyalphaolefins (PAO). Poly-alphaolefins (PAOs) are particularly preferred.

Nitrogen-containing ash-free dispersant

[0022] The lubricating oil composition of the present invention comprises a nitrogen-containing ash-free dispersant (component a) in an amount within a range of 0.01 to 0.3 mass% in terms of the nitrogen content. Preferably the mass-average molecular weight of the nitrogen-containing ash-free dispersant is within a range of 4,500 to 20,000. The phrase "mass-average molecular weight" used in the present specification is the molecular weight determined by GPC analysis with polystyrene as the standard substance.

[0023] Typical examples of the nitrogen-containing ash-free dispersant used in the lubricating oil composition of the present invention are alkenyl and alkyl succinimides derived from polyolefins and derivatives of these succinimides. The amount added is within a range of 0.01 to 0.3 mass% in terms of the nitrogen content based on the total mass of the lubricating oil composition. Typical succinimides are obtained by reacting a succinic anhydride substituted by alkenyl or alkyl groups and having a high molecular weight and a polyalkylene polyamine containing an average of four to ten (preferably five to seven) nitrogen atoms per molecule. The succinimide anhydride that is substituted by alkenyl or alkyl groups and has a high molecular weight is preferably a polyolefin having a number-average molecular weight of approximately 900 to 5,000, particularly polybutene.

[0024] In many cases, chlorination by chlorine is used during the step for obtaining a polybutenyl succinimide by reacting polybutene and maleic anhydride. However, although reactivity is good by this method, it has the effect of a large amount of chlorine (for instance, approximately 2,000 ppm) remaining in the succinimide final product. On the other hand, when thermal reaction that does not use chlorine is employed, the residual chlorine contained in the final product can be kept to a very low level (for instance, 30 ppm or less). Moreover, when polybutene (at least approximately 50% of which is a methylvinylidene structure) having a high reactivity in comparison to conventional polybutene (that is primarily β-olefin in structure) is used, there is an advantage in that reactivity is increased, even by the thermal reaction method. The amount of unreacted polybutene in the dispersant decreases as the reactivity increases and therefore, it is possible to obtain a dispersant having a high effective component (succinimide) concentration. Consequently, preferably the succinimide that is used is produced by obtaining a polybutenyl succinimide anhydride by thermal reaction using highly reactive polybutene and then reacting this polybutenyl succinic anhydride with a polyalkylene polyamine having an average of four to ten nitrogen atoms (per one molecule). This succinimide can be further reacted with boric acid or an alcohol, aldehyde, ketone, alkyl phenol, cyclic carbonate, organic acid, and the like and used as a so-called modified succinimide. In particular, a boric acid-containing alkenyl (or alkyl) succinimide obtained by reaction with boric acid or a boron compound can be used in order to efficiently increase thermal and oxidation stability. Examples of this succinimide are mono-types, bis-types, and poly-types in accordance with the number of imide structures per molecule, but the bis-type or poly-type is preferred as the succinimide used for the purpose of the present invention.

[0025] Examples of other nitrogen-containing ash-free dispersants are polymeric succinimide dispersants derived from ethylene-α-olefin copolymer (having a molecular weight of 1,000 to 15,000, for instance) and alkenyl benzylamine ash-free dispersants.

[0026] According to the lubricating oil composition of the present invention, Nitrogen-containing dispersion-type viscosity index improvers can also be used in place of the nitrogen-containing ash-free dispersant. A nitrogen-containing olefin polymer or a nitrogen-containing polymethacrylate having a mass-average molecular weight of 90,000 or greater (in terms of polystyrene molecular weight by GPC analysis) is used as the nitrogen-containing dispersion-type viscosity index-improving agent. Taking thermal stability into consideration, the former nitrogen-containing olefin copolymer is effective.

[0027] The lubricating oil composition of the present invention contains a nitrogen-containing ash-free dispersant and/or nitrogen-containing dispersion-type viscosity index-improving agent as an active ingredient. These can also be used in combination with another ash-free dispersant, such as an alkenyl succinic acid ester ash-free dispersant.

Metal-containing detergent

[0028] The lubricating oil composition of the present invention contains, as a metal-containing detergent, an alkaline earth metal-containing detergent (component (b)) in an amount within a range of 0.08 to 0.4 mass%. Examples of alkaline earth metals are calcium, barium, and magnesium, but calcium is preferred. Moreover, preferably a sulfonate or phenate of the alkaline earth metal is used as the metal-containing detergent. A combination of a sulfonate of an alkaline earth metal and a phenate of an alkaline earth metal can also be used. It is also possible to use a combination of these metal-containing detergents and a metal-containing detergent such as an alkyl salicylate and/or alkyl carboxylate of an alkaline earth metal (particularly calcium).

[0029] Examples of calcium sulfonates are perbasic calcium sulfonate having a total base value of 150 to 500 mgKOH/g and low-basic calcium sulfonate having a total base value of 5 to 60 mgKOH/g. Preferably the perbasic calcium sulfonate is perbasic alkylated calcium benzene sulfonate or alkylated calcium toluene sulfonate having alkyl groups with 10 or more carbon atoms (usually the degree of perbasic conversion is within a range of 5 to 25). On the other hand, preferably the low-basic calcium sulfonate is alkylated calcium benzene sulfonate or alkylated calcium toluene sulfonate having alkyl groups with ten or more carbon atoms and is usually one that is nearly a neutral salt subjected to virtually no perbasic conversion (preferably the degree of perbasic conversion is within a range of 0.1 to 1.5). However, preferably a combination of a perbasic calcium sulfonate and a low-basic calcium sulfonate is used. It should be noted that the sulfonate can be a synthetic sulfonate as described above, or it can be a petroleum sulfonate obtained by sulfonating a lubricating oil fraction of a mineral oil to a calcium salt. Consequently, a petroleum low-basic calcium sulfonate/perbasic calcium sulfonate such as described above is preferred for the purpose of the present invention.

[0030] Perbasic sulfurized calcium phenate having a total base value of 120 to 350 mgKOH/g is known as a calcium phenate. A perbasic sulfurized alkyl phenol calcium having alkyl groups with ten or more carbon atoms is preferred.

Phosphorus-containing anti-wear agent

[0031] The lubricating oil composition of the present invention contains a phosphorus-containing anti-wear agent (component c) in an amount within a range of 0.05 to 0.12 mass% in terms of the amount of phosphorus. Preferred phosphorus-containing anti-wear agents are zinc dihydrocarbyl dithiophosphate, zinc dihydrocarbyl monothiophate, and zinc dihydrocarbyl phosphate, which are known as lubricating oil additives that are multiperformance in that they have antioxidant performance and anti-wear performance.

[0032] A primary or secondary alkyl group-type zinc dialkyl dithiophosphate is usually used as the zinc dihydrocarbyl dithiophosphate. A zinc dialkyl dithiophosphate having secondary alkyl groups derived from a C_{3-18} secondary alcohol is effective in terms of anti-wear performance. In contrast to this, a zinc dialkyl dithiophosphate having primary alkyl groups derived from a C_{3-18} primary alcohol has a tendency toward being superior in terms of heat resistance and wear-reducing activity. Moreover, a combination of a secondary alkyl group-type zinc dialkyl dithiophosphate and a primary alkyl group-type zinc dialkyl dithiophosphate can be used. Furthermore, it is also possible to use a zinc dialkyl dithiophosphate that is a mixed type of primary and secondary alkyl groups derived from a mixed alcohol of a primary alcohol and a secondary alcohol.

[0033] A zinc dialkylaryl dithiophosphate (such as a zinc dialkylaryl dithiophosphate derived from dodecyl phenol) can also be used as the phosphorus-containing anti-wear agent.

[0034] Moreover, it is also possible to use a phosphoric acid ester, phosphorus acid ester, or thiophosphoric acid ester as the phosphorus-containing anti-wear agent.

Anti-oxidant

[0035] The lubricating oil composition of the present invention further contains, in an amount that is within a range of 0.1 to 7 mass%, at least one antioxidant (component d) selected from the group consisting of phenol compounds (phenol antioxidants), amine compounds (amine antioxidants), and molybdenum compounds (molybdenum antioxidants).

[0036] A hindered phenol compound is generally used as the phenol antioxidant, and a diaryl amine compound is generally used as the amine antioxidant. Hindered phenol antioxidants and diaryl amine antioxidants are both also effective in improving high-temperature detergency. Diaryl amine antioxidants in particular have a base value derived from nitrogen and are effective in improving high-temperature detergency. On the other hand, hindered phenol antioxidants are effective in preventing oxidative degradation by NO_x.

[0037] Examples of hindered phenol antioxidants are 2,6-di-t-butyl-p-cresol, 4,4'-methylenebis(2,6-di-t-butylphenol), 4,4'-methylenebis(6-t-butyl-o-cresol), 4,4'-isoropylidenebis(2,6)\-di-t-butylphenol), 4,4'-bis(2,6-di-t-butylphenol), 2,2'-methylenebis(4-methyl-6-t-butylphenol), 4,4'-thiobis(2-methyl-6-t-butylphenol), 2,2-thiodiethylenebis[3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate], octyl 3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate, octadecyl 3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate, and octyl 3-(5-t-butyl-4-hydroxy-3-methylphenyl)propionate.

[0038] Examples of amine antioxidants are C_{4-9} mixed alkyl diphenyl amines, p,p'-dioctyldiphenylamine, phenyl-α-naphthylamine, phenyl-β-naphthylamine, alkylated-α-naphthylamine, and alkylated-phenyl-α-naphthylamine.

[0039] Examples of molybdenum antioxidants are oxymolybdenum complexes of basic nitrogen compounds. Examples of preferred oxymolybdenum complexes of basic nitrogen compounds are oxymolybdenum complexes of succinimide and oxymolybdenum complexes of carbonamide. Oxymolybdenum complexes of basic nitrogen compounds can be produced using the following method, for instance. A molybdenum complex is produced by reacting an acidic molybdenum compound or salt thereof with a basic nitrogen compound, such as a succinimide, carbonamide, hydrocarbon monoamine, hydrocarbon polyamine, Mannich hydrochloric acid, phosphonamide, thiophosphonamide, phosphoric amide, dispersion-type viscosity index-improving agent (or a mixture thereof), while maintaining the reaction temperature at 120°C or lower.

[0040] Moreover, it is also possible to use a molybdenum-containing compound other than an oxymolybdenum complex of a basic nitrogen compound in place of the oxymolybdenum complex of the basic nitrogen compound, or in combination with the oxymolybdenum complex of a basic nitrogen compound. Examples of the combined molybdenum-containing compounds that can be used are sulfurized oxymolybdenum dithiocarbamates and sulfurized oxymolybdenum dithiophosphates.

[0041] The phenol antioxidant (particularly hindered phenol antioxidant), amine antioxidant (particularly diaryl amine antioxidant), and molybdenum antioxidant (particularly oxymolybdenum complex of basic nitrogen compound) can be used alone, or they can be used as an arbitrary combination with one another as desired. It is also possible to use these in combination with an oil-soluble antioxidant.

Viscosity index-improving agent

[0042] The lubricating oil composition of the present invention further comprises a viscosity index-improving agent (component e) in an amount within a range of 0.5 to 20 mass%. Examples of viscosity index-improving agents are polymethacrylate viscosity index-improving agents such as polyalkylmethacrylate, and viscosity index-improving agents based on olefin copolymers, such as ethylene-propylene copolymer, styrene-butadiene copolymer, and polyisoprene. Of these viscosity index-improving agents, olefin copolymer viscosity index-improving agents have high thermal stability and are effective in terms of the object of the present invention. One having a shear stability index (SSI) of 30 or less (particularly 25 or less) is particularly preferable for the object of the present invention. Moreover, a dispersion-type viscosity index-improving agent or multifunctional viscosity index-improving agent that imparts dispersion performance to these polymer compounds is preferably used. These viscosity index-improving agents can be used alone, or a combination of any two or more viscosity index-improving agents can be used.

Organic sulfur compound

[0043] Preferably the lubricating oil composition of the present invention further comprises an organic sulfur compound that is effective in terms of wear resistance and oxidation resistance. Examples of organic sulfur compounds having such a property are sulfurized olefins, sulfurized esters, sulfurized oils and fats, polysulfide compound, dimercaptothiadiazoles, dithiophosphoric acid esters, and dithiocarbamates.

Other additives

[0044] The addition of an alkali metal borate hydrate to the lubricating oil composition of the present invention is effective in terms of high-temperature detergency and imparting a base value. The amount of alkali metal borate hydrate is 5 mass% or less, particularly 0.01 to 5 mass%. Alkali metal borate hydrates often have an ash component, sulfur component, and the like, but taking into consideration the properties of the lubricating oil composition of the present invention, an alkali metal borate hydrate can be effectively used by adjusting the amount added.

[0045] The lubricating oil composition of the present invention can also contain a small amount of various auxiliary additives. Examples of such auxiliary additives are zinc dithiocarbamate and methylene bis(dibutyl dithiocarbamate), oil-soluble copper compounds, and organic amide compounds (such as oleyl amide) that function as antioxidants or anti-wear agents. Moreover, it is possible to add compounds such as benzotriazole compounds and thiadiazole compounds that function as metal deactivators. It is possible to add polyoxyalkylene nonionic surfactants such as polyoxyethylene alkylphenyl ethers and copolymers of ethylene oxide and propylene oxide that function as anti-rust agents and demulsifiers. It is possible to add various amides, polyhydric alcohol aliphatic acid esters, or derivatives thereof that function as wear adjusters. Moreover, it is possible to add a variety of compounds that function as antifoaming agent and pour point depressants. Note that preferably these auxiliary additives are each used in an amount that is 3 mass% or less (particularly a range of 0.001 to 3 mass%) in terms of the lubricating oil composition.

Examples

[0046] The present invention is further described by the following illustrative non-limiting working examples.

[Examples 1 and 2, comparative examples, and reference examples]

(1) Production of lubricating oil composition

[0047] The lubricating oil composition of the present invention (SAE viscosity grade: 5W20, high-temperature, high-shear viscosity: 2.9 mPa·s or higher) was produced (Examples 1 and 2) using the following base oil and additives (in the following amounts). Moreover, a lubricating oil composition having an SAE viscosity grade of 5W20 (high-temperature, high-shear viscosity of approximately 2.6 mPa·s) was produced as a comparative example and a lubricating oil composition having an SAE viscosity grade of 10W30 (high-temperature, high-shear viscosity of 2.9 mPa·s or higher) was produced as a reference example.

(2) Base oil

[0048] Base oill: Mixture (having viscosity index of 142, a dynamic viscosity at 100°C of 4.9 mm^2/s, and NOACK evaporation loss of 10.1 %) of mineral oil base oil a (having a viscosity index of 137, a dynamic viscosity at 100°C of 4.1 mm^2/s, and a NOACK evaporation loss of 13.6%) obtained by hydrogenation and isomerization, fractionation, and then dewaxing using slack wax as the starting material and mineral oil base oil b (having a viscosity index of 148, a dynamic viscosity at 100°C of 6.6 mm^2/s, and NOACK evaporation loss of 5.0%) obtained by hydrogenation and isomerization, fractionation, and then dewaxing using slack wax as the starting material, at a weight ratio of 60:40 (base oil a: base oil b).

[0049] Base oil 2: Hydrocracked mineral oil (having a viscosity index of 128, a dynamic viscosity at 100°C of 4.2 mm^2/s, and NOACK evaporation loss of 14.2%)

[0050] Base oil 3: Mixture (having viscosity index of 115, dynamic viscosity at 100°C of 6.7 mm^2/s, and NOACK evaporation loss of 10.8%) of hydrocracked mineral oil a (having a viscosity index of 122, a dynamic viscosity at 100°C of 5.6 mm^2/s, and NOACK evaporation loss of 12.4%) and hydrocracked mineral oil b (having a viscosity index of 99, a dynamic viscosity at 100°C of 10.7 mm^2/s, and NOACK evaporation loss of 6.0%), at a weight ratio of 73:27 (mineral oil a:mineral oil b)

[0051] Note: The amount of base oil that, together with the total amount of the following additives, brought the total to 100 mass%.

(3) Additives

[Nitrogen-containing ash-free dispersant]

[0052] 1) Ash-free dispersant 1 (mass-average molecular weight: 5,100 (in terms of polystyrene by GPC analysis; same hereafter), nitrogen content: 1.95 mass%, boron content: 0.63 mass%, chlorine content: less than 5 ppm by mass; obtained by reacting a highly reactive polyisobutene having a number-average molecular weight of approximately 1,300 (at least approximately 50% of which had a methyl vinylidene structure) and maleic anhydride by thermal reaction, reacting the resulting polyisobutenyl succinic anhydride with a polyalkylene polyamine having an average number of nitrogen atoms of 6.5 (per one molecule) to obtain the bis-type of succinimide, and then reacting this bis-type of succinimide with boric acid)

Amount added: 0.06 mass% (in terms ofN)

[0053] 2) ash-free dispersant 2 (mass-average molecular weight: 12,800, nitrogen content: 1.0 mass%, chlorine content: 30 ppm by mass; obtained by reacting a highly reactive polyisobutene having a number-average molecular weight of approximately 2,300 (at least approximately 50% of which had a methyl vinylidene structure) and maleic anhydride by thermal reaction, reacting the resulting polyisobutenyl succinic anhydride with a polyalkylene polyamine having an average number of nitrogen atoms of 6.5 (per one molecule) to obtain the bis-type of succinimide, and then reacting this bis-type of succinimide with ethylene carbonate)

Amount added: 0.01 mass% (in terms ofN)

[Alkaline earth metal-containing detergent]

[0054] 1) Perbasic calcium phenate (sulfurized phenate having C_{12} branched alkyl groups, Ca: 9.6 mass%, S: 3.4 mass%, TBN: 264 mgKOH/g)

Amount added: 0.15 mass% (in terms of Ca)

[0055] 2) Perbasic calcium sulfonate (alkyl toluene sulfonate having C_{20-24} alkyl groups, Ca: 16.0 mass%, S: 1.6 mass%, TBN: 425 mgKOH/g, degree of perbasic conversion: 19)

Amount added: 0.07 mass% (in terms of Ca)

[0056] 3) Low-basic calcium sulfonate (alkyl benzene sulfonate having C_{14-24} alkyl groups, Ca: 2.4 mass%, S: 2.9 mass%, TBN: 17 mgKOH/g, degree of perbasic conversion: 0.34)

Amount added: 0.01 mass% (in terms of Ca)

[Zinc dithiophosphate]

[0057] Zinc di(secondary-alkyl) dithiophosphate (P: 7.2 mass%< Zn: 7.8 mass%, S: 14 mass%, produced derived from C_{3-8} secondary alcohol)

Amount added: 0.06 mass% (in terms of P)

[0058] Zinc di(primary alkyl) dithiophosphate (P: 7.3 mass%, Zn: 8.4 mass%, S: 14 mass%, produced derived from C_8 primary alcohol)

Amount added: 0.03 mass% (in terms of P)

[Antioxidant]

[0059] Dialkyl diphenyl amine (alkyl groups: mixture of C_4 and C_8, N: 4.6 mass) Amount added: 0.45 mass%

[Organic sulfur compound] (used in Example 2 only)

[0060] Sulfurized isobutylene (S: 42 mass%)
[0061] Amount added: 0.3 mass%

[Viscosity index-improving agent]

[0062] Polymethacrylate viscosity index-improving agent (SSI = 18, mass-average molecular weight: 200,000) - used in examples 1 and 2 and comparative example
[0063] Amount added: 5.1 mass% (example 1), 5.0 mass% (example 2), 5.1 mass%

(Comparative example)

[0064] Ethylene propylene copolymer viscosity index-improving agent (SSI = 24) - used in Reference example
[0065] Amount added: 4.6 mass%

[Pour point depressant]

[0066] Polymethacrylate pour point depressant: 0.3 mass%

[Other additives]

[0067] Combination of small amounts each of additives such as anti-wear agent, anti-rust agent, defoaming agent, and the like
[0068] Amount added: 0.6 mass%

Evaluation of lubricating oil composition

[0069]

(1) Viscosity properties of lubricating oil composition (high-temperature, high-shear viscosity, dynamic viscosity (at 100°C and 40°C), viscosity index, cranking viscosity (at -25°C or -30°C) and pumping temperature (at -35°C) were determined under the conditions described below.
(2) Moreover, the NOACK evaporation loss (%) at 250°C of the lubricating oil composition was determined by ASTM D5800, method B.
(3) Furthermore, the Shell four spheres test was conducted as a test to evaluate wear resistance. According to the Shell four spheres test, sample oil was heated to 75°C and tests were performed for 60 minutes under a load of 40 kgf at 1,200 rotations per minute. The diameter of the abrasion scar left on the surface of the test spheres was determined.

Table 1 shows the properties of each of the lubricating oil compositions and the results of the Shell four spheres test of examples 1 and 2, the comparative example, and the reference example.

Table 1

	Example 1	Example 2	Comparative Example	Reference Example
Viscosity grade	5W20	5W20	5W20	10W30
Base oil	Base oil 1	Base oil 1	Base oil 2	Base oil 3
High-temperature, high-shear viscosity	2.93	2.91	2.62	3.15

(continued)

	Example 1	Example 2	Comparative Example	Reference Example
Dynamic viscosity (100°C)	9.15	9.05	8.02	10.1
Dynamic viscosity (40°C)	44.1	43.7	36.3	65.7
Viscosity index	196	195	203	139
Cranking viscosity -25°C	-	-	-	5815
-30°C	3630	3590	2800	-
Pumping viscosity at -35°C	Passed	Passed	Passed	Passed*
NOACK evaporation loss (%)	9.7	9.8	14.0	11.5
Shell four spheres test Average abrasion diameter (mm)	0.47	0.47	0.54	0.48

[0070] Note: The high-temperature, high-shear viscosity is the viscosity at a shear speed of $10^6 s^{-1}$ and temperature of 150°C (units mPa·s). The dynamic viscosity units are mm^2/s and the cranking viscosity units are mPa·s. Moreover, a pumping viscosity that "passed" means that the pumping viscosity satisfied the regulation for pumping viscosity (at a determination temperature of -35°C) for SAE viscosity grade 5W20. However, the determination temperature was -30°C for pumping viscosity required by 10W30 and the "passed*" indicates that the determination passed the regulation for pumping viscosity at -30°C.

[0071] The following are clear from the properties and results of evaluating each lubricating oil composition of examples 1 and 2, the comparative example, and the reference example shown in Table 1.

(1) The lubricating oil composition of examples 1 and 2 is an excellent fuel-efficient SAE grade 5W20 lubricating oil composition, but has virtually the same wear resistance as the SAE grade 10W30 lubricating oil composition of the reference example, which is of relatively inferior fuel efficiency.

(2) On the other hand, the lubricating oil composition of the comparative example has a high NOACK evaporation loss, low high-temperature, high-shear viscosity, and inferior wear resistance.

Claims

1. A lubricating oil composition for automobile engine lubrication, which is a lubricating oil composition comprising a base oil having an SAE viscosity grade of 5W20, wherein the viscosity index is within a range of 140 to 230, the high-shear viscosity at 150°C is 2.9 mPa·s or higher, and the NOACK evaporation loss is 13% or less, further comprising:

a) a nitrogen-containing ash-free dispersant at 0.01 to 0.3 mass% in terms of the nitrogen content,
b) an alkaline earth metal-containing detergent at 0.08 to 0.4 mass% in terms of alkaline earth metal content,
c) a phosphorus-containing anti-wear agent at 0.05 to 0.12 wt% in terms of phosphorus content,
d) an antioxidant selected from the group consisting of amine compounds, phenol compounds, and molybdenum compounds at 0.1 to 7 mass%,
e) a viscosity index-improving agent at 0.5 to 20 mass%, and further wherein
the amount of each additive component is the mass% in terms of the total amount of lubricating oil composition.

2. The lubricating oil composition according to claim 1, wherein the dynamic viscosity at 100°C is within a range of 8.5 mm^2/s or greater, but less than 9.3 mm^2/s.

3. The lubricating oil composition according to claim 1, wherein the base oil comprises as a base oil component at least 80 mass% of a mineral oil base oil having a dynamic viscosity at 100°C that is within a range of 2 to 9 mm^2/s and a viscosity index of 133 to 160.

4. The lubricating oil composition according to claim 3, wherein the base oil is a mineral oil having a dynamic viscosity at 100°C that is within a range of 2 to 9 mm^2/s and a viscosity index of 133 to 160.

5. The lubricating oil composition according to claim 1, wherein the base oil is a base oil having a viscosity index of 133 to 160 that is obtained by hydrogenation and isomerization of either a slack wax or a synthetic wax produced by the Fischer-Tropsch method and then distillation and dewaxing treatment.

6. The lubricating oil composition according to claim 1, wherein the viscosity index-improving agent is a polymethacrylate polymer having a shear stability index of 30 or less.

7. The lubricating oil composition according to claim 1, which further comprises an organic sulfur compound as an additive component.

8. The lubricating oil composition according to claim 1, which is for lubrication of a motorcycle four-cycle gasoline engine.

9. The lubricating oil composition according to claim 1, which is for lubricating the engine of a diesel engine vehicle having an exhaust gas after-treatment device.

10. A method for lubricating a motorcycle four-cycle gasoline engine using the lubricating oil composition according to claim 1.

11. A method for lubricating an engine of a diesel engine vehicle having an exhaust gas after-treatment device using the lubricating oil composition according to claim 1.

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 15 7940

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2011/115265 A1 (IDEMITSU KOSAN CO [JP]; YAMADA RYOU [JP]) 22 September 2011 (2011-09-22) * examples 2,5 * & US 2013/029892 A1 (YAMADA RYOU [JP]) 31 January 2013 (2013-01-31) -----	1-11	INV. C10M171/02 ADD. C10N30/06 C10N40/25
A	US 5 863 873 A (BOVINGTON CHARLES HERBERT [GB]) 26 January 1999 (1999-01-26) * example 2 * -----	1-11	
X	US 2009/163393 A1 (BOFFA ALEXANDER B [US] ET AL) 25 June 2009 (2009-06-25) * example 5 * -----	1-11	
A	TAYLOR ET AL: "Improved fuel efficiency by lubricant design: A review", PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS, PART J.JOURNAL OF ENGINEERING TRIBOLOGY, MECHANICAL ENGINEERING PUBLICATIONS, BURY ST. EDMUNDS, GB, vol. 214, no. 1, 1 January 2000 (2000-01-01), pages 1-15, XP009169924, ISSN: 1350-6501 * figures 14-15 * -----	1-11	TECHNICAL FIELDS SEARCHED (IPC): C10M

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 May 2013	Bertrand, Samuel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 15 7940

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-05-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011115265 A1	22-09-2011	CN 102782107 A	14-11-2012
		JP 2011195734 A	06-10-2011
		TW 201144427 A	16-12-2011
		US 2013029892 A1	31-01-2013
		WO 2011115265 A1	22-09-2011
US 5863873 A	26-01-1999	CA 2286898 A1	15-10-1998
		DE 69805294 D1	13-06-2002
		DE 69805294 T2	21-11-2002
		EP 0973854 A1	26-01-2000
		US 5863873 A	26-01-1999
		US 5962381 A	05-10-1999
		WO 9845389 A1	15-10-1998
US 2009163393 A1	25-06-2009	CA 2647628 A1	21-06-2009
		EP 2077313 A2	08-07-2009
		JP 2009149891 A	09-07-2009
		SG 153769 A1	29-07-2009
		US 2009163393 A1	25-06-2009

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2012051849 A **[0001]**
- JP 6306384 A **[0006]**
- JP 2003505533 A **[0007]**
- JP 2000087070 A **[0008]**