

DESCRIPTION

LUBRICATING OIL COMPOSITION FOR TRUNK PISTON DIESEL ENGINE

5 Technical Field

[0001] The present invention relates to lubricating oil compositions for medium speed trunk piston diesel engines, and specifically relates to lubricating oil compositions for medium speed four-stroke trunk piston marine diesel engines.

10 Background Art

[0002] For diesel engines used for ships and power generation, heavy fuels (e.g. C heavy oil) including asphaltene components are used in view of economic efficiency. For a lubricating oil composition for such diesel engines, demanded are cleaning action to prevent fouling of the engines by the asphaltene components in heavy fuels, acid neutralizing property to neutralize the acid components derived from sulfur in heavy fuels, and water separation property for washing treatments with water by an oil purifying device. Further, low temperature fluidity of the lubricating oil is also important when ships travel waters of low water temperature. In addition, compared to high speed diesel engines, such as car diesel engines, medium speed four-stroke trunk piston marine diesel engines are operated at a lower speed of approximately 200 rpm to 1200 rpm, generally at a constant speed, and operated under the conditions of higher temperature and higher load. Thus, a lubricating oil having a high viscosity is commonly used as a lubricating oil for medium speed four-stroke trunk piston marine diesel engines, in order to secure a proper oil film thickness at lubricating faces of the cylinder liner, bearing, cam, etc..

[0003] In response to the recent trend of energy saving, reduction of fuel consumption is also demanded in marine diesel engines. For example, Patent Literature 1 points out that the wear of the top ring of the piston in a trunk piston diesel engine increases the fuel consumption, that is, when a severe wear of the piston ring occurs, the fuel gas leaks from the

gap between the worn piston ring and cylinder liner, which results in the increase in the fuel consumption. Patent Literature 1 says that the lubricating oil composition of Patent Literature 1 is effective to reduce the wear of the top ring of piston.

[0004] However, on a lubricating oil composition for medium speed four-stroke trunk piston marine diesel engines, there has not been any examination of active approaches for the reduction itself of the fuel consumption, not of passively inhibiting the fuel consumption by inhibiting the increase with time in the fuel consumption.

Citation List

10 Patent Literatures

[0005] Patent Literature 1: JP 2008-169228 A

SUMMARY OF INVENTION

Technical Problem

15 [0006] An object of the present invention is to provide a lubricating oil composition for a medium speed trunk piston diesel engine that can reduce the fuel consumption.

Solution to Problem

[0007] A first aspect of the present invention is a lubricating oil composition for a medium speed trunk piston diesel engine including:

20 (A) a lubricant base oil being one or more selected from the group consisting of: a mineral or synthetic oil having a kinematic viscosity at 100°C of no less than 3 mm²/s and less than 6 mm²/s, a mineral or synthetic oil having a kinematic viscosity at 100°C of no less than 6 mm²/s and less than 9 mm²/s, and a mineral or synthetic oil having a kinematic viscosity at 100°C of 9 to 12 mm²/s; and

(B) a metallic detergent being one or more calcium salicylate detergent optionally in combination with a calcium phenate detergent,

wherein the lubricating oil composition has a kinematic viscosity at 100°C of 7.0 to

11.0 mm²/s, and a base number determined by perchloric acid method of 7 to 55 mgKOH/g.

[0008] In the present invention, "medium speed trunk piston diesel engine" means a trunk piston diesel engine having a rated speed (rotational speed with maximum continuous output. It is also referred to as continuous maximum rotational speed or continuous rotational speed) of 200 rotations/min to 1250 rotations/m. The rated speed is typically 300 rotations/min to 1000 rotations/min.

[0009] In the first aspect of the present invention, it is preferable to have an embodiment wherein a total soap content of the (B) metallic detergent is no less than 4.0 mass% on the basis of total mass of the composition. In this embodiment, an embodiment wherein a mass ratio of a calcium carbonate content derived from the (B) metallic detergent to the total soap content (calcium carbonate content / total soap content) is no less than 0.1 is preferable. In this embodiment, an embodiment wherein the total soap content of the (B) metallic detergent is no less than 4.6 mass% on the basis of total mass of the composition is more preferable, and in this embodiment, an embodiment wherein the (B) metallic detergent includes the one or more calcium salicylate detergent only is especially preferable. In these embodiments, an embodiment wherein the (B) metallic detergent includes a neutral calcium salicylate detergent having a base number of no more than 70 mgKOH/g is preferably employed.

[0010] As a preferable embodiment of the first aspect of the present invention, an embodiment wherein the (B) metallic detergent includes a calcium salicylate having a C14 to C18 alkyl group and/or a calcium salicylate having a C20 to C30 alkyl group; and a mass ratio of a soap content of the calcium salicylate having the C20 to C30 alkyl group to a soap content of the total calcium salicylate is 0 to 0.95 may be given for example.

[0011] A second aspect of the present invention is a method for lubricating a medium speed trunk piston diesel engine including the step of: lubricating a medium speed trunk piston diesel engine by means of the lubricating oil composition for a medium speed trunk piston diesel engine according to the first aspect.

The method for lubricating a medium speed trunk piston diesel engine according to the second aspect normally includes supplying the lubricating oil composition according to

the first aspect to a medium speed trunk piston diesel engine.

Advantageous Effects of Invention

5 [0012] According to the lubricating oil composition for a medium speed trunk piston diesel engine according to the first aspect of the present invention, and the method for lubricating a medium speed trunk piston diesel engine according to the second aspect of the present invention, it is possible to reduce the fuel consumption of a medium speed trunk piston diesel engine.

10 DESCRIPTION OF EMBODIMENTS

[0013] Hereinafter, the present invention will be described in detail. It should be noted that, unless otherwise mentioned, "A to B" regarding numerical values A and B means "A or more and B or less". When the unit of the numerical value A is omitted, the unit given to the numerical value B is applied as the unit of the numerical value A. "or" means a logical sum
15 unless otherwise noted.

[0014] <(A) Lubricant base oil>

The lubricant base oil in the lubricating oil composition for a medium speed trunk piston diesel engine of the present invention is one or two or more selected from the group consisting of: a mineral or synthetic oil having a kinematic viscosity at 100°C of no less than
20 3 mm²/s and less than 6 mm²/s; a mineral or synthetic oil having a kinematic viscosity at 100°C of no less than 6 mm²/s and less than 9 mm²/s; and a mineral or synthetic oil having a kinematic viscosity at 100°C of 9 to 12 mm²/s.

[0015] As the mineral oil, mineral base oils used for normal lubricating oils may be used without particular limitations. Specifically, a product made by purifying a lubricating oil
25 fraction obtained by vacuum distillation of a residue of atmospheric distillation of a crude oil, by one or more treatments of solvent deasphalting, solvent extraction, hydrogenolysis, solvent dewaxing, hydrorefining, and the like; an wax-isomerized mineral oil; a lubricant base oil produced by a method of isomerizing a GTL WAX (Gas To Liquid wax) produced for

example by Fisher-Tropsh process, and the like may be given for example.

[0016] The total aromatic content of the mineral base oil is not particularly limited, and preferably no more than 40 mass%, and more preferably no more than 30 mass%. The total aromatic content may be 0 mass%. However, in view of the solubility of additives, the total aromatic content is preferably no less than 1 mass%, more preferably no less than 5 mass%, further preferably no less than 10 mass%, and especially preferably no less than 20 mass%. If the total aromatic content of the base oil is more than 40 mass%, the oxidation stability is inferior, which is not preferable. The above-described total aromatic content means the content of aromatic fraction measured in conformity with ASTM D2549. The aromatic fraction normally includes: alkyl benzene; alkyl naphthalene; anthracene, phenanthrene, and alkylating substances thereof; compounds in which four or more benzene rings are condensed; and compounds having a hetero aromatic group such as pyridines, quinolines, phenols, and naphthols.

[0017] Sulfur content in the mineral base oil is not particularly limited, and preferably no more than 1 mass%, and more preferably no more than 0.5 mass%. The sulfur content may be 0 mass%, but preferably no less than 0.1 mass%, and more preferably no less than 0.2 mass%. By using a mineral base oil containing a some extent of sulfur, it is possible to increase the solubility of additives.

[0018] As the synthetic oil, synthetic base oils used for normal lubricating oils may be used without particular limitations. Specifically, examples thereof include: polybutene and hydride thereof; poly α -olefines of 1-octene oligomer and 1-decene oligomer, etc., and hydrides thereof; diesters such as ditridecyl glutarate, di-2-ethylhexyl adipate, diisodecyl adipate, ditridecyl adipate, and di-2-ethylhexyl sebacate; polyol esters such as trimechylolpropane caprylate, trimethylolpropane pelargonate, pentaerythritol-2-ethylhexanoate, and pentaerythritol pelargonate; copolymers of dicarboxylic acids such as dibutyl maleate and a C2 to C30 α -olefin; aromatic-based synthetic oils such as alkylnaphthalene, alkylbenzene, and aromatic esters; and mixtures thereof.

[0019] Examples of the mineral or synthetic base oil having a kinematic viscosity at 100°C

of no less than 3 mm²/s and less than 6 mm²/s include mineral or synthetic base oils of SAE10. Examples of the mineral or synthetic oil having a kinematic viscosity at 100°C of no less than 6 mm²/s and less than 9 mm²/s include mineral or synthetic base oils of SAE20. Examples of the mineral or synthetic oil having a kinematic viscosity at 100°C of no less than 9 mm²/s and no more than 12 mm²/s include mineral or synthetic base oils of SAE30.

[0020] As a preferable embodiment of the lubricant base oil of the present invention, one or a mixture of two or more selected from the group consisting of the following (A-1) to (A-3) may be given for example.

(A-1) mineral base oil having a saturated component of no less than 90 mass%, sulfur content of no more than 0.03 mass% in terms of an element, and a kinematic viscosity of no less than 80

(A-2) mineral base oil having a saturated component of less than 90 mass%, sulfur content of more than 0.03 mass% in terms of an element, and a kinematic viscosity of no less than 80

(A-3) synthetic base oil

The saturated component in the present invention is measured by the method defined in ASTM D 2007-93.

[0021] The kinematic viscosity of the lubricant base oil is not particularly limited. However, in view of obtaining a good viscosity characteristic at a low temperature to a high temperature, the value of the kinematic viscosity is preferably no less than 80, more preferably no less than 85, and further preferably no less than 90. The upper limit of the kinematic viscosity is not particularly limited, and in view of solubility of additives and storage stability, preferably no more than 170, and more preferably no more than 160.

[0022] The evaporation loss of the lubricant base oil is not particularly limited, and in view of oil consumption, preferably no more than 20 mass%, more preferably no more than 16 mass%, and especially preferably no more than 10 mass%, as a NOACK evaporation loss (evaporation amount of lubricating oil measured in conformity with ASTM D 5800).

[0023] <(B) Metallic detergent>

The lubricating oil composition of the present invention includes at least a calcium

salicylate detergent as a metallic detergent. As the metallic detergent, one or more calcium salicylate detergent may be used alone, or one or more calcium salicylate detergent and calcium phenate detergent may be used in combination. Using one or more calcium salicylate detergent alone is preferable. It is preferable that the metallic detergent is overbased by calcium carbonate.

[0024] In the lubricating oil composition of the present invention, it is preferable that the total soap content of the metallic detergent is no less than 4.0 mass% on the basis of total mass of the composition. Here, the total soap content of the metallic detergent means the total mass of the metallic detergent in terms of neutral salt.

[0025] In the lubricating oil composition of the present invention, the mass ratio of the calcium carbonate content derived from the metallic detergent to the total soap content of the metallic detergent (calcium carbonate content / total soap content) is preferably no less than 0.1, and more preferably no less than 0.15, in view of more increasing the reduction effect of the fuel consumption. When this condition is satisfied, the total soap content of the metallic detergent is especially preferably no less than 4.6 mass% on the basis of total mass of the composition, in view of further increasing the reduction effect of the fuel consumption.

[0026] The calcium carbonate content derived from the metallic detergent is preferably no less than 0.5 mass% and more preferably no less than 0.8 mass%, on the basis of total mass of the composition. The upper limit is not particularly limited, and preferably no more than 4.5 mass%.

[0027] The lubricating oil composition of the present invention may preferably include a neutral calcium salicylate detergent having a base number determined by perchloric acid method of no more than 70 mgKOH/g, in view of easily making the total soap content of the metallic detergent no less than 4.0 mass%, preferably no less than 4.6 mass%.

[0028] The alkyl group in alkylsalicylic acid metal salt constituting the calcium salicylate detergent is a C10 to C40 alkyl group, preferably a C10 to C19 or C20 to C30 alkyl group, and further preferably a C14 to C18 or C20 to C26 alkyl group. In view of having a good low-temperature viscosity characteristic, the alkyl group is desirably a C14 to C18 alkyl group,

and in view of having a good soot-dispersing property, desirably a C20 to C30 alkyl group.

[0029] Examples of the C10 to C40 alkyl group include decyl group, undecyl group, dodecyl group, tridecyl group, tetradecyl group, pentadecyl group, hexadecyl group, heptadecyl group, octadecyl group, nonadecyl group, icosyl group, henicosyl group, docosyl group, tricosyl group, tetracosyl group, pentacosyl group, hexacosyl group, heptacosyl group, octacosyl group, nonacosyl group, and triacontyl group. The alkyl group may be linear or branched, and may be a primary alkyl group, secondary alkyl group, and tertiary alkyl group. In the present invention, a secondary alkyl group is especially preferable in view of easily obtaining the above desirable salicylic acid metal salt.

[0030] Examples of the metallic detergent in the lubricating oil composition of the present invention include a calcium salicylate detergent having a C14 to C18 short chain alkyl group, and a calcium salicylate detergent having a C20 to C30 long chain alkyl group. Either one of the calcium salicylate detergents may be used alone, and both of the calcium salicylate detergents may be used in combination. However, in view of increasing the low-temperature fluidity of the lubricating oil composition, the ratio (mass ratio) of the soap content of the calcium salicylate detergent having a C20 to C30 long chain alkyl group to the soap content of the total calcium salicylate is preferably no more than 0.95 and more preferably no more than 0.8.

[0031] The method for manufacturing the calcium salicylate detergent is not particularly limited, and a known method may be applied. For example, the calcium salicylate detergent may be manufactured by: manufacturing alkylsalicylic acid by a method of alkylating 1 mol of phenol by 1 mol or more of a C10 to C40 olefin such as a polymer or copolymer of ethylene, propylene, butane, etc., preferably a linear α -olefin of ethylene polymer and the like, and thereafter carboxylating the alkylated material by a carbonic acid gas and the like, or a method of alkylating 1 mol of salicylic acid by 1 mol or more of the above-described olefin, preferably the above-described linear α -olefin; and reacting the alkylsalicylic acid and a calcium base such as calcium oxide and calcium hydroxide, or once obtaining an alkali metal salt such as sodium salt and potassium salt, thereafter further substituting the alkali metal ion

with a calcium ion.

[0032] The calcium salicylate detergent includes basic salts obtained by a heating of the calcium salicylate (neutral salt) obtained as described above and excess of another calcium salt or calcium base (calcium oxide or calcium hydroxide), under the existence of water, and overbased salts obtained by the reaction of the above-described neutral salt and calcium hydroxide under the existence of carbonic acid gas.

[0033] As the metallic detergent in the lubricating oil composition of the present invention, the calcium salicylate detergent may be used alone, or may be used with another metallic detergent such as phenate detergent and sulfonate detergent. In view of the micelle stability in using with an overbased salicylate detergent, a phenate detergent is preferably used, and a calcium phenate detergent is especially preferably used.

[0034] As the calcium phenate detergent, for example a calcium salt of alkylphenol sulfide obtained by the reaction of sulfur and alkylphenol having at least one C4 to C30, preferably C10 to C18, linear or branched alkyl group, or a calcium salt which is a Mannich reaction product of alkylphenol obtained by the reaction of alkylphenol and formaldehyde is preferably used.

The base number of the phenate detergent is normally 0 to 500 mgKOH/g, preferably 20 to 450 mgKOH/g, and more preferably 150 to 300 mgKOH/g.

When a phenate detergent is used, the content thereof is not particularly limited, and normally 0.1 to 30 mass%, preferably 0.5 to 10 mass%, and especially preferably 1.0 to 3 mass%, on the basis of total mass of the composition.

[0035] When a calcium salicylate detergent and another metallic detergent (for example a calcium phenate detergent) are used in combination in the lubricating oil composition of the present invention, the mass ratio of the total soap content of the calcium salicylate detergent to the total soap content of the metallic detergent (calcium salicylate / total metallic detergent) is preferably no less than 0.6, more preferably no less than 0.7, and may be 1.0, by mass ratio.

[0036] <Other additives>

The lubricating oil composition of the present invention may further include, in

addition to the above-described lubricant base oil and metallic detergent, at least one selected from the group consisting of an ashless dispersant, wear inhibitor or extreme pressure agent, friction modifier, antioxidant, pour point depressant, viscosity index improver, metal deactivator, corrosion inhibitor, antirust agent, anti-emulsifier, and defoamer.

- 5 [0037] As the ashless dispersant, a known ashless dispersant used for lubricating oils may be used without particular limitations. Examples thereof include a nitrogen-containing compound having at least one C40 to C400 linear or branched alkyl group or alkenyl group in the molecular and a derivative thereof.

10 Examples of the nitrogen-containing compound include succinimide, benzylamine, polyamine, and Mannich base. Examples of the derivative thereof include derivatives produced by the action of a boron compound such as boric acid and borate salt, a phosphorus compound such as (thio)phosphoric acid and (thio)phosphoric acid salt, an organic acid, hydroxyl(poly)oxyalkylenecarbonate, or the like with the nitrogen-containing compound. In the present invention, one or two or more optionally selected from the above may be blended.

- 15 As the ashless dispersant, a mono type and/or bis type succinimide ashless dispersant, especially a bis type succinimide ashless dispersant may be preferably used, in view of having a high-temperature cleaning property. The succinimide ashless dispersant may include boron, or may not include boron. In view of the seizure resistance property, a succinimide ashless dispersant including boron is especially preferable.

- 20 When the lubricating oil composition of the present invention includes an ashless dispersant, the content thereof is not particularly limited, and for example it may be 0.1 to 5 mass% on the basis of total mass of the composition. In view of securing water separation property for washing treatments with water by an oil purifying device of the diesel engine, the content is preferably less than 3 mass% and more preferably less than 2 mass% on the basis of
25 total mass of the composition, and preferably less than 0.05 mass% and more preferably less than 0.03 mass% in terms of nitrogen amount. It is also possible to have a lubricating oil composition not including an ashless dispersant.

[0038] As the wear inhibitor or extreme pressure agent, a known wear inhibitor or extreme

pressure agent may be used without particular limitations. For example, sulfur-based, phosphorus-based, or sulfur-phosphorus based extreme pressure agent may be used. Specifically, zinc dithiophosphates, phosphorous esters, thiophosphorous esters, dithiophosphorous esters, trithiophosphorous esters, phosphoric esters, thiophosphoric esters, dithiophosphoric esters, trithiophosphoric esters, amine salts thereof, metal salts thereof, derivatives thereof, dithiocarbamates, disulfides, polysulfides, olefin sulfides, fat sulfides, and the like may be given for example. When these wear inhibitors or extreme pressure agents are contained in the lubricating oil composition of the present invention, the content thereof is normally 0.01 to 5 mass% on the basis of total mass of the composition.

[0039] As the friction modifier, a known friction modifier may be used without particular limitations. Examples thereof include ashless friction modifiers such as fatty acid ester-based, aliphatic amine-based, and fatty acid amide-based friction modifier, and metallic friction modifiers such as molybdenum dithiocarbamate and molybdenum dithiophosphate. When these friction modifiers are contained in the lubricating oil composition of the present invention, the content thereof is normally 0.01 to 5 mass% on the basis of total mass of the composition.

[0040] As the antioxidant, a known antioxidant may be used without particular limitations. Examples thereof include: phenol-based antioxidants such as 2,6-di-tert-butyl-4-methylphenol (DBPC) and 4,4'-methylenebis(2,6-di-tert-butylphenol); amine-based antioxidants such as alkyldiphenylamine and (alkyl)phenyl- α -naphthylamine; and metallic antioxidants. When an antioxidant is contained in the lubricating oil composition of the present invention, the content thereof is normally 0.1 to 5 mass% on the basis of total mass of the composition.

[0040] As the viscosity index improver, a known viscosity index improver may be used without particular limitations. Examples thereof include polymethacrylate-based viscosity index improvers, olefin copolymer-based viscosity index improvers, styrene-diene copolymer-based viscosity index improvers, styrene-maleic anhydride acid ester copolymer-based viscosity index improvers, and polyalkylstyrene-based viscosity index improvers. The weight average molecular weight of the viscosity index improver is

normally 800 to 1000000, and preferably 100000 to 900000. When a viscosity index improver is contained in the lubricating oil composition of the present invention, the content thereof is normally 0.1 to 20 mass% on the basis of total mass of the composition.

5 [0042] As the pour point depressant, a known pour point depressant such as polymethacrylate-based polymers may be used without particular limitations, depending on the characteristics of the lubricant base oil to be used. When a pour point depressant is contained in the lubricating oil composition of the present invention, the content thereof is normally 0.01 to 1 mass% on the basis of total mass of the composition.

10 [0043] As the corrosion inhibitor, a known corrosion inhibitor such as benzotriazole-based, tolyltriazole-based, thiadiazole-based, and imidazole-based compounds may be used without particular limitations. When these corrosion inhibitors are contained in the lubricating oil composition of the present invention, the content thereof is normally 0.005 to 5 mass% on the basis of total mass of the composition.

15 [0044] As the antirust agent, a known antirust agent such as petroleum sulfonate, alkylbenzene sulfonate, dinonylnaphthalene sulfonate, alkenylsuccinic acid ester, and polyhydric alcohol ester may be used without particular limitations. When these antirust agents are contained in the lubricating oil composition of the present invention, the content thereof is normally 0.005 to 5 mass% on the basis of total mass of the composition.

20 [0045] As the anti-emulsifier, a known anti-emulsifier for example a polyalkylene glycol-based non-ionic surfactant agent, such as polyoxyethylenealkylether, polyoxyethylenealkylphenylether, and polyoxyethylenealkylnaphthylether, may be used without particular limitations. When these anti-emulsifiers are contained in the lubricating oil composition of the present invention, the content thereof is normally 0.005 to 5 mass% on the basis of total mass of the composition.

25 [0046] As the metal deactivator, a known metal inactivator such as imidazoline, pyrimidine derivative, alkylthiadiazole, mercaptobenzothiazole, benzotriazole and derivative thereof, 1,3,4-thiadiazolepolysulfide, 1,3,4-thiadiazolyl-2,5-bisdialkyldithiocarbamate, 2-(alkyldithio)benzoimidazole, and β -(o-carboxybenzylthio)propionitrile may be used without

particular limitations. When these metal inactivators are contained in the lubricating oil composition of the present invention, the content thereof is normally 0.005 to 1 mass% on the basis of total mass of the composition.

[0047] As the defoamer, a known defoamer such as silicone, fluorosilicol, and fluoroalkylether may be used without particular limitations. When these defoamers are contained in the lubricating oil composition of the present invention, the content thereof is normally 0.0005 to 1 mass% on the basis of total mass of the composition.

[0048] <Lubricating oil composition>

The kinematic viscosity at 100°C of the lubricating oil composition of the present invention is 7.0 to 11.0 mm²/s, preferably no less than 8.0 mm²/s, and preferably no more than 10.5 mm²/s. If the kinematic viscosity of the composition is less than the above-described lower limit, it gets difficult to secure the oil film thickness and oil pressure required for the reliability of the medium speed diesel engine. If the kinematic viscosity of the composition is more than the above-described upper limit, it gets difficult to provide the reduction effect of the fuel consumption. It is noted that the kinematic viscosity at 100°C mentioned here means the kinematic viscosity at 100°C defined in ASTM D-445.

[0049] The base number of the lubricating oil composition of the present invention needs to be no less than 7 mgKOH/g, preferably no less than 9 mgKOH/g, and more preferably no less than 10 mgKOH/g, in order to provide a good high-temperature cleaning property and acid neutralizing performance even when a high-sulfur fuel containing asphaltene is used. In addition, in order to prevent bore polishing and scuffing of the liner due to the accumulation of excess ash on the piston top land, the base number needs to be no more than 55 mgKOH/g, and preferably no more than 50 mgKOH/g.

The base number mentioned here means the base number determined by perchloric acid method measured by ASTM D-2896.

[0050] The sulfated ash content of the lubricating oil composition of the present invention is not particularly limited, and preferably no less than 0.9 mass%, more preferably no less than 1.2 mass%, and preferably no more than 7.0 mass%, and more preferably no more than 6.5

mass%. The sulfated ash content mentioned here is the value measured by the method defined in 5. "Determination of sulfated acid" of JIS K2272, and is mainly from metal-containing additives.

[0051] Because a medium speed trunk piston marine diesel engine normally has a device to
5 heat the lubricating oil, the pour point of the lubricating oil composition of the present invention may be more than 0°C. The pour point is preferably no more than 5°C, more preferably no more than 0°C, and especially preferably no more than -10°C.

Examples

10 [0052] Hereinafter the present invention will be further specifically described based on Examples and Comparative Examples. It is noted that the present invention is not limited to these Examples.

[0053] <Examples 1 to 12 and Comparative Example 1>

As shown in Table 1, lubricating oil compositions of the present invention (Examples
15 1 to 12) and a lubricating oil composition for comparison (Comparative Example 1) were each prepared. In the table, "inmass%" means mass% on the basis of total mass of the base oil, and "mass%" means mass% on the basis of total mass of the composition.

[0054]

[Table 1]

		Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Comp. Ex. 1
Base oil														
Base oil 1 (*1)	inmass%	-	-	-	-	-	-	-	35	-	-	-	-	-
Base oil 2 (*2)	inmass%	55	51	52	67	58	60	70	50	55	40	40	50	45
Base oil 3 (*3)	inmass%	45	49	48	33	42	40	30	15	45	60	60	50	45
Base oil 4 (*4)	inmass%	-	-	-	-	-	-	-	-	-	-	-	-	10
Additive														
Metallic detergent A (*5)	mass%	2.5	-	-	-	-	-	-	-	-	2.5	-	-	-
Metallic detergent B (*6)	mass%	7	5.5	-	3	1	-	-	-	-	8	8	-	-
Metallic detergent C (*7)	mass%	-	-	5.5	-	-	-	-	-	-	-	2.5	-	7.5
Metallic detergent D (*8)	mass%	-	5	-	-	7	-	-	-	-	-	-	-	-
Metallic detergent E (*9)	mass%	-	-	-	3.5	-	-	4.5	-	8	-	-	9	3.5
Metallic detergent F (*10)	mass%	4	-	7	6	6	6.5	10	34	7	-	-	-	-
Antioxidant (*11)	mass%	1	1	1	1	1	1	1	1	1	1	1	1	1
Abrasion inhibitor (*12)	mass%	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
Ashless dispersant (*13)	mass%	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Kinematic viscosity (100°C)	mm ² /s	10.1	10.3	10.2	10.1	10.0	10.3	10.1	10.2	10.4	10.2	10.2	10.1	12.0
Base number (perchloric acid method)	mgKOH/g	20.2	20.9	19.6	19.9	20.4	20.0	20.4	20.4	29.8	20.0	20.6	20.7	20.8
Total soap content	mass%	5.1	4.0	4.2	4.9	5.7	5.5	5.9	14.6	5.8	3.8	3.8	3.5	4.2
Ca salicylate (C14-18) soap content	mass%	2.7	2.1	1.2	1.1	0.4	0.0	0.0	0.0	0.0	3.8	3.6	0.0	2.9
Ca salicylate (C20-30) soap content	mass%	1.7	2.0	3.0	3.8	5.3	5.5	5.9	14.6	5.8	0.0	0.0	3.5	1.4
CaCO ₃ content	mass%	1.3	0.8	1.3	1.2	1.3	1.2	1.2	0.3	2.0	1.3	1.4	1.5	1.4
CaCO ₃ content / soap content	mass%/mass%	0.25	0.20	0.30	0.25	0.23	0.22	0.20	0.02	0.35	0.4	0.4	0.4	0.4
Ca salicylate soap content ratio (C20-30)/[(C20-30)+(C14-18)]	mass%/mass%	0.39	0.48	0.71	0.77	0.93	1.00	1.00	1.00	1.00	0.00	0.00	1.00	0.32
Engine test fuel consumption	g/kWh	224.9	226.1	226.0	224.3	224.4	224.2	223.4	225.5	223.8	226.7	226.7	226.6	227.0
Reduction rate of fuel consumption	%	0.9	0.4	0.4	1.2	1.1	1.2	1.6	0.6	1.4	0.1	0.1	0.2	0.0
Pour point	°C	-27.5	-25.0	-17.5	-15.0	-10.0	0.0	-2.5	-2.5	0.0	-35.0	-35.0	0.0	-30.0

*1) Base oil 1: mineral base oil, 40°C kinematic viscosity 18.9mm²/s, 100°C kinematic viscosity 4.3mm²/s, viscosity index 125, sulfur <0.03%

*2) Base oil 2: mineral base oil, 40°C kinematic viscosity 54.9mm²/s, 100°C kinematic viscosity 7.4mm²/s, viscosity index 95, sulfur 0.66%

*3) Base oil 3: mineral base oil, 40°C kinematic viscosity 95.0mm²/s, 100°C kinematic viscosity 11.0mm²/s, viscosity index 97, sulfur 0.58%

*4) Base oil 4: mineral base oil, 40°C kinematic viscosity 476.1mm²/s, 100°C kinematic viscosity 31.4mm²/s, viscosity index 96, sulfur 0.44%

*5) Metallic detergent A: Ca phenate, base number 255mgKOH/g, soap content 30mass%, calcium carbonate content 20mass%

*6) Metallic detergent B: Ca alkylsalicylate, C14-18 alkyl group derived from C14-18 olefin, base number 170mgKOH/g, soap content 38mass%, calcium carbonate content 11mass%

*7) Metallic detergent C: Ca alkylsalicylate, C14-18 alkyl group derived from C14-18 olefin, base number 280mgKOH/g, soap content 23mass%, calcium carbonate content 22mass%

*8) Metallic detergent D: Ca alkylsalicylate, C20-30 alkyl group derived from C20-30 olefin, base number 230mgKOH/g, soap content 39mass%, calcium carbonate content 17mass%

*9) Metallic detergent E: Ca alkylsalicylate, C20-30 alkyl group derived from C20-30 olefin, base number 320mgKOH/g, soap content 35mass%, calcium carbonate content 25mass%

*10) Metallic detergent F: Ca alkylsalicylate, C20-30 alkyl group derived from C20-30 olefin, base number 60mgKOH/g, soap content 43mass%, calcium carbonate content 0.8mass%

*11) Antioxidant: amine-based antioxidant

*12) Abrasion inhibitor: zinc diethyldithiophosphate

*13) Ashless dispersant: polybutenyl succinimide

[0055] (Evaluation of fuel consumption reduction performance)

On each of the lubricating oil compositions of Examples 1 to 12 and Comparative Example 1, the fuel consumption when the composition was used as an engine oil of a medium speed four-stroke trunk piston marine diesel engine was measured. As the medium speed four-stroke trunk piston marine diesel engine, WD300 manufactured by Ricardo PLC (bore 135 mm × stroke 152 mm, single cylinder, mean effective pressure 2.5 MPa, rated speed 1200 rpm) was used, and as a fuel, a Grade 1 diesel defined in JIS K2204 (sulfur content: less than 0.0010 mass%) was used. The engine was operated at a constant speed for one hour under the conditions of 1200 rpm of engine speed and 54 kW of load. The fuel consumption during the operation was converted to a value per unit output (g/kWh). The results are shown in Table 1.

[0056] As is seen from Table 1, the lubricating oil compositions of Example 1 to 12 were able to reduce the fuel consumption compared to the lubricating oil composition of Comparative Example 1 having a kinematic viscosity at 100°C of more than 11 mm²/s. Specifically, each of the compositions of Examples 1 to 9 having a total soap content of metallic detergent of no less than 4.0 mass% was able to reduce the fuel consumption by no less than 0.4 %. Further, each of the lubricating oil compositions of Example 1, 4 to 7 and 9, having a total soap content of metallic detergent of no less than 4.6 mass% on the basis of total mass of the composition, and having a mass ratio of the calcium carbonate derived from the metallic detergent to the total soap content of the metallic detergent (calcium carbonate content / total soap content) of no less than 0.1, was able to reduce the fuel consumption by no less than 0.9 %. Among them, each of the lubricating oil compositions of Examples 4 to 7 and 9 including one or more calcium salicylate detergent alone as a metallic detergent was able to reduce the fuel consumption by no less than 1.1 %.

[0057] From the above results, it was shown that it was possible to reduce the fuel consumption of a medium speed trunk piston diesel engine, according to the lubricating oil composition of the present invention.

Industrial applicability

- [0058] The lubricating oil composition for a medium speed trunk piston diesel engine of the present invention and the method for lubricating a medium speed trunk piston diesel engine using the composition may be employed preferably for lubrication of marine main engines, marine generators, and medium speed trunk piston diesel engines for overland private power generators, and especially preferably for lubrication of medium speed trunk piston marine diesel engines.
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CLAIMS

1. A lubricating oil composition for a medium speed trunk piston diesel engine comprising:

5 (A) a lubricant base oil being one or more selected from the group consisting of: a mineral or synthetic oil having a kinematic viscosity at 100°C of no less than 3 mm²/s and less than 6 mm²/s, a mineral or synthetic oil having a kinematic viscosity at 100°C of no less than 6 mm²/s and less than 9 mm²/s, and a mineral or synthetic oil having a kinematic viscosity at 100°C of 9 to 12 mm²/s; and

10 (B) a metallic detergent being one or more calcium salicylate detergent optionally in combination with a calcium phenate detergent,

wherein the lubricating oil composition has a kinematic viscosity at 100°C of 7.0 to 11.0 mm²/s, and a base number determined by perchloric acid method of 7 to 55 mgKOH/g.

15 2. The lubricating oil composition for a medium speed trunk piston diesel engine according to claim 1,

wherein a total soap content of the (B) metallic detergent is no less than 4.0 mass% on the basis of total mass of the composition.

20 3. The lubricating oil composition for a medium speed trunk piston diesel engine according to claim 2,

wherein a mass ratio of a calcium carbonate content derived from the (B) metallic detergent to the total soap content (calcium carbonate content / total soap content) is no less than 0.1.

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4. The lubricating oil composition for a medium speed trunk piston diesel engine according to claim 3,

wherein the total soap content of the (B) metallic detergent is no less than 4.6 mass%

on the basis of total mass of the composition.

5. The lubricating oil composition for a medium speed trunk piston diesel engine according to claim 4,

5 wherein the (B) metallic detergent comprises the one or more calcium salicylate detergent only.

6. The lubricating oil composition for a medium speed trunk piston diesel engine according to any one of claims 2 to 5,

10 wherein the (B) metallic detergent comprises a neutral calcium salicylate detergent having a base number of no more than 70 mgKOH/g.

7. The lubricating oil composition for a medium speed trunk piston diesel engine according to any one of claims 1 to 6,

15 wherein the (B) metallic detergent comprises a calcium salicylate having a C14 to C18 alkyl group and/or a calcium salicylate having a C20 to C30 alkyl group; and
a mass ratio of a soap content of the calcium salicylate having the C20 to C30 alkyl group to a soap content of the total calcium salicylate is 0 to 0.95.

20 8. A method for lubricating a medium speed trunk piston diesel engine comprising the step of:

lubricating a medium speed trunk piston diesel engine by means of the lubricating oil composition for a medium speed trunk piston diesel engine according to any one of claims 1 to 7.

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