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(54) **Lubricating composition**

(57) The present invention provides a lubricating composition comprising:

- a base oil;
- a molybdenum-containing compound; and
- a fatty acid amide;

wherein the lubricating composition comprises less than

50ppm of zinc.

Furthermore, the present invention provides the use of the lubricating composition, in particular in a gas engine, in order to improve friction reduction properties (in particular according to the SRV test of DIN 51834-1).

EP 2 441 818 A1

Description

[0001] The present invention relates to a lubricating composition, in particular for use as a gas engine oil.

[0002] In recent years the specifications for finished lubricants have required the lubricant formulators to develop lubricants having, among others, improved friction reducing properties with the purpose of meeting energy saving (or "fuel economy") trends.

[0003] As an example, US 2007/0265176 discloses to this end the use of a lubricating oil composition comprising a major amount of a base oil having a viscosity index greater than 80, a kinematic viscosity at 100°C of from 2 to 50 mm²/s, containing 90 wt. % or more saturates, having less than 5 ppm sulphur and wherein the base oil is derived from a waxy feed, and a minor amount of: (a) a polyol ester of an aliphatic carboxylic acid having 12 to 24 carbon atoms; and (b) an oil soluble or oil dispersible molybdenum compound.

[0004] Furthermore, US 2008/0015127 discloses the use of a lubricating composition comprising a base oil, a friction modifier and a dispersant wherein the lubricating composition comprises less than 325 ppm boron.

[0005] US 6 562 765 discloses an engine oil comprising a base oil and at least 450 ppm molybdenum of a friction modifier composition containing a specific oxymolybdenum complex and a specific molybdenum dithiocarbamate.

[0006] It is an object of the present invention to improve the friction reduction properties of lubricating compositions, especially for use in a gas engine.

[0007] It is another object of the present invention to provide alternative lubricating compositions for use in a gas engine.

[0008] Since zinc-containing additives can negatively impact some exhaust gases treatment equipment, it is another object of the present invention to provide zinc-free lubricating compositions, having improved friction reduction properties, especially for use in a gas engine. One or more of the above or other objects can be obtained by the present invention by providing a lubricating composition comprising:

- a base oil;
- a molybdenum-containing compound; and
- a fatty acid amide;

wherein the lubricating composition comprises less than 50 ppm zinc.

[0009] It has now surprisingly been found according to the present invention that the lubricating compositions according to the present invention may exhibit improved friction reduction properties.

[0010] There are no particular limitations regarding the base oil used in lubricating composition according to the present invention, and various conventional mineral oils, synthetic oils as well as naturally derived esters such as vegetable oils may be conveniently used.

[0011] The base oil used in the present invention may conveniently comprise mixtures of one or more mineral oils and/or one or more synthetic oils; thus, according to the present invention, the term "base oil" may refer to a mixture containing more than one base oil type. Mineral oils include liquid petroleum oils and solvent-treated, or acid-treated mineral lubricating oil of the paraffinic, naphthenic, or mixed paraffinic/naphthenic type which may be further refined by hydrofinishing processes and/or dewaxing.

[0012] Suitable base oils for use in the lubricating oil composition of the present invention are Group I-III mineral base oils, Group IV poly-alpha olefins (PAOs), Group I-III Fischer-Tropsch derived base oils and mixtures thereof.

[0013] By "Group I", "Group II", "Group III" and "Group IV" base oils in the present invention are meant lubricating oil base oils according to the definitions of American Petroleum Institute (API) for category III and IV. These API categories are defined in API Publication 1509, 15th Edition, Appendix E, April 2002.

[0014] Fischer-Tropsch derived base oils are known in the art. By the term "Fischer-Tropsch derived" is meant that a base oil is, or is derived from, a synthesis product of a Fischer-Tropsch process. A Fischer-Tropsch derived base oil may also be referred to as a GTL (Gas-To-Liquids) base oil. Suitable Fischer-Tropsch derived base oils that may be conveniently used as the base oil in the lubricating composition of the present invention are those as for example disclosed in EP 0 776 959, EP 0 668 342, WO 97/21788, WO 00/15736, WO 00/14188, WO 00/14187, WO 00/14183, WO 00/14179, WO 00/08115, WO 99/41332, EP 1 029 029, WO 01/18156 and WO 01/57166.

[0015] Synthetic oils include hydrocarbon oils such as olefin oligomers (including polyalphaolefin base oils; PAOs), dibasic acid esters, polyol esters, polyalkylene glycols (PAGs), alkyl naphthalenes and dewaxed waxy isomerates. Synthetic hydrocarbon base oils sold by the Shell Group under the designation "Shell XHVI" (trade mark) may be conveniently used.

[0016] Poly-alpha olefin base oils (PAOs) and their manufacture are well known in the art. Preferred poly-alpha olefin base oils that may be used in the lubricating compositions of the present invention may be derived from linear C₂ to C₃₂, preferably C₆ to C₁₆, alpha olefins. Particularly preferred feedstocks for said poly-alpha olefins are 1-octene, 1-decene, 1-dodecene and 1-tetradecene.

[0017] The total amount of base oil incorporated in the lubricating composition of the present invention is preferably

present in an amount in the range of from 60 to 99 wt.%, more preferably in an amount in the range of from 65 to 98 wt.% and most preferably in an amount in the range of from 70 to 95 wt.%, with respect to the total weight of the lubricating composition.

[0018] There are no particular limitations regarding the molybdenum-containing compound used in lubricating composition according to the present invention and various conventional molybdenum-containing compounds may be conveniently used.

[0019] Preferably, the molybdenum-containing compound is a sulphur-containing molybdenum-containing compound such as a compound selected from the group consisting of a molybdenum dithiocarbamate (MoDTC), molybdenum dithiophosphate, molybdenum dithiophosphinate, molybdenum xanthate, molybdenum thioxanthate, molybdenum sulfide and mixtures thereof. The molybdenum-containing compound may also be a di- or trinuclear molybdenum compound. Most preferably, the molybdenum compound is a molybdenum dithiocarbamate compound. Preferably the lubricating composition according to the present invention comprises at least 0.40 wt.%, more preferably at least 0.45 wt.%, even more preferably at least 0.50 wt.% of the molybdenum-containing compound, based on the total weight of the lubricating composition. Typically, the lubricating composition comprises at most 1.5 wt.%, more typically at most 1.0 wt.%, of the molybdenum-containing compound, based on the total weight of the lubricating composition.

[0020] There are no particular limitations regarding the fatty acid amide as used in lubricating composition according to the present invention and various conventional saturated or unsaturated fatty acid amides such as oleamide, stearamide, behenamide, docosamide, erucamide may be conveniently used. Preferably the fatty acid amide contains from 12 to 26 carbon atoms, more preferably from 16 to 24 carbon atoms, most preferably from 18 to 22 carbon atoms. Especially preferred are the unsaturated fatty acid amides, preferably containing 18 to 22 carbon atoms such as oleamide (C₁₈), arachidonamide (C₂₀) and erucamide (C₂₂). It is even more preferred that the fatty acid amides are monounsaturated fatty acid amides, preferably containing 18 to 22 carbon atoms such as oleamide and erucamide.

[0021] The amount of the fatty acid amide in the compositions of the invention is typically from 0.01 wt.% to 2.0 wt.%, preferably from 0.05 wt.% to 1.5 wt.% and more preferably from 0.1 to 1.0 wt.%, based on the total weight of the lubricating composition.

[0022] According to a preferred embodiment according to the present invention, the lubricating composition further comprises a polyol ester. There are no particular limitations regarding the polyol esters as used in lubricating composition according to the present invention and various conventional polyol esters may be conveniently used.

[0023] Preferably, the polyol ester according to the present invention is a polyol ester of an aliphatic carboxylic acid having 12 to 24 carbon atoms, more preferably 14 to 20 carbon atoms, most preferably 16 to 18 carbon atoms. The polyol moiety of the polyol ester may include polyols such as diols, triols and the like such as ethylene glycol, propylene glycol, glycerol, sorbitol, etc.

[0024] Examples of the carboxylic acid moiety of the polyol ester include octadecanoic acid, oleic acid, hexadecanoic acid, dodecanoic acid, tetradecanoic acid and iso-forms thereof (i.e. having branched carbon chains). Preferably the carboxylic acid moiety of the polyol ester is a fatty acid.

[0025] The polyol esters used in the present invention may be mixtures of mono-, di- and tri-esters, but preferably are predominantly the monoesters.

[0026] It is even more preferred that the polyol ester is a polyol monoester of an iso-fatty acid (i.e. a branched fatty acid) such as glycerol mono-isostearate, which is commercially readily available. Other polyol esters such as the oleic acid monoester of glycerol may be conveniently used as well.

[0027] The amount of the polyol ester in the compositions of the invention is typically from 0.01 wt.% to 2.0 wt.%, preferably from 0.2 wt.% to 1.2 wt.% and more preferably from 0.4 to 0.8 wt.%, based on the total weight of the lubricant composition.

[0028] The lubricating composition according to the present invention may further comprise one or more other additives such as anti-oxidants, anti-wear additives, dispersants, detergents, overbased detergents, extreme pressure additives, other friction modifiers, viscosity modifiers, pour point depressants, metal passivators, corrosion inhibitors, demulsifiers, anti-foam agents, seal compatibility agents and additive diluent base oils, etc.

[0029] Since zinc containing additives can negatively impact some exhaust gases treatment equipment, the additives used in the present invention are essentially zinc-free, i.e. the lubricating composition of the present invention comprises less than 50 ppm of zinc, preferably less than 40 ppm of zinc, more preferably less than 30 ppm of zinc. In a particularly preferred embodiment, the additives used in the present invention are zinc-free.

[0030] As the person skilled in the art is familiar with the above and other additives, these are not further discussed here in detail. Specific examples of such additives are described in for example Kirk-Othmer Encyclopedia of Chemical Technology, third edition, volume 14, pages 477-526.

[0031] The lubricating compositions of the present invention may be conveniently prepared by admixing the one or more additives with the base oil(s).

[0032] The above-mentioned additives are typically present in an amount in the range of from 0.01 to 35.0 wt.%, based on the total weight of the lubricating composition, preferably in an amount in the range of from 0.05 to 25.0 wt.%, more

preferably from 1.0 to 20.0 wt.%, based on the total weight of the lubricating composition.

[0033] According to a preferred embodiment of the present invention, the lubricating composition has a sulphated ash content (according to ASTM D 874) of at most 1.2 wt.%, preferably at most 0.90 wt%, more preferably at most 0.50 wt.%.

[0034] Further it is preferred that the composition has a total base number (TBN) value (according to ASTM D 2896) of between 4.0 and 12.0 mg KOH/g.

[0035] Moreover, the lubricating composition according to the present invention preferably has a calcium content (according to ASTM D 4951) of at most 0.25 wt.%.

[0036] Typically, the kinematic viscosity 100°C (according to ASTM D 445) of the composition according to the present invention is between 9.3 and 26.1 cSt, preferably above 9.3 and below 16.3 cSt.

[0037] In another aspect, the present invention provides the use of a lubricating composition according to the present invention, in particular in a gas engine, in order to improve the friction reduction properties (in particular according to the SRV test of DIN 51834-1).

[0038] The lubricating compositions according to the present invention are useful for lubricating apparatus generally, but in particular for use as engine oils for internal combustion engines. These engine oils include passenger car engines, diesel engines, marine diesel engines, gas engines, two- and four-cycle engines, etc., and in particular gas engines.

[0039] The present invention is described below with reference to the following Examples, which are not intended to limit the scope of the present invention in any way.

Examples

Lubricating Oil Compositions

[0040] Various lubricating compositions for use in a gas engine were formulated.

[0041] Table 1 indicates the composition and properties of the fully formulated gas engine oil formulations that were tested; the amounts of the components are given in wt.%, based on the total weight of the fully formulated formulations.

[0042] All tested gas engine oil formulations were formulated as SAE 40 formulations meeting the so-called SAE J300 Specifications (as revised in May 2004; SAE stands for Society of Automotive Engineers).

[0043] All the tested gas engine oil formulations contained a combination of a base oil, an additive package and - if present - a total amount of 1.5 wt.% of one or more friction modifiers, based on the total weight of the composition.

[0044] The additive packages contained a combination of additives including anti-oxidants, zinc-based or zinc-free anti-wear additives, an ashless dispersant, overbased and ashless detergents, a pour point depressant, a corrosion inhibitor and a metal passivator.

[0045] "Additive package 1", "Additive package 2", "Additive package 3" and "Additive package 4" were so-called Low Ash additive packages, i.e. resulting in a total Sulfated Ash content of 0.50 wt.%; "Additive package 1" provided a TBN of about 4.5 mg KOH/g (according to ASTM D 2896); "Additive package 2" provided a TBN of about 9.0 mg KOH/g; "Additive package 4" provided a TBN of about 7.4 mg KOH/g.

[0046] "Additive package 3" was the same as "Additive package 2" except that "Additive Package 3" didn't contain a zinc component.

[0047] "Additive package 4" was the same as "Additive package 2" except that it didn't contain a zinc component and had an exchanged detergent additive.

[0048] "Base oil 1" was a commercially available Group II base oil having a kinematic viscosity at 100°C (ASTM D445) of approx. 12.4 cSt (mm²s⁻¹). Base oil 1 is commercially available from e.g. Chevron Products Company (San Ramon, CA, United States) (under the trade designation "Chevron 600 R").

[0049] "Friction modifier 1" (hereafter "FM 1") was a molybdenum-containing dithiocarbamate compound. FM 1 is commercially available from e.g. Infineum International Ltd (Abingdon, United Kingdom) under the trade designation "Infineum C9455".

[0050] "Friction modifier 2" (hereafter "FM 2") was a polyol ester, more specifically a glycerol mono-isostearate (i.e. a glycerol monoester of an iso-fatty acid). FM 2 is commercially available from e.g. Croda International Plc (Snaith, United Kingdom) under the trade designation "Prisorine 2040".

[0051] "Friction modifier 3" (hereafter "FM 3") was a fatty acid amide, more specifically an oleamide. FM 3 is commercially available from e.g. Croda Oleochemicals (Hull, United Kingdom) under the trade designation "Crodamide O".

[0052] The compositions of Examples 1-9 were obtained by mixing the base oils with the additive package and friction modifier(s) using conventional lubricant blending procedures.

Component [wt. %]	Example 1*	Example 2*	Example 3*	Example 4 *	Example 5*	Example 6*	Example 7*	Example 8	Example 9
Base oil 1 (Group II)	91.00	89.50	89.5	89.5	91.00	89.5	89.50	89.8	89.8
Additive package 1	9.00	9.00	9.00	9.00	-	-	-	-	-
Additive package 2	-	-	-	-	9.00	9.00	9.00	-	-
Additive package 3 (zinc-free)	-	-	-	-	-	-	-	8.7	-
Additive package 4 (zinc-free)	-	-	-	-	-	-	-	-	8.7
FM 1 (Mo-compound)	-	0.75	0.75	0.60	-	0.75	1.5	0.75	0.75
FM 2 (polyol ester; i.e. glycerol mono-isostearate)	(polyol -	0.75	-	0.60	-	0.375	-	0.375	0.375
FM 3 (Fatty acid amide; i.e. oleamide)	-	-	0.75	0.3	-	0.375	-	0.375	0.375
TOTAL	100	100	100	100	100	100	100	(100	100
*Comparative Example									

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Table 1 (continued)

Properties of the formulated lubricating composition									
Component [wt. %]	Example 1*	Example 2*	Example 3*	Example 4*	Example 5*	Example 6*	Example 7*	Example 8	Example 9
Sulfated ash content ¹ [wt. %]	0.49	0.50	0.50	0.50	0.48	0.48	0.47	0.47 1	0.47
TBN value ² [mg KOH/g]	4.56	4.56	4.58	4.56	9.30	9.32	9.51	9.51	7.40
Kinematic viscosity at 100°C ³ [cSt]	13.71	13.46	13.29	13.55	13.53	13.66	13.98	13.78	13.67
Kinematic viscosity at 40°C ³ [cSt]	128.00	125.20	124.20	126.70	126.70	128.20	132.80	131.00	127.40
Ca content ⁴ [wt. %]	0.14	0.14	0.14	0.14	0.13	0.13	0.13	0.13	0.13
Zn content ⁴ [wt. %]	0.03	0.03	0.03	0.04	0.03	0.03	0.03	<0.005	<0.005
*Comparative Example ¹ According to ASTM D 874 ² According to ASTM D 2896 ³ According to ASTM D 445 ⁴ According to ASTM D 4951									

Friction Reduction Properties

[0053] In order to demonstrate the friction reduction properties of the present invention, measurements were performed according to the SRV-test of DIN 51834-1, whilst following the ASTM D 6425 prescriptions with respect to test machine and materials. In the test, the following test conditions were used:

- Load: 50 N
- Temperature: 150°C
- Reciprocating Frequency: 50 Hz
- Stroke length: 1 mm
- Time: 90 minutes.

[0054] The measured friction reduction properties are indicated in Table 2 below. The "normalised friction coefficient" refers to the relative value when compared to the value of Comparative Example 1; the lower this normalised friction coefficient is, the more friction reduction occurs.

Table 2[illegible]

Discussion

[0055] As can be learned from Table 2, the friction reduction values for the compositions according to the present invention (Examples 8 and 9) were significantly improved when compared with Comparative Examples 1 and 5 (containing no friction modifier) and Comparative Examples 2 and 7 (containing the same total amount of friction modifier as Examples 8 and 9, i.e. a total of 1.5 wt% of friction modifier, but containing no fatty acid amide such as an oleamide). This is a clear indication of desirable friction reduction properties for the compositions according to the present invention.

[0056] In addition, the compositions according to the present invention (Examples 8 and 9) have the advantage that they contain less than 0.005 wt% of zinc.

Claims

1. A lubricating composition comprising:

- a base oil;
- a molybdenum-containing compound; and
- a fatty acid amide;

wherein the lubricating composition comprises less than 50 ppm of zinc.

2. Lubricating composition according to Claim 1 wherein the lubricating composition comprises less than 40 ppm of zinc.

3. Lubricating composition according to Claim 1 or 2
wherein the lubricating composition comprises less than 30 ppm of zinc.

4. Lubricating composition according to any of Claims 1 to 3 wherein the lubricating composition is free of zinc.

5. Lubricating composition according to any of claims 1 to 4, wherein the molybdenum-containing compound is a sulphur-containing molybdenum-containing compound.

6. Lubricating composition according to claim 5, wherein the molybdenum-containing compound is a dithiocarbamate compound.

7. Lubricating composition according to any of claims 1 to 6 wherein the composition comprises at least 0.40 wt.%, more preferably at least 0.45 wt.%, even more preferably at least 0.50 wt. % of the molybdenum-containing compound.

8. Lubricating composition according to any of claims 1 to 7, wherein the fatty acid amide contains from 12 to 26 carbon atoms, preferably from 16 to 24 carbon atoms, more preferably from 18 to 22 carbon atoms.

9. Lubricating composition according to any of claims 1 to 8, further comprising a polyol ester.

10. Lubricating composition according to claim 9, wherein the polyol ester is a polyol ester of an aliphatic carboxylic acid containing from 12 to 24 carbon atoms.

11. Lubricating composition according to claim 9 or 10,
wherein the polyol ester is a polyol monoester of an iso-fatty acid, preferably containing from 14 to 20 carbon atoms, more preferably from 16 to 18 carbon atoms.

12. Use of a lubricating composition according to any of claims 1 to 11, in particular in a gas engine, in order to improve friction reduction properties (in particular according to the SRV test of DIN 51834-1).



EUROPEAN SEARCH REPORT

Application Number
EP 10 18 7249

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Place of search Munich		Date of completion of the search 16 February 2011	Examiner Bertrand, Samuel
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 2
EPO FORM 1503 03 82 (P04C01)



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2

EPO FORM 1503 03.82 (P04C01)

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EP 10 18 7249

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