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(54) Lubricating composition containing metal salixarate as detergent and succinimides as dispersants

(57) The present invention provides a composition (a) a detergent package comprising: (i) a metal salixarate; and (ii) optionally a detergent other than component (a)(i); (b) a dispersant package comprising: (i) a dispersant with a carbonyl to nitrogen ratio of 1 or higher ; and (ii) a dispersant with a carbonyl to nitrogen ratio of less than 1; (c) an antioxidant package comprising: (i) a hindered phenol; and (d) an oil of lubricating viscosity, wherein the composition has a phosphorus content of less than or equal to 800 ppm; and wherein the sulphated ash content is less than or equal to 1.1 weight percent of the composition. The invention further provides a process for preparing the composition and its use.

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Description

FIELD OF INVENTION

[0001] The present invention relates to a lubricating oil composition containing a dispersant package, a detergent package and antioxidant package. The composition has improved engine cleanliness, improved detergency, decreased sludge formation and decreased wear.

BACKGROUND OF THE INVENTION

[0002] It is well known for lubricating oils to contain a number of additives used to protect the engine from wear, the accumulation of sludge and filter plugging. Common additives for engine lubricating oils are zinc dialkyldithiophosphate (ZDDP) as an antiwear additive, and overbased calcium sulphonate detergents. It is believed that ZDDP antiwear additives protect the engine by forming a protective film on metal surfaces. Typical treatment quantities of ZDDP range from 1 to 2 weight percent based on the total weight of the lubricant. Detergents such as overbased calcium sulphonate help keep the engine parts clean of soot and other deposits, and offer an alkalinity reserve. Typical treatment quantities of detergents range from 0.05 to 10 weight percent based on the total weight of the lubricant.

[0003] In recent years phosphates and sulphonates derived from engine lubricants have been shown to contribute in part to particulate emissions. Further, sulphur and phosphorus tend to poison the NO_x catalysts used in catalytic converters, resulting in a reduction in performance of said catalysts. Any reduction in the performance of catalytic converters tends to result in increased amounts of pollutants such as nitric oxide and/or sulphur oxides. However, reducing the amount of ZDDP will increase the amount of wear in an engine. Also reducing the amount of detergent will decrease engine cleanliness and result in increased soot deposits.

[0004] International Publication WO03/18728 (Cressey et al.) discloses additives for lubricants containing linear compounds containing phenolic and salicylic units in the form of oligomers or polymers. The linear compounds may be salted with calcium and optionally cosalted with boric acid. The additives have detergency and/or antiwear properties. Lubricant examples contain an ashless dispersant and a zinc dithiophosphate.

[0005] US Patent Number 6,200,936 (Moreton) discloses compounds containing phenolic units and salicylic units in a lubricating composition. The compounds may be salted with calcium. The examples of lubricating compositions contain phenolic units with a dodecyl alkyl group. The compounds of the invention may be used as a detergent in gasoline or diesel fuel. They also stabilise gasoline or diesel compositions against thermal decomposition.

[0006] International Publication WO99/25793 (Taylor) discloses a fuel composition containing kerosene and compounds containing phenolic units and salicylic units. The compounds may be salted with calcium. The examples of lubricating compositions contain phenolic units with a dodecyl alkyl group.

[0007] International Publication WO01/56968 (Taylor et al.) discloses a cyclic compound containing phenolic units and salicylic units. The salicylic units may be salted with a metal or an ammonium cation.

[0008] U.S. Patent Number 6,310,009 (Kocsis et al.) relates to the use of saligenin derivatives in lubricating compositions. The formulations contain borated or non-borated magnesium saligenin derivatives. These compositions exhibit improved seal compatibility and reduced copper and lead corrosion.

[0009] It has now been found that the composition of the present invention provides engine cleanliness, detergency and antioxidant performance to an oil of lubricating viscosity often used in engine oil.

SUMMARY OF THE INVENTION

[0010] The present invention provides a composition comprising:

(a) a detergent package comprising:

(i) a metal salixarate; and
(ii) optionally a detergent other than component (a)(i);

(b) a dispersant package comprising:

(i) a dispersant with a carbonyl to nitrogen ratio of 1 or higher; and
(ii) a dispersant with a carbonyl to nitrogen ratio of less than 1;

(c) an antioxidant package comprising:

(i) a hindered phenol; and

(d) an oil of lubricating viscosity,

wherein the composition has a phosphorus content of less than or equal to 800 ppm; and wherein the sulphated ash content is less than or equal to 1.1 weight percent of the composition.

[0011] The invention further provides a process for the preparation of a composition comprising mixing:

(a) a detergent package comprising:

(i) a metal salixarate; and
(ii) optionally a detergent other than component (a)(i);

(b) a dispersant package comprising:

(i) a dispersant with a carbonyl to nitrogen ratio of 1 or higher; and
(ii) a dispersant with a carbonyl to nitrogen ratio of less than 1;

(c) an antioxidant package comprising:

(i) a hindered phenol; and

(d) an oil of lubricating viscosity,

wherein the composition has a phosphorus content of less than or equal to 800 ppm; and wherein the sulphated ash content is less than or equal to 1.1 weight percent of the composition.

[0012] The use of the composition of the invention is capable of imparting at least one or more of improved engine cleanliness, improved detergency, decreased sludge formation, decreased wear, decreased bore polishing and decreased oil consumption.

DETAILED DESCRIPTION OF THE INVENTION

[0013] The present invention provides a composition as described above. Often the composition has a total sulphur content in one aspect below 0.5 wt %, in another aspect below 0.3 wt %, in yet another aspect 0.2 wt % or less and in yet another aspect 0.1 wt % or less. Often the major source of sulphur in the composition of the invention is derived from diluent oil.

[0014] Often the composition has a total phosphorus content of less than or equal to 800 ppm, in another aspect equal to or less than 700 ppm, in yet another aspect equal to or less than 600 ppm, in yet another aspect equal to or less than 550 ppm and in yet another aspect equal to or less than 500 ppm of the composition. In one embodiment of the invention the phosphorus is present from 200 ppm or 300 ppm to 475 ppm or 580 ppm or even 780 ppm.

[0015] Often the composition has a total ash content as determined by ASTM D-874 of below 1.5 wt %, in one aspect equal to or less than 1.1 wt %, in another aspect equal to or less than 1.0 wt %, in yet another aspect equal to or less than 0.8 wt % and in yet another aspect equal to or less than 0.5 wt % of the composition. In one embodiment the total ash content is present from 0.1 wt % or 0.2 wt % to 0.6 wt % or 0.7 wt%.

Detergent Package

[0016] The detergent package contains a metal salixarate and optionally at least one detergent other than the metal salixarate. The other detergent compounds are well known in the art and are often selected from the group consisting of a sulphonate, a phenate, a sulphurised phenate, a carboxylate, a phosphate, a saligenin, and an alkylsalicylate. Saligenin chemistry is disclosed in more detail in US Patent Number 6,310,009. Phenate, alkylsalicylate and phosphate chemistry is disclosed in "Chemistry and Technology of Lubricants," Edited by R.M. Mortier and S.T. Orszulik, 2nd Edition, Chapter 3, section 3.2.2, page 82 to 85, Copyright 1997. Sulphonate chemistry is disclosed in "Chemistry and Technology of Lubricants," Edited by R.M. Mortier and S.T. Orszulik, 2nd Edition, Chapter 3, section 3.2.1, page 77 to 82, Copyright 1997.

[0017] Often the detergent compounds will be in the form of a metal salt or metal salts. In one aspect of the invention the metal is selected from an alkali metal or alkaline earth metal such as magnesium, calcium, potassium or sodium or mixtures thereof. Suitable examples of a metal detergent include a magnesium saligenin, a calcium saligenin, a calcium

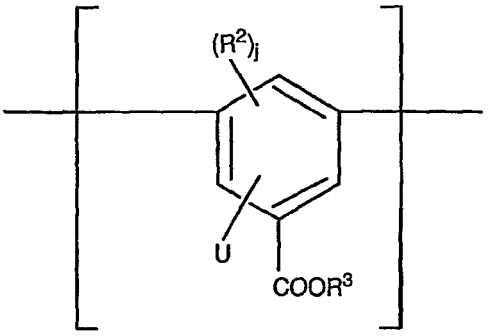
alkylsalicylate, a magnesium alkylsalicylate, a calcium sulphonate, a magnesium sulphonate or mixtures thereof. In one embodiment the other detergent compound is a magnesium saligenin.

[0018] The detergent package often contains the metal of the metal salt present at 50 ppm to 1200 ppm, in one aspect 75 ppm to 1000 ppm, in another aspect 120 ppm to 800 ppm and in yet another aspect 150 ppm to 700 ppm, for example, about 225 ppm, about 275 ppm, about 325 ppm, about 400 ppm, or about 550 ppm or less.

[0019] The detergent package is often present on an oil free basis at 0.01 to 20, in one aspect 0.05 to 15, in another aspect 0.1 to 12, in another aspect 0.15 to 8 and in yet another aspect 0.25 to 4 weight percent of the composition. In one aspect the detergent contains the metal salixarate present at 10 wt % or more of the detergent package, in another aspect 20 wt % or more of the detergent package and in another aspect 30 wt % or more of the detergent package. In one aspect the metal salixarate is present at 0.25 to 4 weight percent of the composition.

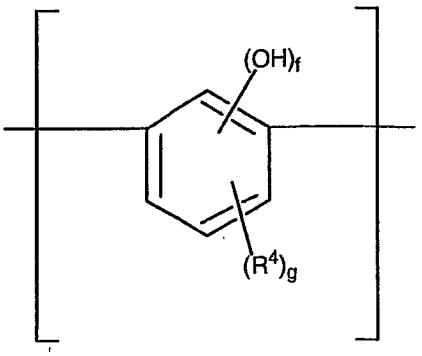
Salixarate Salt Detergent

[0020] The substrate of the metal salixarate of the invention is often represented by a substantially linear compound comprising at least one unit of the formulae (I) or (II):



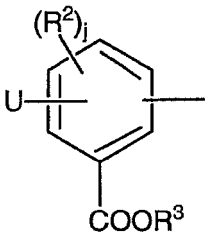
(I)

or

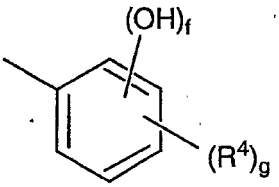


(II)

each end of the compound having a terminal group of formulae (III) or (IV):



(III)



(IV)

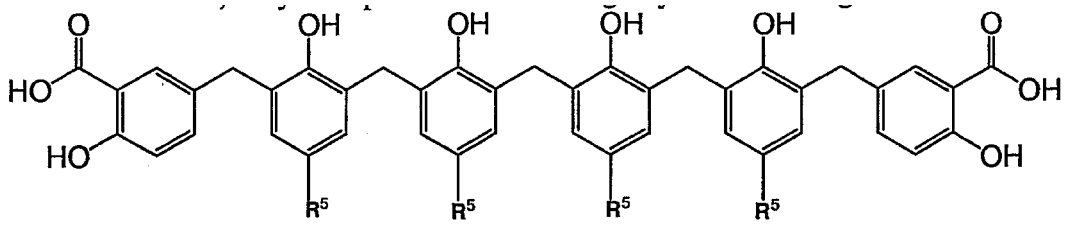
such groups being linked by divalent bridging groups, which may be the same or different for each linkage; wherein in formulas (I)-(IV) f in one aspect is 1, 2 or 3, in another aspect 1 or 2; U is -OH, $-NH_2$ $-NHR^1$, $-N(R^1)_2$ or mixtures thereof, R^1 is a hydrocarbyl group containing 1 to 5 carbon atoms; R^2 is hydroxyl or a hydrocarbyl group and j is 0, 1, or 2; R^3 is hydrogen or a hydrocarbyl group; R^4 is a hydrocarbyl group or a substituted hydrocarbyl group; g is 1, 2 or 3, provided at least one R^4 group contains 8 or more carbon atoms; and wherein the molecules on average contain at least one of unit (I) or (III) and at least one of unit (II) or (IV) and the ratio of the total number of units (I) and (III) to the total number of units of (II) and (IV) in the composition is 0.1:1 to 2:1.

[0021] The U group in formulae (i) and (iii) may be located in one or more positions ortho, meta, or para to the $-COOR^3$ group. In one embodiment of the invention, the U group is located ortho to the $-COOR^3$ group. When the U group is a -OH group, formulae (i) and (iii) are derived from 2-hydroxybenzoic acid (often called salicylic acid), 3-hydroxybenzoic acid, 4-hydroxybenzoic acid or mixtures thereof. When U is a $-NH_2$ group, formulae (i) and (iii) are derived from 2-aminobenzoic acid (often called anthranilic acid), 3-aminobenzoic acid, 4-aminobenzoic acid or mixtures thereof.

[0022] The divalent bridging group, which may be the same or different in each occurrence, includes $-CH_2-$ (methylene bridge) and $-CH_2OCH_2-$ (ether bridge), either of which may be derived from an aldehyde such as formaldehyde or a formaldehyde equivalent (e.g., paraform, formalin), ethanal or propanal.

[0023] The metal of the metal salixarate is often mono-valent, di-valent or mixtures thereof. In one aspect of the invention the metal is selected from an alkali metal or alkaline earth metal such as magnesium, calcium, potassium or sodium or mixtures thereof.

[0024] It is believed that a significant fraction of salixarate molecules (prior to neutralisation) may be represented on average by the following formula:



(V)

wherein each R^5 may be the same or different, and are hydrogen or an alkyl group, provided at least one R^5 is alkyl. In one embodiment, R^5 is a polyisobutene group (especially of molecular weight 200 to 1,000, or 550). Significant amounts of di-or trinuclear species may also be present containing one salicylic end group of formula (III). The salixarate detergent may be used alone or with other detergents.

[0025] Salixarate derivatives and methods of their preparation are described in greater detail in U.S. patent number 6,200,936 and PCT Publications WO 01/56968 and WO 03/18728.

Dispersant Package

[0026] The dispersants of the invention are often derived from N-substituted long chain alkenyl succinimides. The invention requires at least 2 dispersants, one with a high Total Base Number and one with a high Total Acid Number. Generally dispersants with a high TAN number have a carbonyl to nitrogen ratio of 1 or higher, in one aspect 1.2 or higher, in another aspect 1.4 or higher and in yet another aspect 1.45 or higher, for example 1.5. Generally dispersants with a high TBN number have a carbonyl to nitrogen ratio of less than 1, in one aspect 0.94 or lower, in another aspect

0.88 or lower and in another aspect 0.8 or lower, for instance 0.77. The carbonyl to nitrogen ratio is to be calculated on a molar basis, that is, the ratio of moles of carbonyl functionality (e.g., -C(O)O-) to the moles of nitrogen functionality (e.g., amine nitrogens).

[0027] The dispersant package is often present on an oil free basis at 0.01 to 30, in one aspect 0.5 to 25, in another aspect 1.5 to 20 and in yet another aspect 3 to 15 weight percent of the composition. Often the dispersant with a high Total Base Number is present at lower concentration than the dispersant with a high Total Acid Number. Alternatively the amount of dispersant with a high Total Acid Number and a high Total Base Number is equal. In yet another alternative the dispersant with a high Total Acid Number is often present at lower concentration than the dispersant with a high Total Base Number. Often the dispersant present in the greater quantity is present at greater than 50% of the amount of dispersant present in the package, in one aspect greater than 55% of the amount of dispersant present in the package, in yet another aspect greater than 60% of the amount of dispersant present in the package. For example the dispersant present in the greater quantity may be present from 61% to 95% of the dispersant, in one aspect 62% to 90% of the dispersant and in yet another aspect 63% to 85% of the dispersant present in the package. In one aspect the ratio of high TAN dispersant to high TBN dispersant is 1:1 to 15:1, in another aspect 2:1 to 10:1 and in another aspect 3:1 to 6:1. In certain embodiments the mixture of dispersants has a TAN which is at least 15% or at least 20% of the TBN of the mixture of dispersants, for example, 15 to 30% of the TBN. In certain embodiments the TBN/TAN ratio for the mixture of dispersants is 3:1 to 7:1.

[0028] The N-substituted long chain alkenyl succinimides have a variety of chemical structures and include a mono-succinimide and/or a di-succinimide. Often the long chain alkenyl group will have number average molecular weight of 350 to 10,000, in one aspect 400 to 7000, in another aspect 500 to 5000 and in yet another aspect 500 to 4000. In one embodiment the long chain alkenyl group is a polyisobutylene group, which has a number average molecular weight from 800 to 1600 and in another embodiment from 1600 to 3000. The succinimide is often prepared by the condensation of a hydrocarbyl-substituted acylating agent (e.g., hydrocarbyl-substituted succinic anhydride) with a polyamine or an amino alcohol, often a polyalkylene polyamine or poly(ethyleneamine) such as triethylene tetramine, tetraethylene pentamine, pentaethylene hexamine or, in one embodiment, polyamine still bottoms.

[0029] N-substituted long chain alkenyl succinimides dispersant additives and their preparation are disclosed, for instance, in US Patent Numbers 3,361,673, 3,401,118 and 4,234,435.

[0030] Other dispersants may also be present. One class of suitable dispersants include Mannich bases, which are the reaction products of alkyl phenols in which the alkyl group typically contains at least 30 carbon atoms with aldehydes (especially formaldehyde) and amines (especially polyalkylene polyamines) and are described in more detail in U.S. Patent 3,634,515.

[0031] Another class of ashless dispersant is high molecular weight esters. These materials are similar to the above-described succinimides except that they may be seen as having been prepared by reaction of a hydrocarbyl acylating agent and a polyhydric aliphatic alcohol such as glycerol, pentaerythritol, or sorbitol. Such materials are described in more detail in U.S. Patent 3,381,022.

[0032] Other dispersants include polymeric dispersant additives, which are generally hydrocarbon-based polymers which contain polar functionality to impart dispersancy characteristics to the polymer.

[0033] Dispersants may also be post-treated by reaction with any of a variety of agents. Among these are urea, thiourea, dimercaptothiadiazoles, carbon disulfide, aldehydes, ketones, carboxylic acids, hydrocarbon-substituted succinic anhydrides, nitriles, epoxides, boron compounds, and phosphorus compounds. References detailing such treatment are listed in U.S. Patent 4,654,403. (The carbonyl to nitrogen ratio herein is calculated prior to any such post-treatment.)

[0034] There are two commonly employed processes for making N-substituted long chain alkenyl succinimide dispersants. These differ in the method by which a polyalkylene (typically polyisobutylene, but also copolymers including ethylene copolymer) substituent is prepared and by which it is affixed to a mono- or diacid or anhydride moiety, especially a succinic anhydride moiety or its reactive equivalent. In a conventional process (a), isobutylene is polymerised in the presence of $AlCl_3$ to produce a mixture of polymers comprising predominantly tri-substituted olefin and tetra-substituted olefin end groups, with only a very small amount (for instance, less than 20 percent) of chains containing a terminal vinylidene group. In an alternative, "chlorine-free" or "thermal" process (b), isobutylene is polymerised in the presence of BF_3 catalyst to produce a mixture of polymers comprising predominantly (for instance, at least 70 percent) terminal vinylidene groups, with smaller amounts of tetra-substituted end groups and other structures. These materials, sometimes referred to as "high vinylidene PIB," are also described in U.S. Patent 6,165,235. Generally a dispersant with a carbonyl to nitrogen ratio of 1 or higher; or a dispersant with a carbonyl to nitrogen ratio of less than 1 may be prepared using either process.

[0035] Amines which may be used in preparing dispersants include those with at least one reactive N-H group. Suitable examples of an amine are selected from the group consisting of an amine compound containing only a single reactive amino group per molecule; (ii) a polyamine; (iii) an aminoalcohol; (iv) a cyclic amine; and (v) mixtures of (i) to (iv).

[0036] In one embodiment the polyamine is an alkylenepolyamine often selected from the group consisting of an ethylenepolyamine, a propylenepolyamine, a butylenepolyamine and mixtures thereof. Examples of a propylenep-

olyamine include propylenediamine, dipropylenetriamine or mixtures thereof. An especially useful class of amine is derived from an ethylenepolyamines, selected from the group consisting of ethylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenehexamine, polyamine still bottoms and mixtures thereof.

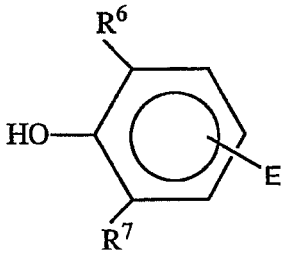
[0037] In one embodiment the polyamine includes a α,β-diaminoalkane or mixtures thereof. Suitable examples of the α,β-diaminoalkane include a diaminopropane, a diaminobutane or mixtures thereof. Especially useful examples of a diaminoalkanes include those selected from the group consisting of N-(2-aminoethyl)-1,3-propane diamine, 3,3'-diamine-N-methyldipropylamine, tris(2-aminoethyl)amine, N,N-bis(3-aminopropyl)-1,3-propane diamine, N,N'-1,2-ethanediyl-bis-(1,3-propane diamine) and mixtures thereof.

[0038] In one embodiment another polyamine includes di-(trimethylene)triamine, piperazine, diaminocyclohexanes or mixtures thereof.

[0039] Aminoalcohols suitable for the invention contain 1 to 6 and in one aspect 1 to 3 hydroxy groups; and 1 to 8 and in one aspect 1 to 2 amine groups. When the amine is an aminoalcohol, the amine is often selected from the group consisting of ethanolamine, isopropanolamine, diethanolamine, triethanolamine, diethylethanolamine, dimethylethanolamine, dibutylethanolamine, 3-amino-1,2-propanediol; serinol; 2-amino-2-methyl-1,3-propanediol; tris(hydroxymethyl)-aminomethane; 1-amino-1-deoxy-D-sorbitol; diethanol amine; diisopropanolamine; N-methyl-N,N-diethanol amine; triethanolamine; N,N,N',N'-tetrakis(2-hydroxypropyl)ethylenediamine, 2-amino-2-methyl-1-propanol, 2-dimethylamino-methyl-1-propanediol, 2-amino-2-ethyl-1,3-propanediol, 2-amino-2-methyl-1,3-propanediol, 2-amino-1-butanol and mixtures thereof.

Antioxidant Package

[0040] The hindered phenol suitable for the invention is often represented by the formula:

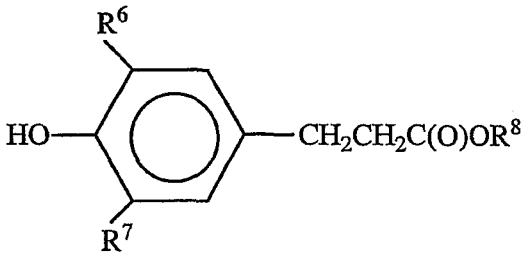


(VI)

wherein R^6 and R^7 are independently branched or linear alkyl groups containing in one aspect 1 to 24, in another aspect 4 to 18, and in yet another aspect 4 to 12 carbon atoms; and E is hydrogen, a hydrocarbyl group, a bridging group linking to a second aromatic group, an ester-containing group, or mixtures thereof.

[0041] R^6 and R^7 may be either straight or branched chain and suitable examples include secondary butyl and tertiary butyl.

[0042] In one embodiment, the hindered phenol of formula (VI) suitable for the invention are esters or acids represented by the formula:

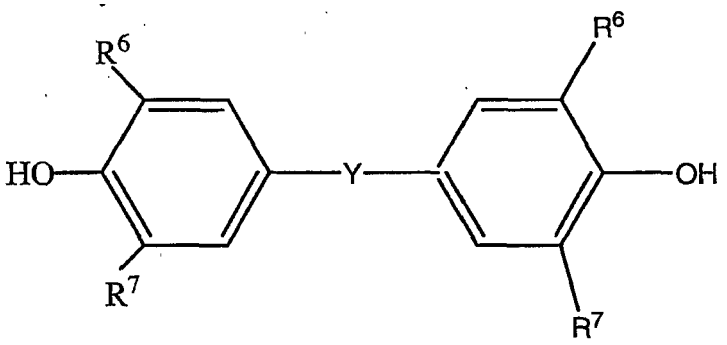


(VIa)

wherein R^6 and R^7 are as defined above and R^8 is hydrogen, a hydrocarbyl group or mixtures thereof. When R^8 is a hydrocarbyl group, R^8 is often selected from the group consisting of butyl, sec-butyl, isobutyl, tert-butyl, pentyl, n-hexyl, sec-hexyl, n-octyl, 2-ethylhexyl, nonyl, decyl, undecyl, dodecyl and mixtures thereof.

[0043] In one embodiment, the hindered phenol of formula (VI) suitable for the invention contains a bridging group. Examples of suitable bridging groups include an alkylene bridge or an ether bridge, often containing 1 to 8, in one aspect 1 to 6, in another aspect 1 to 4 and in yet another aspect 1 to 2 carbon atoms. Examples of a suitable bridge group include $-CH_2-$, $-CH_2CH_2-$, $-CH_2OCH_2-$ and $-CH_2CH_2OCH_2CH_2-$.

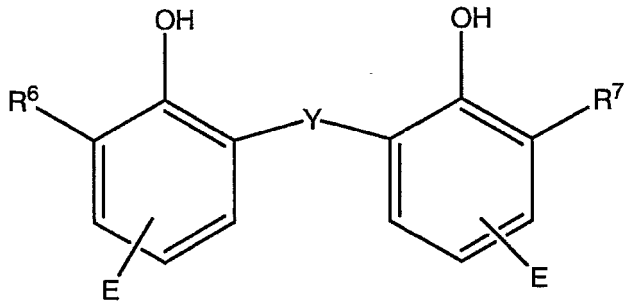
[0044] When present, the hindered phenol with a bridging group is often represented by the formula:



(VIb)

wherein R^6 and R^7 are defined above and Y is a bridging group. Examples of a methylene-bridged hindered phenol include 4,4'-methylene-bis-(6-tert-butyl-o-cresol), 4,4 -methylene-bis-(2-tert-amyl-o-cresol) and 4,4 -methylene-bis-(2,6-di-tertbutylphenol).

[0045] The hindered phenol of the invention also includes compounds represented by the formula:



(VII)

wherein R^6 and R^7, E and Y are defined above. Examples of a suitable methylene-bridged hindered phenol of formula (VII) include 2,2 -methylene-bis-(4-methyl-6-tert-butylphenol), and 2,2 -methylene-bis-(4-ethyl-6-tertbutylphenol), 2,2'-methylene-bis-(4-propyl-6-tert-butylphenol).

[0046] The antioxidant package is often present on an oil free basis at 0.01 to 20, in one aspect 0.1 to 15, in another aspect 0.5 to 10 and in yet another aspect 1 to 5 weight percent of the composition. In one aspect at least 50 wt % of the antioxidant package is a hindered phenol. In one aspect the hindered phenol is present at 0.2 to 3 weight percent of the composition; alternatively 0.01 to 15 or 0.05 to 10 or 0.1 to 5 or 0.5 to 4 weight percent..

Oils of Lubricating Viscosity

[0047] The lubricating oil composition of the present invention may be added to an oil of lubricating viscosity. The oil includes natural and synthetic oils, oil derived from hydrocracking, hydrogenation, hydrofinishing, unrefined, refined and re-refined oils, or mixtures thereof.

[0048] Unrefined oils are those obtained directly from a natural or synthetic source generally without (or with little) further purification treatment.

[0049] Refined oils are similar to the unrefined oils except they have been further treated in one or more purification steps to improve one or more properties. Purification techniques are known in the art and include solvent extraction, secondary distillation, acid or base extraction, filtration, percolation and the like.

[0050] Re-refined oils are also known as reclaimed or reprocessed oils, and are obtained by processes similar to those used to obtain refined oils and often are additionally processed by techniques directed to removal of spent additives and oil breakdown products.

[0051] Natural oils useful in making the inventive lubricants include animal oils, vegetable oils (e.g., castor oil, lard oil), mineral lubricating oils such as liquid petroleum oils and solvent-treated or acid-treated mineral lubricating oils of the paraffinic, naphthenic or mixed paraffinic-naphthenic types and oils derived from coal or shale or mixtures thereof.

[0052] Synthetic lubricating oils are useful and include hydrocarbon oils such as polymerised and interpolymerised

olefins (e.g., polybutylenes, polypropylenes, propyleneisobutylene copolymers); poly(1-hexenes), poly(1-octenes), poly (1-decenes), and mixtures thereof; alkyl-benzenes (e.g. dodecylbenzenes, tetradecylbenzenes, dinonylbenzenes, di-(2-ethylhexyl)-benzenes); polyphenyls (e.g., biphenyls, terphenyls, alkylated polyphenyls); alkylated diphenyl ethers and alkylated diphenyl sulphides and the derivatives, analogs and homologs thereof or mixtures thereof.

[0053] Other synthetic lubricating oils include but are not limited to polyol esters, liquid esters of phosphorus-containing acids (e.g., tricresyl phosphate, trioctyl phosphate, and the diethyl ester of decane phosphonic acid), and polymeric tetrahydrofurans. Synthetic oils may be produced by Fischer-Tropsch reactions and typically may be hydroisomerised Fischer-Tropsch hydrocarbons or waxes.

[0054] Oils of lubricating viscosity may also be defined as specified in the American Petroleum Institute (API) Base Oil Interchangeability Guidelines. The five base oil groups are as follows: Group I (sulphur content >0.03 wt %, and/or <90 wt % saturates, viscosity index 80-120); Group II (sulphur content ≤0.03 wt %, and ≥90 wt % saturates, viscosity index 80-120); Group III (sulphur content ≤0.03 wt %, and ≥90 wt % saturates, viscosity index ≥120); Group IV (all polyalphaolefins (PAO's)); and Group V (all others not included in Groups I, II, III, or IV). The oil of lubricating viscosity is selected from the group consisting of an API Group I, II, III, IV, V oil and mixtures thereof; in one aspect an API Group II, III, IV or V oil and mixtures thereof; and in yet another aspect an API Group III, IV or V oil and mixtures thereof. If the oil of lubricating viscosity is an API Group II, III, IV or V oil there may be up to a maximum of 20 wt %, in one aspect up to a maximum of 10 wt %, in anther aspect up to a maximum of 5 wt % and in yet another aspect up to a maximum of 1.5 wt % of the lubricating oil an API Group I oil.

[0055] Examples of suitable API Group III oils include Nexbase™ 3050, Nexbase™ 3043, Nexbase™ 3060, PAO-6, Priolube™ 1976, Yubase™ 4, Yubase™ 6, and Shell™ XHVI 5.2.

[0056] The oil of lubricating viscosity is often present at up to 99.97, in one aspect up to 99.69, in another aspect up to 97.75 and in yet another aspect up to 95.5 weight percent of the composition. The composition is often classed as a SAE XW-Y lubricating oil, wherein X is 0 or 5; and Y is 20, 30, 40 or 50.

[0057] If the present invention is in the form of a concentrate (which may be combined with additional oil to form, in whole or in part, a finished lubricant), the ratio of each of the above-mentioned dispersant, as well as other components, to diluent oil is often 80:20 to 10:90 by weight.

Other Performance Additives

[0058] The composition of the invention optionally further includes other performance additives. The other performance additives selected from the group consisting of antioxidants other than component (c), corrosion inhibitors, antiwear agents, friction modifiers, viscosity modifiers, antiscuffing agents, foam inhibitors, demulsifiers, pour point depressants, seal swelling agents and mixtures thereof.

[0059] The total combined amount of the other performance additives present on an oil free basis is often from 0 to 25, in one aspect 0.01 to 20, in another aspect 0.05 to 15 and in yet another aspect 0.1 to 10 weight percent of the composition. Although one or more of the other performance additives may be present, it is common for the other performance additives to be present in different amounts relative to each other.

Friction Modifiers

[0060] When present in the invention, the friction modifier may be a monoester of a polyol and an aliphatic carboxylic acid, often an acid containing 12 to 24 carbon atoms. Often the monoester of a polyol and an aliphatic carboxylic acid is in the form of a mixture with a sunflower oil or the like, which may be present in the friction modifier mixture from 5 to 95, in one aspect 10 to 90, in another aspect 20 to 85 and in yet another aspect 20 to 80 weight percent of said mixture.

[0061] Polyols include diols, triols, and alcohols with higher numbers of alcoholic OH groups. Polyhydric alcohols include ethylene glycols, including di-, tri- and tetraethylene glycols; propylene glycols, including di-, tri- and tetrapropylene glycols; glycerol; butane diol; hexane diol; sorbitol; arabitol; mannitol; sucrose; fructose; glucose; cyclohexane diol; erythritol; and pentaerythritols, including di- and tripentaerythritol. Often the polyol is diethylene glycol, triethylene glycol, glycerol, sorbitol, pentaerythritol or dipentaerythritol.

[0062] The aliphatic carboxylic acids which form the esters are those acids containing 12 to 24 carbon atoms. Acids containing straight chain hydrocarbyl groups containing 12 to 24 carbon atoms are often used, for instance, 14 to 20 or 16 to 18 carbon atoms. Such acids may be used in combination with acids with more or fewer carbon atoms as well. Generally the acid is a monocarboxylic acid. Examples of carboxylic acids include dodecanoic acid, stearic acid, lauric acid, behenic acid, and oleic acid.

[0063] The esters used in the present invention are in particular the monoesters of such polyols and such carboxylic acids. Often the ester is glycerol monooleate. It is to be understood that glycerol monooleate, as is the case with other such materials, in its commercially available grade, is a mixture which includes such materials as glycerol, oleic acid, other long chain acids, glycerol dioleate, and glycerol trioleate. The commercial material is believed to include 60 ± 5

percent by weight of the chemical species "glycerol monooleate," along with 35 ± 5 percent glycerol dioleate, and less than 5 percent trioleate and oleic acid. The amounts of the monoesters, described below, are calculated based on the actual, corrected, amount of polyol monoester present in any such mixture.

[0064] Other friction modifiers that are suitable for the invention include fatty amines, fatty phosphites, fatty acid amides, fatty epoxides, alkoxylated fatty amines, metal salts of fatty acids, sulphurised olefins, fatty imidazolines, condensation products of carboxylic acids and polyalkylene-polyamines, amine salts of alkylphosphoric acids.

Other Antioxidants

[0065] Optionally the invention includes an antioxidant other than a hindered phenol, such as, a diphenylamine antioxidant, a molybdenum dithiocarbamate, a sulphurised olefin, or mixtures thereof. Diphenylamine antioxidant additives often contain in one aspect 6 or fewer, in another aspect 4 or fewer and in yet another aspect 3 or fewer hydrocarbyl groups such as 1 or 2. Each hydrocarbyl group often contains in one aspect 1 to 24, in another aspect 2 to 18 and in yet another aspect 4 to 12 carbon atoms. In one embodiment of the invention the composition contains a diphenylamine antioxidant.

[0066] Examples of suitable diphenylamine antioxidants include octyl diphenylamine, nonyl diphenylamine, bis-octyl diphenylamine, and bis-nonyl diphenylamine.

Viscosity Modifiers

[0067] Optionally the invention contains a viscosity modifier. Viscosity modifiers are known and include polymeric materials including hydrogenated styrene-butadiene rubbers, an olefin copolymer, hydrogenated styrene-isoprene polymers, hydrogenated radical isoprene polymers, polymethacrylate acid esters, polyacrylate acid esters, polyalkyl styrenes, alkenyl aryl conjugated diene copolymers, polyalkylmethacrylates, esters of maleic anhydride-styrene copolymers or mixtures thereof.

[0068] Often polymethacrylate viscosity modifiers include copolymers of (a) a methacrylic acid ester containing 9 to 30 carbons in the ester group, (b) a methacrylic acid ester containing 7 to 12 carbons in the ester group wherein the ester group contains a 2-(C_{1-4} alkyl)-substituent and optionally (c) at least one monomer selected from the group consisting of a methacrylic acid ester containing from 2 to 8 carbon atoms in the ester group and which are different from methacrylic acid esters used in (a) and (b) above. A more detailed description of polymethacrylate viscosity modifiers is disclosed in US Patent Number 6,124,249.

[0069] Often viscosity modifiers derived from an olefin copolymer backbone contain in one aspect 2 to 4, in another aspect 2 to 3 and in yet another aspect 2 different olefin monomers. The olefin monomers often contain in one aspect 2 to 20, in another aspect 2 to 10, in yet another aspect 2 to 6 and in yet another aspect 2 to 4 carbon atoms.

[0070] The olefin copolymer often contains an ethylene monomer and at least one other comonomer derived from an alpha-olefin having the formula $H_2C=CHR^8$, wherein R^8 is a hydrocarbyl group, in one aspect an alkyl radical containing 1 to 18, in one aspect 1 to 10, in another aspect 1 to 6 and in yet another aspect 1 to 3 carbon atoms. The hydrocarbyl group includes an alkyl radical that has a straight chain, a branched chain or mixtures thereof. Examples of a suitable comonomer include propylene, 1-butene, 1-hexene, 1-octene, 4-methylpentene-1, 1-decene, 1-dodecene, 1-tridecene, 1-tetradecene, 1-pentadecene, 1-hexadecene, 1-heptadecene, 1-octadecene, 1-nonadecene or mixtures thereof. Examples of the olefin copolymers include ethylene-propylene copolymers, ethylenebutene-1 copolymers and mixtures thereof.

[0071] In one embodiment of the invention the optional viscosity modifier is a mixture of 2 or more olefin containing copolymers. For example a mixture of 2 copolymers derived from (A) a copolymer comprising 45 to 85 % by weight of units derived from ethylene, having a $\overline{M}_W$ of 50,000 to 300,000, $\overline{M}w$ /$\overline{W}n$ less than 3, and a melting point of 0°C to 60°C; and (B) a block copolymer comprising a vinyl aromatic comonomer moiety and a second comonomer moiety.

[0072] The copolymer (A) is often prepared by copolymerising ethylene and other monomers, usually propylene.

[0073] Among the monomers which may be used to prepare the (B) copolymers of the present inventions are 1,3-butadiene, 1,2-pentadiene, 1,3-pentadiene, isoprene, 1,5-hexadiene, and 2-chloro-1,3 butadiene, and aromatic olefins such as styrene, α-methyl styrene, ortho-methyl styrene, meta-methyl styrene, para-methyl styrene, and para-t-butyl styrene, and mixtures thereof. Other comonomers may be included in the mixture and in the polymer, which do not substantially change the character of the resulting polymer.

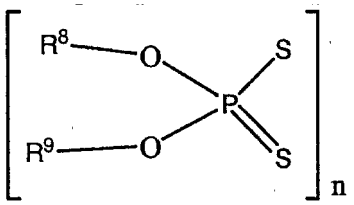
[0074] Suitable styrene/isoprene hydrogenated copolymers are available commercially from Infineum under the trade names Infineum™ SV140 (formerly Shellvis™ 40) (M_w ca. 200,000), Infineum™ SF150 (M_w ca. 150,000) and Infineum™ SV160 (M_w ca. 150,000), as well as from Septon Company of America (Kuraray Group) under the trade names Septon™ 1020 (M_w ca. 150,000) and Septon™ 1001 (M_w ca. 200,000). Suitable styrene/1,3-butadiene hydrogenated random block copolymers are available from BASF under the trade name Glissoviscal™ (M_w ca. 160,000-220,000). A more detailed description of certain of these polymers and their manufacture is found in U.S. Patent 5,747,433, see column

3 lines 56 through column 8 line 62. A more detailed description of the mixture of the 2 or more olefin containing copolymers is given in US Patent Application 60/458666, now PCT Application WO 04/087849.

[0075] Optionally the viscosity modifier copolymers are further grafted with an unsaturated dicarboxylic acid anhydride or derivatives thereof and an amine to form a dispersant viscosity modifier (often referred to as DVM), thus named, because they also exhibit dispersant properties.

Antiwear Agent

[0076] The invention optionally includes an antiwear agent such as a metal hydrocarbyl dithiophosphate often represented by the formula:



M' (VIII)

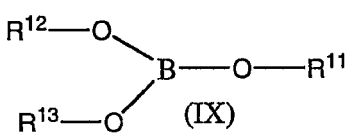
wherein R^9 and R^{10} are independently hydrogen, hydrocarbyl groups or mixtures thereof, provided that at least one of R^9 and R^{10} is a hydrocarbyl group, often containing in one aspect 1 to 30, in another aspect 2 to 20 and in yet another aspect 2 to 15 carbon atoms.

[0077] M' is a metal, and n is an integer equal to the available valence of M'. M' is mono- or di- or tri- valent, in one aspect M' is divalent and in another aspect a divalent transition metal. In one embodiment M' is zinc. In one embodiment M' is calcium. In one embodiment M' is barium. Examples of a metal hydrocarbyl dithiophosphate include zinc dihydrocarbyl dithiophosphates (often referred to as ZDDP, ZDP or ZDTP).

[0078] Optionally the invention further contains a borate ester antiwear agent. The borate ester may be prepared by the reaction of a boron compound and at least one compound selected from epoxy compounds, halohydrin compounds, epihalohydrin compounds, alcohols and mixtures thereof. Often the alcohols include monohydric alcohols, dihydric alcohols, trihydric alcohols or higher alcohols.

[0079] Boron compounds suitable for preparing the borate ester include the various forms selected from the group consisting of boric acid (including metaboric acid, HBO_2, orthoboric acid, H_3BO_3, and tetraboric acid, $H_2B_4O_7$), boric oxide, boron trioxide and alkyl borates. The borate ester may also be prepared from boron halides.

[0080] The borate ester formed by the reaction of a boron compound and an epoxy compound may be represented by at least one compound derived from the formulae:



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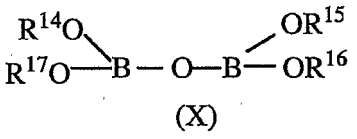

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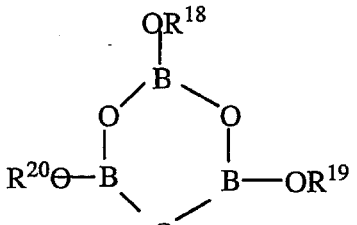

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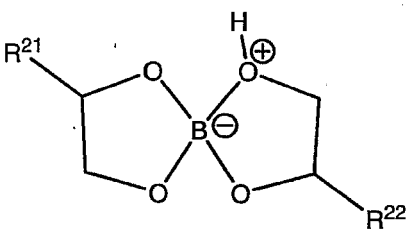

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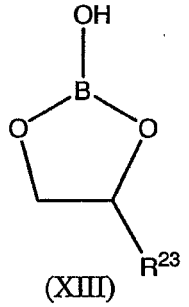
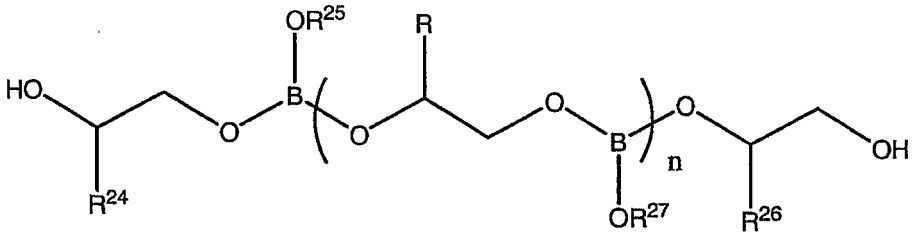


(XIII)



(XIV)

wherein R^{11}, R^{12} and R^{13} may be hydrogen or hydrocarbyl groups provided at least one, in one aspect at least two of R^{11}, R^{12} and R^{13} are hydrocarbyl groups.

In one embodiment, R^{11} is a hydrocarbyl group; and R^{12} and R^{13} are hydrogen. In one embodiment, R^{11} and R^{12} are hydrocarbyl groups and R^{13} is hydrogen. In one embodiment R^{11}, R^{12} and R^{13} are all hydrocarbyl groups. The hydrocarbyl groups may be alkyl, aryl or cycloalkyl when any 2 adjacent R groups are connected in a ring.

[0081] Often there is no upper limit on the number of carbon atoms in the hydrocarbyl groups, but a practical limit is 500, in one aspect 400, in another aspect 200 and in yet another aspect 100 or 60. For example the number of carbon atoms present in R^{11}, R^{12} and R^{13} may be 1 to 60, or 1 to 40 or even 1 to 30 carbon atoms, provided the total number of carbon atoms in R^{11}, R^{12} and R^{13} is 9 or more, in one aspect 10 or more, in another aspect 12 or more and in yet another aspect 14 or more.

[0082] R^{14} to R^{20} inclusive may be hydrogen or hydrocarbyl groups, provided at least one of R^{14} to R^{17} and/or R^{18} to R^{20} is a hydrocarbyl group. R^{21} to R^{26} inclusive are independently hydrogen or a hydrocarbyl group, although it is common for at least one of R^{21} to R^{26} to be a hydrocarbyl group; and R^{27} may be hydrogen or a hydrocarbyl group, although it is common for R^{27} to be hydrogen. The hydrocarbyl group definition for R^{14} to R^{27} inclusive is the same as the definition given for R^{11}, R^{12} and R^{13}.

[0083] Examples of groups suitable for R^{11} to R^{27} inclusive include isopropyl, n-butyl, isobutyl, amyl, 2-pentenyl, 4-methyl-2-pentyl, 2-ethyl-1-hexyl, 2-ethylhexyl, heptyl, isooctyl, nonyl, decyl, undecyl, dodecenyl, dodecyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, nonadecyl and eicosyl groups.

[0084] Suitable examples of the optional borate ester include tripropyl borate, tributyl borate, tripentyl borate, trihexyl borate, triheptyl borate, trioctyl borate, trinonyl borate and tridecyl borate. Borate ester compounds are discussed in more detail in European Patent 976 814.

[0085] The composition of the invention optionally contains antiwear agent additives other than a metal hydrocarbyl dithiophosphate including phosphoric acid esters or salts thereof; phosphites; and phosphorus-containing carboxylic esters, ethers, and amides or mixtures thereof. Often phosphoric acid esters contain a hydrocarbyl ester group with 4 to 40, in one aspect 4 to 30 and in another aspect 6 to 24 carbon atoms. In one embodiment the hydrocarbyl ester group is alkyl and in another embodiment the hydrocarbyl group is aryl.

[0086] Other optional performance additives include, for example, corrosion inhibitors octylamine octanoate, condensation products of dodecenyl succinic acid or anhydride and a fatty acid such as oleic acid with a polyamine; metal deactivators including derivatives of benzotriazoles, 1,2,4-triazoles, benzimidazoles, 2-alkyldithiobenzimidazoles or 2-alkyldithiobenzothiazoles; foam inhibitors including copolymers of ethyl acrylate and 2-ethylhexylacrylate and optionally vinyl acetate; demulsifiers including trialkyl phosphates, polyethylene glycols, polyethylene oxides, polypropylene oxides and (ethylene oxide-propylene oxide) polymers; pour point depressants including esters of maleic anhydride-styrene, polymethacrylates, polyacrylates or polyacrylamides; and seal swell agents including Exxon Necton-37™ (FN 1380) and Exxon Mineral Seal Oil (FN 3200); may also be used in the composition of the invention.

Process

[0087] The invention further provides a process for the preparation of a composition as described above.

[0088] Components (a)-(d) are often mixed sequentially, separately for the composition of the invention, although two or more of the components may also be mixed simultaneously. The mixing conditions are often 15°C to 130°C, in one aspect 20°C to 120°C and in another aspect 25°C to 110°C; and for a period of time in the range 30 seconds to 48 hours, in one aspect 2 minutes to 24 hours, in another aspect 5 minutes to 16 hours and in yet another aspect 10 minutes to 5 hours; and at pressures in the range 86 kPa to 266 kPa (650 mm Hg to 2000 mm Hg), in one aspect 91 kPa to 200 kPa (690 mm Hg to 1500 mm Hg), and in another aspect 95 kPa to 133 kPa (715 mm Hg to 1000 mm Hg).

[0089] The process optionally includes mixing other optional performance additives as described above. The optional performance additives are often added sequentially, separately or as a concentrate.

Industrial Application

[0090] The composition of the present invention is useful as a lubricant in internal combustion engines, for example diesel fuelled engines, gasoline fuelled engines, natural gas fuelled engines or a mixed gasoline/alcohol fuelled engines.

[0091] In one embodiment of the invention provides a method for lubricating an internal combustion engine, comprising supplying thereto a lubricant comprising the composition as described herein. The use of the composition of the invention is capable of imparting at least one or more of improved engine cleanliness, improved detergency, decreased sludge formation, decreased wear, decreased bore polishing and decreased oil consumption.

[0092] The following examples provide an illustration of the invention. These examples are non exhaustive and are not intended to limit the scope of the invention.

EXAMPLES

Reference Example 1

[0093] Reference Example 1 is a 5W-30 lubricating oil containing on an oil free basis about 6% of succinimide dispersants, with the high TAN dispersant present in higher quantity than the high TBN dispersant; on an oil free basis about 2.8 wt % hindered phenol antioxidant; and a detergent package containing an alkylsalicylate (AC60C® commercially available from Infineum) present on an oil free basis at about 1.1 wt %. The lubricating oil has a phosphorus content of 480 ppm and a sulphated ash content of 0.49 wt %.

Example 1

[0094] Example 1 is the same as Reference Example 1, except the detergent package containing alkylsalicylate is replaced by a calcium sulphonate detergent and a calcium salixarate detergent (each commercially available from The Lubrizol Corporation) together present on an oil free basis at about 1.1 wt %.

Reference Example 2

[0095] Reference Example 2 is the same as Example 1, except the high TAN dispersant is used alone.

Reference Example 3

[0096] Reference Example 3 is the same as Reference Example 1, except the detergent package containing alkylsalicylate is replaced by a calcium sulphonate and a calcium phenate.

Example 2

[0097] Example 2 is the same as Reference Example 1, except the detergent package containing alkylsalicylate is replaced by calcium sulphonate, a calcium phenate and a calcium salixarate.

Preparative Example A

[0098] Blends are prepared of a 50:50 mixture by weight of an ethylene-propylene copolymer (Polymer A) and a styrene/isoprene hydrogenated copolymer (Polymer B), each of which are commercially available viscosity modifiers. Polymer A is first dissolved in a 150N mineral oil containing 0.1% of a butylated hydroxytoluene (BHT) antioxidant. The antioxidant is added to the mineral oil at room temperature. Polymer A, which is in a pellet from, is slowly added to the oil while it is being heated and stirred under high agitation. After all the polymer A has been added, the oil is continued to be heated to 130°C and is maintained at that temperature until all the Polymer A pellets are fully dissolved. Polymer B, which is also in a pellet form, is then added to the oil with strong agitation at 130°C until all of Polymer B is fully dissolved. The blends are maintained at 130°C under strong agitation for an additional two hours to ensure that all the polymers are fully soluble.

Example 3

[0099] Example 3 is a 5W-30 lubricating oil containing on an oil free basis about 6% of succinimide dispersants, with a high TAN dispersant present in higher quantity than the high TBN dispersant; on an oil free basis about 2.8% hindered phenol antioxidant; and a detergent package containing only a calcium salixarate on an oil free basis at 1.2 wt % and

an olefin copolymer viscosity modifier present on an oil free basis at about 1 wt %. The lubricating oil has a phosphorus content of 480 ppm and a sulphated ash content of 0.44 wt %.

Example 4

[0100] Example 4 is the same as Reference Example 4, except the viscosity modifier is the product of Preparative Example A.

Reference Example 4

[0101] Reference Example 4 is the same as Reference Example 3, except the composition contains an antioxidant package with a hindered phenol and a diphenylamine. The detergent package is present at about 1.1 wt %. The lubricating oil has a phosphorus content of 760 ppm and an ash content of 0.76 wt %.

Example 5

[0102] Example 5 is the same as Reference Example 4, except the detergent package present at 0.8 wt% contains a calcium sulphonate, a calcium phenate and a calcium salixarate instead of alkylsalicylate.

Reference Example 5

[0103] Reference Example 5 is a is a 5W-30 lubricating oil containing on an oil free basis about 6% of succinimide dispersants with a high TAN dispersant present in higher quantity than the high TBN dispersant; on an oil free basis about 0.65% hindered phenol antioxidant; and a detergent package containing only a magnesium saligenin on an oil free basis at 0.9 wt %. The lubricating oil has a magnesium content of 400 ppm, a phosphorus content of 1300 ppm, an ash content of 1.65 wt %.

Example 6

[0104] Example 6 is 5W-40 lubricating oil containing on an oil free basis about 11.9% of succinimide dispersants with a high TAN dispersant present in higher quantity than the high TBN dispersant; on an oil free basis about 3% hindered phenol antioxidant; and a detergent package containing a calcium salixarate and a magnesium saligenin, present together on an oil free basis at 1.0 wt %. The lubricating oil has a magnesium content of 100 ppm, a phosphorus content of 500 ppm, a sulphated ash content of 0.97 wt %.

Test 1: Cleanliness Test

[0105] A piston engine cleanliness test is carried out based on the Coordinating European Council (CEC) test method CEC L-78-T-99. The results are based on a merit rating and higher numbers indicate better piston cleanliness. The results obtained are:

Table 1: TDi Piston Cleanliness Ratings

Example	Rating
Reference Example 1	57
Reference Example 2	56
Example 1	60
Reference Example 3	55
Example 2	60
Example 3	53
Example 4	65

[0106] The results from Table 1 indicate that the combination of a high TAN dispersant and a high TBN dispersant (in Example 1) have improved piston cleanliness compared with Reference Examples 2 with only one dispersant.

[0107] Comparing Example 1 and Reference Example 1 indicates that a (a) dispersant package with a high TAN dispersant, a high TBN dispersant detergent package containing a salixarate; and a hindered phenol antioxidant package improves piston cleanliness compared with a detergent package free of salixarate. Likewise comparing Example 2 and Reference Example 3 again indicates the piston cleanliness properties of the composition of the invention.

[0108] Comparing Example 3 and Reference Example 4 indicates that the composition of the invention has piston cleanliness properties even in the presence of viscosity modifiers.

Test 2: Sludge and Wear Test

[0109] A sludge test M111ESL is carried out based on the Coordinating European Council (CEC) test method CEC-L-53-T-95. The test conditions used are conditions E of the test method. The test produces a sludge rating and the average engine Cam-wear scar (μm). The higher the sludge rating results the less sludge is formed in the engine and the lower wear scar values indicate decreased engine wear. The results obtained are:

Table 2: M111ESL Sludge and Wear Test Data

Example	Sludge Rating	Cam wear scar (μm)
Reference Example 4	9.0	3.3
Example 5	9.3	3.0

[0110] The results indicate the composition of the invention decreases sludge formation and engine wear.

Test 3 MB OM 441 LA Heavy Duty Diesel Cleanliness Test

[0111] The heavy duty diesel cleanliness test MB OM 441 LA is carried out based on the Coordinating European Council (CEC) test method CEC-L-52-T-97. The test produces engine cleanliness data and data associated with engine durability. The results obtained are:

Table 3: MB OM 441 LA Test Data

	Reference Example 5	Example 6
Average Engine Sludge (rating)	9.5	9.5
Piston Cleanliness Rating (rating)	34.6 (Fail)	40.0
General Deposit Cleanliness (demerit)	1.8	1.9
Average Wear scar (demerit)	1.9	2.0
Bore Polishing (%)	2.5	0.6
Average Cylinder Wear (mm)	n/a	0.0009
Ring Sticking 2 Piston Rings (ASF)	0.9	0.17
Specific Oil Consumption (g/h)	111.49 (Fail)	77.7
Boost Pressure Loss (Total %)	-2.87	-3.4

[0112] The results indicate the composition of the invention has improved piston cleanliness, decreased bore polishing and decreased oil consumption compared with the reference example. Other measurements shown in Table 3 are within acceptable limits.

[0113] Overall the composition of the invention improves engine cleanliness, improves detergency, decreases sludge formation, decrease wear, decreased bore polishing and decreased oil consumption.

[0114] In this specification the terms "hydrocarbyl substituent" or "hydrocarbyl group," as used herein are used in its ordinary sense, which is well-known to those skilled in the art. Specifically, it refers to a group primarily composed of carbon and hydrogen atoms and attached to the remainder of the molecule through a carbon atom and which does not exclude the presence of other atoms or groups in a proportion insufficient to detract from the molecule having a predominantly hydrocarbon character. In general, no more than two, in one aspect no more than one, non-hydrocarbon

substituent will be present for every ten carbon atoms in the hydrocarbyl group; typically, there will be no non-hydrocarbon substituents in the hydrocarbyl group. A more detailed definition of the terms "hydrocarbyl substituent" or "hydrocarbyl group," is provided in US Patent Number 6,583,092.

[0115] Each of the documents referred to above is incorporated herein by reference. Except in the Examples, or where otherwise explicitly indicated, all numerical quantities in this description specifying amounts of materials, reaction conditions, molecular weights, number of carbon atoms, and the like, are to be understood as modified by the word "about." Unless otherwise indicated, each chemical or composition referred to herein should be interpreted as being a commercial grade material which may contain the isomers, by-products, derivatives, and other such materials which are normally understood to be present in the commercial grade. However, the amount of each chemical component is presented exclusive of any solvent or diluent oil, which may be customarily present in the commercial material, unless otherwise indicated. It is to be understood that the upper and lower amount, range, and ratio limits set forth herein may be independently combined. Similarly, the ranges and amounts for each element of the invention may be used together with ranges or amounts for any of the other elements. As used herein, the expression "consisting essentially of" permits the inclusion of substances that do not materially affect the basic and novel characteristics of the composition under consideration.

[0116] Disclosed is:

1. A composition comprising:

(a) a detergent package comprising:

(i) a metal salixarate; and
(ii) optionally a detergent other than component (a)(i);

(b) a dispersant package comprising:

a. a dispersant with a carbonyl to nitrogen ratio of about 1 or higher; and
b. a dispersant with a carbonyl to nitrogen ratio of less than about 1;

(c) an antioxidant package comprising:

a. a hindered phenol; and

(d) an oil of lubricating viscosity,

wherein the composition has a phosphorus content of less than or equal to about 800 ppm; and wherein the sulphated ash content is less than or equal to about 1.1 weight percent of the composition.

2. The composition of item 1 further comprising a detergent other than component (a)(i).

3. The composition of item 1 further comprising a viscosity modifier.

4. The composition of item 3, wherein the viscosity modifier is a mixture of 2 copolymers derived from (A) a copolymer comprising 45 to 85 % by weight of units derived from ethylene, having a $\overline{M}_w$ of 50,000 to 300,000, $\overline{M}w/\overline{M}n$ less than 3, and a melting point of 0°C to 60°C; and (B) a block copolymer comprising a vinyl aromatic comonomer moiety and a second comonomer moiety.

5. The composition of item 1 further comprising a diphenylamine antioxidant, a molybdenum dithiocarbamate, a sulphurised olefin, or mixtures thereof.

6. The composition of item 1 further comprising a borate ester.

7. The composition of item 2, wherein the detergent other than component (a)(i) is selected from the group consisting of a sulphonate, a phenate, a sulphurised phenate, a carboxylate, a phosphate, a saligenin, and an alkylsalicylate.

8. The composition of item 7, wherein the detergent other than component (a)(i) is in the form of a metal salt.

9. The composition of item 8, wherein the metal salt is an alkaline earth metal.

10. The composition of item9, wherein the metal salt is present at about 550 ppm or less.

11. The composition of item 10, wherein the metal salt is calcium or magnesium.

12. The composition of item 2, wherein the detergent other than component (a)(i) is a magnesium saligenin, a calcium saligenin, a magnesium sulphonate, a calcium sulphonate or mixtures thereof.

13. The composition of claim 1 further comprising a metal hydrocarbyl dithiophosphate.

14. The composition of item 1 wherein the TBN/TAN ratio for the mixture of dispersants is about 3:1 to about 7:1

15. A process for the preparation of a composition comprising mixing:

(a) a detergent package comprising:

a. a metal salixarate; and
b. optionally a detergent other than component (a)(i);

(b) a dispersant package comprising:

a. a dispersant with a carbonyl to nitrogen ratio of about 1 or higher; and
b. a dispersant with a carbonyl to nitrogen ratio of less than about 1;

(c) an antioxidant package comprising:

a. a hindered phenol; and

(d) an oil of lubricating viscosity,

wherein the composition has a phosphorus content of less than or equal to about 800 ppm; and wherein the sulphated ash content is less than or equal to about 1.1 weight percent of the composition.

Claims

1. A composition comprising:

(a) a detergent package comprising:

(i) a metal salixarate; and
(ii) a detergent other than component (a)(i), wherein the detergent other than component (a)(i) is a magnesium saligenin, a calcium saligenin, a magnesium sulphonate, a calcium sulphonate or mixtures thereof;

(b) a dispersant package comprising:

a. a dispersant with a carbonyl to nitrogen ratio of 1 or higher; and
b. a dispersant with a carbonyl to nitrogen ratio of less than 1;

(c) an antioxidant package comprising:

a. a hindered phenol; and

(d) an oil of lubricating viscosity,

wherein the composition has a phosphorus content of less than or equal to 800 ppm; and wherein the sulphated ash content is less than or equal to 1.1 weight percent of the composition.

2. The composition of claim 1 further comprising a viscosity modifier.

3. The composition of claim 2, wherein the viscosity modifier is a mixture of 2 copolymers derived from (A) a copolymer comprising 45 to 85 % by weight of units derived from ethylene, having a Mw of 50,000 to 300,000 Mw/Mn less than 3, and a melting point of 0 °C to 60 °C; and (B) a block copolymer comprising a vinyl aromatic comonomer moiety and a second comonomer moiety.

4. The composition of claim 1 further comprising a diphenylamine antioxidant, a molybdenum dithiocarbamate, a sulphurised olefin, or mixtures thereof.

5. The composition of claim 1 further comprising a borate ester.

6. The composition of claim 2, wherein the detergent other than component (a)(i) is selected from the group consisting of a sulphonate, a phenate, a sulphurised phenate, a carboxylate, a phosphate, a saligenin, and an alkylsalicylate.

7. The composition of claim 1, wherein the detergent other than component (a)(i) is present at 550 ppm or less.

8. The composition of claim 1 further comprising a metal hydrocarbyl dithiophosphate.

9. The composition of claim 1 wherein the TBN/TAN ratio for the mixture of dispersants is 3:1 1 to 7:1.

10. A process for the preparation of a composition comprising mixing:

(a) a detergent package comprising:

(i) a metal salixarate; and
(ii) a detergent other than component (a)(i), wherein the detergent other than component (a)(i) is a magnesium saligenin, a calcium saligenin, a magnesium sulphonate, a calcium sulphonate or mixtures thereof;

(b) a dispersant package comprising:

a. a dispersant with a carbonyl to nitrogen ratio of 1 or higher; and
b. a dispersant with a carbonyl to nitrogen ratio of less than 1;

(c) an antioxidant package comprising:

a. a hindered phenol; and

(d) an oil of lubricating viscosity,

wherein the composition has a phosphorus content of less than or equal to 800 ppm; and wherein the sulphated ash content is less than or equal to 1.1 weight percent of the composition.

11. Use of the composition of any one of claims 1 to 9 form imparting at least one or more of improved engine cleanliness, improved detergency, decreased sludge formation, decreased wear, decreased bore polishing and decreased oil consumption.

REFERENCES CITED IN THE DESCRIPTION

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