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(54) LOW VISCOSITY ENGINE OILS CONTAINING ISOMERIZED ALKYL-HYDROXYBENZOATE DETERGENTS

NIEDRIGVISKOSE MOTORÖLE MIT ISOMERISIERTEN ALKYL-HYDROXYBENZOAT-DETERGENTIEN

HUILES DE MOTEUR À FAIBLE VISCOSITÉ CONTENANT DES DÉTERGENTS À BASE DE COMPOSÉS HYDROXYBENZOATES SUBSTITUES AVEC ALKYLE ISOMERISÉ

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(73) Proprietors:
- **Chevron Oronite Company LLC**
  San Ramon, CA 94583 (US)
- **Chevron Japan Ltd.**
  Tokyo 105-6218 (JP)

(72) Inventors:
- **BOFFA, Alexander Bowman**
  San Ramon
  CA 94583 (US)
- **WARD, Jacob Daniel**
  San Ramon
  California 94583 (US)
- **MILLER, Brendan P.**
  San Ramon
  CA 94583 (US)
- **TANAKA, Isao**
  Tokyo 105-6218 (JP)
- **OHKUBO, Hitoshi**
  Tokyo 105-6218 (JP)
- **KUBO, Koichi**
  Tokyo 105-6218 (JP)
- **MILLER, John Robert**
  San Ramon
  CA 94583 (US)
- **CAMPBELL, Curtis Bay**
  San Ramon
  California 94583 (US)

(74) Representative: **Haseltine Lake Kempner LLP**
Redcliff Quay
120 Redcliff Street
Bristol BS1 6HU (GB)

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EP 3 645 686 B1

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US-A1- 2016 215 234

Description

BACKGROUND

[0001] Engine oil is blended with various additives in order to satisfy various performance requirements. One well known way to increase fuel economy is to decrease the viscosity of the lubricating oil. However, this approach is now reaching the limits of current equipment capabilities and specifications.

[0002] The boundary friction regime is an important consideration in the design of low viscosity engine oils. Boundary friction occurs when the fluid film separating two surfaces becomes thinner than the height of asperities on the surfaces. The resulting surface to surface contact creates undesirable high friction and poor fuel economy in an engine. Boundary friction in an engine can occur under high loads, low engine speeds and at low oil viscosities. Low viscosity engine oils make the engine more susceptible to operating in boundary friction conditions due to the oil's thinner, less robust film. Because additives - not base oil - influence the coefficient of friction under boundary conditions, additives that demonstrate lower coefficients of friction under boundary conditions will give superior fuel economy in a low viscosity oil in an engine (i.e., less than 20 SAE grade). Second, it is also of high importance to have additives with superior low temperature performance to meet the demands of a 0W-XX lubricating oil which have more severe low temperature pumping and cranking requirements. JP 2013-170217 A discloses a low-viscosity lubricant composition having a HTHS viscosity at 150°C of 2.6 mPa.s or less, capable of sufficiently suppressing the rise of the friction coefficient in boundary lubrication area for providing excellent fuel-efficient property.

[0003] Despite the advances in lubricant oil formulation technology, there exists a need for a low viscosity engine oil lubricant possessing the benefits described above.

SUMMARY OF THE DISCLOSURE

[0004] This disclosure generally relates to a lubricating oil composition having a HTHS viscosity at 150°C in a range of 1.3 to 2.5 mPa.s (1.3 to 2.5 cP), comprising: (a) a major amount of an oil of lubricating viscosity having a kinematic viscosity at 100°C in a range of 1.5 to 6.0 mm^2/s; and (b) an overbased metal salt of an alkyl-substituted detergent as defined in the appended claims.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0005] To facilitate the understanding of the subject matter disclosed herein, a number of terms, abbreviations or other shorthand as used herein are defined below. Any term, abbreviation or shorthand not defined is understood to have the ordinary meaning used by a skilled artisan contemporaneous with the submission of this application.

Definitions:

[0006] In this specification, the following words and expressions, if and when used, have the meanings given below.

[0007] A "major amount" means in excess of 50 weight % of a composition.

[0008] A "minor amount" means less than 50 weight % of a composition, expressed in respect of the stated additive and in respect of the total mass of all the additives present in the composition, reckoned as active ingredient of the additive or additives.

[0009] "Active ingredients" or "actives" refers to additive material that is not diluent or solvent.

[0010] All percentages reported are weight % on an active ingredient basis (i.e., without regard to carrier or diluent oil) unless otherwise stated.

[0011] The term "phenate" means a salt of a phenol.

[0012] The abbreviation "ppm" means parts per million by weight, based on the total weight of the lubricating oil composition.

[0013] Total base number (TBN) was determined in accordance with ASTM D2896.

[0014] High temperature high shear (HTHS) viscosity at 150°C was determined in accordance with ASTM D4683.

[0015] Kinematic viscosity at 100°C (KV_{100}) was determined in accordance with ASTM D445.

[0016] Cold Cranking Simulator (CCS) viscosity at -35°C was determined in accordance with ASTM D5293.

[0017] Noack volatility was determined in accordance with ASTM D5800.

[0018] Boron, calcium, magnesium, molybdenum, phosphorus, sulfur, and zinc contents were determined in accordance with ASTM D5185.

[0019] Nitrogen content was determined in accordance with ASTM D4629.

[0020] Metal - The term "metal" refers to alkali metals, alkaline earth metals, or mixtures thereof.

[0021] Olefins - The term "olefins" refers to a class of unsaturated aliphatic hydrocarbons having one or more carbon-

carbon double bonds, obtained by a number of processes. Those containing one double bond are called mono-alkenes, and those with two double bonds are called dienes, alkyldienes, or diolefins. Alpha olefins are particularly reactive because the double bond is between the first and second carbons. Examples are 1-octene and 1-octadecene, which are used as the starting point for medium-biodegradable surfactants. Linear and branched olefins are also included in the definition of olefins.

[0022] Normal Alpha Olefins - The term "Normal Alpha Olefins" "refers to olefins which are straight chain, non-branched hydrocarbons with carbon-carbon double bond present in the alpha or primary position of the hydrocarbon chain.

[0023] Isomerized Normal Alpha Olefin. The term "Isomerized Normal Alpha Olefin" as used herein refers to an alpha olefin that has been subjected to isomerization conditions which results in an alteration of the distribution of the olefin species present and/or the introduction of branching along the alkyl chain. The isomerized olefin product may be obtained by isomerizing a linear alpha olefin containing from 10 to 40 carbon atoms, preferably from 20 to 28 carbon atoms, and preferably from 20 to 24 carbon atoms.

[0024] C_{10-40} Normal Alpha Olefins - This term defines a fraction of normal alpha olefins wherein the carbon numbers below 10 have been removed by distillation or other fractionation methods.

[0025] All ASTM standards referred to herein are the most current versions as of the filing date of the present application.

[0026] The present invention is defined in and by the appended claims.

Phenolic-based Alkylhydroxybenzoate Detergent

[0027] In one aspect of the present disclosure, the phenolic-based alkylhydroxybenzoate detergent is an isomerized olefin alkylhydroxybenzoate detergent.

[0028] In one aspect of the present disclosure, the TBN of the alkylhydroxybenzoate detergent derived from C_{10}-C_{40} isomerized NAO is 100-700, 100-650, 100-600, 100-500, 100-400, 100-300, 150-250, 175-250, 175-225 mg KOH/gram on oil free-basis.

[0029] In one aspect of the present disclosure, the alkylhydroxybenzoate detergent is derived from C_{10}-C_{40} isomerized NAO and has a TBN of from 10 to 300, preferably from 50 to 300, more preferably from 100 to 300, even more preferably from 150 to 300, and most preferably from 175 to 250 mgKOH/gram on active basis.

[0030] According to the present invention, the alkylhydroxybenzoate detergent derived from C_{10}-C_{40} isomerized NAO is a Ca alkylhydroxybenzoate detergent.

[0031] In one aspect of the present disclosure, the alkylhydroxybenzoate detergent derived from C_{10}-C_{40} isomerized NAO can be an alkylated hydroxybenzoate detergent. In another embodiment, the detergent can be a salicylate detergent.

[0032] In one aspect of the present disclosure, the alkylhydroxybenzoate derived from C_{10}-C_{40} isomerized NAO may be prepared as described in US Patent 8, 993,499

[0033] In one aspect of the present disclosure, the alkylhydroxybenzoate detergent is made from an alkylphenol having an alkyl group derived from an isomerized alpha olefin having from 14 to 28 carbon atoms per molecule, preferably from 20 to 24 carbon atoms, or preferably from 14 to 18 carbon atoms, or preferably from 20 to 28 carbon atoms per molecule.

[0034] In one aspect of the present disclosure, the alkylhydroxybenzoate derived from C_{10}-C_{40} isomerized NAO is made from an alkylphenol with an alkyl group derived from an isomerized NAO having an isomerization level (I) from 0.10 to 0.40, preferably from 0.10 to 0.35, preferably from 0.10 to 0.30, preferably from 0.12 to 0.30. and more preferably from 0.12 to 0.20.

[0035] In one aspect of the present disclosure, the alkylhydroxybenzoate derived from C_{10}-C_{40} isomerized NAO is made from one or more alkylphenols with an alkyl group derived from C_{10}-C_{40} isomerized NAO and one or more alkylphenols with an alkyl group different from C_{10}-C_{40} isomerized NAO.

[0036] In one aspect of the present disclosure, the isomerized NAO of the alkylhydroxybenzoate detergent has an isomerization level of 0.16, and have from 20 to 24 carbon atoms.

[0037] In one aspect of the present disclosure, the isomerized NAO of the alkylhydroxybenzoate detergent has an isomerization level of 0.26, and have from 20 to 24 carbon atoms.

[0038] In one aspect of the present disclosure, the lubricating oil composition comprises 0.01 to 2.0 wt.% in terms of Ca content of the alkylhydroxybenzoate derived from C_{10}-C_{40} isomerized NAO, preferably 0.1 to 1.0 wt. %, more preferably 0.05 to 0.5 wt. %, more preferably 0.1 to 0.5 wt.%.

[0039] In one aspect of the present disclosure, the lubricating oil composition comprising the alkylhydroxybenzoate detergent derived from C_{10}-C_{40} isomerized NAO is an automotive engine oil composition, a gas engine oil composition, a dual fuel engine oil composition, a mobile gas engine oil composition, or a locomotive engine oil composition.

[0040] In one aspect of the present disclosure, the lubricating oil composition comprising the alkylhydroxybenzoate detergent derived from C_{10}-C_{40} isomerized NAO is a functional fluid for automotive and industrial applications, such as transmission oil, hydraulic oil, tractor fluid, gear oil, and the like.

[0041] In one aspect of the present disclosure, the lubricating oil composition comprising the alkylhydroxybenzoate detergent derived from C_{10}-C_{40} isomerized NAO is a multi-grade oil or mono-grade oil.

[0042] In one aspect of the present disclosure, the lubricating oil composition comprising the alkylhydroxybenzoate detergent derived from C_{10}-C_{40} isomerized NAO lubricates crankcases, gears, as well as clutches.

Phenolic-based Phenate Detergent (embodiment not according to present invention)

[0043] In one aspect the phenolic-based detergent is an isomerized olefin phenate detergent.

[0044] In one aspect the isomerized olefin phenate detergent has a TBN of 100-600, 150-500, 150-450, 200-450, 250-450, 300-450, 300- 400, 325-425, 350-425, 350-400 mgKOH/gram on an oil free basis.

[0045] In one aspect the phenolic-based detergent is an alkylated phenate detergent wherein the alkyl group is derived from an isomerized normal alpha olefin having from 10 to 40 carbon atoms per molecule.

[0046] In one aspect the phenolic-based detergent has an isomerization level (I) of the normal alpha olefin is between from about 0.10 to about 0.40, preferably from about 0.10 to about 0.30, preferably from about 0.12 to about 0.30, and more preferably from about 0.22 to about 0.30.

[0047] In one aspect the phenate detergent is a sulfurized phenate detergent.

[0048] In one aspect the isomerized olefin phenate detergent can be prepared as described in US Patent 8,580,717.

[0049] In one aspect the alkyl group is derived from an isomerized alpha olefin having from 14 to 30, from 16 to 30, from 18 to 30, from 20 to 28, 20 to 24, or from 18 to 28 carbon atoms per molecule.

[0050] The isomerization level of the alpha olefin is about 0.26, and having from 20 to 24 carbon atoms.

Oil of Lubricating Viscosity

[0051] The oil of lubricating viscosity (sometimes referred to as "base stock" or "base oil") is the primary liquid constituent of a lubricant, into which additives and possibly other oils are blended, for example to produce a final lubricant (or lubricant composition). A base oil is useful for making concentrates as well as for making lubricating oil compositions therefrom, and may be selected from natural and synthetic lubricating oils and combinations thereof.

[0052] Natural oils include animal and vegetable oils, liquid petroleum oils and hydrorefined, solvent-treated mineral lubricating oils of the paraffinic, naphthenic and mixed paraffinic-naphthenic types. Oils of lubricating viscosity derived from coal or shale are also useful base oils.

[0053] Synthetic lubricating oils include hydrocarbon oils such as polymerized and interpolymerized olefins (e.g., polybutylenes, polypropylenes, propylene-isobutylene copolymers, chlorinated polybutylenes, poly(1-hexenes), poly(1-octenes), poly(1-decenes); alkylbenzenes (e.g., dodecylbenzenes, tetradecylbenzenes, dinonylbenzenes, di(2-ethylhexyl)benzenes; polyphenols (e.g., biphenyls, terphenyls, alkylated polyphenols); and alkylated diphenyl ethers and alkylated diphenyl sulfides and the derivatives, analogues and homologues thereof.

[0054] Another suitable class of synthetic lubricating oils comprises the esters of dicarboxylic acids (e.g., malonic acid, alkyl malonic acids, alkenyl malonic acids, succinic acid, alkyl succinic acids and alkenyl succinic acids, maleic acid, fumaric acid, azelaic acid, suberic acid, sebacic acid, adipic acid, linoleic acid dimer, phthalic acid) with a variety of alcohols (e.g., butyl alcohol, hexyl alcohol, dodecyl alcohol, 2-ethylhexyl alcohol, ethylene glycol, diethylene glycol monoether, propylene glycol). Specific examples of these esters include dibutyl adipate, di(2-ethylhexyl) sebacate, di-*n*-hexyl fumarate, dioctyl sebacate, diisooctyl azelate, diisodecyl azelate, dioctyl phthalate, didecyl phthalate, dieicosyl sebacate, the 2-ethylhexyl diester of linoleic acid dimer, and the complex ester formed by reacting one mole of sebacic acid with two moles of tetraethylene glycol and two moles of 2-ethylhexanoic acid.

[0055] Esters useful as synthetic oils also include those made from C_5 to C_{12} monocarboxylic acids and polyols, and polyol ethers such as neopentyl glycol, trimethylolpropane, pentaerythritol, dipentaerythritol and tripentaerythritol.

[0056] The base oil may be derived from Fischer-Tropsch synthesized hydrocarbons. Fischer-Tropsch synthesized hydrocarbons are made from synthesis gas containing H_2 and CO using a Fischer-Tropsch catalyst. Such hydrocarbons typically require further processing in order to be useful as the base oil. For example, the hydrocarbons may be hydroisomerized; hydrocracked and hydroisomerized; dewaxed; or hydroisomerized and dewaxed; using processes known to those skilled in the art.

[0057] Unrefined, refined and re-refined oils can be used in the present lubricating oil composition. Unrefined oils are those obtained directly from a natural or synthetic source without further purification treatment. For example, a shale oil obtained directly from retorting operations, a petroleum oil obtained directly from distillation or ester oil obtained directly from an esterification process and used without further treatment would be unrefined oil. Refined oils are similar to unrefined oils except they have been further treated in one or more purification steps to improve one or more properties. Many such purification techniques, such as distillation, solvent extraction, acid or base extraction, filtration and percolation are known to those skilled in the art. Re-refined oils are obtained by processes similar to those used to obtain refined oils applied to refined oils which have been already used in service. Such re-refined oils are also known as reclaimed or reprocessed oils and often are additionally processed by techniques for approval of spent additive and oil breakdown products.

[0058] Hence, the base oil which may be used to make the present lubricating oil composition may be selected from any of the base oils in Groups I-V as specified in the American Petroleum Institute (API) Base Oil Interchangeability Guidelines (API Publication 1509). Such base oil groups are summarized in Table 1 below:

Table 1

	Base Oil Properties		
Group$^{(a)}$	Saturates$^{(b)}$, wt. %	Sulfur$^{(c)}$, wt. %	Viscosity Index$^{(d)}$
Group I	<90 and/or	>0.03	80 to <120
Group II	≥90	≤0.03	80 to <120
Group III	≥90	≤0.03	≥120
Group IV	Polyalphaolefins (PAOs)		
Group V	All other base stocks not included in Groups I, II, III or IV		

$^{(a)}$ Groups I-III are mineral oil base stocks.
$^{(b)}$ Determined in accordance with ASTM D2007.
$^{(c)}$ Determined in accordance with ASTM D2622, ASTM D3120, ASTM D4294 or ASTM D4927.
$^{(d)}$ Determined in accordance with ASTM D2270.

[0059] Base oils suitable for use herein are any of the variety corresponding to API Group II, Group III, Group IV, and Group V oils and combinations thereof, preferably the Group III to Group V oils due to their exceptional volatility, stability, viscometric and cleanliness features.

[0060] The base oil constitutes the major component of the present lubricating oil composition and is present is an amount ranging from greater than 50 to 99 wt. % (e.g., 70 to 95 wt. %, or 85 to 95 wt. %).

[0061] The base oil may be selected from any of the synthetic or natural oils typically used as crankcase lubricating oils for spark-ignited internal combustion engines. The base oil typically has a kinematic viscosity at 100°C in a range of 1.5 to 6 mm^2/s. In the case where the kinematic viscosity at 100°C of the lubricating base oil exceeds 6 mm^2/s, low temperature viscosity properties may be reduced, and sufficient fuel efficiency may not be obtained. At a kinematic viscosity of 1.5 mm^2/s or less, formation of an oil film in a lubrication place is insufficient; for this reason, lubrication is inferior, and the evaporation loss of the lubricating oil composition may be increased.

[0062] Preferably, the base oil has a viscosity index of at least 90 (e.g., at least 95, at least 105, at least 110, at least 115, or at least 120). If the viscosity index is less than 90, not only viscosity-temperature properties, heat and oxidation stability, and anti-volatilization are reduced, but also the coefficient of friction tends to be increased; and resistance against wear tends to be reduced.

Lubricating Oil Composition

[0063] The lubricating oil composition may be a multi-grade oil identified by the viscosity grade descriptor SAE 0W-X, wherein X represents any one of 8, 12, and 16.

[0064] The lubricating oil composition has a high temperature shear (HTHS) viscosity at 150°C of 2.3 cP or less (e.g., 1.0 to 2.6 cP, or 1.3 to 2.3 cP), such as 2.0 cP or less (e.g., 1.0 to 2.0 cP, or 1.3 to 2.3 cP), or even 1.7 cP or less (e.g., 1.0 to 1.7 cP, or 1.3 to 1.7 cP).

[0065] The lubricating oil composition has a viscosity index of at least 135 (e.g., 135 to 400, or 135 to 250), at least 150 (e.g., 150 to 400, 150 to 250), at least 165 (e.g., 165 to 400, or 165 to 250), at least 190 (e.g., 190 to 400, or 190 to 250), or at least 200 (e.g., 200 to 400, or 200 to 250). If the viscosity index of the lubricating oil composition is less than 135, it may be difficult to improve fuel efficiency while maintaining the HTHS viscosity at 150°C. If the viscosity index of the lubricating oil composition exceeds 400, evaporation properties may be reduced, and deficits due to insufficient solubility of the additive and matching properties with a seal material may be caused.

[0066] The lubricating oil composition has a kinematic viscosity at 100°C in a range of 3 to 12 mm^2/s (e.g., 3 to 8.2 mm^2/s, 3.5 to 8.2 mm^2/s, or 4 to 8.2 mm^2/s).

[0067] In general, the level of sulfur in the lubricating oil compositions of the present invention is less than or equal to about 0.7 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of sulfur of about 0.01 wt. % to about 0.70 wt. %, 0.01 to 0.6 wt.%, 0.01 to 0.5 wt.%, 0.01 to 0.4 wt.%, 0.01 to 0.3 wt.%, 0.01 to 0.2 wt.%, 0.01 wt. % to 0.10 wt. %. In one embodiment, the level of sulfur in the lubricating oil compositions of the present invention is less than or equal to about 0.60 wt. %, less than or equal to about 0.50 wt. %, less than or equal to about 0.40 wt. %, less than or equal to about 0.30 wt. %, less than or equal to about 0.20 wt. %, less than or equal to about 0.10 wt. % based on the total weight of the lubricating oil composition.

[0068] In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.12 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of phosphorus of about 0.01 wt. % to about 0.12 wt. %. In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.11 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of phosphorus of about 0.01 wt. % to about 0.11 wt. %. In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.10 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of phosphorus of about 0.01 wt. % to about 0.10 wt. %. In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.09 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of phosphorus of about 0.01 wt. % to about 0.09 wt. %. In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.08 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of phosphorus of about 0.01 wt. % to about 0.08 wt. %. In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.07 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of phosphorus of about 0.01 wt. % to about 0.07 wt. %. In one embodiment, the levels of phosphorus in the lubricating oil compositions of the present invention is less than or equal to about 0.05 wt. %, based on the total weight of the lubricating oil composition, e.g., a level of phosphorus of about 0.01 wt. % to about 0.05 wt. %.

[0069] In one embodiment, the level of sulfated ash produced by the lubricating oil compositions of the present invention is less than or equal to about 1.60 wt. % as determined by ASTM D 874, e.g., a level of sulfated ash of from about 0.10 to about 1.60 wt. % as determined by ASTM D 874. In one embodiment, the level of sulfated ash produced by the lubricating oil compositions of the present invention is less than or equal to about 1.00 wt. % as determined by ASTM D 874, e.g., a level of sulfated ash of from about 0.10 to about 1.00 wt. % as determined by ASTM D 874. In one embodiment, the level of sulfated ash produced by the lubricating oil compositions of the present invention is less than or equal to about 0.80 wt. % as determined by ASTM D 874, e.g., a level of sulfated ash of from about 0.10 to about 0.80 wt. % as determined by ASTM D 874. In one embodiment, the level of sulfated ash produced by the lubricating oil compositions of the present invention is less than or equal to about 0.60 wt. % as determined by ASTM D 874, e.g., a level of sulfated ash of from about 0.10 to about 0.60 wt. % as determined by ASTM D 874.

[0070] Suitably, the present lubricating oil composition may have a total base number (TBN) of 4 to 15 mg KOH/g (e.g., 5 to 12 mg KOH/g, 6 to 12 mg KOH/g, or 8 to 12 mg KOH/g).

Viscosity Modifier

[0071] The lubricating oil composition may also include a viscosity modifier. Viscosity modifiers function to impart high and low temperature operability to a lubricating oil. The viscosity modifier used may have that sole function, or may be multifunctional. Multifunctional viscosity modifiers that also function as dispersants are also known. Suitable viscosity modifiers include polyisobutylene, copolymers of ethylene and propylene and higher alpha-olefins, polymethacrylates, polyalkylmethacrylates, methacrylate copolymers, copolymers of an unsaturated dicarboxylic acid and a vinyl compound, interpolymers of styrene and acrylic esters, and partially hydrogenated copolymers of styrene/isoprene, styrene/butadiene, and isoprene/butadiene, as well as the partially hydrogenated homopolymers of butadiene and isoprene and isoprene/divinylbenzene. In one embodiment, the viscosity modifier is a polyalkylmethacrylate. The topology of the viscosity modifier could include, but is not limited to, linear, branched, hyperbranched, star, or comb topology.

[0072] Suitable viscosity modifiers have a Permanent Shear Stability Index (PSSI) of 30 or less (e.g., 10 or less, 5 or less, or even 2 or less). PSSI is a measure of the irreversible decrease, resulting from shear, in an oil's viscosity contributed by an additive. PSSI is determined according to ASTM D6022. The lubricating oil compositions of the present disclosure display stay-in-grade capability. Retention of kinematic viscosity at 100°C within a single SAE viscosity grade classification by a fresh oil and its sheared version is evidence of an oil's stay-in-grade capability.

[0073] The viscosity modifier may be used in an amount of from 0.5 to 15.0 wt. % (e.g., 0.5 to 10 wt. %, 0.5 to 5 wt. %, 1.0 to 15 wt. %, 1.0 to 10 wt. %, or 1.0 to 5 wt. %), based on the total weight of the lubricating oil composition. In one embodiment, a viscosity modifier is not present in the lubricating oil compositions described herein.

Additional Lubricating Oil Additives

[0074] The lubricating oil compositions of the present disclosure may also contain other conventional additives that can impart or improve any desirable property of the lubricating oil composition in which these additives are dispersed or dissolved. Any additive known to a person of ordinary skill in the art may be used in the lubricating oil compositions disclosed herein. Some suitable additives have been described in Mortier et al., "Chemistry and Technology of Lubricants", 2nd Edition, London, Springer, (1996); and Leslie R. Rudnick, "Lubricant Additives: Chemistry and Applications", New York, Marcel Dekker (2003),

[0075] For example, the lubricating oil compositions can be blended with antioxidants, anti-wear agents, detergents such as metal detergents, rust inhibitors, dehazing agents, demulsifying agents, metal deactivating agents, friction modifiers, pour point depressants, antifoaming agents, co-solvents, corrosion-inhibitors, ashless dispersants, multifunctional agents, dyes, extreme pressure agents and the like and mixtures thereof. A variety of the additives are known and commercially available. These additives, or their analogous compounds, can be employed for the preparation of the lubricating oil compositions of the disclosure by the usual blending procedures.

[0076] In the preparation of lubricating oil formulations it is common practice to introduce the additives in the form of 10 to 100 wt. % active ingredient concentrates in hydrocarbon oil, e.g. mineral lubricating oil, or other suitable solvent.

[0077] Usually these concentrates may be diluted with 3 to 100, e.g., 5 to 40, parts by weight of lubricating oil per part by weight of the additive package in forming finished lubricants, e.g. crankcase motor oils. The purpose of concentrates, of course, is to make the handling of the various materials less difficult and awkward as well as to facilitate solution or dispersion in the final blend.

[0078] Each of the foregoing additives, when used, is used at a functionally effective amount to impart the desired properties to the lubricant. Thus, for example, if an additive is a friction modifier, a functionally effective amount of this friction modifier would be an amount sufficient to impart the desired friction modifying characteristics to the lubricant.

[0079] In general, the concentration of each of the additives in the lubricating oil composition, when used, may range from about 0.001 wt. % to about 20 wt. %, from about 0.01 wt. % to about 15 wt. %, or from about 0.1 wt. % to about 10 wt. %, from about 0.005 wt.% to about 5 wt.%, or from about 0.1 wt.% to about 2.5 wt.%, based on the total weight of the lubricating oil composition. Further, the total amount of the additives in the lubricating oil composition may range from about 0.001 wt.% to about 20 wt.%, from about 0.01 wt.% to about 10 wt.%, or from about 0.1 wt.% to about 5 wt.%, based on the total weight of the lubricating oil composition.

[0080] The following examples are presented to exemplify embodiments of the disclosure but are not intended to limit the disclosure to the specific embodiments set forth. Unless indicated to the contrary, all parts and percentages are by weight. Specific details described in each example should not be construed as necessary features of the disclosure.It will be understood that various modifications may be made to the embodiments disclosed herein. Therefore the above description should not be construed as limiting, but merely as exemplifications of preferred embodiments. For example, the functions described above and implemented as the best mode for operating the present disclosure are for illustration purposes only.

EXAMPLES

[0081] The following examples are intended for illustrative purposes only and do not limit in any way the scope of the present disclosure.

[0082] The isomerization level was measured by an NMR method.

Isomerization level (I) and NMR method

[0083] The isomerization level (I) of the olefin was determined by hydrogen-1 (1H) NMR. The NMR spectra were obtained on a Bruker Ultrashield Plus 400 in chloroform-d1 at 400 MHz using TopSpin 3.2 spectral processing software.

[0084] The isomerization level (I) represents the relative amount of methyl groups ($-CH_3$) (chemical shift 0.30-1.01 ppm) attached to the methylene backbone groups ($-CH_2-$) (chemical shift 1.01-1.38 ppm) and is defined by Equation (1) as shown below,

[0085] $I = m/(m+n)$ Equation (1) where m is NMR integral for methyl groups with chemical shifts between 0.30 ± 0.03 to 1.01 ± 0.03 ppm, and n is NMR integral for methylene groups with chemical shifts between 1.01 ± 0.03 to 1.38 ± 0.10 ppm.

[0086] Example A and Examples 1-6 are embodiments not according to the present invention.

Example A

[0087] An alkylated phenol and alkylated phenate were prepared in substantially the same manner as in U.S. Patent No. 8,580,717 using a C_{20-24} isomerized normal alpha olefin. The isomerization level of the alpha olefin is about 0.26. The resulting product calcium content was 9.66%; 3.41% of sulfur, 8.2% unreacted alkylphenol and had a kinematic viscosity at 100° C. of 319 cSt. The estimated TBN was about 400 mg KOH/g on an oil free basis. The diluent oil was 35 wt. %.

Comparative Example A

[0088] An alkylated phenol and alkylated phenate were prepared using a propylene tetramer available from Chevron

Oronite. The resulting product calcium content was 9.66%; 3.41% of sulfur, 8.2% unreacted alkylphenol and had a kinematic viscosity at 100° C. of 319 cSt. The TBN was 380 mg KOH/g on an actives basis. The diluent oil was 31.4 wt. %.

Baseline 1

[0089] A lubricating oil composition was prepared that contained a major amount of a base oil of lubricating viscosity and the following additives, to provide a finished oil having a HTHS viscosity at 150°C of 1.4 cP:

(1) an ethylene carbonate post-treated bis-succinimide;
(2) a borated bis-succinimide dispersant;
(3) 0.10 wt. % in terms of calcium content of an overbased calcium sulfonate detergent;
(4) 0.05 wt. % in terms of magnesium content, of an overbased magnesium sulfonate detergent;
(5) 770 ppm in terms of phosphorus content, of a mixture of a primary zinc dialkyldithiophosphate and a secondary zinc dialkyldithiophosphate;
(6) a sulfurized molybdenum succinimide complex;
(7) a borated organic friction modifier;
(8) an alkylated diphenylamine antioxidant;
(9) a foam inhibitor;
(10) 2.5 wt. % of a non-dispersant polyalkylmethacrylate comb viscosity modifier having a PSSI of 1; and
(11) the remainder, a Group II base oil (YUBASE® 2).

Example 1

[0090] To formulation baseline 1 was added 0.04 wt. % in terms of calcium content, of a calcium phenate detergent of Example A.

Comparative Example 1

[0091] To formulation baseline 1 was added 0.04 wt. % in terms of calcium content, of a calcium phenate detergent of Comparative Example A.

Baseline 2

[0092] A lubricating oil composition was prepared that contained a major amount of a base oil of lubricating viscosity and the following additives, to provide an SAE 0W-8 finished oil:

(1) an ethylene carbonate post-treated bis-succinimide;
(2) a borated bis-succinimide dispersant;
(3) 0.10 wt. % in terms of calcium content of an overbased calcium sulfonate detergent;
(4) 0.05 wt. % in terms of magnesium content, of an overbased magnesium sulfonate detergent;
(5) 770 ppm in terms of phosphorus content, of a mixture of a primary zinc dialkyldithiophosphate and a secondary zinc dialkyldithiophosphate;
(6) a sulfurized molybdenum succinimide complex;
(7) a borated organic friction modifier;
(8) an alkylated diphenylamine antioxidant;
(9) a foam inhibitor;
(10) 3.0 wt. % of a non-dispersant polyalkylmethacrylate viscosity modifier having a PSSI of 1; and
(11) the remainder, a Group II base oil (YUBASE® 3).

Example 2

[0093] To formulation baseline 2 was added 0.04 wt. % in terms of calcium content, of a calcium phenate detergent of Example A.

Comparative Example 2

[0094] To formulation baseline 2 was added 0.04 wt. % in terms of calcium content, of a calcium phenate detergent of Comparative Example A.

Baseline 3

[0095] A lubricating oil composition was prepared that contained a major amount of a base oil of lubricating viscosity and the following additives, to provide an SAE 0W-12 finished oil:

(1) an ethylene carbonate post-treated bis-succinimide;
(2) a borated bis-succinimide dispersant;
(3) 0.10 wt. % in terms of calcium content of an overbased calcium sulfonate detergent;
(4) 0.05 wt. % in terms of magnesium content, of an overbased magnesium sulfonate detergent;
(5) 770 ppm in terms of phosphorus content, of a mixture of a primary zinc dialkyldithiophosphate and a secondary zinc dialkyldithiophosphate;
(6) a sulfurized molybdenum succinimide complex;
(7) a borated organic friction modifier;
(8) an alkylated diphenylamine antioxidant;
(9) a foam inhibitor;
(10) 2.0 wt. % of a non-dispersant polyalkylmethacrylate viscosity modifier having a PSSI of 1; and
(11) the remainder, a Group III base oil (YUBASE® 4).

Example 3

[0096] To formulation baseline 3 was added 0.04 wt. % in terms of calcium content, of a calcium phenate detergent of Example A.

Comparative Example 3

[0097] To formulation baseline 3 was added 0.04 wt. % in terms of calcium content, of a calcium phenate detergent of Comparative Example A.

Baseline 4

[0098] A lubricating oil composition was prepared that contained a major amount of a base oil of lubricating viscosity and the following additives, to provide a finished oil having a HTHS viscosity at 150°C of 1.4 cP:

(1) an ethylene carbonate post-treated bis-succinimide;
(2) a borated bis-succinimide dispersant;
(3) 0.05 wt. % in terms of magnesium content, of an overbased magnesium sulfonate detergent;
(4) 770 ppm in terms of phosphorus content, of a mixture of a primary zinc dialkyldithiophosphate and a secondary zinc dialkyldithiophosphate;
(5) an alkylated diphenylamine antioxidant;
(6) a sulfurized molybdenum succinimide complex;
(7) a borated organic friction modifier;
(8) a foam inhibitor;
(9) 2.5 wt. % of a non-dispersant polyalkylmethacrylate comb viscosity modifier having a PSSI of 1; and
(10) the remainder, a Group II base oil (YUBASE® 2).

Example 4

[0099] To formulation baseline 4 was added 0.14 wt. % in terms of calcium content, of a calcium phenate detergent of Example A.

Comparative Example 4

[0100] To formulation baseline 4 was added 0.14 wt. % in terms of calcium content, of a calcium phenate detergent of Comparative Example A.

Baseline 5

[0101] A lubricating oil composition was prepared that contained a major amount of a base oil of lubricating viscosity and the following additives, to provide an SAE 0W-8 finished oil:

(1) an ethylene carbonate post-treated bis-succinimide;
(2) a borated bis-succinimide dispersant;
(3) 0.05 wt. % in terms of magnesium content, of an overbased magnesium sulfonate detergent;
(4) 770 ppm in terms of phosphorus content, of a mixture of a primary zinc dialkyldithiophosphate and a secondary zinc dialkyldithiophosphate;
(5) an alkylated diphenylamine antioxidant;
(6) a sulfurized molybdenum succinimide complex;
(7) a borated organic friction modifier;
(8) a foam inhibitor;
(9) 3.0 wt. % of a non-dispersant polyalkylmethacrylate viscosity modifier having a PSSI of 1; and
(10) the remainder, a Group II base oil (YUBASE® 3).

Example 5

[0102] To formulation baseline 5 was added 0.14 wt. % in terms of calcium content, of a calcium phenate detergent of Example A.

Comparative Example 5

[0103] To formulation baseline 5 was added 0.14 wt. % in terms of calcium content, of a calcium phenate detergent of Comparative Example A.

Baseline 6

[0104] A lubricating oil composition was prepared that contained a major amount of a base oil of lubricating viscosity and the following additives, to provide an SAE 0W-12 finished oil:

(1) an ethylene carbonate post-treated bis-succinimide;
(2) a borated bis-succinimide dispersant;
(3) 0.05 wt. % in terms of magnesium content, of an overbased magnesium sulfonate detergent;
(4) 770 ppm in terms of phosphorus content, of a mixture of a primary zinc dialkyldithiophosphate and a secondary zinc dialkyldithiophosphate;
(5) an alkylated diphenylamine antioxidant;
(6) a sulfurized molybdenum succinimide complex;
(7) a borated organic friction modifier;
(8) a foam inhibitor;
(9) 2.0 wt. % of a non-dispersant polyalkylmethacrylate viscosity modifier having a PSSI of 1; and
(10) the remainder, a Group III base oil (YUBASE® 4).

Example 6

[0105] To formulation baseline 6 was added 0.14 wt. % in terms of calcium content, of a calcium phenate detergent of Example A.

Comparative Example 6

[0106] To formulation baseline 6 was added 0.14 wt. % in terms of calcium content, of a calcium phenate detergent of Comparative Example A.

Example B

[0107] An alkylated phenol and alkylhydroxybenzoate were prepared in substantially the same manner as in U.S. Patent No. 8,993,499 using a C_{20-24} isomerized normal alpha olefin. The isomerization level of the alpha olefin is about 0.16. The additive contained 6.4 wt. % Ca, and about 20 wt. % diluent oil, and had a TBN of about 180 mgKOH/g and a basicity index of about 2.4. On an actives basis, the TBN of this additive is about 225 mgKOH/g.

Comparative Example B

[0108] An alkylhydroxybenzoate was prepared from an alkylphenol with an alkyl group derived from C_{14-18} normal alpha olefin with at least 60 mol. % of said alkyl group having a carbon atom number in the range of 14 to 18. The Ca wt% in the alkylhydroxybenzoate is about 6.4 and a TBN of 297 mgKOH/g on an actives basis. The diluent oil was 41 wt%.

Baseline 7

[0109] A lubricating oil composition was prepared that contained a major amount of a base oil of lubricating viscosity and the following additives, to provide an SAE 0W-8 finished oil:

(1) an ethylene carbonate post-treated bis-succinimide;
(2) a borated bis-succinimide dispersant;
(4) 770 ppm in terms of phosphorus content, of a mixture of a primary zinc dialkyldithiophosphate and a secondary zinc dialkyldithiophosphate;
(5) an alkylated diphenylamine;
(6) a sulfurized molybdenum succinimide complex;
(7) a borated organic friction modifier;
(8) 5 ppm in terms of silicon content, of a foam inhibitor;
(9) 0 wt. % VII and 0.4 wt. % PPD; and
(10) the remainder, a Group III base oil (YUBASE® 4).

Example 7

[0110] To formulation baseline 7 was added 0.18 wt. % in terms of calcium content, of a calcium alkylhydroxybenzoate detergent of Example B.

Comparative Example 7

[0111] To formulation baseline 7 was added 0.18 wt. % in terms of calcium content, of a high overbased calcium sulfonate detergent.

Comparative Example 8

[0112] To formulation baseline 7 was added 0.18 wt. % in terms of calcium content, of a calcium alkylhydroxybenzoate detergent of Comparative Example B.

ASTM D4684 Mini-Rotary Viscometer Test (MRV)

[0113] In this test, a test oil is first heated, and then cooled to test temperature, in this case -40° C., in a mini-rotary viscometer cell. Each cell contains a calibrated rotor-stator set, in which the rotor is rotated by means of a string wound around the rotor shaft and attached to a weight. A series of increasing weights are applied to the string starting with a 10 g weight until rotation occurs to determine the yield stress. Results are reported as Yield Stress as the applied force in Pascals. A 150 g weight is then applied to determine the apparent viscosity of the oil. The larger the apparent viscosity, the more likely it is that the oil will not be continuously and adequately supplied to the oil pump inlet. Results are reported as Viscosity in centipoise.
The results of the MRV test for each of the lubricating oil compositions are set forth below in Table2.

Scanning Brookfield

[0114] Scanning Brookfield Viscosity: ASTM D 5133 is used to measure the low temperature, low shear rate, viscosity/temperature dependence of engine oils. The low temperature, low shear viscometric behavior of an engine oil determines whether the oil will flow to the sump inlet screen, then to the oil pump, then to the sites in the engine requiring lubrication in sufficient quantity to prevent engine damage immediately or ultimately after cold temperature starting. ASTM D 5133, the Scanning Brookfield Viscosity technique, measures the Brookfield viscosity of a sample as it is cooled at a constant rate of 1° C./hour. Like the MRV, ASTM D 5133 is intended to relate to an oil's pumpability at low temperatures. The test reports the temperature at which the sample reaches 40,000 cP or the viscosity at - 40 °C. The gelation index is also reported, and is defined as the largest rate of change of viscosity increase from -5° C. to the lowest test temperature.

The current API SL/ILSAC GF-5 specifications for passenger car engine oils require a maximum gelation index of 12. Results are shown below in Table 2.

Pour Point (JIS K 2269)

[0115] A 45 ml sample is warmed in a test tube up to 45 °C and cooled by a specified method. The test tube is taken from the cooling bath each time the temperature of the sample drops by 2.5 °C, the temperature at which the sample stays thoroughly motionless for 5 sec. is read and 2.5 °C is added to this value and the result is taken as the pour point.

Table 2

	Comp. Ex. 1	Ex. 1	Comp. Ex. 2	Ex. 2	Comp. Ex. 3	Ex. 3
Kinematic Viscosity (100°C), mm^2/s	3.789	3.791	4.707	4.707	5.676	5.681
Viscosity Index	194	195	193	193	165	165
CCS Viscosity (-35°C), cP	1010	1008	1906	1891	4361	4388
HTHS Viscosity (150°C), cP	1.42	1.41	1.75	1.75	2.07	2.07
MRV						
Yield Stress (- 40 °C) Pa	No Yield Stress	No Yield Stress	No Yield Stress	No Yield Stress	210 <Y ≤ 245	140 <Y ≤ 175
Viscosity (- 40 °C) mPa s	1,826	1,842	3,513	3,577	589,253	282,118
Scanning Brookfield						
Viscosity (mPa s @ °C)	1,913 @-39.9	1,886 @-39.9	3,628 @-40.0	3,266 @-40.0	104,563 @-33.3	105,254 @-33.3
Gelation Index (@°C)	3.6 @-38.1	3.7 @-38.4	5.6 @-33.9	5.0 @-35.9	12.6 @-28.1	14.6 @-29.4
Pour Point (JIS K 2269)						
°C	≤ -57.5	≤ -57.5	-47.5	-47.5	-22.5	-22.5
	Comp. Ex. 4	Ex. 4	Comp. Ex. 5	Ex. 5	Comp. Ex. 6	Ex. 6
Kinematic Viscosity (100°C), mm^2/s	3.834	3.841	4.780	4.790	5.749	5.759
Viscosity Index	193	193	195	196	166	166
CCS Viscosity (-35°C), cP	1046	1037	1964	1955	4544	4552
HTHS Viscosity (150°C), cP	1.42	1.42	1.72	1.74	2.06	2.07
MRV						
Yield Stress (- 40 °C) Pa	No Yield Stress	No Yield Stress	No Yield Stress	No Yield Stress	245 <Y ≤ 280	210 <Y≤ 245
Viscosity (- 40 °C) mPa s	1,914	1,888	4,225	3,772	609,321	555,107
Scanning Brookfield						
Viscosity (mPa s @ °C)	2,202 @-40.1	1,655 @-39.9	4,114 @-40.1	3,680 @-40.1	105,254 @-36.6	104,563 @-36.0

(continued)

Scanning Brookfield						
Gelation Index (@°C)	5.5 @-38.0	No detection	5.5 @-33.9	6.8 @-34.0	7.0 @-30.7	7.5 @-29.5
Pour Point (JIS K 2269)						
°C	-50.0	≤ -57.5	-37.5	-40.0	-15.0	-20.0

[0116] It is apparent by the data that the formulations containing the phenate of Example A derived from isomerized normal alpha olefin showed superior low temperature properties by one or more measures compared to the phenate detergent that was not derived from isomerized normal alpha olefin. The effect is greater at higher concentrations of the detergent.

Plint TE 77 High Frequency Friction Machine

[0117] Boundary friction coefficient measurements for the Examples and Comparative Examples were obtained using a Plint TE-77 High Frequency Friction Machine (commercially available from Phoenix Tribology).

[0118] A 5mL sample of test oil was placed in the apparatus for each test. The TE-77 was run at 100 °C and 56N of load was placed on the testing specimen. The reciprocating speed was swept from 10Hz to 1Hz, and coefficient of friction data was collected throughout the test. The friction coefficient measurements are shown in Table 3.

Table 3

		Comp. Ex. 7	Comp Ex. 8	Ex. 7
Kinematic Viscosity (100 °C), mm^2/s		5.14	5.33	5.40
Viscosity Index		135.0	136.4	136.4
CCS Viscosity (-35°C), cP		4230	4381	4881
HTHS Viscosity (150°C), cP		1.89	1.93	1.93
Plint TE77				
Coefficient of Friction (100 °C)	1 Hz	0.133	0.092	0.077
	2 Hz	0.132	0.103	0.091
	3 Hz	0.125	0.103	0.096
	4 Hz	0.120	0.102	0.097
	5 Hz	0.112	0.099	0.099
	6 Hz	0.107	0.096	0.098
	7 Hz	0.102	0.092	0.098
	8 Hz	0.097	0.087	0.096
	9 Hz	0.092	0.082	0.093
	10 Hz	0.089	0.078	0.091

[0119] Coefficient of friction data collected for these oils at reciprocating speeds of 1 to 2 Hz are in a boundary friction regime.

[0120] The boundary friction regime is an important consideration in the design of low viscosity engine oils. Boundary friction occurs when the fluid film separating two surfaces becomes thinner than the height of asperities on the surfaces. The resulting surface to surface contact creates undesirable high friction and poor fuel economy in an engine. Boundary friction in an engine can occur under high loads, low engine speeds and at low oil viscosities. Low viscosity engine oils make the engine more susceptible to operating in boundary friction conditions due to the oil's thinner, less robust film. Because additives - not base oil - influence the coefficient of friction under boundary conditions, additives that demonstrate lower coefficients of friction under boundary conditions in the TE-77 will give superior fuel economy in a low viscosity oil in an engine.

[0121] Based on the boundary friction regime results from Example 7, it is evident that the formulation containing the alkylhydroxybenzoate derived from isomerized normal alpha olefin is superior to those not derived from isomerized normal alpha olefin.

Claims

1. A lubricating oil composition having a HTHS viscosity at 150°C determined in accordance with ASTM D4683 in a range of 1.3 to 2.5 mPa.s (1.3 to 2.5 cP), comprising:

   (a) a major amount of an oil of lubricating viscosity having a kinematic viscosity at 100°C determined in accordance with ASTM D445 in a range of 1.5 to 6.0 mm^2/s, wherein "major amount" means in excess of 50 weight % of a composition; and
   (b) an overbased metal salt of an alkyl-substituted phenolic-based detergent, wherein the alkyl group is derived from an isomerized normal alpha olefin having from 10 to 40 carbon atoms per molecule having an isomerization level (I) of the normal alpha olefin of from 0.1 to 0.4; wherein

   the isomerization level (I) of the olefin is determined by hydrogen-1 (1H) NMR obtained on a Bruker Ultrashield Plus 400 in chloroform-d1 at 400 MHz using TopSpin 3.2 spectral processing software, and the isomerization level (I) is:

   $$I = m/(m+n),$$

   where m is NMR integral for methyl groups with chemical shifts between 0.30 ± 0.03 to 1.01 ± 0.03 ppm, and n is NMR integral for methylene groups with chemical shifts between 1.01 ± 0.03 to 1.38 ± 0.10 ppm; and the alkyl-substituted phenolic-based detergent is a Ca alkylhydroxybenzoate compound; and the lubricating oil composition comprises 0.01 to 2.0 wt.% in terms of Ca content of the alkylhydroxybenzoate compound.

2. The lubricating oil composition of claim 1 wherein the alkyl-substituted phenolic-based detergent is a salicylate detergent, wherein the alkyl group is derived from an isomerized alpha olefin having from 10 to 40 carbon atoms per molecule having an isomerization level (I) of the normal alpha olefin of from 0.1 to 0.4.

3. The lubricating oil composition of claim 1, wherein the lubricating oil composition is a 0W-8, 0W-12 or 0W-16 SAE viscosity grade.

4. The lubricating oil composition of claim 1, wherein the oil of lubricating viscosity is a base oil selected from one or more of API Group II, Group III, Group IV, and Group V.

5. The lubricating oil composition of claim 1, wherein the isomerized normal alpha olefin has an isomerization level (I) of the normal alpha olefin of from 0.12 to 0.3, for example, wherein the isomerized normal alpha olefin has an isomerization level (I) of the normal alpha olefin of 0.16 or of 0.26.

6. The lubricating oil composition of claim 1, wherein the normal alpha olefin mixture has from 14 to 28 carbon atoms per molecule.

7. The lubricating oil composition of claim 1 wherein the normal alpha olefin mixture has from 18 to 24 carbon atoms per molecule.

8. The lubricating oil composition of claim 1 wherein the normal alpha olefin mixture has from 20 to 24 carbon atoms per molecule.

9. The lubricating oil composition of claim 1, wherein the TBN of the detergent determined in accordance with ASTM D2896 is from 100 to 600 mg KOH/gram on an oil free basis.

10. The lubricating oil composition of claim 1, further comprising an additional detergent selected from the group con-

sisting of sulfonate, phenate, and salicylate.

11. The lubricating oil composition of claim 10, wherein the detergent is a magnesium sulfonate.

12. The lubricating oil composition of claim 1, further comprising a polymethacrylate dispersant VII.

13. The lubricating oil composition of claim 1, further comprising a primary or secondary zinc dithiophosphate compound or a mixture thereof.

14. The lubricating oil composition of claim 1, further comprising a friction modifier.

15. A method of lubricating an engine comprising lubricating said engine with a lubricating oil composition according to any one of the preceding claims.

Patentansprüche

1. Schmierölzusammensetzung mit einer gemäß ASTM D4683 bestimmten HTHS-Viskosität bei 150 °C in einem Bereich von 1,3 bis 2,5 mPa.s (1,3 bis 2,5 cP), umfassend:

(a) eine größere Menge eines Öls mit Schmierviskosität mit einer gemäß ASTM D445 bestimmten kinematischen Viskosität bei 100 °C in einem Bereich von 1,5 bis 6,0 mm^2/s, wobei "größere Menge" mehr als 50 Gew.-% einer Zusammensetzung bedeutet; und
(b) ein überalkalisiertes Metallsalz eines alkylsubstituierten phenolbasierten Detergens, wobei sich die Alkylgruppe von einem isomerisierten normalen alpha-Olefin mit 10 bis 40 Kohlenstoffatomen pro Molekül mit einem Isomerisierungsgrad (I) des normalen alpha-Olefins von 0,1 bis 0,4 ableitet; wobei

der Isomerisierungsgrad (I) des Olefins durch Wasserstoff-1(1H)-NMR auf einem Bruker Ultrashield Plus 400 in Chloroform-dl bei 400 MHz unter Verwendung von TopSpin-3.2-Spektrenverarbeitungssoftware bestimmt wird und der Isomerisierungsgrad (I)

$$I = m/(m+n)$$

ist, wobei m das NMR-Integral für Methylgruppen mit chemischen Verschiebungen zwischen 0,30 ± 0,03 bis 1,01 ± 0,03 ppm ist und n das NMR-integral für Methylengruppen mit chemischen Verschiebungen zwischen 1,01 ± 0,03 bis 1,38 ± 0,10 ppm ist; und
es sich bei dem alkylsubstituierten phenolbasierten Detergens um eine Ca-Alkylhydroxybenzoat-Verbindung handelt; und

die Schmierölzusammensetzung 0,01 bis 2,0 Gew.-% bezüglich des Ca-Gehalts der Alkylhydroxybenzoat-Verbindung umfasst.

2. Schmierölzusammensetzung nach Anspruch 1, wobei es sich bei dem alkylsubstituierten phenolbasierten Detergens um ein Salicylat-Detergens handelt, wobei sich die Alkylgruppe von einem isomerisierten alpha-Olefin mit 10 bis 40 Kohlenstoffatomen pro Molekül mit einem Isomerisierungsgrad (I) des normalen alpha-Olefins von 0,1 bis 0,4 ableitet.

3. Schmierölzusammensetzung nach Anspruch 1, wobei es sich bei der Schmierölzusammensetzung um eine 0W-8-, 0W-12- oder 0W-16-SAE-Viskositätsklasse handelt.

4. Schmierölzusammensetzung nach Anspruch 1, wobei es sich bei dem Öl mit Schmierviskosität um ein Grundöl handelt, das aus API-Gruppe II, API-Gruppe III, API-Gruppe IV und/oder API-Gruppe V ausgewählt ist.

5. Schmierölzusammensetzung nach Anspruch 1, wobei das isomerisierte normale alpha-Olefin einen Isomerisierungsgrad (I) des normalen alpha-Olefins von 0,12 bis 0,3 aufweist, beispielsweise wobei das isomerisierte normale alpha-Olefin einen Isomerisierungsgrad (I) des normalen alpha-Olefins von 0,16 bis 0,26 aufweist.

6. Schmierölzusammensetzung nach Anspruch 1, wobei das Gemisch von normalen alpha-Olefinen 14 bis 28 Kohlenstoffatome pro Molekül aufweist.

7. Schmierölzusammensetzung nach Anspruch 1, wobei das Gemisch von normalen alpha-Olefinen 18 bis 24 Kohlenstoffatome pro Molekül aufweist.

8. Schmierölzusammensetzung nach Anspruch 1, wobei das Gemisch von normalen alpha-Olefinen 20 bis 24 Kohlenstoffatome pro Molekül aufweist.

9. Schmierölzusammensetzung nach Anspruch 1, wobei die gemäß ASTM D2896 bestimmte TBN des Detergents 100 bis 600 mg KOH/Gramm auf ölfreier Basis beträgt.

10. Schmierölzusammensetzung nach Anspruch 1, ferner umfassend ein zusätzliches Detergens aus der Gruppe bestehend aus Sulfonat, Phenat und Salicylat.

11. Schmierölzusammensetzung nach Anspruch 10, wobei es sich bei dem Detergens um ein Magnesiumsulfonat handelt.

12. Schmierölzusammensetzung nach Anspruch 1, ferner umfassend ein Polymethacrylat-Dispergiermittel VII.

13. Schmierölzusammensetzung nach Anspruch 1, ferner umfassend eine primäre oder sekundäre Zinkdithiophosphatverbindung oder eine Mischung davon.

14. Schmierölzusammensetzung nach Anspruch 1, ferner umfassend einen Reibungsmodifikator.

15. Verfahren zum Schmieren eines Motors, umfassend das Schmieren des Motors mit einer Schmierölzusammensetzung nach einem der vorhergehenden Ansprüche.

Revendications

1. Composition d'huile lubrifiante possédant une viscosité HTHS à 150 °C déterminée conformément à la norme ASTM D4683 dans une plage de 1,3 à 2,5 mPa.s (1,3 à 2,5 cP), comprenant

    (a) une quantité majoritaire d'une huile de viscosité lubrifiante possédant une viscosité cinématique à 100 °C déterminée conformément à la norme ASTM D445 dans une plage de 1,5 à 6,0 mm^2/s, les termes « quantité majoritaire » signifiant plus de 50 % en poids d'une composition ; et
    (b) un sel métallique surbasé d'un détergent à base phénolique substitué par alkyle, le groupe alkyle étant issue d'une alphaoléfine normale isomérisée possédant de 10 à 40 atomes de carbone par molécule possédant un taux d'isomérisation (I) de l'alphaoléfine normale allant de 0,1 à 0,4 ;

    le taux d'isomérisation (I) de l'oléfine étant déterminé par RMN de l'hydrogène-1 (1H) obtenue sur un Bruker Ultrashield Plus 400 dans du chloroforme-d1 à 400 MHz en utilisant un logiciel de traitement spectral TopSpin 3.2, et le taux d'isomérisation (I) étant :

    $$I = m/(m+n),$$

    où m est l'intégrale de RMN pour des groupes méthyle dotés de déplacements chimiques entre 0,30 ± 0,03 et 1,01 ± 0,03 ppm, et n est l'intégrale de RMN pour des groupes méthylène dotés de déplacements chimiques entre 1,01 ± 0,03 et 1,38 ± 0,10 ppm et le détergent à base phénolique substitué par alkyle est un composé de type alkylhydroxybenzoate de Ca ; et
    la composition d'huile lubrifiante comprend 0,01 à 2,0 % en poids en termes de teneur en Ca du composé de type alkylhydroxybenzoate.

2. Composition d'huile lubrifiante selon la revendication 1, le détergent à base phénolique substitué par alkyle étant un détergent de type salicylate, le groupe alkyle étant issu d'une alphaoléfine isomérisée possédant de 10 à 40 atomes de carbone par molécule possédant un taux d'isomérisation (I) de l'alphaoléfine normale allant de 0,1 à 0,4.

3. Composition d'huile lubrifiante selon la revendication 1, la composition d'huile lubrifiante étant d'une qualité de viscosité 0W-8, 0W-12 ou 0W-16 SAE.

4. Composition d'huile lubrifiante selon la revendication 1, l'huile de viscosité lubrifiante étant une huile de base choisie parmi un ou plusieurs parmi le groupe II, le groupe III, le groupe IV et le groupe V de l'API.

5. Composition d'huile lubrifiante selon la revendication 1, l'alphaoléfine normale isomérisée possédant un taux d'isomérisation (I) de l'alphaoléfine normale allant de 0,12 à 0,3, par exemple, l'alphaoléfine normale isomérisée possédant un taux d'isomérisation (I) de l'alphaoléfine normale de 0,16 à 0,26.

6. Composition d'huile lubrifiante selon la revendication 1, le mélange d'alphaoléfines normales possédant de 14 à 28 atomes de carbone par molécule.

7. Composition d'huile lubrifiante selon la revendication 1, le mélange d'alphaoléfines normales possédant de 18 à 24 atomes de carbone par molécule.

8. Composition d'huile lubrifiante selon la revendication 1, le mélange d'alphaoléfines normales possédant de 20 à 24 atomes de carbone par molécule.

9. Composition d'huile lubrifiante selon la revendication 1, le TBN du détergent déterminé conformément à la norme ASTM D2896 étant de 100 à 600 mg de KOH/gramme sur une base exempte d'huile.

10. Composition d'huile lubrifiante selon la revendication 1, comprenant en outre un détergent supplémentaire choisi dans le groupe constitué par un sulfonate, un phénate et un salicylate.

11. Composition d'huile lubrifiante selon la revendication 10, le détergent étant un sulfonate de magnésium.

12. Composition d'huile lubrifiante selon la revendication 1, comprenant en outre un dispersant VII de type polyméthacrylate.

13. Composition d'huile lubrifiante selon la revendication 1, comprenant en outre un composé de type dithiophosphate de zinc primaire ou secondaire ou un mélange correspondant.

14. Composition d'huile lubrifiante selon la revendication 1, comprenant en outre un modificateur de friction.

15. Procédé de lubrification d'un moteur comprenant la lubrification dudit moteur avec une composition d'huile lubrifiante selon l'une quelconque des revendications précédentes.

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

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