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(54) USE OF DISPERSANT VISCOSITY MODIFIERS WITH AMINE FUNCTIONALITY

VERWENDUNG VON DISPERGIEREND WIRKENDEN VISKOSITÄTSMODIFIKATOREN MIT AMINOFUNKTIONALITÄT

UTILISATION DE MODIFIANTS DE VISCOSITÉ DISPERSANTS À FONCTIONNALITÉ AMINE

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(73) Proprietor: **The Lubrizol Corporation**
Wickliffe, OH 44092-2298 (US)

(72) Inventors:

- **PRESTON, Adam**
Wickliffe, OH 44092-2298 (US)
- **ZHANG, Yanshi**
Wickliffe, OH 44092-2298 (US)
- **SLOCUM, Sona, S.**
Wickliffe, OH 44092-2298 (US)

- **GIESELMAN, Matthew, D.**
Wickliffe, OH 44092-2298 (US)

(74) Representative: **D Young & Co LLP**
120 Holborn
London EC1N 2DY (GB)

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Description

BACKGROUND

- 5 **[0001]** The present invention relates to the use of a dispersant viscosity modifier as described herein to improve the film thickness and/or antiwear performance of an engine lubricating composition.
- [0002]** Lubricating oil compositions desirably maintain a relatively stable viscosity over a wide range of temperatures. Viscosity modifiers are often used to reduce the extent of the decrease in viscosity as the temperature is raised or to reduce the extent of the increase in viscosity as the temperature is lowered, or both. Thus, a viscosity modifier ameliorates the change of viscosity of an oil containing it with changes in temperature. The fluidity characteristics of the oil are thereby improved.
- 10 **[0003]** Traditional dispersant viscosity modifiers (DVMs) made from ethylene-propylene copolymers that have been grafted with maleic anhydride and reacted with various amines have shown desirable performance to prevent oil thickening in diesel engines. However, these materials can sometimes provide poor antiwear protection, especially in high soot conditions, leading to increased wear, particularly of seals, for example on the valve train and/or various parts of the crankcase, and expose the components to corrosion.
- 15 **[0004]** There is an ongoing need for dispersant viscosity modifiers that provide viscosity control but which also provide good wear protection and corrosion resistance.
- [0005]** U.S. Pat. No. 2013/0303418, published November 14, 2013, entitled HIGH MOLECULAR WEIGHT POLYMERS AS VISCOSITY MODIFIERS, by FALENDER, et al., discloses a lubricating composition which comprises a base oil and between 10 ppm and 1000 ppm by mass of a viscosity modifier, the viscosity modifier comprising an olefin copolymer. The use of additional monomers is anticipated to allow the inventive polymer to have the properties of dispersants, antioxidants, pour point depressants and other additive chemistry.
- 20 **[0006]** U.S. Pat. No. 4,632,769, issued December 30, 1986, entitled ETHYLENE COPOLYMER VISCOSITY INDEX IMPROVER-DISPERSANT ADDITIVE USEFUL IN OIL COMPOSITIONS, by Gutierrez, et al. describes oil soluble viscosity index improving ethylene copolymers, such as copolymers of ethylene and propylene, which are reacted or grafted with ethylenically unsaturated carboxylic acid moieties and reacted with polyamines having two or more primary amine groups.
- 25 **[0007]** U.S. Pat. No. 5,433,757, issued July 18, 1995, entitled ETHYLENE ALPHA-OLEFIN POLYMER SUBSTITUTED MONO- AND DICARBOXYLIC ACID DISPERSANT ADDITIVES, by Song, et al., discloses an oil-soluble fuel and lubricating oil additive comprising at least one terminally unsaturated ethylene alpha-olefin polymer of 300 to 20,000 number average molecular weight substituted with mono- or dicarboxylic acid producing moieties and can also be reacted with a nucleophilic reagent, such as amines, alcohols, amino alcohols and reactive metal compounds, to form products which are also useful fuel and lubricating oil additives.
- 30 **[0008]** U.S. Pat. No. 4,632,769, issued December 30, 1986, entitled ETHYLENE COPOLYMER VISCOSITY INDEX IMPROVER-DISPERSANT ADDITIVE USEFUL IN OIL COMPOSITIONS, by Gutierrez, et al. describes oil soluble viscosity index improving ethylene copolymers, which are reacted or grafted with ethylenically unsaturated carboxylic acid moieties and reacted with polyamines having two or more primary amine groups and a C22 to C28 olefin carboxylic acid component.
- 35 **[0009]** U.S. Pat. No. 4,137,185, issued January 30, 1979, entitled STABILIZED IMIDE GRAFT OF ETHYLENE COPOLYMERIC ADDITIVES FOR LUBRICANTS, by Gardiner, et al., discloses reacting C1 to C30 monocarboxylic acid anhydrides, and dicarboxylic anhydrides, such as acetic anhydride, succinic anhydride, etc. with an ethylene copolymer reacted with maleic anhydride and a polyalkylene polyamine to inhibit cross linking and viscosity increase due to further reaction of any primary amine groups which were initially unreacted.
- 40 **[0010]** PCT Pub. WO 2011/146692, published November 24, 2011, discloses a lubricating composition containing a copolymer including units derived from an α -olefin and an ethylenically unsaturated carboxylic acid or derivatives thereof, esterified and amidated with an alcohol and an aromatic amine.
- [0011]** US Pub. No. 20140051615, published February 20, 2014, entitled FUNCTIONALIZED COPOLYMERS AND LUBRICATING COMPOSITIONS THEREOF, by Salomon, et al., discloses a lubricating composition containing an oil of lubricating viscosity and a dimercaptiothiadiazole salt of a copolymer comprising units derived from an α -olefin and an ethylenically unsaturated carboxylic acid or derivatives thereof (typically carboxylic acid groups or an anhydride), which are partially esterified with an alcohol. A portion of carboxylic acid groups not esterified are reacted with an amine.
- 50 **[0012]** WO 2014/047017, published March 27, 2014, to The Lubrizol Corp., entitled LUBRICANT COMPRISING A MIXTURE OF AN OLEFIN-ESTER COPOLYMER WITH AN ETHYLENE ALPHA-OLEFIN COPOLYMER, discloses a lubricant composition containing an oil of lubricating viscosity and an esterified copolymer with a backbone containing units derived from an alpha-olefin monomer of at least 6 carbon atoms and an ethylenically unsaturated carboxylic acid or derivative thereof, optionally containing nitrogen functionality; and an ethylene alpha-olefin copolymer comprising greater than 5 weight percent ethylene monomer units. The nitrogen functionality may be derived from reaction with an
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amine, such as morpholines, imidazolinones, aminoamides, β -alanine alkyl esters, aliphatic amines, aromatic amines, aliphatic polyamines, and aromatic polyamines.

[0013] U.S. Provisional Application 61/704,734, filed September 2012, and PCT Application 2012/060025, filed September 2013, entitled MIXTURES OF OLEFIN-ESTER COPOLYMER WITH ETHYLENE α -OLEFIN COPOLYMER AS VISCOSITY MODIFIER, disclose a lubricant composition including an oil of lubricating viscosity and an esterified copolymer with a backbone comprising units derived from an α -olefin monomer and an ethylenically unsaturated carboxylic acid. The copolymer may include nitrogen functionality derived from reaction with an amine selected from morpholines, imidazolinones, aminoamides, α -alanine alkyl esters, aliphatic amines, aromatic amines, aliphatic polyamines, and aromatic polyamines, and mixtures thereof.

[0014] US 2014/0024567 A1 discloses the use of dispersant viscosity modifiers which are ethylene-propylene copolymers grafted with aryloxy-alkylene amines to improve friction and anti-wear performance of a lubricating oil composition.

BRIEF DESCRIPTION

[0015] The invention is set out in the appended set of claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIGURE 1 is a Stribeck plot of traction coefficient vs. log mean speed (mm/s) for lubricating compositions formed with and without an aminated dispersion viscosity modifier; and

FIGURE 2 is a plot of Central Film Thickness (nm) vs. speed (m/s) for lubricating compositions formed with and without an aminated dispersion viscosity modifier.

DETAILED DESCRIPTION

[0017] The present invention relates to the use of a dispersant viscosity modifier to improve film thickness and/or antiwear performance of an engine lubricating composition, wherein the lubricating composition comprises: an oil of lubricating viscosity; and at least 0.05 wt. % of an oil-soluble dispersant viscosity modifier comprising an olefin-based polymer backbone; the olefin-based polymer backbone comprising an ethylene-propylene copolymer and units derived from an ethylenically unsaturated carboxylic acid monomer, and at least one pendent group derived from aminoethyl ethylene urea, wherein each of the at least one pendent groups is independently attached to the olefin-based polymer backbone by succinimide linkage through a linking unit derived from maleic anhydride; and wherein each of the at least one pendent groups is non-ionic, non-basic, and non-acidic,

[0018] The dispersant viscosity modifier has improved performance in engine tests, providing a good viscosity index, good soot dispersion and/or toleration properties, while also providing good antiwear protection and/or corrosion resistance.

[0019] The lubricating composition finds particular application as an engine oil for passenger vehicles and heavy duty diesel vehicles.

[0020] The amounts of additives present in the lubricating composition disclosed herein are expressed on an oil free basis, i.e., amount of actives, unless otherwise noted.

The Dispersant Viscosity Modifier

[0021] The aminated dispersant viscosity modifier is a material that provides viscosity modifier performance in a lubricating composition while also providing dispersant functionality. The aminated dispersant viscosity modifier enables the lubricating composition to provide at least one of antiwear performance, friction modification (particularly for enhancing fuel economy), extreme pressure performance, antioxidant performance, lead, tin or copper (typically lead) corrosion inhibition, decreased corrosiveness towards acrylate or fluoroelastomer seals, or seal swell performance. In particular, reduced corrosion and seals degradation may be obtained. The dispersant viscosity modifier may provide additional and or other benefits to a lubricating composition.

[0022] By "oil soluble," it is meant that the dispersion viscosity modifier is soluble in oil at least to the amounts described herein for desirable for serving its intended purpose.

[0023] The dispersant viscosity modifier of the present invention is an oil-soluble polymer, which includes an olefin-based polymer backbone and one or more pendent groups each independently attached to the olefin-based polymer. The pendent groups are derived from a functionalized aliphatic amine.

[0024] Each of the pendent groups is attached to the polymer chain by a succinimide linkage through a linking unit

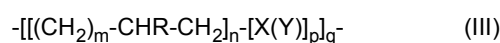
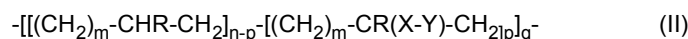
derived from an ethylenically unsaturated carboxylic acid monomer or derivative thereof. These linking units may be grafted onto the olefin-based polymer or form a part of the polymer backbone. The linking group thus links the pendent group to the olefin-based polymer. Each linking group may be derived from a dicarboxylic acid, such as maleic anhydride.

[0025] The aminated dispersant viscosity modifier can be represented by a molecule of the general formula (I):



[0026] where P represents the olefin-based polymer, X represents the linking group, Y represents the pendent group derived from the functionalized aliphatic amine, and x is at least 1, such as from 1 to 20, or 1 to 10, or 1 to 8, e.g., at least 2. As it will be appreciated, there may be many molecules of Formula (I) in the lubricating composition, so the values of x may be considered number average values over all the molecules present. A ratio by weight of linking groups X to the polymer backbone P in the dispersant viscosity modifier may be at least 1:100, or at least 2:100, such as at least 3:100, and in some embodiments, is up to up to 20:100 or up to 10:100.

[0027] In the present invention, P is an ethylene-propylene copolymer. As described herein, the viscosity modifier of Formula (I) may be represented by Formula (II) or (III):



where each R represents H or an alkyl group containing from 1 to 8 carbon atoms,
m, n, and p are independently at least 1,
q is at least 1, such as at least 2.

[0028] Formula (II) represents a viscosity modifier in which the linking group X is grafted onto the polymer backbone P, which can be of the general form $[(CH_2)_m-CHR-CH_2]_n$ prior to grafting. Formula (III) represents a viscosity modifier in which the linking group X is integral with the polymer backbone P.

[0029] As will be appreciated, fewer than all of the linking groups X may be linked to a pendent group Y, although in one embodiment, a majority (at least 50%), or substantially all (at least 80%, or at least 90%, or at least 95%), or all of the linking groups X are linked to a respective pendent group Y.

[0030] In some embodiments, a ratio of n:p (number of ethylene olefin units : number of pendent groups Y) in the molecules of Formulas (II) and (III) (e.g., averaged over all molecules) is at least 2:1, or at least 5:1, or at least 10:1, and in some embodiments, is up to 10,000:1, or up to 1000:1, or up to 100:1.

[0031] The functionalized aliphatic amine includes a primary amino group capable of reacting with the linking units derived from the ethylenically unsaturated carboxylic acid or derivative thereof of the backbone to form a succinimide.

[0032] Each pendent group Y derived from the functionalized aliphatic amine is non-ionic, non-basic, and non-acidic.

[0033] By "aliphatic" it is meant that the functionalized aliphatic amine, and the pendent group Y derived therefrom, has no aromatic groups as part of the functionalized aliphatic amine or pendent group or which are linked directly or indirectly to the pendent group.

[0034] By "non-ionic" it is meant that the bonds within the pendent group are all covalent.

[0035] By "non-basic" it is meant that the pendent groups themselves have substantially no basic character, resulting in a dispersant viscosity modifier having a low total base number (TBN). TBN is a measure of a lubricant's reserve alkalinity. It is measured in milligrams of potassium hydroxide per gram (mg KOH/g). TBN is determined according to the method described in ASTM D2896-11, "Standard Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration," ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/D2896-11. The TBN of the dispersant viscosity modifier, on an oil-free basis, may be less than 5, or less than 3. In theory, the TBN may be at or very close to zero when there are no basic nitrogen atoms remaining after reaction of the amine head group with the polymer backbone. However, because of the possibility for some unreacted amine in the mixture, the dispersant viscosity modifier composition may have a slight basic character. The TBN of the final lubricating composition can be adjusted, using other additives, to a desired level for optimum performance. In other embodiments, the dispersant viscosity modifier may have a higher TBN, such as over 10, e.g., up to 20, or up to 15, on an oil-free basis, such as when there is a basic nitrogen atom remaining after reaction of the amine head group with the polymer backbone. However, a dispersant viscosity modifier with a low TBN is particularly effective.

[0036] By "non-acidic" it is meant that the pendent groups themselves have substantially no acidic character, i.e., substantially no acidic protons, resulting in a dispersant viscosity modifier having a low total acid number (TAN), by which it is meant a TAN of less than 10, or less than 5, or less than 3, or less than 1, on an oil free basis. TAN is determined according to the method described in ASTM D664-11A, "Standard Test Method for Acid Number of Petroleum

Products by Potentiometric Titration," ASTM International, West Conshohocken, PA, 2003 DOI: 10.1520/D0664-11A. In other embodiments, the dispersant viscosity modifier may have a higher TAN, such as over 15, e.g., up to 25, or up to 20, on an oil-free basis, such as when there is an acidic carboxylic acid group remaining after reaction of the amine head group with the polymer backbone. However, a dispersant viscosity modifier with a low TAN is particularly effective.

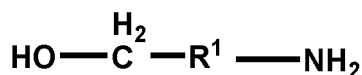
[0037] The functionalized aliphatic amine and the pendent group Y derived therefrom include at least one functional group which includes at least one heteroatom other than nitrogen. Such heteroatoms include oxygen and sulfur. In one embodiment the functional group includes oxygen as the heteroatom. Suitable functional groups that include oxygen include hydroxyl, ester, ether, urea and amide functional groups. In the exemplary embodiment, the functional group is a terminal group and is not further reacted so that it remains available in the lubricating composition to help to provide the useful properties of the dispersion viscosity modifier.

[0038] In an exemplary embodiment, the functionalized aliphatic amine is a monoamine, i.e., has only one amino group. In one embodiment, any nitrogens in the functionalized aliphatic amine that are not part of the amino group are not ionized (do not have a counterion), i.e., are three coordinate. The pendent groups, and the dispersion viscosity modifier as a whole, can thus be free of quaternary ammonium ions (NH_4^+) and similarly free of quaternary phosphonium ions.

[0039] The functional group may be spaced from a nitrogen derived from the functionalized aliphatic amine by a C_4 - C_{24} hydrocarbyl group.

[0040] Exemplary hydroxyl alkyl amines useful for forming pendent group Y include those which have at least one hydroxyl group (-OH), such as a primary hydroxyl group ($-\text{CH}_2\text{-OH}$) or secondary hydroxyl group ($>\text{CH-OH}$), and at least one primary amino group ($-\text{NH}_2$).

[0041] Suitable alkanolamines are those having the formula:



where R^1 is an alkyl group having from 1 to 20 or 1 to 10 carbon atoms, which forms an alcohol functionalized succinimide on reaction with the units derived from the ethylenically unsaturated carboxylic acid or derivative thereof of the backbone.

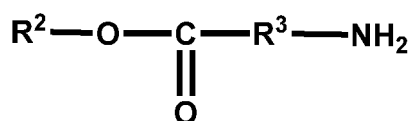
[0042] Examples of such alkanolamines include ethanolamine, 3-aminopropan-1-ol, 4-aminobutan-1-ol, 5-aminopentan-1-ol, 6-aminohexan-1-ol, 7-aminoheptan-1-ol, 8-aminooctan-1-ol, 2-(2-aminoethylamino)ethanol, 3-amino-2,2-dimethylpropan-1-ol, 2-(2-aminoethoxy)ethanol, N-(2-hydroxyethyl)- and 1,3-propanediamine.

[0043] In one embodiment, the hydroxyl alkyl amine is a monoamine.

[0044] In some embodiments the hydroxyl alkyl amine is a secondary amine, such as 2-aminopropan-1-ol, 2-aminobutan-1-ol, 3-aminobutan-1-ol, 2-aminopentan-1-ol, 2-aminohexan-1-ol, 2-aminoheptan-1-ol, or 2-aminooctan-1-ol.

[0045] Exemplary aminoalkyl esters useful for forming pendent group Y include those which have at least one carboxyl group (R-COO), and at least one primary amino group ($-\text{NH}_2$).

[0046] Suitable aminoalkyl esters are those having the formula:

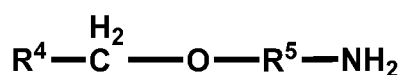


where R^2 is an alkyl group having from 1 to 20 or 1 to 10 carbon atoms and R^3 is an alkylene group having 1 to 20 or 1 to 10 carbon atoms, which forms an unsaturated ester-functional succinimide on reaction with the units derived from the ethylenically unsaturated carboxylic acid or derivative thereof of the backbone.

[0047] Examples of aminoalkyl esters useful for forming pendent group Y include methyl 2-aminoacetate, ethyl 2-aminoacetate, propyl 2-aminoacetate, butyl 2-aminoacetate, methyl 3-aminopropionate, 3-ethoxypropylamine, 3-propoxypropylamine, 3-butoxypropylamine, methyl 4-aminobutanoate, 4-ethoxybutylamine, 4-propoxybutylamine, 4-butoxybutylamine, methyl 5-aminopentanoate, ethyl 5-aminopentanoate, propyl 5-aminopentanoate, butyl 5-aminopentanoate, methyl 6-aminohexanoate, ethyl 6-aminohexanoate, propyl 6-aminohexanoate, and butyl 6-aminopropionate.

[0048] Exemplary aminoalkyl ethers useful for forming pendent group Y include those which have at least one carbonyl group (R-CO-), and at least one primary amino group ($-\text{NH}_2$).

[0049] Suitable aminoalkyl ethers are those having the formula:

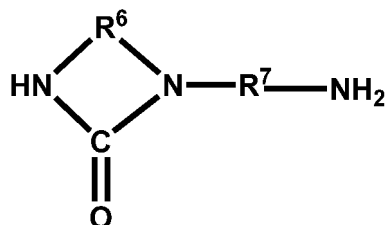


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where R⁴ is an alkyl group having from 1 to 20 or 1 to 10 carbon atoms and R⁵ is an alkylene group having 1 to 20 or 1 to 10 carbon atoms, which forms an unsaturated ether-functional succinimide on reaction with the units derived from the ethylenically unsaturated carboxylic acid or derivative thereof of the backbone.

[0050] Examples of aminoalkyl ethers include 2-methoxyethylamine, 2-ethoxyethylamine, 2-propoxyethylamine, and 2-butoxyethylamine.

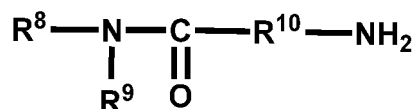
[0051] Suitable aminoalkyl ureas useful for forming pendent group Y are those having the formula:



where R⁶ is an alkylene group having from 1 to 20 or 1 to 10 carbon atoms and R⁷ is an alkylene group having 1 to 20 or 1 to 10 carbon atoms, which forms an unsaturated urea-functional succinimide on reaction with the units derived from the ethylenically unsaturated carboxylic acid or derivative thereof of the backbone.

[0052] Examples of aminoalkyl ureas include aminoethyl ethylene urea, aminoethyl propylene urea, aminopropyl ethylene urea, and aminopropyl propylene urea.

[0053] Suitable aminoalkyl amides are those having the formula:



where R⁸ and R⁹ are independently H or an alkyl group having from 1 to 20 or 1 to 10 carbon atoms and R¹⁰ is an alkylene group having 1 to 20 or 1 to 10 carbon atoms, which forms an unsaturated amide-functional succinimide on reaction with the units derived from the ethylenically unsaturated carboxylic acid or derivative thereof of the backbone. In one embodiment, at least one of R⁸ and R⁹ is H.

[0054] In some embodiments, the aminated dispersant viscosity modifier includes from 1 to 50 of the described pendent group Y, or from 1 to 30, or from 1 to 20, or 1 to 10, or from 1 to 6, or 1 to 4, per molecule of the dispersant viscosity modifier, on average. In some embodiments, the aminated dispersant viscosity modifier includes 1, 2, 3, 4, 5 or 6 pendent group Y, on average.

[0055] The exemplary linking groups X are acylating groups, each independently attached or part of the polymer's backbone. The linking group X is derived from an ethylenically unsaturated carboxylic acid monomer, such as a dicarboxylic acid, or functional equivalent thereof. In some embodiments, the linking group X is derived from maleic anhydride. In some embodiments, the unsaturated carboxylic reactant is grafted on to the olefin-based polymer backbone and the functionalized aliphatic amine is reacted with the unsaturated carboxylic reactant group containing olefin-based polymer backbone. In other embodiments, the unsaturated carboxylic reactant is present in the olefin-based polymer backbone and the functionalized aliphatic amine is reacted with the unsaturated carboxylic reactant group containing olefin-based polymer backbone.

[0056] The polymer backbone P employed in the aminated dispersant viscosity modifier is an ethylene propylene copolymer that can be modified with a carboxylic acid functionality or a reactive equivalent of the carboxylic acid functionality (e.g., anhydride or ester) that serves as the linking group described above.

[0057] Suitable olefin-based polymer backbones P are copolymers of ethylene and propylene that can be subsequently supplied with grafted carboxylic functionality to serve as the linking group or have carboxylic functionality in the backbone itself (such as an ethylene-propylene-co-maleimide). In some embodiments, the ethylene-propylene copolymer is a copolymer where ethylene makes up at least 10 % of the monomer used to prepare the copolymer on a molar basis, or at least 20 mole %, or at least 50 mole %.

[0058] Ethylene-propylene copolymers may consist of 15 to 80 mole % ethylene and 20 to 85 mole % propylene. In some embodiments, the mole ratio is 30 to 80 mole % ethylene and 20 to 70 mole % of at least one C₃ aliphatic monoolefin, for example, 50 to 80 mole % ethylene and 20 to 50 mole % propylene.

[0059] In these embodiments, the polymer backbone (e.g., the ethylene-propylene copolymer), can be an oil-soluble, substantially linear, rubbery material. Also, in certain embodiments, the polymer can be in forms other than substantially linear, that is, it can be a branched polymer or a star polymer. The polymer can also be a random copolymer or a block

copolymer, including diblocks and higher blocks, including tapered blocks and a variety of other structures.

[0060] The polymer backbone (olefin-based polymer) may have a number average molecular weight M_n (measured by gel permeation chromatography, using a polystyrene standard), which can be up to 150,000 or higher, e.g., at least 1,000 or at least 3,000 or at least 5,000, such as up to 150,000 or up to 120,000, or up to 100,000, or up to 50,000, or up to 15,000, e.g., about 3,000 to about 15,000. The aminated dispersant viscosity modifier may have a number average molecular weight M_n (by gel permeation chromatography, polystyrene standard), which can be up to 150,000 or higher, e.g., at least 2,000 or at least 3,000 or at least 5,000, such as up to 150,000 or up to 120,000, or up to 100,000, or up to 50,000, or up to 18,000, e.g., about 4,000 to about 16,000.

[0061] The term "polymer" is used generically to encompass homopolymers, such as ethylene or higher alpha monoolefin polymers, copolymers, terpolymers and/or interpolymers. These materials may contain minor amounts of other olefinic monomers so long as their basic characteristics are not materially changed.

[0062] In one embodiment, the aminated dispersant viscosity modifier is formed by reacting a carboxylic acid-modified polymer backbone with a functionalized aliphatic amine. The unsaturated carboxylic acid monomer used to form the linking group X may be derived from maleic acid and/or anhydride. As noted above, this portion of the linking group may be incorporated and/or attached to the polymer backbone during the polymerization of the polymer backbone, for example, by mixing a monomer containing the linking group in with the other monomers used to prepare the polymer backbone. In other embodiments, this part of the linking group may be added by grafting the group onto an already prepared polymer backbone.

[0063] As noted above, in some embodiments the unsaturated carboxylic acid used to form the linking group is contained within a monomer copolymerized within the polymer backbone chain. In other embodiments, the unsaturated carboxylic reactant may be present as a pendent group attached by, for example, a grafting process.

[0064] Examples of suitable carboxylic-acid containing polymers, which are representative of the polymer backbone described above with carboxylic reactant portion of the linking group attached, include maleic anhydride-ethylene-propylene copolymers, maleic anhydride-styrene copolymers, including partially esterified versions thereof, and copolymers thereof. Nitrogen-containing esterified carboxyl-containing interpolymers prepared from maleic anhydride and styrene-containing polymers are described in U.S. Pat. No. 6,544,935 to Vargo, et al. Other polymer backbones which are used for preparing dispersants may also be used. For example, polymers derived from isobutylene and isoprene are described in U.S. Pub. No. 20040034175 to Kolp. Other suitable polymer backbones include substantially hydrogenated copolymers of vinyl aromatic materials such as styrene and unsaturated hydrocarbons such as conjugated dienes, e.g., butadiene or isoprene. In substantially hydrogenated polymers of this type, the olefinic unsaturation is typically substantially completely hydrogenated by known methods, but the aromatic unsaturation may remain. Such polymers can include random copolymers, block copolymers, or star copolymers. Yet other suitable backbone polymers include styreneethylene-alpha olefin polymers, as described in PCT publication WO 2001/030947, and polyacrylates or polymethacrylates. In the case of such poly(meth)acrylates, the (meth)acrylate monomers within the polymer chain itself may serve as the carboxylic acid functionality or reactive equivalent thereof which is used to react with the amine functionality which provides the linker unit X. Alternatively, additional acid functionality may be copolymerized into the (meth)acrylate chain or even grafted onto it, particularly in the case of acrylate polymers.

[0065] In the present invention, the polymer backbone is prepared from ethylene and propylene, which may then be grafted with a suitable carboxylic acid-containing monomer, to serve as the linking group X.

[0066] The ethylenically unsaturated carboxylic acid monomer may be grafted onto the polymer backbone in a number of ways, such that a resulting polymer intermediate with linking groups X is characterized by having carboxylic acid acylating functions within its structure. Such materials which are attached to the polymer typically contain at least one ethylenic bond (prior to reaction) and at least one, or at least two, carboxylic acid (or its anhydride) groups or a polar group which is convertible into the carboxyl groups by oxidation or hydrolysis. Maleic anhydride or an alkyl-substituted derivative thereof (e.g., methyl maleic anhydride or ethyl maleic anhydride) is suitable for forming the linking groups. It grafts onto the ethylene-propylene copolymer to give two carboxylic acid functionalities. Examples of additional unsaturated carboxylic materials include chlormaleic anhydride, itaconic anhydride, and the corresponding dicarboxylic acids, such as maleic acid, fumaric acid, acrylic acid, cinnamic acid, and their esters.

[0067] Example intermediate polymers of this type are available from Mitsui under the tradename Lucant™, such as Lucant™ A-5320H polymer. Lucant A-5320H is an amorphous Ziegler-Natta copolymer of ethylene and propylene (GPC $M_n=7700$) that is randomly grafted with maleic anhydride (in the presence of a free radical peroxide initiator in a high shear mixer) to a level of about 3.5 weight % maleic anhydride. The final product has molecular weight (GPC polystyrene standards) $M_n=8810$ and $M_w=17200$ and a Total Acid Number of 40 to 45 mg KOH/g.

[0068] The polymer intermediate may then be reacted with the functionalized aliphatic amine to provide the dispersant viscosity modifier. In other embodiments, the pendent groups may be functionalized after reaction of an amine with the linking group.

[0069] The reaction can be carried out in a suitable vehicle, such as a diluent oil and/or toluene, at a sufficient temperature, such as at least 90°C or at least 100°C, but below the decomposition temperature of the product.

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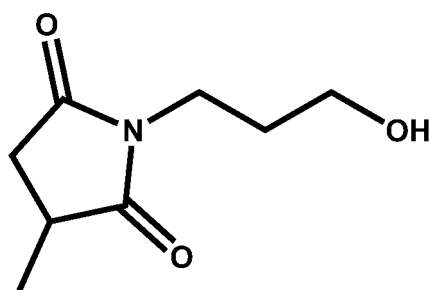
[0070] The aminated dispersant viscosity modifier is present in the lubricating composition at a concentration of at least 0.05 weight %. In further embodiments the aminated dispersant viscosity modifier may be present in the lubricating composition at a concentration of at least 0.1 weight %, or at least 0.2 weight %, or at least 0.5 weight %. The aminated dispersant viscosity modifier may be present in the lubricating composition at a concentration of up to 10 weight %, such as up to 5 weight %, or up to 3 weight %, or up to 2.3 weight %.

[0071] HLB values reported herein are determined by the Griffin Method (see Griffin, William C. (1949), "Classification of Surface-Active Agents by 'HLB'", Journal of the Society of Cosmetic Chemists 1 (5): 311-26 and Griffin, William C. (1954), "Calculation of HLB Values of Non-Ionic Surfactants", Journal of the Society of Cosmetic Chemists 5 (4): 249-56

[0072] In Griffin's method, $HLB = 20 * Mh / M$, where Mh is the molecular mass of the hydrophilic portion of the molecule and M is the molecular mass of the whole molecule. This method covers a range from 0-20.

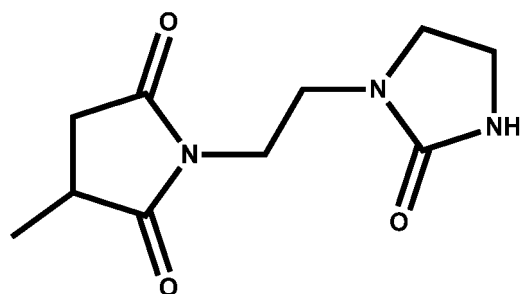
[0073] The aminated dispersant viscosity modifier may have an HLB value according to the Griffin method, of at least 2, or at least 2.5, or at least 3, and can be up to 4.5 or up to 4 for polymer backbones prepared with an average of 3.5 maleic anhydride groups per chain. For polymer backbones prepared with greater amounts of maleic anhydride grafted onto them, such as 6.2 groups per chain, the HLB range can be up to about 6.0.

[0074] For example, a dispersant viscosity modifier with an ethylene propylene backbone having about 240 $CH_2/CH/CH_3$ groups has a molecular mass of approximately 3525, as determined by vapor phase osmometry (VPO). When reacted with 3.5 wt % maleic anhydride (e.g., forming Lucant A-5320H), each polymer backbone chain has, on average, 3.5 sites which can be functionalized with the functionalized aliphatic amine. When reacted with 3-aminopropanol or aminoethyl ethylene urea for example this provides a head group of the form:



(molecular weight = 156.2),

or



(molecular weight= 210)

[0075] Considering these entire head group portions as the respective hydrophilic portion, the Mh term is approximately $156.2 * 3.5 = 547$ for the aminopropanol-based head group. Therefore, the $HLB = 20 * 547 / (3525 + 547) = 2.7$ for a dispersant viscosity modifier composed of ethylene-propylene copolymer aminopropanol pendent groups.

[0076] In a similar fashion, the HLB for the dispersant viscosity modifier composed of an ethylene-propylene copolymer with aminoethyl ethylene urea pendent groups can be computed as 3.5.

[0077] Under the method described herein, the entire head group is considered as the hydrophilic portion, even though it contains some hydrocarbon portions.

Oils of Lubricating Viscosity

[0078] The lubricating composition includes an oil of lubricating viscosity. Suitable oils include both natural and synthetic oils, oil derived from hydrocracking, hydrogenation, and hydrofinishing, unrefined, refined, re-refined oils or mixtures thereof.

[0079] Unrefined oils are those obtained directly from a natural or synthetic source generally without (or with little)

further purification treatment.

[0080] 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.

[0081] 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.

[0082] Natural oils useful in making the inventive lubricants include animal oils, vegetable oils (e.g., castor 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.

[0083] Synthetic lubricating oils are useful and include hydrocarbon oils such as polymerized, oligomerized, or inter-polymerized olefins (e.g., polybutylenes, polypropylenes, propyleneisobutylene copolymers); poly(1-hexenes), poly(1-octenes), trimers or oligomers of 1-decene, e.g., poly(1-decenes), such materials being often referred to as poly α -olefins, and mixtures thereof; alkylbenzenes (e.g., dodecylbenzenes, tetradecylbenzenes, dinonylbenzenes, di-(2-ethyl-hexyl)-benzenes); polyphenyls (e.g., biphenyls, terphenyls, alkylated polyphenyls); diphenyl alkanes, alkylated diphenyl alkanes, alkylated diphenyl ethers and alkylated diphenyl sulfides and the derivatives, analogs and homologs thereof or mixtures thereof.

[0084] Other synthetic lubricating oils include polyol esters (such as Priolube[®]3970), diesters, liquid esters of phosphorus-containing acids (e.g., tricresyl phosphate, trioctyl phosphate, and the diethyl ester of decane phosphonic acid), or polymeric tetrahydrofurans. Synthetic oils may be produced by Fischer-Tropsch reactions and typically may be hydroisomerized Fischer-Tropsch hydrocarbons or waxes. In one embodiment, oils may be prepared by a Fischer-Tropsch gas-to-liquid synthetic procedure as well as other gas-to-liquid oils.

[0085] The base oil may be selected from any of the base oils in Groups I-V of the American Petroleum Institute (API) Base Oil Interchangeability Guidelines, namely

Base Oil Category	Sulfur (%)	Saturates(%)	Viscosity Index
Group I	>0.03 and/or	<90	80 to 120
Group II	≤0.03 and	≥90	80 to 120
Group III	≤0.03 and	≥90	>120
Group IV	All polyalphaolefins (PAOs)		
Group V	All others not included in Groups I, II, III or IV		

[0086] Groups I, II and III are mineral oil base stocks. Oils of lubricating viscosity may also be defined as specified in April 2008 version of "Appendix E - API Base Oil Interchangeability Guidelines for Passenger Car Motor Oils and Diesel Engine Oils", section 1.3 Sub-heading 1.3. "Base Stock Categories." In one embodiment, the oil of lubricating viscosity may be an API Group II or Group III oil. In one embodiment, the oil of lubricating viscosity may be an API Group I oil.

[0087] The oil of lubricating viscosity may have a kinematic viscosity of less than 15 mm²/s (cSt) at 100 °C, and in other embodiments 1-12 or 2-10 or 3-8 or 4-6 mm²/s. Kinematic viscosity is determined by ASTM D445 - 12, "Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)", ASTM International, West Conshohocken, PA, DOI: 10.1520/D0445-12. The dispersant viscosity modifier may have a kinematic viscosity at 100 °C of at least 35 mm²/s, or at least 100 mm²/s, or at least 500 mm²/s.

[0088] The amount of the oil of lubricating viscosity present is typically the balance remaining after subtracting from 100 wt % the sum of the amount of the aminated dispersant viscosity modifier and the other performance additives. The oil of lubricating viscosity may be present in the lubricating composition at a concentration of at least 10 wt %, or at least 20 wt %, or at least 40 wt %, or at least 80 wt %, and may be up to 99 wt %, or up to 95 wt %, or up to 90 wt %.

[0089] The lubricating composition may be in the form of a concentrate and/or a fully formulated lubricant. If the lubricating composition (comprising the additives disclosed herein) 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 these additives to the oil of lubricating viscosity and/or to diluent oil include the ranges of 1:99 to 99:1 by weight, or 80:20 to 10:90 by weight. If the lubricating composition (comprising the additives disclosed herein) is in the form of a finished lubricant, the ratio of these additives to the oil of lubricating viscosity and/or to diluent oil include the ranges of 1:99.9 to 50:50 by weight, or 1:99 to 30:70 by weight.

Additional Performance Additives

[0090] The lubricating composition optionally includes one or more additional performance additives. These additional

performance additives may include one or more metal deactivators, viscosity modifiers, detergents, friction modifiers, antiwear agents, corrosion inhibitors, dispersants, dispersant viscosity modifiers (other than the exemplary compound), extreme pressure agents, antioxidants, foam inhibitors, demulsifiers, pour point depressants, seal swelling agents, antiwear agents, and any combination or mixture thereof. Typically, fullyformulated lubricating oil will contain one or more of these performance additives, and often a package of multiple performance additives.

[0091] In one embodiment, the lubricating composition further includes a dispersant, an antiwear agent, a friction modifier, a viscosity modifier, an antioxidant, an overbased detergent, or a combination thereof, where each of the additives listed may be a mixture of two or more of that type of additive. In one embodiment, the lubricating composition further includes a polyisobutylene succinimide dispersant, an antiwear agent, a friction modifier, a viscosity modifier (typically an olefin copolymer such as an ethylene-propylene copolymer), an antioxidant (including phenolic and aminic antioxidants), an overbased detergent (including overbased sulfonates and phenates), or a combination thereof, where each of the additives listed may be a mixture of two or more of that type of additive.

[0092] In one embodiment, the lubricating composition further includes an antiwear agent such as a metal dihydrocarbyl dithiophosphate (typically zinc dialkyldithiophosphate), wherein the metal dihydrocarbyl dithiophosphate contributes at least 100 ppm, or at least 200 ppm, or 200 ppm to 1000 ppm, or 300 ppm to 800 ppm, or 400 ppm to 600 ppm of phosphorus to the lubricating composition. In one embodiment, the lubricating composition is free of or substantially free of zinc dialkyldithiophosphate (ZDDP).

[0093] In one embodiment, the lubricating composition further includes a dispersant (other than the dispersant viscosity modifier). The dispersant may be present at a concentration of 0 wt % to 20 wt %, such as at least 0.01 wt %, or at least 0.1 wt %, or at least 0.1 wt %, or at least 1 wt %, or up to 20 wt %, or up to 15 wt %, or up to 10 wt %, or up to 6 wt % of the lubricating composition. In one embodiment, the dispersant may be present in the composition at a concentration of 0.2 wt % to 2 wt %.

[0094] Suitable dispersants for use in the exemplary lubricating compositions include succinimide dispersants. In one embodiment, the dispersant may be present as a single dispersant. In one embodiment, the dispersant may be present as a mixture of two or three different dispersants, wherein at least one may be a succinimide dispersant.

[0095] The succinimide dispersant may be a derivative of an aliphatic polyamine, or mixtures thereof. The aliphatic polyamine may be aliphatic polyamine such as an ethylenepolyamine, a propylenepolyamine, a butylenepolyamine, or mixtures thereof. In one embodiment, the aliphatic polyamine may be ethylenepolyamine. In one embodiment, the aliphatic polyamine may be selected from the group consisting of ethylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenehexamine, polyamine still bottoms, and mixtures thereof.

[0096] The dispersant may be a N-substituted long chain alkenyl succinimide. Examples of N-substituted long chain alkenyl succinimides include polyisobutylene succinimide. Typically, the polyisobutylene from which a polyisobutylene succinic anhydride is derived has a number average molecular weight of 350 to 5000, or 550 to 3000 or 750 to 2500. Succinimide dispersants and their preparation are disclosed, for example, in U.S. Pat. Nos. 3,172,892, 3,219,666, 3,316,177, 3,340,281, 3,351,552, 3,381,022, 3,433,744, 3,444,170, 3,467,668, 3,501,405, 3,542,680, 3,576,743, 3,632,511, 4,234,435, Re 26,433, and 6,165,235, 7,238,650, and EP Patent Application 0 355 895 A.

[0097] The dispersant may also be post-treated by conventional methods by a reaction with any of a variety of agents. Among these are boron compounds, urea, thiourea, dimercaptothiadiazoles, carbon disulfide, aldehydes, ketones, carboxylic acids, hydrocarbon-substituted succinic anhydrides, maleic anhydride, nitriles, epoxides, and phosphorus compounds.

[0098] In one embodiment, the lubricating composition further includes a dispersant viscosity modifier other than the aminated dispersant viscosity modifier described herein. The additional dispersant viscosity modifier may be present at a concentration of 0 wt % to 5 wt %, such as at least 0.01 wt %, or at least 0.05 wt %, or up to 5 wt %, or up to 4 wt %, or up to 2 wt % of the lubricating composition.

[0099] Suitable dispersant viscosity modifiers include functionalized polyolefins, for example, ethylene-propylene copolymers that have been functionalized with an acylating agent such as maleic anhydride and an amine; polymethacrylates functionalized with an amine, and esterified styrene-maleic anhydride copolymers reacted with an amine. Exemplary dispersant viscosity modifiers are disclosed, for example, in WO2006/015130 and U.S. Pat. Nos. 4,863,623; 6,107,257; 6,107,258; and 6,117,825.

[0100] In one embodiment, the lubricating composition further includes a phosphorus-containing antiwear agent. The antiwear agent may be present at a concentration of 0 wt % to 3 wt %, such as at least 0.1 wt %, or at least 0.5 wt %, or up to 3 wt %, or up to 1.5 wt %, or up to 0.9 wt % of the lubricating composition. The phosphorus-containing antiwear agent may be a zinc dialkyldithiophosphate, or mixture thereof.

[0101] In one embodiment, the lubricating composition further includes a molybdenum compound. The molybdenum compound may provide the lubricating composition with 0 to 1000 ppm, or 5 to 1000 ppm, or 10 to 750 ppm 5 ppm to 300 ppm, or 20 ppm to 250 ppm of molybdenum. The molybdenum compound may be selected from the group consisting of molybdenum dialkyldithiophosphates, molybdenum dithiocarbamates, amine salts of molybdenum compounds, and mixtures thereof.

[0102] In one embodiment, the lubricating composition further includes an overbased detergent. The overbased detergent may be present at 0 wt % to 15 wt %, or at least 0.1 wt %, or at least 0.2 wt %, or at least 0.2 wt %, or up to 15 wt %, or up to 10 wt %, or up to 8 wt %, or up to 3 wt % of the lubricating composition. For example, in a heavy duty diesel engine, the detergent may be present at 2 wt % to 3 wt % of the lubricating composition. For a passenger car engine, the detergent may be present at 0.2 wt % to 1 wt % of the lubricating composition.

[0103] The overbased detergent may be selected from the group consisting of non-sulfur containing phenates, sulfur containing phenates, sulfonates, salixarates, salicylates, and mixtures thereof.

[0104] The overbased detergent may also include "hybrid" detergents formed with mixed surfactant systems including phenate and/or sulfonate components, e.g., phenate/salicylates, sulfonate/phenates, sulfonate/salicylates, sulfonates/phenates/salicylates, as described; for example, in U.S. Pat. Nos. 6,429,178; 6,429,179; 6,153,565; and 6,281,179. Where, for example, a hybrid sulfonate/phenate detergent is employed, the hybrid detergent can be considered equivalent to amounts of distinct phenate and sulfonate detergents introducing like amounts of phenate and sulfonate soaps, respectively.

[0105] Suitable overbased detergents are sodium salts, calcium salts, magnesium salts, or mixtures of the phenates, sulfur containing phenates, sulfonates, salixarates and salicylates. Overbased phenates and salicylates may have a total base number of 180 to 450 TBN. Overbased sulfonates may have a total base number of 250 to 600, or 300 to 500. In one embodiment, the sulfonate detergent may be predominantly a linear alkylbenzene sulfonate detergent having a metal ratio of at least 8, as described, for example, in U.S. Pub. No. 20050065045. The linear alkylbenzene sulfonate detergent may be particularly useful for assisting in improving fuel economy. The linear alkyl group may be attached to the benzene ring anywhere along the linear chain of the alkyl group, but often in the 2, 3, or 4 position of the linear chain, and in some instances, predominantly in the 2 position, resulting in the linear alkylbenzene sulfonate detergent.

[0106] In one embodiment, the lubricating composition includes an antioxidant, or mixture of antioxidants. The antioxidant may be present at 0 wt % to 15 wt %, or 0.1 wt % to 10 wt %, or 0.5 wt % to 5 wt % of the lubricating composition.

[0107] Antioxidants include sulfurized olefins, alkylated diarylamines (typically alkylated phenyl naphthyl amines for example those commercially available as Irganox[®] L 06 from CIBA, or alkylated diphenylamines such as dinonyl diphenylamine, octyl diphenylamine, dioctyl diphenylamine), hindered phenols, molybdenum compounds (such as molybdenum dithiocarbamates), or mixtures thereof.

[0108] The hindered phenol antioxidant often contains a secondary butyl and/or a tertiary butyl group as a sterically hindering group. The phenol group may be further substituted with a hydrocarbyl group (typically linear or branched alkyl) and/or a bridging group linking to a second aromatic group. Examples of suitable hindered phenol antioxidants include 2,6-di-tert-butylphenol, 4-methyl-2,6-di-tert-butylphenol, 4-ethyl-2,6-di-tert-butyl phenol, 4-propyl-2,6-di-tert-butylphenol or 4-butyl-2,6-di-tert-butylphenol, or 4-dodecyl-2,6-di-tert-butylphenol. In one embodiment, the hindered phenol antioxidant may be an ester and may include, e.g., Irganox[™] L-135 from Ciba. A more detailed description of suitable ester-containing hindered phenol antioxidant chemistry is found in U.S. Patent 6,559,105.

[0109] In one embodiment, the lubricating composition further includes a friction modifier. The friction modifier may be present at 0 wt % to 6 wt %, such as at least 0.05 wt %, or at least 0.1 wt %, or up to 6 wt %, or up to 4 wt %, or up to 2 wt % of the lubricating composition. In one embodiment, the friction modifier is present in the composition at 0.1 to 1.0 wt %. Examples of friction modifiers include long chain fatty acid derivatives of amines, fatty esters, or epoxides; fatty imidazolines such as condensation products of carboxylic acids and polyalkylene-polyamines; amine salts of alkylphosphoric acids; fatty alkyl tartrates; fatty alkyl tartrimidates; or fatty alkyl tartramides. In some embodiments, the term fatty, as used herein, can mean having a C₈ to C₂₂ linear alkyl group.

[0110] Friction modifiers may also encompass materials such as sulfurized fatty compounds and olefins, molybdenum dialkyldithiophosphates, molybdenum dithiocarbamates, sunflower oil or monoester of a polyol and an aliphatic carboxylic acid.

[0111] In one embodiment, the friction modifier may be selected from the group consisting of long chain fatty acid derivatives of amines, long chain fatty esters, or long chain fatty epoxides; fatty imidazolines; amine salts of alkylphosphoric acids; fatty alkyl tartrates; fatty alkyl tartrimidates; and fatty alkyl tartramides.

[0112] In one embodiment, the friction modifier may be a long chain fatty acid ester. In another embodiment, the long chain fatty acid ester may be a monoester or a diester or a mixture thereof, and in another embodiment the long chain fatty acid ester may be a triglyceride.

[0113] Other performance additives such as corrosion inhibitors include those described in U.S. Pub. No. 20050038319, octyl octanamide, condensation products of dodecanyl succinic acid or anhydride and a fatty acid such as oleic acid with a polyamine. In one embodiment, the corrosion inhibitors include a Synalox[®] corrosion inhibitor. The Synalox[®] corrosion inhibitor may be a homopolymer or copolymer of propylene oxide. Synalox[®] corrosion inhibitors are described in a product brochure, Form No. 118-01453-0702 AMS, entitled "SYNALOX Lubricants, High-Performance Polyglycols for Demanding Applications," published by The Dow Chemical Company.

[0114] Metal deactivators including derivatives of benzotriazoles (such as tolyltriazole), dimercaptiothiadiazole derivatives, 1,2,4-triazoles, benzimidazoles, 2-alkyldithiobenzimidazoles, or 2-alkyldithiobenzothiazoles; foam inhibitors in-

cluding copolymers of ethyl acrylate and 2-ethylhexylacrylate and copolymers of ethyl acrylate and 2-ethylhexylacrylate and 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 may be useful.

[0115] Pour point depressants that may be useful in the compositions of the invention include polyalphaolefins, esters of maleic anhydride-styrene, poly(meth)acrylates, polyacrylates or polyacrylamides.

[0116] In different embodiments, the lubricating composition may have a composition as described in Table 1:

Table 1: Example Lubricating Compositions

Additive	Embodiments (wt %)		
	A	B	C
Exemplary Aminated Dispersant Viscosity Modifier	0.05 to 10	0.2 to 3	0.5 to 2
Dispersant	0.05 to 12	0.75 to 8	0.5 to 6
Overbased Detergent	0 or 0.05 to 15	0.1 to 10	0.2 to 8
Antioxidant	0 or 0.05 to 15	0.1 to 10	0.5 to 5
Antiwear Agent	0 or 0.05 to 15	0.1 to 10	0.3 to 5
Friction Modifier	0 or 0.05 to 6	0.05 to 4	0.1 to 2
Viscosity Modifier	0 or 0.05 to 10	0.5 to 8	1 to 6
Any Other Performance Additive	0 or 0.05 to 10	0 or 0.05 to 8	0 or 0.05 to 6
Oil of Lubricating Viscosity	Balance to 100	Balance to 100	Balance to 100

[0117] The aminated dispersant viscosity modifier may be present in embodiments (D) at 0.1 to 8 wt %, or (E) 1 to 7 wt %, or (F) 2 to 6 wt %, or (G) 0.1 to 2 wt %, or (H) 0.3 to 1.2 wt % of the lubricating composition, with the amount of dispersant, overbased detergent, antioxidant, antiwear agent, friction modifier, viscosity modifier, any other performance additive and an oil of lubricating viscosity in amounts shown in the table above for embodiments (A) to (C).

Industrial Applications

[0118] An internal combustion engine may be lubricated by supplying to the internal combustion engine a lubricating composition as disclosed herein. Generally, the lubricating composition is added to the lubricating system of the internal combustion engine, which then delivers the lubricating composition to the critical parts of the engine, during its operation, that require lubrication.

[0119] In the present invention, a use of the dispersant viscosity modifier described herein to improve film thickness and/or antiwear performance of a lubricating composition is provided. These improvements can be considered in addition to the dispersancy and viscosity control performance expected from a dispersant viscosity modifier.

[0120] The lubricating compositions described above may be utilized in an internal combustion engine. The engine components may have a surface of steel or aluminum (typically a surface of steel), and may also be coated for example, with a diamond like carbon (DLC) coating. An aluminum surface may comprise an aluminum alloy that may be a eutectic or hyper-eutectic aluminum alloy (such as those derived from aluminum silicates, aluminum oxides, or other ceramic materials). The aluminum surface may be present on a cylinder bore, cylinder block, or piston ring formed of an aluminum alloy or aluminum composite.

[0121] The internal combustion engine may or may not have an Exhaust Gas Recirculation system. The internal combustion engine may be fitted with an emission control system or a turbocharger. Examples of the emission control system include diesel particulate filters (DPF), or systems employing selective catalytic reduction (SCR).

[0122] In one embodiment, the internal combustion engine may be a diesel fuelled engine (such as a heavy duty diesel engine), a gasoline fuelled engine, a natural gas fuelled engine or a mixed gasoline/alcohol fuelled engine. In one embodiment, the internal combustion engine may be a diesel fuelled engine and in another embodiment a gasoline fuelled engine. In one embodiment, the internal combustion engine may be a biodiesel fuelled engine. The internal combustion engine may be a 2-stroke or 4-stroke engine. Suitable internal combustion engines include marine diesel engines, aviation piston engines, lowload diesel engines, and automobile and truck engines. In one embodiment the internal combustion engine is a gasoline direct injection (GDI) engine.

[0123] The internal combustion engine is distinct from gas turbine. In an internal combustion engine, individual com-

bustion events which through the rod and crankshaft translate from a linear reciprocating force into a rotational torque. In contrast, in a gas turbine (which may also be referred to as a jet engine) it is a continuous combustion process that generates a rotational torque continuously without translation and can also develop thrust at the exhaust outlet. These differences result in the operation conditions of a gas turbine and internal combustion engine different operating environments and stresses.

[0124] The lubricating composition for an internal combustion engine may be suitable for use as an engine lubricant irrespective of the sulfur, phosphorus or sulfated ash (ASTM D-874) content. The sulfur content of the lubricating composition, which is particularly suited to use as an engine oil lubricant, may be 1 wt % or less, or 0.8 wt % or less, or 0.5 wt % or less, or 0.3 wt % or less. In one embodiment, the sulfur content may be in the range of 0 wt % to 0.5 wt %, or 0.01 wt % to 0.3 wt %. The phosphorus content may be 0.2 wt % or less, or 0.12 wt % or less, or 0.1 wt % or less, or 0.085 wt % or less, or 0.08 wt % or less, or even 0.06 wt % or less, 0.055 wt % or less, or 0.05 wt % or less. In one embodiment, the phosphorus content may be 100 ppm to 1000 ppm, or 200 ppm to 600 ppm. The total sulfated ash content may be 2 wt % or less, or 1.5 wt % or less, or 1.1 wt % or less, or 1 wt % or less, or 0.8 wt % or less, or 0.5 wt % or less, or 0.4 wt % or less. In one embodiment, the sulfated ash content may be 0.05 wt % to 0.9 wt %, or 0.1 wt % to 0.2 wt % or to 0.45 wt %. In one embodiment, the lubricating composition may be an engine oil, wherein the lubricating composition may be characterized as having at least one of (i) a sulfur content of 0.5 wt % or less, (ii) a phosphorus content of 0.1 wt % or less, (iii) a sulfated ash content of 1.5 wt % or less, or combinations thereof.

EXAMPLES

[0125] The invention will be further illustrated by the following examples, which set forth particularly advantageous embodiments. While the examples are provided to illustrate the invention, they are not intended to limit it.

[0126] As used herein kinematic viscosity is measured at 100°C (KV_{100}), according to the method of ASTM D445 - 12, "Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)", ASTM International, West Conshohocken, PA, DOI: 10.1520/D0445-12. This test method specifies a procedure for the determination of the kinematic viscosity, of liquid petroleum products by measuring the time for a volume of liquid to flow under gravity through a calibrated glass capillary viscometer. It may be noted that $1 \text{ mm}^2/\text{s} = 10^{-6} \text{ m}^2/\text{s} = 1 \text{ cSt}$.

[0127] The viscosity index (VI) is determined according to ASTM D2270-10e1, "Standard Practice for Calculating Viscosity Index From Kinematic Viscosity at 40 and 100°C," DOI: 10.1520/D2270-10E01.

[0128] The High Temperature/High Shear rate, HTHS (150°C), of a lubricating composition containing the exemplary dispersant viscosity modifier is determined according to the procedure defined in ASTM D 4683-10, "Standard Test Method for Measuring Viscosity of New and Used Engine Oils at High Shear Rate and High Temperature by Tapered Bearing Simulator Viscometer at 150°C," ASTM International, West Conshohocken, PA, which is also known as the Mini Rotary Viscometer test (MRV). This test method determines the viscosity of an oil at 150 °C and $1.0 \cdot 10^6 \text{ s}^{-1}$ using a viscometer having a slightly tapered rotor and stator called the Tapered Bearing Simulator (TBS) Viscometer. Unless otherwise noted, HTHS values are determined by this method and are reported in centipoise (cP). 1 centipoise = 1 mPa-second.

[0129] Low temperature flow to an engine oil pump or oil distribution system is simulated by cold crank measurements in centipoise according to ASTM D5293 - 14, "Standard Test Method for Apparent Viscosity of Engine Oils and Base Stocks Between -5°C and -35°C Using Cold-Cranking Simulator," DOI: 10.1520/D5293-14.

Example 1: Preparation of a 3.5% Maleated Ethylene Propylene Aminoethyl Ethylene Urea Dispersant Viscosity Modifier

[0130] A maleated aminoethyl ethylene urea dispersant viscosity modifier is prepared from aminoethyl ethylene urea and a maleated ethylene propylene copolymer, commercially available from Mitusi as Lucant™ A-5320H.

[0131] A 3-L, four-neck flask equipped with a mechanical stirrer, a thermowell, sub-surface nitrogen inlet, and Dean-Stark trap with condenser is charged with Lucant A-5320H (900.0 g) and diluent oil (936.2 g) and heated to 100 °C. Aminoethylethylene urea (42.1 g) is charged to the flask and the flask contents heated to 160°C. Once at temperature the contents are stirred for 3 h. Upon filtration the product (1798.3 g) is obtained as a viscous oil. The resulting dispersant viscosity modifier is referred to below as 3.5% MAA urea.

Example 2: Preparation of a 3.5% Maleated Ethylene Propylene Aminopropanol Dispersant Viscosity Modifier

[0132] A 5-L, 4-neck flask equipped with a mechanical stirrer, thermowell, sub-surface nitrogen inlet, and Dean-Stark trap with condenser is charged with Lucant A-5320H (1600.0 g) and 3-aminopropanol (87.0 g). The contents of the flask are stirred and heated to 150°C. At around 100°C, the contents form a gel and stirring is halted. Heating is continued and the gel breaks up around 140°C. Stirring is then resumed. With the flask contents at 150°C, additional Lucant A-

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5320H (1600.0 g) is added to the flask over the course of 8 hours. After complete addition, the flask is held at 150°C for 2 hours. The flask temperature is then increased to 160°C and held for 6 hours. A second charge of 3-aminopropanol (4.8 g) is added to the flask and the temperature held at 160°C for an additional 5.5 hours. With the flask at 160°C, vacuum is applied to less than 1 mmHg and held for 1 hour. The vacuum is then released and flask contents cooled, providing the product (3179.2 g) as a viscous oil. The resulting dispersant viscosity modifier is referred to below as 3.5% MAA aminopropanol.

Example 3: Preparation of a 6.5% Maleated Ethylene Propylene Copolymer

[0133] A 2-L, 4-neck flask equipped with a mechanical stirrer, thermowell, sub-surface nitrogen inlet, and an air condenser with attached water cooled condenser is charged with Lucant HC-2000 (1000.0 g), a commercially available olefin copolymer supplied by Mitsui. The contents of the flask are heated to 160°C with a sub-surface nitrogen purge of 0.5 SCFH for 1 hour. Di-tert-butylperoxide (16.0 g) and maleic anhydride (76.0 g) are charged simultaneously to the flask over the course of 2.75 hours. The contents of the flask are held at 160°C for 0.75 hours, then the temperature increased to 180°C with vacuum being applied to 20 mmHg for 4 hours. The vacuum is then released and upon cooling, the product is obtained as a viscous oil (1024.6 g).

Example 4: Preparation of a 6.5% Maleated Ethylene Propylene Aminopropanol Dispersant Viscosity Modifier

[0134] A 3-L, 4-neck flask equipped with a mechanical stirrer, thermowell, sub-surface nitrogen inlet, and Dean-Stark trap with condenser is charged with the 6.5 wt% maleated ethylene propylene copolymer from Example 3 (550.0 g) and diluent oil (1213.2 g) and stirred until homogenous. 869.2 g of this polymer solution is transferred to an addition funnel; the rest of the solution remains in the flask. 3-Aminopropanol (30.3 g) is charged to the flask and the contents of the flask are stirred and heated to 150°C. At approximately 100°C, the flask contents begin to gel and stirring is halted. Near 140°C, the gel breaks and stirring is restarted. When the flask temperature reaches 150°C, the polymer solution in the addition funnel is charged to the flask over 5 hours, after which the flask is held at 150°C for 5 hours. Vacuum is applied to the flask at 4 mmHg for 30 min. The vacuum is then released and the product is filtered, providing the product as an orange viscous oil (1712.0 g) The resulting dispersant viscosity modifier is referred to below as 6.5% MAA aminopropanol.

Preparation of Lubricating Compositions

1. Passenger Car Engine Oil formulation

[0135] The dispersant viscosity modifier of Example 1 is prepared at 50 wt% polymer in 50 wt% diluent oil. The dispersant viscosity modifier of Example 2 is prepared at 100 wt% polymer in 0 wt% diluent oil.

[0136] This is blended into a group III base oil in amounts by weight to form lubricating compositions, as summarized in Table 2 below. Comparative Example 5 includes an amine-free dispersant viscosity modifier (a polymethacrylate (84% C12-15 methacrylate/16% methyl methacrylate), with a weight average molecular weight of 330,000). Examples 6 and 7 contain the dispersant viscosity modifiers of Examples 1 and 2 respectively as well as some of the amine-free dispersant viscosity modifier used in Example 5.

[0137] Each of the blends is designed to have nearly equivalent kinematic viscosities at 100°C (KV_{100}) to allow for direct comparison:

KV_{100}	about 8.65 cSt,
VI	about 235,
HTHS (150°C)	about 2.6cP,
D5293 (-35) cold crank	about 3650 cP

Table 2: Treat rates (wt % of Lubricating Composition)

Lubricating composition	Comparative Ex. 5	Ex. 6	Ex 7
3.5% MAA urea from Ex. 1		0.72 (0.36)	
3.5% MAA 3-aminopropanol from Ex. 2			0.36 (0.36)
amine-free dispersant viscosity modifier	6.01 (2.16)	5.01 (1.80)	5.01 (1.80)

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(continued)

Lubricating composition	Comparative Ex. 5	Ex. 6	Ex 7
Pour Point Depressant	0.1	0.1	0.1
Dispersant-Inhibitor Package	9.18	9.18	9.18
Base Oil	balance	balance	balance

[0138] The data in parenthesis is the amount of actives for each component. The weight % actives are based on the entire composition. The Dispersant-Inhibitor Package may include some oil. The lubricating compositions of Examples 5-7 include about 0.75% zinc dialkyldithiophosphate (ZDDP) (which delivers about 0.076% phosphorus to the lubricating composition).

[0139] Friction properties were determined using a Mini Traction Machine (MTM). The lubricants are evaluated in a commercially-available mini-traction tester machine. A simulated concentrated contact forms between a steel ball and a steel disc (Smooth disk). Traction measurements are made at a rolling speed (of the steel ball) of 2.5 m/s and a 20% slide to roll ratio. The temperature was 140 °C and load was 72N. FIGURE 1 shows the Stribeck curve obtained.

[0140] Given the parameters of this particular experiment the performance of both the 3.5% MAA urea and the 3.5% MAA aminopropanol in the finished fluid can be measured in all three regions of the Stribeck curve. The area of interest is the mixed regime, which can be found between the two vertical lines. The mixed regime is indicative of the durability of the friction modifier characteristics of the dispersant viscosity modifier, as determined by the Sequence VID engine test (ASTM D7589), which is heavily weighted towards the mixed regime.

[0141] From the MTM data, both the 3.5% MAA urea and the 3.5% MAA aminopropanol outperformed the baseline formulation (Ex. 5).

2. Heavy Duty Engine Oil formulation

[0142] For this study, comparative Example 8 includes the dispersant viscosity modifier of Example 3 (32 wt % polymer, 68 wt % oil). In the blend of Example 9, this is replaced with the 6.5 % MAA aminopropanol of Example 4 (prepared at 32 wt % polymer, 68 wt % oil) at a treat rate to obtain the following viscometric parameters:

Kv₁₀₀ about 12-10.5 cSt
HTHS (150 °C) ≥ 3.5 cP
D5293 (-25) cold crank about 5800-6600 cP

[0143] The treat rate for the 6.5% MAA aminopropanol and Baseline (Ex. 8) can be found in Table 3.

Table 3: Treat rates (wt % of Lubricating Composition)

	Comp. Ex. 8	Ex. 9
dispersant viscosity modifier from Ex. 3, wt%	2.05 (0.66 wt% active)	
6.5% MAA 3-aminopropanol from Ex 4, wt%		2.20 (0.7 wt% active)
Viscosity Modifier	3.9 (0.49 wt% active)	3.9 (0.49 wt% active)
Pour Point Depressant	0.2	0.2
Dispersant-Inhibitor Package	14.85	14.85
Base Oil	Balance	Balance

[0144] The weight % actives are also based on the entire composition. The lubricating compositions of Examples 8 and 9 include about 1% zinc dialkyldithiophosphate (ZDDP) (which delivers about 0.11% phosphorus to the composition). The compositions include about 1% sulfated ash and have a TBN of about 8.5.

[0145] The film thickness of the blends in Table 3 when subjected to boundary, mixed and hydrodynamic lubrication conditions is measured by an elastohydrodynamic (EHD) ball on plate rig. Briefly, a chamber is flooded with one of the blends from Table 3. The chamber is equipped with a ball that rolls on a glass plate and a chromium spacer. By digital analysis of the interference pattern of reflected light shined on the ball in contact with the plate, the film thickness is measured to the nanometer scale. The experiment is performed at 140°C over a variety of rolling speeds. Conditions

are as follows: 0.5 GPa Hertz Pressure, 17 N.

[0146] FIGURE 2 shows the EHD data obtained. It can be seen that the Example 9 dispersant viscosity modifier forms a thicker film, as compared to comparative Example 8.

[0147] The term "hydrocarbyl group" is used herein in its ordinary sense, which is well-known to those skilled in the art. Specifically, it refers to a group having a carbon atom directly attached to the remainder of the molecule and having predominantly hydrocarbon character. Examples of hydrocarbyl groups include:

(i) hydrocarbon substituents, that is, aliphatic (e.g., alkyl or alkenyl), alicyclic (e.g., cycloalkyl, cycloalkenyl) substituents, and aromatic-, aliphatic-, and alicyclic-substituted aromatic substituents, as well as cyclic substituents wherein the ring is completed through another portion of the molecule (e.g., two substituents together form a ring);

(ii) substituted hydrocarbon substituents, that is, substituents containing non-hydrocarbon groups which, in the context of this invention, do not alter the predominantly hydrocarbon nature of the substituent (e.g., halo (especially chloro and fluoro), hydroxy, alkoxy, mercapto, alkylmercapto, nitro, nitroso, and sulfoxy);

(iii) hetero substituents, that is, substituents which, while having a predominantly hydrocarbon character, in the context of this invention, contain other than carbon in a ring or chain otherwise composed of carbon atoms.

[0148] Heteroatoms include sulfur, oxygen, nitrogen, and encompass substituents such as pyridyl, furyl, thienyl, and imidazolyl. In general, no more than two, and in some embodiments, no more than one non-hydrocarbon substituent is present for every ten carbon atoms in the hydrocarbyl group. In one embodiment, there are no non-hydrocarbon substituents in the hydrocarbyl group.

[0149] It is known that some of the materials described above may interact in the final formulation, so that the components of the final formulation may be different from those that are initially added. The products formed thereby, including the products formed upon employing lubricant composition of the present invention in its intended use, may not be susceptible of easy description. Nevertheless, all such modifications and reaction products are included within the scope of the present invention; the present invention encompasses lubricant composition prepared by admixing the components described above.

[0150] 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.

[0151] While the invention has been explained in relation to its preferred embodiments, it is to be understood that various modifications thereof will become apparent to those skilled in the art upon reading the specification. Therefore, it is to be understood that the invention disclosed herein is intended to cover such modifications as fall within the scope of the appended claims.

Claims

1. Use of a dispersant viscosity modifier to improve film thickness and/or antiwear performance of an engine lubricating composition, the lubricating composition comprising:

an oil of lubricating viscosity; and
at least 0.05 wt. % of an oil-soluble dispersant viscosity modifier comprising:

an olefin-based polymer backbone, the olefin-based polymer backbone comprising an ethylene-propylene copolymer, and

at least one pendent group derived from aminoethyl ethylene urea, wherein each of the at least one pendent groups is independently attached to the olefin-based polymer backbone by a succinimide linkage through a linking unit derived from maleic anhydride; and wherein each of the at least one pendent groups is non-ionic, non-basic, and non-acidic.

2. The use of claim 1, wherein a ratio by weight of the pendent groups to the polymer backbone in the dispersant viscosity modifier is at least 1:100, or is at least 2:100, or up to 10:100.

3. The use of claim 1 or claim 2, wherein the dispersant viscosity modifier comprises at least two of the pendent groups

per molecule of the dispersant viscosity modifier, on average.

4. The use of any one of claims 1-3, wherein the dispersant viscosity modifier has at least one of:

an HLB value of up to 6, or at least 2, where $HLB = 20 \cdot M_h / M$, where M_h is the molecular mass of the hydrophilic portion of the molecule and M is the molecular mass of the whole molecule;
 a TBN up to 5, on an oil-free basis, according to the method described in ASTM D2896-11; and
 a TAN of up to 5, on an oil-free basis, according to the method described in ASTM D664-11A.

5. The use of any one of claims 1-4, wherein the ethylene-propylene copolymer comprises at least 10 mole percent ethylene.

6. The use of any one of claims 1-5, wherein the olefin-based polymer backbone has a number average molecular weight, as measured by gel permeation chromatography, using a polystyrene standard, of greater than at least 1000.

7. The use of any one of claims 1-6, wherein the oil of lubricating viscosity is present in the composition at a concentration of at least 10 wt. %.

8. The use of any one of claims 1-7, wherein the oil of lubricating viscosity has a kinematic viscosity at 100 °C, as determined by ASTM D445 - 12, of less than 15 mm²/s.

9. The use of any one of claims 1-8, wherein the dispersant viscosity modifier has a kinematic viscosity at 100 °C, as determined by ASTM D445 - 12, of at least 35 mm²/s.

10. The use of any one of claims 1-9, wherein the composition further comprises at least one of a dispersant, a detergent, an overbased detergent, an antioxidant a viscosity modifier, a friction modifier, a corrosion inhibitor, a pour point depressant, a seal swell agent, a demulsifier, and an antiwear agent.

Patentansprüche

1. Verwendung eines Dispergiermittelviskositätsmodifikators, um eine Filmdicke und/oder eine Antiverschleißleistung einer Motorschmiermittelzusammensetzung zu verbessern, die Schmiermittelzusammensetzung umfassend:

ein Öl mit Schmierviskosität; und
 mindestens zu 0,05 Gew.-% einen öllöslichen Dispergiermittelviskositätsmodifikator, umfassend:
 ein Polymerrückgrat auf Olefinbasis, das Polymerrückgrat auf Olefinbasis umfassend ein Ethylen-Propylen-Copolymer, und
 mindestens eine seitenständige Gruppe, die von Aminoethylethylenharnstoff abgeleitet ist, wobei jede der mindestens einen seitenständigen Gruppe unabhängig an das Polymerrückgrat auf Olefinbasis durch eine Succinimid-Verknüpfung über eine Verknüpfungseinheit, die von Maleinsäureanhydrid abgeleitet ist, gebunden ist; und wobei jede der mindestens einen seitenständigen Gruppe nicht ionisch, nicht basisch und nicht sauer ist.

2. Verwendung nach Anspruch 1, wobei ein Gewichtsverhältnis der seitenständigen Gruppen zu dem Polymerrückgrat in dem Dispergiermittelviskositätsmodifikator mindestens 1: 100 beträgt oder mindestens 2 : 100 oder bis zu 10 : 100 beträgt.

3. Verwendung nach Anspruch 1 oder 2, wobei der Dispergiermittelviskositätsmodifikator durchschnittlich mindestens zwei der seitenständigen Gruppen pro Molekül des Dispergiermittelviskositätsmodifikators umfasst.

4. Verwendung nach einem der Ansprüche 1 bis 3, wobei der Dispergiermittelviskositätsmodifikator mindestens eines von Folgendem aufweist:

einen HLB-Wert von bis zu 6 oder mindestens 2, wobei $HLB = 20 \cdot M_h / M$, wobei M_h die Molekülmasse des hydrophilen Abschnitts des Moleküls ist und M die Molekülmasse des gesamten Moleküls ist;
 ein TBN bis zu 5, auf einer ölfreien Basis, gemäß dem in ASTM D2896-11 beschriebenen Verfahren; und
 ein TAN von bis zu 5, auf einer ölfreien Basis, gemäß dem in ASTM D664-11A beschriebenen Verfahren.

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5. Verwendung nach einem der Ansprüche 1 bis 4, wobei das Ethylen-Propylen-Copolymer mindestens zu 10 Mol- % Ethylen umfasst.
- 5 6. Verwendung nach einem der Ansprüche 1 bis 5, wobei das Polymerrückgrat auf Olefinbasis ein zahlenmittleres Molekulargewicht, gemessen durch Gelpermeationschromatographie, unter Verwendung eines Polystyrolstandards, von mehr als mindestens 1000 aufweist.
7. Verwendung nach einem der Ansprüche 1 bis 6, wobei das Öl mit Schmierviskosität in der Zusammensetzung in einer Konzentration zu mindestens 10 Gew.-% vorhanden ist.
- 10 8. Verwendung nach einem der Ansprüche 1 bis 7, wobei das Öl mit Schmierviskosität eine kinematische Viskosität bei 100 °C, wie durch ASTM D445-12 bestimmt, von weniger als 15 mm²/s aufweist.
9. Verwendung nach einem der Ansprüche 1 bis 8, wobei der Dispergiertmittelviskositätsmodifikator eine kinematische Viskosität bei 100 °C, wie durch ASTM D445-12 bestimmt, von mindestens 35 mm²/s aufweist.
- 15 10. Verwendung nach einem der Ansprüche 1 bis 9, wobei die Zusammensetzung ferner mindestens eines von einem Dispergiertmittel, einem Detergens, einem überbasischen Detergens, einem Antioxidationsmittel, einem Viskositätsmodifizierer, einem Reibungsmodifizierer, einem Korrosionsinhibitor, einem Stockpunktersenkungsmittel, einem Dichtungsquellmittel, einem Demulgator und einem Antiverschleißmittel umfasst.
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Revendications

- 25 1. Utilisation d'un modificateur de viscosité dispersant pour améliorer l'épaisseur de film et/ou la performance antiusure d'une composition lubrifiante de moteur, la composition lubrifiante comprenant :
- une huile de viscosité lubrifiante ; et
au moins 0,05 % en poids d'un modificateur de viscosité dispersant oléosoluble comprenant :
- 30 un squelette polymère à base d'oléfine, le squelette polymère à base d'oléfine comprenant un copolymère d'éthylène-propylène, et
au moins un groupe greffé dérivé d'aminoéthyl-éthylène-urée, chacun parmi l'au moins un groupe greffé étant indépendamment fixé au squelette polymère à base d'oléfine par une liaison succinimide par l'intermédiaire d'un motif de liaison dérivé d'anhydride maléique ; et dans laquelle chacun parmi l'au moins un groupe greffé est non ioniques, non basique, et non acide.
- 35 2. Utilisation selon la revendication 1, dans laquelle un rapport en poids des groupes greffés au squelette polymère dans le modificateur de viscosité dispersant est d'au moins 1:100, ou est d'au moins 2:100, ou jusqu'à 10:100.
- 40 3. Utilisation selon la revendication 1 ou la revendication 2, dans laquelle le modificateur de viscosité dispersant comprend au moins deux des groupes greffés par molécule du modificateur de viscosité dispersant, en moyenne.
4. Utilisation selon l'une quelconque des revendications 1 à 3, dans laquelle le modificateur de viscosité dispersant a au moins l'un parmi :
- 45 une valeur HLB allant jusqu'à 6, ou au moins 2, où $HLB = 20 \cdot Mh/M$, où Mh est la masse moléculaire de la partie hydrophile de la molécule et M est la masse moléculaire de la molécule entière ;
un TBN jusqu'à 5, sur une base sans huile, selon le procédé décrit dans l'ASTM D2896-11 ; et
un TAN allant jusqu'à 5, sur une base sans huile, selon le procédé décrit dans l'ASTM D664-11A.
- 50 5. Utilisation selon l'une quelconque des revendications 1 à 4, dans laquelle le copolymère éthylène-propylène comprend au moins 10 pour cent molaires d'éthylène.
- 55 6. Utilisation selon l'une quelconque des revendications 1 à 5, dans laquelle le squelette polymère à base d'oléfine a un poids moléculaire moyen en nombre, tel que mesuré par chromatographie par perméation sur gel, à l'aide d'un étalon de polystyrène, supérieur à au moins 1000.

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7. Utilisation selon l'une quelconque des revendications 1 à 6, dans laquelle l'huile de viscosité lubrifiante est présente dans la composition à une concentration d'au moins 10 % en poids.
- 5 8. Utilisation selon l'une quelconque des revendications 1 à 7, dans laquelle l'huile de viscosité lubrifiante a une viscosité cinématique à 100 °C, telle que déterminée par ASTM D445 - 12, inférieure à 15 mm²/s.
9. Utilisation selon l'une quelconque des revendications 1 à 8, dans laquelle le modificateur de viscosité dispersant a une viscosité cinématique à 100 °C, telle que déterminée par ASTM D445 - 12, d'au moins 35 mm²/s.
- 10 10. Utilisation selon l'une quelconque des revendications 1 à 9, dans laquelle la composition comprend en outre au moins l'un parmi un dispersant, un détergent, un détergent surbasique, un antioxydant un modificateur de viscosité, un modificateur de friction, un inhibiteur de corrosion, un abaisseur de point d'écoulement, un agent de gonflement étanchéifiant, un désémulsifiant, et un agent antiusure.

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Stribeck Curves; 140 C and 72 N

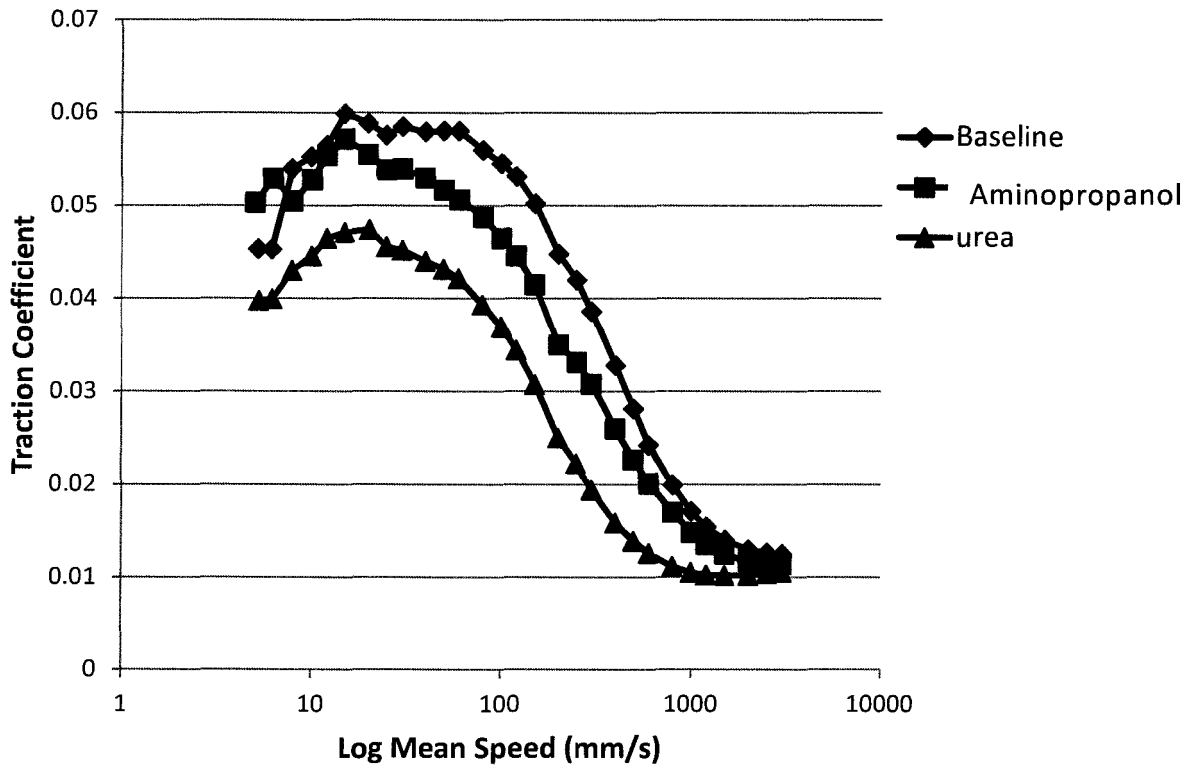


FIG. 1

Film Thickness at 140 °C and 17 N

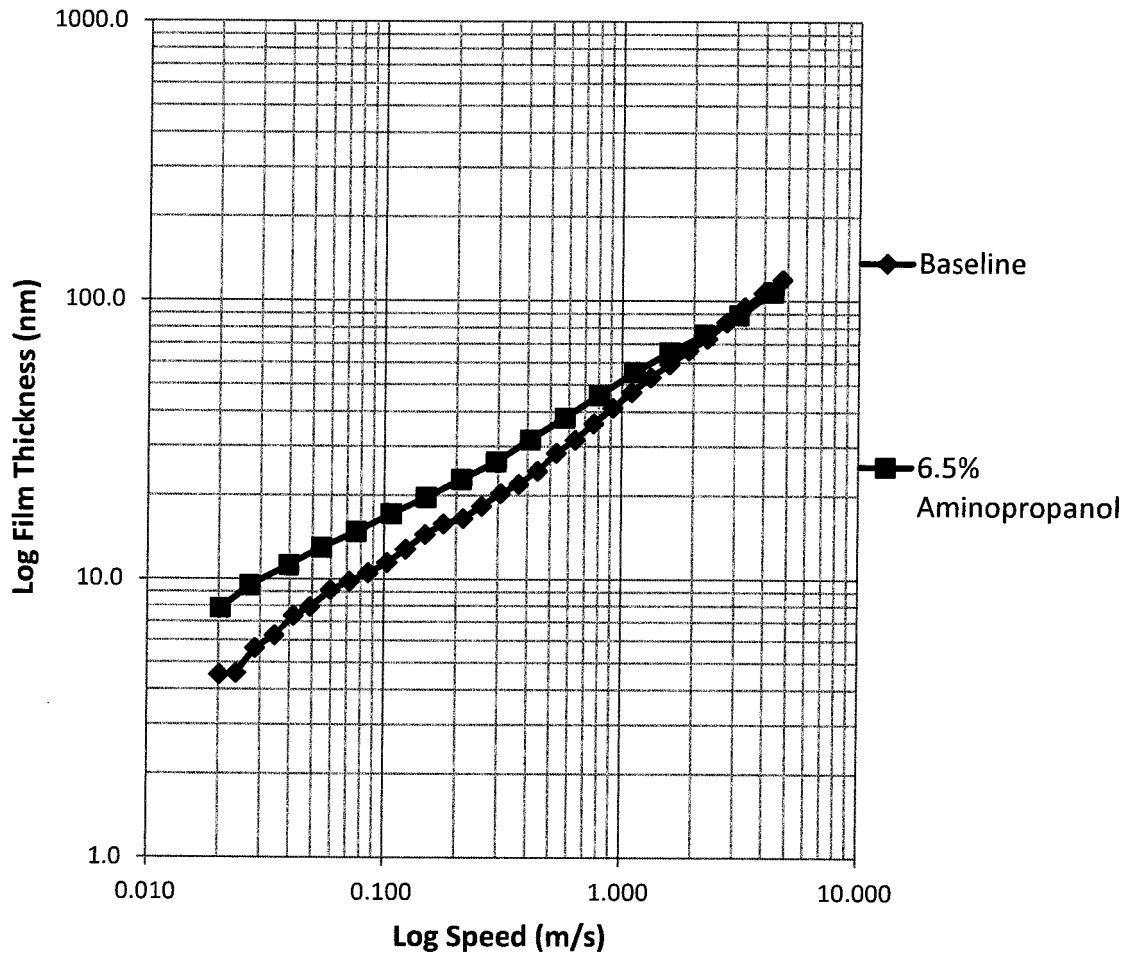


FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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