

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
24 August 2006 (24.08.2006)

PCT

(10) International Publication Number
WO 2006/088693 A2

(51) International Patent Classification:

C08F 8/30 (2006.01) **C10M 133/56** (2006.01)
C08F 8/14 (2006.01)

(21) International Application Number:

PCT/US2006/004238

(22) International Filing Date: 3 February 2006 (03.02.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/652,704 14 February 2005 (14.02.2005) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: NOVEL VISCOSITY MODIFYING DISPERSANT

(57) **Abstract:** The present invention provides a process for preparing an oil soluble product comprising reacting: (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; (b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000; and (c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol, wherein the oil soluble product has a mole ratio of acylating agents (a) to (b) of 1:greater than 2. The invention further provides the use of the oil soluble product in a lubricating composition for lubricating an internal combustion engine.



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TITLE

Novel Viscosity Modifying Dispersant

FIELD OF INVENTION

The present invention relates to a novel viscosity modifying dispersant. The invention further provides a method of preparing the novel viscosity modifying dispersant, compositions containing the novel viscosity modifying dispersant and its use in a lubricating composition.

BACKGROUND OF THE INVENTION

[0001] The use of polymers as rheology modifiers (or viscosity modifiers) or dispersants in oils of lubricating viscosity is well known. Typical dispersant chemistry is derived from a polyisobutylene succinimide; and a viscosity modifier is often based on an olefin copolymer, especially an ethylene-propylene copolymer. However, it is well known that said dispersant or viscosity modifier chemistry containing an olefinic chain may adversely affect low temperature viscometrics of a lubricating composition.

[0002] US Patent 4,517,104 discloses an ethylene copolymer viscosity index improving dispersant additive useful in oil compositions. The ethylene copolymer is the reaction product of (a) a copolymer comprising 15 wt % to 90 wt % ethylene, a comonomer derived from 10 wt % to 85 wt % of C₃ to C₂₈ alpha-olefin; (b) an alkylene or oxyalkylene amine; and (c) a long chain hydrocarbyl substituted succinic anhydride or acid. The patent discloses in the examples a reaction product having a mole ratio of copolymer to a long chain hydrocarbyl substituted succinic anhydride or acid of 1 to 1 or less.

[0003] US Patent 5,512,192 discloses a dispersant viscosity modifier for lubricants. The dispersant viscosity modifier is prepared by reacting oil soluble substantially hydrogenated vinyl substituted aromatic-aliphatic diene block copolymers with an ethylenically unsaturated carboxylic acid or functional derivative thereof with at least one polyester, at least one polyamine and at least one hydrocarbyl substituted carboxylic acid or anhydride.

[0004] US Patent 5,035,821 discloses a polymer with an end-capped multifunctional viscosity index improver with dispersant properties. The polymer is an ethylene copolymer grafted with (a) an ethylenically unsaturated

carboxylic acid moiety (e.g., succinic anhydride); then further reacted with (b) a polyamine having two or more primary amino groups or a polyol; (c) a long chain hydrocarbyl substituted dicarboxylic acid material (e.g., alkenyl succinic anhydride) having a functionality of at least 1.2; and (d) a short chain hydrocarbyl substituted dicarboxylic acid or anhydride.

[0005] It would be desirable to have an oil soluble product with at least one property selected from acceptable cleanliness, acceptable viscometrics (i.e. low temperature viscometrics or acceptable high temperature viscometrics) and acceptable dispersant properties. The present invention provides an oil soluble product with at least one such property.

SUMMARY OF THE INVENTION

[0006] In one embodiment the present invention provides a process for preparing an oil soluble product comprising reacting: (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; (b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000; and (c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol, wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than 2.

[0007] In one embodiment the present invention provides a process for preparing an oil soluble product comprising reacting: (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; and (b) a reaction product of an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000 and at least one of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol, wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than 2.

[0008] In one embodiment the present invention provides a lubricating composition comprising: (I) an oil of lubricating viscosity; and (II) an oil soluble reaction product of: (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; (b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000; and (c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol,

wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than 2.

DETAILED DESCRIPTION OF THE INVENTION

[0009] In one embodiment the present invention provides a process for preparing an oil soluble product comprising reacting:

- (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent;
- (b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000; and
- (c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol,

wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than 2.

[0010] In one embodiment the oil soluble product is prepared by reacting (a) + (b) + (c) in a one-step process. The reaction referred to here and elsewhere in this specification may involve grafting or other reactive processes. A one-step process generally involves adding all of the reactants into a vessel and reacting them to form a product has a mole ratio of (a) : (b) of 1:greater than 2. Further a person skilled in the art will appreciate that the oil soluble product of the invention is a product derived from (a) + (b) + (c). Components (a) + (b) + (c) may also react to give a by-product by reacting (a) + (b) and/or (a) + (c). However, a person skilled in the art will also appreciate that (a) + (b) and/or (a) + (c) may form as intermediates in the formation of the oil soluble product.

[0011] In several embodiment the process is carried out at a temperature in the range of 70°C to 300°C, 100°C to 220°C or 145°C to 200°C. In several embodiments the process is carried out for a period of time in the range of 30 seconds to 48 hours, 2 minutes to 24 hours, 5 minutes to 16 hours, or 30 minutes to 4 hours. In several embodiments the process is carried out at a pressure in the range of 86.4 kPa to 266 kPa (650 mm Hg to 2000 mm Hg), 91.8 kPa to 200 kPa (690 mm Hg to 1500 mm Hg) or 95.1 kPa to 133 kPa (715 mm Hg to 1000 mm Hg).

[0012] In one embodiment the oil soluble product is prepared by reacting (a) + (b) in a two-step process. Typically the two step process comprises (I) preparing a reaction product of an acylating agent substituted with a hydrocarbyl

group having a number average molecular weight of 350 to 5000 and at least one of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol; and (II) reacting the product of step (I) with an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent. Generally the reaction product of step (I) is a pre-formed dispersant. Therefore the oil soluble product may be prepared in a two step process comprising pre-reacting (b) and (c) to form a dispersant and reacting the dispersant with (a). A person skilled in the art will also appreciate that steps (I) and (II) of the two-step process may be conducted in either order.

[0013] Reaction conditions for step one (i.e. preparation of the dispersant) are well known in the art and are disclosed, for instance, in US Patent Numbers 3,361,673, 3,401,118 and 4,234,435.

[0014] The reaction conditions for step two of the process are the same as described for the one step process described above.

[0015] In one embodiment the oil soluble product is free or substantially free of a short chain hydrocarbyl substituted dicarboxylic acid. As used herein the term "short chain" means a carbon chain containing less than 16 carbon atoms.

[0016] In one embodiment the present invention provides process for preparing an oil soluble product comprising reacting:

(a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; and

(b) a dispersant having hydrocarbyl group which has a number average molecular weight of less than about 5000,

wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than 2.

[0017] In one embodiment the present invention provides process for preparing an oil soluble product comprising reacting:

(a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; and

(b) a reaction product of an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000 and at least one of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol, wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than 2.

[0018] In one embodiment the present invention further provides an oil soluble product obtained (or obtainable) by the process described above.

[0019] In one embodiment the oil soluble product is believed to be formed by crosslinking of (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; and (b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000 with (c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol. The compound (c) is believed to serve as a crosslinking agent by condensing or otherwise reacting, at least in part, with the acylating functionality of molecules of both components (a) and (b)

[0020] A person skilled in the art will appreciate that the mole ratio of (a) : (b) may be modified such that amino and/or hydroxy groups sufficiently cross-link the oil soluble product to ensure the dispersant exhibits viscosity index improving properties. If the degree of crosslinking is too high the product gels and becomes oil-insoluble. Alternatively if the degree of crosslinking is too low, the oil soluble product typically has viscosity modifying properties with a modest degree of dispersancy (i.e. a conventional dispersant viscosity modifier).

[0021] In several embodiments the mole ratio of (a) : (b) is 1:4 or more, or 1:8 or more, or 1:10 or more. Examples of suitable ranges for the mole ratio of (a) to (b) include 1:3 to 1:100, 1:6 to 1:85 or 1:12 to 1:75. A person skilled in the art will appreciate that the mole ratio of (b) is greater than the mole ratio of (a).

[0022] When the olefin copolymer (having a number average molecular weight of more than about 5000 functionalised with an acylating agent) is pre-formed in the presence of a medium (e.g., an oil of lubricating viscosity) the oil soluble product will typically have a mole ratio of (a) : (b) of 1:9 or more or 1:13. Typically the mole ratio of (a) to (b) is less than 1:30 or 1:25. It is believed that pre-forming the olefin copolymer provides an oil soluble product with the ratio of acylating agents (a) to (b) typically less than 1:30 because a portion of the acylating agent is grafted on to the medium.

[0023] When the olefin copolymer (having a number average molecular weight of more than about 5000 functionalised with an acylating agent) is pre-formed in the absence of a medium, e.g., in an extruder, the oil soluble product

typically has mole ratio of (a) to (b) in several embodiments of 1:10 or more, 1:20 or more, 1:30 or more or 1:35 or more. Examples of suitable ranges for the mole ratio of (a) to (b) include 1:35 to 1:140, 1:45 to 1:100 or 1:60 to 1:90.

[0024] In one embodiment the oil soluble product is prepared in the presence of a medium. The medium is one in which the reactants are generally soluble, often a substantially inert normally liquid organic diluent. Examples include oils of lubricating viscosity such as an oil with low in halogen content or alkyl aromatic compounds such as toluene, xylene and naphthalene.

[0025] In one embodiment the oil soluble product is formed in the absence of a medium for polymerisation. Generally processes that do not require a medium for polymerisation are carried out in an extruder reaction vessel.

Olefin Copolymer Functionalised with Acylating Agent

[0026] In one embodiment the olefin copolymer includes hydrogenated copolymers of styrene-butadiene, ethylene-propylene polymers, hydrogenated styrene-isoprene polymers, hydrogenated alkenyl aryl conjugated diene copolymers, or mixtures thereof.

[0027] In one embodiment the olefin copolymer is selected from the group consisting of styrene-butadiene polymers, ethylene-propylene polymers, hydrogenated alkenyl aryl conjugated diene copolymers, and mixtures thereof.

[0028] In one embodiment the olefin copolymer comprises hydrogenated styrene-isoprene polymers, with the proviso that mole ratio of (a) : (b) is 1:8 or more or any of the ratios or ratios described above that are 1:8 or more.

[0029] In several embodiments the olefin copolymer functionalised with an acylating agent has a number average molecular weight of more than 5000, 10,000 or more, or 20,000 or 30,000 or more. Examples of suitable ranges for the number average molecular weight include 7500 to 350,000, 12,000 to 200,000, 25,000 to 100,000, 30,000 to 80,000 or 35,000 to 60,000.

[0030] In one embodiment the olefin copolymer which serves as a viscosity modifier is derived from an ethylene monomer and at least one other comonomer derived from an alpha-olefin having the formula $H_2C=CHR^1$, wherein R^1 is a hydrocarbyl group, especially an alkyl radical. In several embodiments the alkyl radical contains 1 to 30, 1 to 10, 1 to 6 or 1 to 3 carbon atoms. The hydrocarbyl group includes an alkyl radical that has a straight chain, a branched chain or mixtures thereof. Examples of comonomers include propylene, 1-butene,

1-hexene, 1-octene, 4-methyl-1-pentene, 1-decene or mixtures thereof. In one embodiment the comonomer includes 1-butene, propylene or mixtures thereof. Examples of the olefin copolymers include ethylene-propylene copolymers, ethylene-1-butene copolymers or mixtures thereof.

[0031] In several other embodiments the alpha-olefin includes a comonomer with 6 to 40, 10 to 34 or 14 to 22 carbon atoms. Examples of alpha-olefins include 1-decene 1-undecene, 1-dodecene, 1-tridecene, 1-butadecene, 1-pentadecene, 1-hexadecene, 1-heptadecene 1-octadecene, 1-nonadecene, 1-eicosene, 1-doeicosene, 2-tetracosene, 3-methyl-1-henicosene, 4-ethyl-2-tetracosene or mixtures thereof or reactive equivalents thereof. Useful examples of alpha-olefins include 1-pentadecene, 1-hexadecene, 1-heptadecene 1-octadecene, 1-nonadecene or mixtures thereof. The alpha-olefins are often commercially available as mixtures, especially as mixtures of C₁₆-C₁₈ alpha olefins.

[0032] In one embodiment the olefin copolymer is an ethylene-propylene copolymer and may contain up to 3, 4 or 5 monomer types, that is, it may contain additional monomers beside ethylene and propylene. The composition of the ethylene-propylene copolymer in several embodiments has an ethylene content from 15 wt % to 90 wt % or 30 wt % to 80 wt % of the copolymer; and a propylene content of 10 wt % to 85 wt % or 20 wt % to 70 wt % of the copolymer. In one embodiment olefin copolymer is an ethylene-propylene copolymer, with the ethylene content ranging from 15 wt % to 90 wt % of the copolymer and the propylene content ranging from 10 wt % to 85 wt % of the copolymer.

Acylating Agent

[0033] The acylating agent which may be substituted onto the olefin copolymer of (a) or which may be substituted with the hydrocarbyl group of (b) in one embodiment is an unsaturated carboxylic acid anhydride or derivative thereof that may be wholly esterified, partially esterified or mixtures thereof. In one embodiment the acylating agent of component (a) comprises an unsaturated carboxylic acid or reactive equivalents thereof. When partially esterified other derivatives include acids, salts or mixtures thereof. Suitable salts include alkali metals, alkaline earth metals or mixtures thereof. The salts include lithium, sodium, potassium, magnesium, calcium or mixtures thereof. The unsaturated

carboxylic acids or derivatives thereof may comprise acrylic acid, methyl acrylate, methacrylic acid, maleic acid or anhydride, fumaric acid, itaconic acid or anhydride or mixtures thereof or reactive equivalents thereof. In another embodiment the acylating agent of (b) comprises a succinic anhydride.

[0034] Suitable examples of the unsaturated dicarboxylic acid anhydride or derivatives include itaconic anhydride, maleic anhydride, methyl maleic anhydride, ethyl maleic anhydride, dimethyl maleic anhydride or mixtures thereof. The unsaturated carboxylic acid anhydrides or derivatives thereof functionality may be used alone or in combination.

[0035] The acylating agent, when reacted and/or grafted with (a) a olefin copolymer having a number average molecular weight of more than about 5000, may be incorporated into an olefin polymer backbone and/or grafted on to the backbone. In one embodiment the unsaturated carboxylic acid anhydride or derivatives thereof is grafted onto the backbone. In one embodiment the unsaturated carboxylic acid anhydride or derivatives thereof is incorporated into olefin polymer backbone.

Acylating Agent Substituted with a Hydrocarbyl Group

[0036] The acylating agent may be reacted with a hydrocarbon to form an acylating agent substituted with a hydrocarbyl group of (b). In several embodiments the acylating agent is substituted with a hydrocarbyl group derived from a hydrocarbon with a number average molecular weight of 350 to 5000, 400 to 3000, 450 to 2500, 500 to 2300, 550 to 1600 or 900 to 1600.

[0037] The hydrocarbyl group substituted onto the acylating agent in one embodiment is a substituted or unsubstituted oxyalkylene or a polyolefin, such as a polyisobutylene or polybutene. In one embodiment the acylating agent substituted with a hydrocarbyl group comprises a polyisobutylene succinic acid or anhydride, wherein the polyisobutylene has a number average molecular weight of 350 to 3000.

[0038] The acylating agent may be grafted or reacted onto an olefin copolymer viscosity modifier by a similar process as taught in US Patent 4,160,739 and/or 4,161,452.

Polyamine

[0039] In one embodiment the oil soluble product is formed in the presence of a polyamine. Suitable polyamines are well known to a person skilled in the

art of preparing a dispersant. Examples of suitable polyamines include alkylene amines or oxyalkylene amines. Alkylene amine typically contain alkylene groups containing 2 to 20 or 2 to 10 carbon atoms; and 2 to 14 or 2 to 10 nitrogen atoms. Suitable examples of polyamines include ethylenepolyamines, propylenepolyamines, butylenepolyamines or mixtures thereof. Examples of ethylenepolyamines include triethylene tetramine, tetraethylene pentamine, pentaethylene hexamine, amine still bottoms (often described as HPAX™) or mixtures thereof. In one embodiment the polyamine is still bottoms.

Polyol

[0040] In one embodiment the oil soluble product is formed in the presence of a polyol or mixtures thereof. Examples of suitable polyols include compounds containing 2 to 10 or 2 to 6 hydroxyl groups. Examples of a generic class of suitable polyol compounds include glycol, and glycerol. Examples of suitable polyol compounds include glycerol, erythritol, 2-hydroxymethyl-2-methyl-1,3-propanediol (trimethylolethane), 2-hydroxymethyl-2-ethyl-1,3-propanediol (trimethylolpropane), 1,2,4-hexanetriol, ethylene glycol, propylene glycol, butylene glycol, pentaerythritol, dipentaerythritol, mannitol, sorbitol or mixtures thereof.

Aminoalcohol

[0041] In one embodiment the oil soluble product is formed in the presence of an aminoalcohol. Examples of aminoalcohols include ethanolamine, isopropanolamine, diethanolamine, triethanolamine, diethylethanolamine, dimethylethanolamine, dibutylethanolamine, 3-amino-1,2-propanediol, serinol, 2-amino-2-methyl-1,3-propanediol, tris(hydroxymethyl)-aminomethane, 1-amino-1-deoxy-D-sorbitol, diethanol amine; diisopropanolamine, N-methyl-N,N-diethanol amine, triethanolamine, N,N,N',N'-tetrakis(2-hydroxypropyl)ethylenediamine, 2-amino-2-methyl-1-propanol, 2-dimethylamino-methyl-1-propanediol, 2-amino-2-ethyl-1,3-propanediol, 2-amino-2-methyl-1,3-propanediol, 2-amino-1-butanol or mixtures thereof. In one embodiment the aminoalcohol is ethanolamine.

Lubricating Composition

[0042] In one embodiment the present invention provides a lubricating composition comprising:

- (I) an oil of lubricating viscosity; and

(II) an oil soluble reaction product of:

(a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent;

(b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000; and

(c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol,

wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1: greater than 2.

Oil of Lubricating Viscosity

[0043] In one embodiment the emulsion composition includes natural or synthetic oils of lubricating viscosity, oil derived from hydrocracking, hydrogenation, hydrofinishing, unrefined, refined and re-refined oils or mixtures thereof.

[0044] Natural oils include animal oils, vegetable oils, mineral oils or mixtures thereof. Synthetic oils include a hydrocarbon oil, a silicon-based oil, a liquid esters of phosphorus-containing acid. Synthetic oils may be produced by Fischer-Tropsch reactions and typically may be hydroisomerised Fischer-Tropsch hydrocarbons or waxes.

[0045] Oils of lubricating viscosity may also be defined as specified in the American Petroleum Institute (API) Base Oil Interchangeability Guidelines. In several embodiments the oil of lubricating viscosity comprises an API Group I, II, III, IV, V, VI or mixtures thereof, or an API Group I, II, III or mixtures thereof. If the oil of lubricating viscosity is an API Group II, III, IV, V or VI oil there may be up to a maximum of 40 wt % or up to a maximum of 5 wt % of the lubricating oil being an API Group I oil.

[0046] In one embodiment the lubricating composition has a SAE viscosity grade from XW-Y, wherein X is an integer from 0 to 20 and Y is an integer from 20 to 50.

[0047] In several embodiments X is an integer chosen from 0, 5, 10, 15 or 20; and Y is an integer chosen from 20, 25, 30, 35, 40, 45 or 50.

[0048] In several embodiments the oil of lubricating viscosity is present from 40 wt % to 99.9 wt %, or from 50 wt % to 97 wt %, or from 55 wt % to 95 wt %, or from 60 wt % to 90 wt % of the lubricating composition.

Additional Performance Additive

[0049] The composition optionally further includes at least one additional performance additive. The additional performance additives include metal deactivators, detergents, dispersants, friction modifiers, viscosity modifiers, dispersant viscosity modifiers, extreme pressure agents, antiwear agents, antioxidants, corrosion inhibitors, foam inhibitors, demulsifiers, pour point depressants, seal swelling agents or mixtures thereof.

[0050] In several embodiments the total combined amount of the additional performance additive compounds are present from 0 wt % to 25 wt %, 0.01 wt % to 20 wt %, 0.1 wt % to 15 wt % or 0.5 wt % to 10 wt % of the composition. Although one or more of the additional performance additives may be present, it is common for the additional performance additives to be present in different amounts relative to each other.

[0051] If the present invention is in the form of a concentrate (which can be combined with additional oil to form, in whole or in part, a finished lubricant), the ratio of the oil soluble product of the invention and the optional additional performance additives in an oil of lubricating viscosity, to diluent oil including may be in the range of 80:20 to 10:90 or to 5:95 by weight.

[0052] Antioxidants include molybdenum dithiocarbamates, sulphurised olefins, hindered phenols, diphenylamine. Detergents include neutral or overbased, Newtonian or non-Newtonian, basic salts of alkali, alkaline earth and transition metals with one or more of a phenate, a sulphurised phenate, a sulphonate, a carboxylic acid, a phosphorus acid, a mono- and/or a di-thiophosphoric acid, a saligenin, an alkylsalicylate, a salixarate. Dispersants include N-substituted long chain alkenyl succinimide as well as posted treated versions thereof. Post-treated dispersants include those treated by reaction with urea, thiourea, dimercaptothiadiazoles, carbon disulphide, aldehydes, ketones, carboxylic acids, hydrocarbon-substituted succinic anhydrides, nitriles, epoxides, boron compounds, or phosphorus compounds. Viscosity modifiers include hydrogenated copolymers of styrene-butadiene, olefin copolymers other than the oil soluble product of the invention (such as ethylene-propylene polymers, polyisobutenes, hydrogenated styrene-isoprene polymers, hydrogenated isoprene polymers), polymethacrylate acid esters, polyacrylate acid esters, polyalkyl

styrenes, hydrogenated alkenyl aryl conjugated diene copolymers, polyalkylmethacrylates and esters of maleic anhydride-styrene copolymers.

[0053] Antiwear agents include compounds such as metal thiophosphates, especially zinc dialkyldithiophosphates; phosphoric acid esters or salt thereof; phosphites; and phosphorus-containing carboxylic esters, ethers, and amides. Antiscuffing agents including organic sulphides and polysulphides, such as benzyldisulphide, bis-(chlorobenzyl) disulphide, dibutyl tetrasulphide, di-tertiary butyl polysulphide, di-tert-butylsulphide, sulphurised Diels-Alder adducts or alkyl sulphenyl N'N-dialkyl dithiocarbamates. Extreme Pressure (EP) agents including chlorinated wax, organic sulphides and polysulphides, such as benzyldisulphide, bis-(chlorobenzyl) disulphide, dibutyl tetrasulphide, sulphurised methyl ester of oleic acid, sulphurised alkylphenol, sulphurised dipentene, sulphurised terpene, and sulphurised Diels-Alder adducts; phosphosulphurised hydrocarbons, metal thiocarbamates, such as zinc dioctyldithiocarbamate and barium heptylphenol diacid. Any of the above classes of additives may also be used in the composition of the invention.

[0054] Additionally the invention may also include friction modifiers including fatty amines, esters such as borated glycerol esters, fatty phosphites, fatty acid amides, fatty epoxides, borated fatty epoxides, alkoxyated fatty amines, borated alkoxyated fatty amines, metal salts of fatty acids, fatty imidazolines, condensation products of carboxylic acids and polyalkylene-polyamines, amine salts of alkylphosphoric acids. The formulation of the invention may also include dispersant viscosity modifiers (often referred to as DVM), including functionalised polyolefins, for example, ethylene-propylene copolymers that have been functionalized with the reaction product of maleic anhydride and an amine; polymethacrylates functionalised with an amine, or styrene-maleic anhydride copolymers reacted with an amine.

[0055] Other performance additives such as corrosion inhibitors including octylamine octanoate, condensation products of dodecenyl succinic acid or anhydride and a fatty acid such as oleic acid with a polyamine; metal deactivators including derivatives of benzotriazoles, 1,2,4-triazoles, benzimidazoles, 2-alkyldithiobenzimidazoles or 2-alkyldithiobenzothiazoles; foam inhibitors including copolymers of ethyl acrylate and 2-ethylhexylacrylate and optionally vinyl acetate; demulsifiers including trialkyl phosphates,

polyethylene glycols, polyethylene oxides, polypropylene oxides and (ethylene oxide-propylene oxide) polymers; pour point depressants including esters of maleic anhydride-styrene, polymethacrylates, polyacrylates or polyacrylamides; and seal swell agents including Exxon Necton-37™ (FN 1380) and Exxon Mineral Seal Oil (FN 3200); may also be used in the composition of the invention.

Industrial Application

[0056] The oil soluble product of the present invention is useful as a dispersant with viscosity index improving properties for a transmission fluid, a gear oil, a hydraulic fluid or an internal combustion engine lubricant, for example, for diesel fuelled engines, gasoline fuelled engines, natural gas fuelled engines or mixed gasoline/alcohol fuelled engines.

[0057] In one embodiment of the invention provides a method for lubricating an internal combustion engine, comprising supplying thereto a lubricant comprising the oil soluble product as described herein. The use of the oil soluble product in an internal combustion engine may impart one or more properties selected from acceptable cleanliness, acceptable viscometrics (i.e. low temperature viscosmetrics or acceptable high temperature viscometrics) and acceptable dispersant properties.

[0058] In several embodiments the oil soluble product is present in a lubricating composition from 0.001 wt % to 30 wt %, 0.1 wt % to 20 wt %, 0.5 wt % to 15 wt %, 1 wt % to 10 wt % or from 2 wt % to 8 wt % of the lubricating composition.

[0059] The following examples provide illustrations of the invention. These examples are non exhaustive and are not intended to limit the scope of the invention.

EXAMPLES

Preparative Example 1 (Prep EX1)

[0060] A mixture of a Group III oil of Nexbase 3050™ supplied by Fortum oil company (2000g) and toluene (360g) is heated to 125°C under N₂ in a 5-litre flask. At this temperature, a 25SSI ethylene-propylene copolymer (424g) is added portion wise and the mixture left to heat for a further three hours. The reaction is then heated to 160°C and tert-butylperoxide (24g) in toluene (80ml) is added drop wise to the polymer solution over 105 minutes. Ten minutes after the

start of the initiator addition, maleic anhydride (41.6g) in acetone (80ml) is added drop wise to the mixture over 90 minutes. The solution is then left to heat at this temperature for a further two hours. The volatile solvents are removed by distillation under reduced pressure to give a viscous yellow oil (2453g, 99%).

Examples 1 to 5

[0061] Examples 1 to 5 are prepared by reacting/grafting a polyisobutylene (PIBSA) with a number average molecular weight of 1600 in the amounts shown in Table 1 (PIBSA is diluted to 70 % active ingredient in diluent oil) with the product of Preparative Example 1 and an amine (triethylene tetramine) at 180 °C under a nitrogen atmosphere until a viscous product is formed. Table 1 summarises the amounts of chemicals reacted.

Table 1

Example	Amount of Prep EX1 (g and wt %)	Amount of PIBSA (g)	Amount of amine (g)
EX1	20g (1.4 wt %)	250	10.5
EX2	40 g (2.2 wt %)	300	10.2
EX3	96 g (4.5 wt %)	304	10.5
EX4	70 g (5.3 wt %)	175	7.0
EX5	100 g (6.3 wt %)	200	7.1

Reference Examples 1 to 4

[0062] Reference Examples 1 to 5 are prepared by reacting a 25 SSI ethylene-propylene copolymer (OCP1) a PIBSA (diluted to 70 % in diluent oil) with the product of an amine (triethylene tetramine) at 180 °C under a nitrogen atmosphere until a viscous product is formed. Table 2 summarises the amounts of chemicals reacted.

Table 2

Reference Example	OCP1 (g and wt %)	Amount of PIBSA (g)	Amount of amine (g)
REF1	25 g (1.4 wt %)	250	8.2
REF2	50 g (2.2 wt %)	300	10.0
REF3	95g (5.3 wt %)	175	5.8
REF4	145 g (6.3 wt %)	200	6.6

Lubricating Compositions

[0063] A series of lubricating compositions containing Examples 1 to 5 and Reference Examples 1 to 4 are prepared by blending 4.2 wt % of the product of said Examples in a base oil to form 5W-30 compositions; and optionally in the presence of a portion of a conventional olefin viscosity modifier. The lubricating compositions prepared are summarised in Table 3.

Table 3

LC	Example	V.M. Present	LC	Example	V.M. Present
1	EX1	No	6	EX1	Yes
2	EX2	No	7	EX2	Yes
3	EX3	No	8	EX3	Yes
4	EX4	No	9	EX4	Yes
5	EX5	No	10	EX5	Yes

Footnote to Table 3: LC is the lubricating composition.

[0064] Reference Lubricating Compositions (REFLC) 1 to 4 are prepared in the same manner as Lubricating Compositions 6 to 10, except the product of Reference Examples 1 to 4 are used respectively.

[0065] Reference Lubricating Composition 5 (REFLC 5) contains a polyisobutylene dispersant with number average molecular weight of 1600 and a portion of an olefin viscosity modifier.

[0066] Lubricating compositions 11 to 12 are prepared by blending 4.2 wt % of the oil soluble product of Example 4 into an oil of lubricating viscosity in a similar process as lubricating composition LC 9, except the amount of viscosity modifier is reduced by 24 wt % less and 30 wt % respectively.

[0067] Lubricating compositions 13 to 14 are prepared by blending 4.2 wt % of the oil soluble product of Example 5 into an oil of lubricating viscosity in a similar process as lubricating composition LC 10, except the amount of viscosity modifier is reduced by 32 wt % less and 73 wt % respectively.

Test 1: Viscosity Measurements

[0068] The Kinematic viscosity at 100°C (KV100) and the Cold Crank Simulator (CCS run at -30 °C) viscosity are determined for Examples 1 to 5 and Reference Examples 1 to 4 by employing ASTM methods D445 and D5293 respectively. The results obtained are presented in Table 4.

Table 4

Lubricating Composition Example	KV100 (mm/s)	CCS (at -30 °C)
LC6	11.7	5990
REFLC 1	11.4	6000
LC7	12.12	5900
REFLC 2	11.48	5830
LC9	13.9	5870
REFLC 3	13.27	6280
LC10	16.39	6450
REFLC 4	14.06	6120
REFLC5	11.4	6000

Table 5

Lubricating Composition Example	Reduction in Viscosity Modifier Content	KV100 (mm/s)	CCS (at -30 °C)
LC9	Full Portion	13.9	5870
LC11	-24 wt %	12.2	5370
LC12	-30 wt %	11.8	5100
LC10	Full Portion	16.39	6450
LC13	-32 wt %	14.8	5780
LC14	-73 wt %	12.1	4870

[0069] In Summary, the results in Table 4 and Table 5 demonstrate that the oil soluble product of the invention is capable of providing a lubricating composition with at least one of acceptable low temperature viscosmetrics or acceptable high temperature viscosmetrics. Furthermore, the oil soluble product of the invention demonstrates that the amount of a conventional viscosity modifier may be reduced without adversely affecting high temperature viscosmetrics whilst providing acceptable low temperature viscosmetrics.

[0070] While the invention has been explained, 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.

[0071] Each of the documents referred to above is incorporated herein by reference. Except in the Examples, or where otherwise explicitly indicated, all numerical quantities in this description specifying amounts of materials, reaction conditions, molecular weights, number of carbon atoms, and the like, are to be understood as modified by the word "about." Unless otherwise indicated, each chemical or composition referred to herein should be interpreted as being a commercial grade material which may contain the isomers, by-products, derivatives, and other such materials which are normally understood to be

present in the commercial grade. However, the amount of each chemical component is presented exclusive of any solvent or diluent oil, which may be customarily present in the commercial material, unless otherwise indicated. It is to be understood that the upper and lower amount, range, and ratio limits set forth herein may be independently combined. Similarly, the ranges and amounts for each element of the invention may be used together with ranges or amounts for any of the other elements. As used herein any member of a genus (or list) may be excluded from the claims.

[0072] As used herein, the term "hydrocarbyl substituent" or "hydrocarbyl group" is used 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:

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);

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);

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; and heteroatoms include sulphur, oxygen, nitrogen, and encompass substituents as pyridyl, furyl, thienyl and imidazolyl. In general, no more than two, in one aspect no more than one, non-hydrocarbon substituent will be present for every ten carbon atoms in the hydrocarbyl group; typically, there will be no non-hydrocarbon substituents in the hydrocarbyl group.

What is claimed is:

1. A process for preparing an oil soluble product comprising reacting:
 - (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent;
 - (b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000; and
 - (c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol,wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than about 2.
2. The process of claim 1, wherein the mole ratio of (a) : (b) is 1:about 4 or more, or 1:about 8 or more.
3. The process of claim 1, wherein the oil soluble product is prepared in an extruder reaction vessel; and wherein the mole ratio of (a) : (b) is 1:about 10 or more.
4. An oil soluble product obtained by the process of claim 1.
5. The process of claim 1, wherein the acylating agent of component (a) comprises an unsaturated carboxylic acid or reactive equivalents thereof.
6. The process of claim 5, wherein the acylating agent is acrylic acid, methyl acrylate, methacrylic acid, maleic acid or anhydride, fumaric acid, itaconic acid or anhydride or mixtures thereof.
7. The process of claim 1, wherein the oil soluble product is prepared in a two step process comprising (I) pre-reacting (b) and (c) to form a dispersant and (II) reacting the resulting dispersant with (a).
8. The process of claim 1, wherein the olefin copolymer comprises hydrogenated copolymers of styrene-butadiene, ethylene-propylene polymers, hydrogenated styrene-isoprene polymers, hydrogenated alkenyl aryl conjugated diene copolymers, or mixtures thereof.

9. The process of claim 1, wherein the olefin copolymer is selected from the group consisting of styrene-butadiene polymers, ethylene-propylene polymers, hydrogenated alkenyl aryl conjugated diene copolymers, and mixtures thereof.

10. The process of claim 8, wherein the olefin copolymer comprises ethylene-propylene polymers.

11. The process of claim 10, wherein the olefin copolymer comprises an ethylene-propylene copolymer, wherein the ethylene content is from about 15 wt % to about 90 wt % of the copolymer; and wherein the propylene content is from about 10 wt % to about 85 wt % of the copolymer.

12. The process of claim 1, wherein the olefin copolymer has a number average molecular weight from about 7500 to about 350,000.

13. The process of claim 1, wherein the hydrocarbyl group of (b) comprises a substituted oxyalkylene or a polyolefin having a number average molecular weight of about 400 to about 3000.

14. The process of claim 13, wherein the hydrocarbyl group of (b) comprises a polyisobutylene succinic acid or anhydride, and wherein the polyisobutylene has a number average molecular weight of about 450 to about 2500.

15. The process of claim 1, wherein the polyamine comprises an ethylenepolyamine, a propylenepolyamine, a butylenepolyamine or mixtures thereof.

16. The process of claim 1, wherein the polyol comprises a glycol, a glycerol or mixtures thereof.

17. A process for preparing an oil soluble product comprising reacting:

(a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent; and

(b) a reaction product of an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000 and at least one of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol, wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than about 2.

18. A lubricating composition comprising:
- (I) an oil of lubricating viscosity; and
 - (II) an oil soluble reaction product of:
 - (a) an olefin copolymer having a number average molecular weight of more than about 5000 functionalised with an acylating agent;
 - (b) an acylating agent substituted with a hydrocarbyl group having a number average molecular weight of about 350 to about 5000; and
 - (c) a compound selected from the group consisting of (i) a polyamine; (ii) a polyol; and (iii) an aminoalcohol,
- wherein the oil soluble product has a mole ratio of acylating agents (a) : (b) of 1:greater than 2.