DISPERSANT VISCOSITY INDEX IMPROVERS HAVING HIGH ETHYLENE CONTENT AND LUBRICATING OIL COMPOSITIONS CONTAINING THE SAME

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A polymeric composition is disclosed which contains an ethylene-alpha olefin copolymer backbone having at least 82 mole % ethylene and at most 18 mole % of an about C₃₆ alpha-omega olefin, wherein the alpha-omega olefin has a monomer distribution resulting from a R₁R₂ product measured by ¹³C-NMR below 0.8 and a level of regioinversions less than 2 per 1000 carbon atoms, and an amide group having the formula (I) and/or an imide group having the formula (II):

wherein P is the ethylene-alpha olefin copolymer backbone, R₁ is hydrogen or —CO—X’, R₂ and R₃ are independently hydrogen or —CH₃, X and X’ are independently —OH, alkoxy of 1 to about 24 carbon atoms, or a secondary or tertiary amine, provided that at least one of X and X’ is a secondary or tertiary amine, and Z is a tertiary amine, wherein Z and X and X’ when X and X’ are secondary or tertiary amines, are each independently derived from one or more amine compounds described herein.
DISPERSOR VISCOSITY INDEX IMPROVERS HAVING HIGH ETHYLENE CONTENT AND LUBRICATING OIL COMPOSITIONS CONTAINING THE SAME

[0001] The present invention relates to dispersant viscosity index improvers employable as additives in synthetic and petroleum oils, particularly lubricating oils. More particularly, the present invention relates to dispersant viscosity index improvers having high ethylene content which have been grafted: with an ethylenically unsaturated acylating agent and subsequently reacted with an amine compound.

BACKGROUND OF THE INVENTION

[0002] Hydrocarbon polymers, particularly ethylene-propylene copolymers, are in widespread use as viscosity index (V.I.) improving additives for oil compositions, particularly lubricating oil compositions. A substantial body of prior art exists directed towards further reacting these ethylene copolymers to form a multi-functional V.I. improver. This is a material useful as a V.I.-dispersant oil additive so as to improve not only the V.I. properties of the oil but also impart dispersancy so as to suspend soot or sludge that may form during the operation or use of the lubricant in engines. Various patents teach grafting ethylene copolymers with maleic anhydride, followed by reaction with an amine. A number of these prior disclosures teach reducing or avoiding the use of polyamine having two primary amine groups to thereby reduce cross-linking problems which become more of a problem as the number of amine moieties added to the polymer molecule is increased in order to increase dispersancy. Generally, these patents used a primary-tertiary amine.

[0003] U.S. Pat. No. 4,160,739, issued Jul. 10, 1979, to Stambaugh et al. discloses graft copolymers wherein the backbone polymer is a polymeric hydrocarbon such as substantially linear ethylene-propylene copolymer and the grafted units are the residues of a monomer system comprising maleic acid or anhydride and one or more other monomers copolymerizable therewith, the monomer system being post-reacted with a polyamine compound comprising a primary or secondary amine. The graft copolymers impart combined, detergent, viscosity index improvement and other useful properties to lubricating oils and hydrocarbon motor fuels.

[0004] U.S. Pat. No. 4,320,019, issued Mar. 16, 1982, to Hayashi discloses reaction products prepared by reacting (a) inter polymers of ethylene, one or more C3 to C8 alpha-monolefins, and one or more polymers selected from non-conjugated dienes and trienes, in the absence of free radical initiator with (b) one or more olefinic carboxylic acid acylating agents to form an acylating reaction intermediate which is further reacted with (c) an amine. These reaction products have been found useful as multi-functional additives to a variety of lubricating oils for enhancing their dispersancy as well as improving their viscosity-temperature relationship.

[0005] U.S. Pat. No. 4,735,736, issued Apr. 5, 1988, to Chung discloses oil-soluble ethylene alpha-olefin hydrocarbon polymers, useful as V.I. improvers, such as ethylene copolymer, preferably ethylene-propylene copolymer, grafted with an unsaturated acid material, such as maleic anhydride, preferably by solid state grafting followed by reaction with a polyamine, preferably a tertiary-primary amine, and treatment and/or reaction with aliphatic monoaminie. The resulting material is used in oil compositions, such as lubricating oil, as a viscosity index improver having sludge dispersancy properties. The monoamine treatment inhibits viscosity growth of the additive upon storage.

[0006] U.S. Pat. No. 4,863,623, issued Sep. 5, 1989, to Nalesnik discloses an additive composition comprising a graft and an amine-derivatized copolymer prepared from ethylene and at least one C3 to C10 alpha-monoolefin and, optionally, a polyene selected from non-conjugated dienes and trienes comprising from about 15 to 80 mole % of ethylene, from about 20 to 85 mole % of the C3 to C10 alpha-monoolefin and from about 0 to 15 mole % of the polyene having a average molecular weight ranging from about 5,000 to 500,000 which has been reacted with at least one olefinic carboxylic acid acylating agent to form one or more acylating reaction intermediates characterized by having a carboxylic acid acylating group within their structure and reacting the reaction intermediate with an amino-arylmethane compound from the group consisting of an N-arylpheynlenediamine, an aminothiazole, an alchanger, an aminoindole, an anipyrrole, an amino-indazoline, an aminomercaptotriazole and an aminopyrimidine to form the graft and amine-derivatized copolymer. A lubricating oil composition containing the amine-derivatized copolymer is also disclosed.

[0007] U.S. Pat. No. 5,055,213, issued Oct. 8, 1991, to Germanaud et al. discloses additives resulting from the condensation of a primary or secondary amine and/or of an alkyene polyamine with a copolymer containing vicinal carboxylic groups. Derivatives of phenothiazine, or naphthylamine and of diphenylamine are employed in most cases as alkyene polyamine. These compounds can be employed as multifunctional additives to lubricants.

[0008] U.S. Pat. No. 5,182,041, issued Jan. 26, 1993, to Benfaino et al. discloses an additive composition comprising a graft and an amine-derivatized polymer having an average molecular weight ranging from about 300 to 3,500 which has been reacted with at least one olefinic carboxylic acid acylating agent to form one or more acylating reaction intermediates characterized by having a carboxylic acid acylating group within their structure and reacting the reaction intermediate with an amino-arylmethane compound from the group consisting of an N-arylpheynlenediamine, an aminothiazole, an alchanger, an aminoindole, an amino-indazoline, an aminomercaptotriazole and an aminopyrimidine to form the graft and amine-derivatized copolymer.

[0009] U.S. Pat. No. 5,366,647, issued Nov. 22, 1994, to Gutierrez et al. discloses a lubricating oil concentrate containing an oil soluble composition useful as a multifunctional viscosity index improver additive comprising an ethylene alpha-olefin polymer substituted with a mono- or dicarboxylic acid and at least one nucleophlic reagent selected from amines, alcohols, amino-alcohols, and reactive metal compounds. In this case, the unsaturated mono- or dicarboxylic moiety is introduced by reaction with the end chain unsaturation of the ethylene alpha-olefin copolymer in a peroxide free reaction.

from about 30 wt% to about 60 wt% monomer units derived from ethylene and the B copolymer comprising from about 60 wt% to about 80 wt% units derived from ethylene.

[0011] U.S. Pat. No. 5,429,757, issued Jul. 4, 1995, and U.S. Pat. No. 5,563,118, issued Oct. 8, 1996, to Mishra et al. disclose an additive composition comprising a graft and derivatized copolymer prepared from ethylene and at least one C₃ to C₁₀ alpha-monoolefin and, optionally, a polyene selected from non-conjugated dienes and trienes comprising from about 15 to 80 mole % of ethylene, from about 20 to 85 mole % of the C₃ to C₁₀ alpha-monoolefin and from about 0 to 15 mole % of the polyene having an average molecular weight ranging from about 5,000 to 500,000, which has been reacted with at least one olefinic (carboxylic acid acylating agent to form one or more acylating reaction intermediates characterized by having a carboxylic acid acylating group within their structure and reacting the reaction intermediate with an amino-aromatic compound to form the graft derivatized copolymer.

[0012] U.S. Pat. No. 6,107,257, issued Aug. 22, 2000, to Valchek et al. discloses a novel additive comprising a highly grafted, multifunctional olefin copolymer comprising a graft and amine-derivatized copolymer prepared from ethylene and at least one C₃ to C₂₅ alpha-monoolefin and, optionally, a polyene, wherein the copolymer of ethylene and at least one C₃ to C₂₅ alpha-monoolefin has a graft thereon from 0.3 to 0.75 carboxylic groups per 1000 number average molecular weight units of olefin copolymer and wherein the olefin copolymer has a number average molecular weight of between 20,000 and 150,000.

[0013] U.S. Pat. No. 6,107,258, issued Aug. 22, 2000, to Esche, Jr. et al. discloses novel functionalized olefin copolymers and their use as additives in fuel and lubricating oil compositions. The functionalized olefin copolymers comprise an olefin copolymer on which has been grafted an ethylenically unsaturated carboxylic acid, or derivative thereof, to form an acylated olefin copolymer containing reactive carboxylic group. The acylated olefin copolymer is reacted with a coupling compound, which contains more than one amine, thiol and/or hydroxy group capable of reacting with the carboxylic group of preferably more than one acylated olefin copolymer to form the novel additives. Additionally, the acylated olefin copolymers, either before or after forming the coupling compound, are reacted with a performance enhancing compound or compounds, i.e., compounds containing only one functional group capable of reacting with the carboxylic group of the acylated olefin copolymer, in order to obtain further benefits such as improved antioxidant, antiwear and additional dispersancy properties.

[0014] WO97/32946, issued Sep. 12, 1997, to Hughes et al. discloses linear ethylene polymers with defined melt flow and critical shear rate for onset of melt fracture used for the production of oleaginous compositions. It also discloses the grafting of these linear backbones with maleic anhydride as well as their reaction with a carboxylic acid, an amine or an alcohol.

[0015] Canadian Patent No. 2,021,959, issued Nov. 28, 2000, to Migdal et al. discloses an additive composition comprising a graft and an amine-derivatized copolymer prepared from ethylene and at least one C₃ to C₁₀ alpha-monoolefin and, optionally, a polyene selected from non-conjugated dienes and trienes comprising from about 15 to 80 mole % of ethylene, from about 20 to 85 mole % of the C₃ to C₁₀ alpha-monoolefin and from about 0 to 15 mole % of the polyene having an average molecular weight ranging from about 1,000 to 40,000 which has been reacted with at least one olefinic carboxylic acid acylating agent to form one or more acylating reaction intermediates characterized by having at least about 1.5 wt% of a carboxylic acid acylating group within their structure and reacting the reaction intermediate with an amino-aromatic polyamine compound from the group consisting of an N-arylphenylenediamine, an aminothiazole, an aminocarbazole, an aminoisindole, an aminoazopyrrolyle, an amino-indazolizoline, an aminomercaptotiazole and an amidopyrimidine to form the graft and amine-derivatized copolymer.

SUMMARY OF THE INVENTION

[0017] The present invention relates to dispersant viscosity index improvers. In particular, the present invention relates to a polymeric composition having an ethylene-alpha olefin copolymer backbone comprising at least 82 mole % ethylene and at most 18 mole % of an about C₃₀ to about C₃₈ alpha-monoolefin, wherein the alpha-monoolefin has a monomer distribution resulting from a R₁-R₄ product measured by ¹³C-NMR below 0.8 and a level of regio-inversions less than 2 per 1000 carbon atoms, and an amide group having the formula (i) and/or an imide group having the formula (ii):

\[
\begin{align*}
\text{R}_1 & \quad \text{O} \\
\text{P} & \quad \text{R}_3 \\
\text{R}_2 & \quad \text{X}
\end{align*}
\]

\[
\begin{align*}
\text{R}_1 & \quad \text{O} \\
\text{P} & \quad \text{R}_3 \\
\text{R}_2 & \quad \text{O}
\end{align*}
\]

[0018] wherein P is the ethylene-alpha olefin copolymer backbone. R₁ is hydrogen or —CO—X', R₂ and R₃ are
independently hydrogen or $-\text{CH}_3$, $X$ and $X'$ are independently $-\text{OH}$, alkoxyl of 1 to about 24 carbon atoms, or a secondary or tertiary amine, provided that at least one of $X$ and $X'$ is a secondary or tertiary amine, and $Z$ is a tertiary amine, wherein $Z$ and $X$ and $X'$, when $X$ and $X'$ are secondary or tertiary amines, are each independently derived from one or more of the following amines:

(a) an aromatic amine comprising two aromatic groups linked by a group, $L$, represented by the following formula:

$$
\begin{array}{c}
\text{R}_4 \begin{array}{c} \text{R}_7 \\
\text{Y}_3 \end{array} \begin{array}{c} \text{L} \\
\text{Y}_2 \end{array} \begin{array}{c} \text{R}_6 \\
\text{Y}_1 \end{array}
\end{array}
\end{array}
$$

wherein $L$ is selected from $-\text{O}-$, $-\text{N}\equiv\text{N}$, $-\text{NH}$, $-\text{CH}_2\text{NH}$, $-\text{C(O)NR}_4^-$, $-\text{CO}_2\text{H}$, $-\text{SO}_2\text{H}$, $-\text{SO}_2\text{NH}$, wherein $R_4$ and $R_7$ are independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

(b) an aminothiazole selected from the group consisting of aminothiazole, aminobenzothiazole, aminobenzothiadiazole and aminobenzothiazole;

(c) an aminocarbazole represented by the formula:

$$
\begin{array}{c}
\text{R}_{12} \begin{array}{c} \text{N} \\
\text{H} \end{array} \begin{array}{c} \text{R}_{13} \\
\text{NH}_2
\end{array}
\end{array}
$$

wherein $R_{12}$ and $R_{13}$ independently represent a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(d) an aminoadindole represented by the formula:

$$
\begin{array}{c}
\text{H}_2\text{N} \begin{array}{c} \text{R}_{14} \\
\text{H}
\end{array} \begin{array}{c} \text{N} \\
\text{H}
\end{array} \begin{array}{c} \text{R}_{15} \\
\text{NH}_2
\end{array}
\end{array}
$$

wherein $R_{14}$ represents a hydrogen, an alkyl or an alkenyl group having from about 2 to about 6 carbon atoms and $R_{15}$ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(e) an amino-pyrole represented by the formula:

$$
\begin{array}{c}
\text{R}_{16} \begin{array}{c} \text{R}_{15} \\
\text{NH}_2
\end{array}
\end{array}
$$

(f) an aminoindazolinone represented by the formula:

$$
\begin{array}{c}
\text{H}_2\text{N} \begin{array}{c} \text{N} \\
\text{H}
\end{array} \begin{array}{c} \text{O} \\
\text{N}
\end{array} \begin{array}{c} \text{R}_{17} \\
\text{H}
\end{array}
\end{array}
$$

wherein $R_{17}$ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(g) an aminomercaptotriazole represented by the formula:

$$
\begin{array}{c}
\text{H}_2\text{N} \begin{array}{c} \text{O} \\
\text{N}
\end{array} \begin{array}{c} \text{N} \\
\text{H}
\end{array} \begin{array}{c} \text{H}
\end{array}
\end{array}
$$

(h) an aminopyrimidine represented by the formula:

$$
\begin{array}{c}
\text{R}_{18} \begin{array}{c} \text{NH}_2 \\
\text{H}
\end{array}
\end{array}
$$

wherein $R_{18}$ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;
[0036] wherein \( R_{18} \) represents a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

[0037] (i) a ring substituted or unsubstituted aniline, such as nitroaniline or 4-aminooctanilide;

[0038] (j) an aminoquinoline;

[0039] (k) an aminobenzimidazole;

[0040] (l) a N,N-diisopropylphenylenediamine; and

[0041] (m) a benzylamine

[0042] In a further embodiment, the present invention relates to dispersant viscosity index improvers having high ethylene alpha-monomoolefin copolymer content prepared by the process of grafting an ethylene-alpha-monomoolefin copolymer backbone comprising at least 82 mole % ethylene and at most 18 mole % an about C₃ to about C₂₈ alpha-monomoolefin, wherein the alpha-monomoolefin has a monomer distribution resulting from a \( R_{18} \) product measured by \(^{13}\)C-NMR below 0.8 and a level of regio-inversions less than 2 per 1000 carbon atoms, with an ethylenically unsaturated acylating agent and subsequently reacting the resulting grafted copolymer with one, or more of the following amines:

[0043] (a) an aromatic amine comprising aromatic groups linked by a group, \( L \), represented by the following formula:

\[
\begin{align*}
\text{R}_1 & \quad \text{Y}_1 \\
\text{R}_2 & \quad \text{Y}_2 \\
\text{R}_3 & \quad \text{Y}_3 \\
\text{R}_4 & \quad \text{Y}_4 \\
\end{align*}
\]

[0044] wherein \( L \) is selected from \(-\text{O}-\), \(-\text{N}═\text{N}-\), \(-\text{NH}_2\), \(-\text{CH}_2\text{NH}_2\), \(-\text{C(O)NR}_4\), \(-\text{C(O)O}-\), \(-\text{SO}_2\), \(-\text{SO}_2\text{NR}_4\) or \(-\text{SO}_2\text{NH}_2\); wherein \( R_1 \) and \( R_4 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

[0045] wherein each \( Y_1 \), \( Y_2 \), \( Y_3 \) and \( Y_4 \) are independently \( N \) or \( \text{CH} \) provided that \( Y_1 \) and \( Y_2 \) may not both be \( N \);

[0046] \( R_1 \) and \( R_2 \) independently represent a hydrogen, an alkyl, an aryl or alkaryl group, \(-\text{OH}\), \(-\text{NO}_2\), \(-\text{SO}_2\text{H}\), \(-\text{SO}_2\text{Na}\), \(-\text{CO}_2\text{H} \) or salt thereof, \(-\text{NH}_2\text{-aryl}, -\text{NH}_2\text{-alkyl}, -\text{NH}_2\text{-alkaryl}, -\text{NH}_2\text{-anaryl} \) having up to about 24 carbon atoms or a branched or straight chain group having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyl, aralkyl, alkaryl, hydroxyalkyl or aminoaalkyl;

[0047] \( R_3 \) and \( R_5 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms, \(-\text{OH}\), \(-\text{SO}_2\text{H} \) or \(-\text{SO}_2\text{Na}\) and \( R_6 \);

[0048] \( R_7 \) represents \(-\text{NH}_2\), \(-\text{NHR}_{11}\), wherein \( R_{11} \) is an alkyl or an alkoxyl group having from about 1 to about 8 carbon atoms, \(-\text{CH}_3\), \(-\text{CH}_2\text{(CH}_3)_n\text{NH}_2\) or \(-\text{CH}_2\text{-aryl-NH} \) and \( n \) is from 0 to about 10;

[0049] (b) an aminothiazole selected from the group consisting of aminothiazole, aminobenzothiazole, aminobenzothiadiazole and aminosulphathiazole,
(a) an N-arylphenylenediamine represented by the formula:

[0069] wherein R_{16} represents a hydrogen, an alkyl, an aralkyl, or an alkoxyl group having from about 1 to about 8 carbon atoms;

[0070] wherein P is the ethylene-alpha olefin copolymer backbone, R_{1} is hydrogen or —CO—X, R_{2} and R_{3} are independently hydrogen or —CH—X, X and X' are independently —OH, alkoxyl of 1 to about 24 carbon atoms, or a secondary or tertiary amine, provided that at least one of X and X' is a secondary or tertiary amine, and Z is a tertiary amine, wherein Z and X and X', when X and X' are secondary or tertiary amines, are each independently derived from one or more of the amines in (a)-(m) above.

[0080] Another aspect of the present invention relates to a method of improving the soot and/or sludge dispersancy in an internal combustion engine by operating the internal combustion engine with the lubricating oil composition of the present invention containing the polymeric composition.

[0081] Among other things, the dispersant viscosity index improvers having high ethylene-alpha olefin copolymer content which have been grafted with an ethylenically unsaturated acryling agent and subsequently reacted with an amine compound provide multi-functional properties in lubricating oil compositions. In particular, the dispersant viscosity index improvers of the present invention provide superior soot and/or sludge dispersancy as well as viscosity index improvement when used in lubricating oil compositions for internal combustion engines. Such a lubricating oil composition is useful as a method of improving the soot and/or sludge dispersancy in an internal combustion engine, when
the internal combustion engine is operated using the lubricating oil composition of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0082] Prior to discussing the present invention in detail, the following terms will have the following meanings unless expressly stated to the contrary.

[0083] The terms "graft" or "grafted" relate to covalent bonding of the grafting monomer to a polymer chain of the polymeric composition.

[0084] The term "oil soluble" refers to the ability of a material to dissolve in aliphatic and aromatic hydrocarbons such as lubricating oils or fuels in essentially all proportions.

[0085] The term "R,R,R product" refers to the product of R and R, where R, is being defined as the ratio of the kinetic constant for the reaction of ethylene with a second ethylene unit and the kinetic constant for the reaction of ethylene with propylene and R, as the ratio of the kinetic constant for the reaction of propylene with a second propylene unit and the kinetic constant for the reaction of propylene with ethylene. An "R,R,R product" above 1 usually refers to polymers which are considered as blocky copolymers. The polymers of the present invention have a low "R,R,R product" and are more alternating copolymers.

[0086] The term "level of regio-inversions" refers to the presence of monomer sequences where propylene (or the higher alpha-olefin) is polymerized head to tail or tail to tail which translates into sequences of even-numbered methylene units instead of head to tail which translates into sequences of odd-numbered methylene units. The polymers of the present invention have almost no regio-inversions.


[0088] The polymer or copolymer substrate or backbone of the present invention may be prepared from ethylene and propylene or it may be prepared from ethylene and a higher olefin within the range of an about C5 to about C30 alpha-olefinic monomer wherein the alpha-olefinic monomer has a monomer distribution resulting from a R,R,R product measured by 13C-NMR below 0.8 and a level of regio-inversions less than 2 per 1000 carbon atoms.

[0089] More complex polymer substrates, often designated as interpolymer, may be prepared using a third component. The third component generally used to prepare an interpolymer substrate is a polyene monomer selected from non-conjugated dienes and trienes. The non-conjugated diene component is one having from about 5 to about 14 carbon atoms in the chain. Preferably, the diene monomer is characterized by the presence of a vinyl group in its structure and can include cyclic and bi-cyclo compounds. Representative dienes include 1,4-hexadiene, 1,4-cyclohexadiene, dicyclopentadiene, 5-ethylidenecyclopenta diene, 5-methylene-2-norbornene, 5-methylene-2-norbornene, 1,5-heptadiene, and 1,6-octadiene. A mixture of more than one diene can be used in the preparation of the interpolymer. A preferred non-conjugated diene for preparing a terpolymer or interpolymer substrate is 1,4-hexadiene.

[0090] The triene component will have at least two non-conjugated double bonds, and up to about 30 carbon atoms in the chain. Typical trienes useful in preparing the interpolymer of the present invention are 1-isopropylidene-3a,4,7,7a-tetrahydroindene, 1-isopropylidenecyclcopentadiene, dihydro-isodicyclopentadiene, and 2-(2-methylene-4-methyl-3-pentenyl)(2,2,1)bicyclo-5-heptene.

[0091] The polymerization reaction to form the polymer or copolymer backbone is generally carried out in the presence of a catalyst in a solvent medium. The polymerization solvent may be any suitable inert organic solvent that is liquid under reaction conditions for solution polymerization of monoolefins which is generally conducted in the presence of a Ziegler-type catalyst. Examples of satisfactory hydrocarbon solvents include straight chain paraffins having from about 5 to about 8 carbon atoms, with hexane being preferred. Aromatic hydrocarbons, preferably aromatic hydrocarbon having a single benzene nucleus, such as benzene, toluene and the like; and saturated cyclic hydrocarbons having boiling point ranges approximating those of the straight-chain paraffinic hydrocarbons and aromatic hydrocarbons described above, are particularly suitable. The solvent selected may be a mixture of one or more of the foregoing hydrocarbons. It is desirable that the solvent be free of substances that will interfere with a Ziegler polymerization reaction.

[0092] In a typical preparation of a polymer or copolymer backbone, the ethylene is first introduced into a reactor and the temperature in the reactor is raised moderately to about 30°C. Dry propylene is fed into the reactor until the pressure reaches about 40 to about 45 inches of mercury. The pressure is then increased to about 60 inches of mercury and dry ethylene and 5-ethylidene-2-norbornene are fed to the reactor. The monomer feeds are stopped and a mixture of aluminum sesquichloride and vanadium oxytrichloride is added to initiate the polymerization reaction. Completion of the polymerization reaction is evidenced by a drop in the pressure in the reactor.

[0093] Ethylene-propylene or higher alpha-monoolefin copolymers of the present invention may consist of at least 82 mole % ethylene and at most 18 mole % propylene or higher alpha-monoolefin with the preferred mole ratios being at least 84 mole % ethylene and at most 16 mole % of a about C3 to about C28 alpha-monoolefin.

[0094] Preferably, the alpha-monoolefin is from about C3 to about C20 and more preferably from about C6 to about C12 alpha-monoolefin. Most preferred alpha-monoolefin is octene.

[0095] Terpolymer variations of the foregoing polymers may contain from 0 to about 10 mole %, preferably about 0 to about 6 mole %, more preferably about 0 to about 3 mole %, of a non-conjugated diene or triene. In the most preferred embodiment, the foregoing polymers will not contain any non-conjugated diene or triene.

[0096] The polymer substrate, that is the ethylene copolymer or terpolymer is an oil-soluble, substantially linear, rubbery material having a weight average molecular weight from about 5,000 to about 500,000 with a preferred weight
average molecular weight range of about 25,000 to about 250,000 and a most preferred range from about 50,000 to about 150,000.

[0097] The terms polymer and copolymer are used generically to encompass ethylene copolymers, terpolymers or inter polymers. These materials may contain minor amounts of other olefinic monomers so long as their basic characteristics are not materially changed.

[0098] An ethylenically unsaturated acylating agent is next grafted onto the prescribed copolymer backbone. The ethylenically unsaturated acylating agent can be represented by formula (A) and/or formula (B):

![Diagram](https://via.placeholder.com/150)

wherein \( R_1 \) is hydrogen or —CO—W, \( R_2 \) and \( R_3 \) are independently hydrogen or —CH\(_2\)-; and \( W \) and \( W' \) are independently —OH, or alkoxyl having 1 to about 24 carbon atoms.

[0100] Maleic anhydride or a derivative thereof is the preferred ethylenically unsaturated acylating agent. It grafts onto the ethylene copolymer or terpolymer to give two carboxylic acid functionalities.

[0101] The ethylenically unsaturated acylating agent may be grafted onto the copolymer backbone in a number of ways. It may be grafted onto tile backbone by a thermal process known as the "ene" process or by grafting in solution or in melt form using a free-radical initiator. The free-radical induced grafting of ethylenically unsaturated acylating agents is carried out in solvents, such as hexane, heptane, mineral oil or aromatic solvents, which do not react with the peroxide, it is carried out at an elevated temperature in the range of about 100° C. to about 250° C., preferably about 120° C. to about 190° C. and more preferably at about 150° C. to about 180° C., e.g. above 160° C., in a solvent preferably a mineral oil solution containing, e.g. about 1 wt % to about 50 wt %, preferably about 5 wt % to about 30 wt %, based on the initial total oil solution, of the ethylene copolymer and preferably under an inert environment.

[0102] The free-radical initiators which may be used are peroxides (diacetyl peroxides such as benzoyl peroxide, dialkyl peroxides such as 1,1-bis(tert-butylperoxy)cyclohexane, 1.1-bis(tert-butylperoxy)-3,3,5-trimethyl cyclohexane, 2,2-bis(tert-butylperoxy)butane, dicumyl peroxide, tert-butyl cumyl peroxide, a,b-bis(tert-butylperoxyisopropyl)benzene, di-tert-butyl peroxide (DTBP), 2,5-dimethyl-2,5-di(tert-butylperoxy)hexane, 2,5-dimethyl-2,5-di(tert-butylperoxy)-hexyne), hydroperoxides, peroxysteres such as tert-butyl peroxy benzoinate, tert-butylperoxy acetate, O,O-tert-butyl-O-(2-ethylhexyl)monooxepoxy carbonate, peroxketals such as n-butyl 4,4-di-(tert-butylperoxy)valerate and the like and azo compounds and preferably those which have a boiling point greater than about 100° C. and decompose thermally within the grafting temperature range to provide free radicals. The initiator is used in an amount of between about 0.005% and about 1% by weight based on the weight of the reaction mixture solution. The grafting is preferably carried out in an inert atmosphere, such as under nitrogen blanketing. The resulting polymer intermediate is characterized by having acylating group, typified by a carboxylic acid or acid chloride, within its structure.

[0103] In the solid or melt process for forming a graft copolymer, the ethylenically unsaturated acylating agent with the optional use of a radical initiator is grafted on to the melt rubber using rubber masticating or shearing equipment. Single screw but preferably twin screw extruder reactors such as co-rotating intermeshing extruders or counter-rotating non-intermeshing extruders but also co- kneaders such as those sold by Buss are especially preferred. The temperature of the molten material in this process may range from about 120° C. to about 400° C.

[0104] The preferred sequence of events used for the grafting reaction consists of melting the copolymeric composition, adding and dispersing the grafting monomer, introducing the peroxide and venting the unreacted monomer and by-products resulting from the peroxide decomposition. Other sequences may include feeding the monomers and the peroxide pre-dissolved in a solvent.

[0105] The copolymer intermediate is then reacted with an amine compound from the group consisting of:

![Diagram](https://via.placeholder.com/150)

wherein \( \mathbf{L} \) is selected from —O—, —N=N—, —NH—, —CH\(_2\)-NH—, —C(O)N\(_2\), —C(O)O—, —SO\(_2\)—, —SO\(_2\)NR\(_2\) and —SO\(_2\)NH—; wherein \( R_8 \) and \( R_9 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms.

[0106] (a) an aromatic amine comprising two aromatic groups, linked by a group \( \mathbf{L} \), represented by the following formula:

![Diagram](https://via.placeholder.com/150)

wherein \( \mathbf{L} \) is selected from —O—, —N=N—, —NH—, —CH\(_2\)-NH—, —C(O)N\(_2\), —C(O)O—, —SO\(_2\)—, —SO\(_2\)NR\(_2\) and —SO\(_2\)NH—; wherein \( R_8 \) and \( R_9 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms; and

[0107] wherein \( \mathbf{L} \) is selected from —O—, —N=N—, —NH—, —CH\(_2\)-NH—, —C(O)N\(_2\), —C(O)O—, —SO\(_2\)—, —SO\(_2\)NR\(_2\) and —SO\(_2\)NH—; wherein \( R_8 \) and \( R_9 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms; and

[0108] wherein \( \mathbf{L} \) is selected from —O—, —N=N—, —NH—, —CH\(_2\)-NH—, —C(O)N\(_2\), —C(O)O—, —SO\(_2\)—, —SO\(_2\)NR\(_2\) and —SO\(_2\)NH—; wherein \( R_8 \) and \( R_9 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms; and

[0109] wherein \( \mathbf{L} \) is selected from —O—, —N=N—, —NH—, —CH\(_2\)-NH—, —C(O)N\(_2\), —C(O)O—, —SO\(_2\)—, —SO\(_2\)NR\(_2\) and —SO\(_2\)NH—; wherein \( R_8 \) and \( R_9 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms; and

[0110] wherein \( \mathbf{L} \) is selected from —O—, —N=N—, —NH—, —CH\(_2\)-NH—, —C(O)N\(_2\), —C(O)O—, —SO\(_2\)—, —SO\(_2\)NR\(_2\) and —SO\(_2\)NH—; wherein \( R_8 \) and \( R_9 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms; and

[0111] wherein \( \mathbf{L} \) is selected from —O—, —N=N—, —NH—, —CH\(_2\)-NH—, —C(O)N\(_2\), —C(O)O—, —SO\(_2\)—, —SO\(_2\)NR\(_2\) and —SO\(_2\)NH—; wherein \( R_8 \) and \( R_9 \) independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms; and
[0112] (b) an aminothiazole selected from the group consisting of aminothiazole, aminobenzothiazole, aminobenzothiadiazole and aminocarbazole;

[0113] (c) an aminocarbazole represented by the formula:

\[
\begin{array}{c}
\text{R}_{12} \quad \text{R}_{13} \quad \text{NH}_2 \\
\text{H} \\
\text{R}_{12} \quad \text{R}_{13}
\end{array}
\]

wherein \( \text{R}_{12} \) and \( \text{R}_{13} \) independently represent a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

[0114] (d) an aminoindole represented by the formula:

\[
\begin{array}{c}
\text{R}_{14} \\
\text{H} \\
\text{N} \\
\text{H}
\end{array}
\]

wherein \( \text{R}_{14} \) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

[0115] (e) an aminopyrrole represented by the formula:

\[
\begin{array}{c}
\text{R}_{16} \quad \text{R}_{17} \quad \text{NH}_2 \\
\text{N} \\
\text{H}
\end{array}
\]

wherein \( \text{R}_{16} \) represents a divalent alkylene group having from about 2 to about 6 carbon atoms and \( \text{R}_{17} \) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

[0116] (f) an amino-indazolinone represented by the formula:

\[
\begin{array}{c}
\text{O} \\
\text{H}_2 \text{N} \\
\text{O}
\end{array}
\]

wherein \( \text{R}_{18} \) represents a hydrogen, an alkyl, an alkenyl or an alkoxy group having from about 1 to about 8 carbon atoms;

[0117] (g) an aminomercaptotriazole represented by the formula:

\[
\begin{array}{c}
\text{NH}_2 \\
\text{S} \\
\text{N} \\
\text{H}
\end{array}
\]

wherein \( \text{R}_{19} \) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

[0118] (h) an aminopyrimidine represented by the formula:

\[
\begin{array}{c}
\text{R}_{18} \quad \text{N} \\
\text{H}
\end{array}
\]

wherein \( \text{R}_{18} \) represents a hydrogen, an alkyl, an alkenyl or an alkoxy group having from about 1 to about 8 carbon atoms,

[0119] (i) a ring substituted or unsubstituted aniline, such as nitroaniline or 4-aminoacetanilide;

[0120] (j) an anilinoquinoline;

[0121] (k) an aminobenzimidazole;

[0122] (l) a N,N-dialkylphenylenediamine; and

[0123] (m) a benzylamine.

[0124] The aromatic amine compounds above are substantially described, for example, in U.S. Pat. No. 4,863,623 and U.S. Patent Application Publication No. 200610235316A1, the disclosures of which are, herein incorporated by reference for all purposes.

[0125] The reaction between the copolymer intermediate having grafted thereon carboxylic acid or acid chloride acylating group and the prescribed amine compound is conducted by heating a solution of the copolymer backbone under inert conditions and then adding the amine compound to the heated solution generally with mixing to effect the reaction. It is convenient to employ an oil solution of the copolymer backbone heated to about 140° C. to about 175° C. while maintaining the solution under a nitrogen blanket. The amine compound is added to this solution and the reaction is effected under the noted conditions. The reaction can also be carried out without solvent in a reactive extruder.

[0126] The amine compound may, in general, contain one or more reactive (condensable) amino groups. A single reactive amino group is sometimes preferred. Multiple amino groups, as in the case of the above described N,N-dialkylphenylenediamine, can be useful as well, especially if they are reacted under relatively mild conditions so as to avoid excessive crosslinking or gelation of the polymer.

[0127] The above-described amine compounds can be used alone or in combination with each other. They can also be used in combination with additional, aromatic or non-aromatic, e.g., aliphatic, amines, which, in one embodiment, comprise about 1 to about 8 carbon atoms. Other aromatic amines can include such amines as aminodiphenylamine. These additional amines can be included for a variety of reasons. Sometimes it may be desirable to incorporate an aliphatic amine in order to assure complete reaction of the
acid group of the polymer, in the event that some residual acid group may tend to react incompletely with the relatively more bulky aromatic amine. Alternatively, the aliphatic amine may replace a portion of a more costly aromatic amine, while maintaining the majority of the performance of the aromatic amine. Aliphatic monoamines include methylamine, ethyamine, propylamine and various higher amines. Diamines or polyamines can be used for this function, provided that, in general, they have only a single reactive amino group, that is, a primary or secondary, and preferably primary, group. Suitable examples of diamines include dimethylaminopropylamine, diethyldimethylamine, dibutylaminopropylamine, dimethylaminomethylamine, diethyldimethylamine, dibutylaminomethylamine, 1-(2-aminooethyl) piperidine, 1-(2-aminooethyl)pyrrolidone, aminoethylethylmorpholine, and aminopropylmorpholine. Preferably the aliphatic amine having a single reactive amino group is N,N-dimethylaminopropylamine or aminopropylmorpholine. 

[0133] Preferably, the amine is an aromatic amine selected from the group consisting of:

(a) an N-arylphenylenediamine represented by the formula:

[0135] wherein R represents a hydrogen, —NH—aryl, —NH-alkyl, —NH-alkaryl, —NH-aralkyl having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyl, aralkyl, alkaryl, hydroxyalkyl or aralkyl; and

(b) a phenoxanilamine represented by the formula:

[0138] wherein R represents a hydrogen, —NH—aryl, —NH-alkyl, —NH-alkaryl, —NH-aralkyl having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyl, aralkyl, alkaryl, hydroxyalkyl or aralkyl; and

[0139] Particularly preferred N-arylphenylenediamines are the N-phenyl-1,4-phenylenediamine, N-phenyl-1,3-phenylenediamine, and N-phenyl-1,2-phenylenediamine. Most preferably, the N-arylphenylenediamine is N-phenyl-1,4-phenylenediamine. Preferably, the phenoxanilamine is 4-phenoxanilamine.

The Lubricant Composition

[0143] The polymeric composition or the oil-soluble product produced by the process of the present invention are typically added to base oil in sufficient amounts to provide scuff and/or sludge dispersancy as well as viscosity index improvement when used in lubricating oil compositions for internal combustion engines. Generally, the lubricating oil compositions of the present invention will contain a major amount of base oil of lubricating viscosity and a minor amount of the polymeric composition or the oil-soluble product produced by the process of the present invention.

Base Oil of Lubricating Viscosity

[0144] Base oil as used herein is defined as a base stock or blend of base stocks which is a lubricant component that is produced by each manufacturer to the same specifications (independent of feed source or manufacturer’s location); that meets the same manufacturer’s specification; and that is identified by a unique formula, product identification number, or both. Base stocks may be manufactured using a variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerization, esterification, and rerefining. Refined stock shall be substantially free from materials introduced through manufacturing, contamination, or previous use.

[0145] The base oil of this invention may be any natural or synthetic lubricating base oil fraction particularly those having a kinematic viscosity at 1000 centigrade (0°C) and about 4 centistokes (cSt) to about 20 cSt. Hydrocarbon synthetic oils may include, for example, oils prepared from the polymerization of ethylene, polyalphaolefin or PAO, or from hydrocarbon synthesis procedures using carbon monoxide and hydrogen gases such as in a Fisher-Tropsch process. A preferred base oil is one that comprises little, if any, heavy fraction; e.g., little if any, lube oil fraction of viscosity about 20 cSt or higher at about 100°C. Oils used as the base oil will be selected or blended depending on the desired end use and the additives in the finished oil to give the desired grade of engine oil, e.g. a lubricating oil composition having an SAE Viscosity Grade of 0W, 0W-20, 0W-30, 0W-40, 0W-50, 0W-60, 5W-20, 5W-30, 5W-40, 5W-50, 5W-60, 10W-20, 10W-30, 10W-40, 10W-50, 15W-20, 15W-30, or 15W-40.

[0146] The base oil may be derived from natural lubricating oils, synthetic lubricating oils or mixtures thereof. Suitable base oil includes base stocks obtained by isomerization of synthetic wax and slack wax, as well as hydrocrackate base stocks produced by hydrocracking (rather than solvent extracting) the aromatic and polar components of the crude. Suitable base oils include those in all API categories I, II, III, IV and V as defined in API Publication 1509, 14th Edition, Addendum 1, December 1998. Saturates levels and viscosity indices for Group I, II and III base oils are listed in Table 1. Group IV base oils are polyalphaolefins (PAO). Group V base oils include all other base oils not included in Groups I, II, III or IV.
TABLE 1

<table>
<thead>
<tr>
<th>Saturates, Sulfur and Viscosity Index of Group I, II, III, IV and V Base Stocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturates (As determined by ASTM D2007)</td>
</tr>
<tr>
<td>Group I: ASTM D2277</td>
</tr>
<tr>
<td>Less than 90% saturates and/or Greater than or equal to 0.3% sulfur</td>
</tr>
<tr>
<td>Greater than or equal to 90% saturates and less than or equal to 0.03% sulfur</td>
</tr>
<tr>
<td>Greater than or equal to 90% saturates and less than or equal to 0.03% sulfur</td>
</tr>
<tr>
<td>All Polyalphaolefins (PAOs)</td>
</tr>
</tbody>
</table>

NATURAL LUBRICATING OILS

Natural lubricating oils may include animal oils, vegetable oils (e.g., rapeseed oil, castor oil, and lard oil), petroleum oils, mineral oils, and oils derived from coal or shale.

SYNTHETIC OILS

Synthetic oils may include hydrocarbon oils and halogen-substituted hydrocarbon oils such as polymerized and interpolymerized olefins, alkylbenzenes, polyphenyls, alkylated diphenyl ethers, alkylated diphenyl sulfides, as well as their derivatives, analogues and homologues thereof, and the like. Synthetic lubricating oils also include alkylene oxide polymers, interpolymers, copolymers and derivatives thereof wherein the terminal hydroxyl groups have been modified by esterification, etherification, etc. Another suitable class of synthetic lubricating oils comprises the esters of dicarboxylic acids with a variety of alcohols: Esters useful as synthetic oils also include those made from about C₆ to about C₁₂ monocarboxylic acids and polyols and polyol ethers. Tri-alkyl phosphate ester oils such as those exemplified by tri-n-butyl phosphate and tri-iso-butyl phosphate are also suitable for use as base oils.

SILICON-BASED OILS

Silicon-based oils (such as the polyalkyl-, polyaryl-, polyalkoxy-, or polyaryoxy-siloxane oils and silicate oils) comprise another useful class of synthetic lubricating oils. Other synthetic lubricating oils include liquid esters of phosphorus-containing acids, polymeric tetrahydrofurans, polyalphaolefins, and the like.

BASE OILS

The base oil may be derived from unrefined, refined, rerefined oils, or mixtures thereof. Unrefined oils are obtained directly from a natural source or synthetic source (e.g., coal, shale, or tar sand bitumen) without further purification or treatment. Examples of unrefined oils include a shale oil obtained directly from a retorting operation, a petroleum oil obtained directly from distillations or an ester oil obtained directly from an esterification process, each of which may then be used without further treatment. Refined oils are similar to the unrefined oils except that refined oils have been treated in one or more purification steps to improve one or more properties. Suitable purification techniques include distillation, hydrocracking, hydrotreating, dewaxing, solvent extraction, acid or base extraction, filtration, and percolation, all of which are known to those skilled in the art. Rerefining oils are obtained by treating used oils in processes similar to those used to obtain the refined oils. These rerefining oils are also known as reclaimed or reprocessed oils and often are additionally processed by techniques for removal of spent additives and oil breakdown products.

BASE OIL DERIVED FROM THE HYDROISOMERIZATION OF WAX MAY ALSO BE USED, EITHER ALONE OR IN COMBINATION WITH THE AFORESAID NATURAL AND/OR SYNTHETIC BASE OIL.

SUCH WAX ISOMERATE OIL IS PRODUCED BY THE HYDROISOMERIZATION OF NATURAL OR SYNTHETIC WAXES OR MIXTURES THEREOF OVER A HYDROISOMERIZATION CATALYST.

OTHER ADDITIVE COMPONENTS

THE FOLLOWING ADDITIVE COMPONENTS ARE EXAMPLES OF COMPONENTS THAT CAN BE FAVORABLY EMPLOYED IN COMBINATION WITH THE LUBRICATING ADDITIVE OF THE PRESENT INVENTION.

1) Phenol type phenolic oxidation inhibitors: 4,4'-methylenebis (2,6-di-tert-butylphenol), 4,4'-bis (2,6-di-tert-butylphenol), 4,4'-bis (2-methyl-6-tert-
butylphenol), 2,2′-(methylenebis(4-methyl-6-tert-butyphenol), 4,4′-butyl dene-bis(3-methyl-6-tert-butyphenol), 4,4′-isopropylidenedibis(2,6-di-tert-butyphenol), 2,2′-methylenebis(4-methyl-6-nonylphenol), 2,2′-isobutyl dene-bis(4,6-dimethylphenol), 2,2′-methylenebis(4-methyl-6-cyclohexylphenol), 2,6-di-tert-butyl-4-methylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,4-dimethyl-6-tert-butylphenol, 2,6-di-tert-α-dimethylaminop-t-cresol, 2,6-di-tert-4(N,N-dimethylaminoethylphenol), 4,4′-thiodibis(2-methyl-6-tert-butyphenol), 2,2′-thiodis(4-methyl-6-tert-butyphenol), bis(3-methyl-4-hydroxy-5-tert-butylbenzyl)sulfide and bis(3,5-di-tert-butyl-4-hydroxybenzyl).

[0160] 2) Diphenylamine type oxidation inhibitor: alkylated diphenylamine, phenyl-α-naphthylamine and alkylated α-naphthylamine.

[0161] 3) Other types: metal dithiocarbamate (e.g., zinc dithiocarbamate), and methylbenzis(dibutylthidithiocarbamate).

[0162] (D) Rust Inhibitors (Anti-rust agents):


[0164] 2) Other compounds: stearic acid and other fatty acids, dicarboxylic acids, metal soaps, fatty acid amine salts, metal salts of heavy sulfonic acid, partial carboxylic acid ester of polyhydric alcohol and phosporic ester.

[0165] (E) Demulsifiers: addition product of alkylphenol and ethylenoxide, polyoxyethylene alkyl ether and polyoxyethylene sorbitane ester.


[0167] (G) Friction modifiers: fatty alcohol, fatty acid, amine, borated ester and other esters.

[0168] (H) Multifunctional additives: sulfurized oxymolybdenum dithiocarbamate, sulfurized oxymolybdenum organo phosphorodithiate, oxymolybdenum monoglyceryle, oxymolybdenum diethylate amide, amine-oxymolybdenum complex compound and sulfur-containing oxymolybdenum complex compounds.

[0169] (I) Viscosity Index improvers (VII): poly(methacrylate type polymers, ethylene-propylene copolymers, styrene-isoprene copolymers, hydrogenated styrene-isoprene copolymers, hydrogenated star-branched polyisoprene, polyisobutylene, hydrogenated star-branched styrene-isoprene copolymer and dispersant type viscosity index improvers.

[0170] (J) Pour point depressants: polymethyl methacrylates, alkylmethacrylates and dialkyl fumarate-vinyl acetate copolymers.

[0171] (K) Foam inhibitors: alkyl methacrylate polymers and dimethyl silicone polymers.

[0172] (L) Wear Inhibitors: zinc dialkyl dithiophosphate (Zn-DTP, primary alkyl type, secondary alkyl type, aryl type or mixtures thereof).

EXAMPLES

[0173] The invention will be further illustrated by the following examples, which set forth particularly advantageous method embodiments. While the Examples are provided to illustrate the present invention, they are not intended to limit it.

Example 1

[0174] An ethylene-octene copolymer having 86.7 mole % ethylene, a R<sub>1</sub>R<sub>2</sub> product of 0.32 and less than 0.1 regression per 1000 carbon atoms was grafted with maleic anhydride (MA) using peroxide on a non-intermeshing counter-rotating twin screw extruder (30 mm, Length/ Diameter = 48) under the following conditions: 96.3 wt % of polymer, 3.1 wt % of Crystalman® Maleic Anhydride (available from ExxonMobil Chemical Company) were fed at 7 kgf feed rate to the hopper of the extruder and 1.9 wt % of a 10% solution of Luperox® 130 (di-tertiary butyl peroxide available from Atolina Chemical Incorporated) dissolved in Marcol® 52 oil (mineral oil available from ESSO Petroleum Company Limited) were added to the second barrel. The screw speed was set at 350 rpm and following temperature profile was used: 180°C, 185°C, 205°C, 180°C with the die at 135°C. Excess reagents as well as peroxide decomposition products were removed with vacuum prior to polymer recovery.

[0175] The amount of MA grafted was 2.8 wt %. The maleated copolymer was dissolved in neutral oil at a concentration of 7 wt %. 100 parts of the maleated copolymer/oil mixture were charged to a stirred glass reactor and heated to about 160°C. 0.38 parts of N-phenyl-1,4-phenylenediamine (NPPDA) (1.05 moles of N-phenyl-1,4-phenylenediamine per mole of grafted MA) were charged to the reactor. The reactor was held at about 160°C for two hours. 1.63 parts of an alcohol ethoxylate (Huntsman Surftonic® 1,2,4-7, a seven-mole ethoxylate of a linear, primary about C<sub>10</sub>, to about C<sub>14</sub> alcohol) were added to reaction mixture just before the reaction mixture was cooled to stabilize viscosity. Three subsequent batches were synthesized using the same raw materials and procedures. A total of four batches were made and blended together. The resulting dispersant viscosity index improver was blended into a formulated lubricating oil composition as indicated in Table 2 below, using a base oil to achieve a kinematic viscosity at about 100°C equal to 14.5 cSt. The finished lubricating oil composition was then run in the Mack T-11 engine test as specified in ASTM D7156. The amount of soot present in the finished lubricating oil composition when the lubricating oil composition viscosity increased 12 cSt above the initial viscosity was determined by interpolating soot and viscosity data obtained throughout the test. The amount of soot in the finished lubricating oil composition at an increase of 12 cSt was found to be 7.18 wt.

Example 2

[0176] The dispersant viscosity index improver of Example 2 was prepared and tested according to Example 1 except that the amine compound used was 4-Phenyloxylane (4-PA) instead of NPPDA. The amount of soot in the
lubricating oil composition at an increase of 12 cSt was determined to be 6.02 wt % in the Mack T-11 engine test.

Example 3

[0177] An ethylene-octene copolymer having 86.7 mole % ethylene, a R1R2 product of 0.32 and less than 0.1 regioinversions per 1000 carbon atoms was grafted with MA under the following conditions: 95.8 wt % of polymer, 4 wt % of Crystalm® Maleic Anhydride (available from ExxonMobil Chemical Company) were fed at 7 kg/hr feed rate to the hopper of the extruder and 2.23 wt % of a 10% solution of Luperox® 130 (di-tertiary butyl peroxide available from Atofina Chemical Incorporated) dissolved in Marcol® 52 oil (mineral oil available from ESSO Petroleum Company Limited) were added to the second barrel. The screw speed was set at 400 rpm and following temperature profile was used: 180° C., 190° C., 210° C., 180° C. with the die at 180° C. The amount of MA grafted was 3.2 wt %.

[0178] The maleated copolymer was dissolved in neutral oil to a concentration of 7 wt %. 100 parts of the maleated copolymer/oil mixture were charged to a stirred glass reactor and heated to about 160° C. 1.63 parts of an alcohol ethoxylate (Huntsman Surfonic® L24-7, a seven-mole ethoxylate of a linear, primary about C12 to about C14 alcohol) and 0.46 parts of NPPDA (1.05 moles of NPPDA per mole of grafted MA) were charged to the reactor. The reactor was held at about 160° C. for two hours and then cooled. Three subsequent batches were synthesized using the same raw materials and procedures. A total of four batches were made and blended together. When the resulting dispersant viscosity index improver was blended into a formulated lubricating oil composition and tested in the Mack T-11 engine test, the amount of soot in the finished lubricating oil composition at an increase of 12 cSt was found to be 7.59 wt %.

Comparative Example A

[0179] An ethylene-propylene copolymer having 73.2 mole % ethylene, R1R2 product of 1.06 and 23.6 regioinversions per 1000 carbon atoms was grafted with MA under the following conditions: 96.8 wt % of polymer, 3.2 wt % of Crystalm® Maleic Anhydride (available from ExxonMobil Chemical Company) were fed at 7 kg/hr feed rate to the hopper of the extruder and 2.44 wt % of a 10% solution of Luperox® 130 (di-tertiary butyl peroxide available from Atofina Chemical Incorporated) dissolved in Marcol® 52 oil (mineral oil available from ESSO Petroleum Company Limited) were added to the second barrel. The screw speed was set at 250 rpm and following temperature profile was used: 160° C., 185° C., 205° C., 210° C. with the die at 160° C. The amount of MA grafted was 2.0 wt %. The maleated copolymer was dissolved in neutral oil to a concentration of 6%. 100 parts of the maleated copolymer/oil mixture were charged to a stirred glass reactor and heated to about 160° C. 0.81 parts of an alcohol ethoxylate (Huntsman Surfonic® L24-7, a seven-mole ethoxylate of a linear, primary about 012 to about C14 alcohol) and 0.24 parts 0.1 of NPPDA (1.05 moles of NPPDA per mole of grafted MA) were first combined and then charged to the reactor. The reactor was held at about 160° C. for two hours and then cooled. Three subsequent batches were synthesized using the same raw materials and procedures. A total of four batches were made and blended together. The resulting dispersant viscosity index improver was blended into a formulated lubricating oil composition to achieve a kinematic viscosity at about 100° C. equal to 114.5 cSt. The finished lubricating oil composition was then run in the Mack T-11 engine test. The amount of soot present in the finished lubricating oil composition when the lubricating oil composition viscosity increased 12 cSt above the initial viscosity was 4.91 wt %.

Comparative Example B

[0180] The dispersant viscosity index improver of Comparative Example B was prepared and tested according to Comparative Example A except that: the amine compound used was 4-phenoxylaniline (4-PDA) instead of NPPDA. The amount of soot in the finished lubricating oil composition at an increase of 12 cSt was determined to be 5.42 wt % in the Mack T-12 engine test.

Comparative Example C

[0181] The maleated ethylene-propylene copolymer having 73.2 mole % ethylene of Comparative Example A was further grafted with MA in a second pass extrusion process under the following conditions: 98 wt % of polymer, 2 wt % of Crystalm® Maleic Anhydride (available from ExxonMobil Chemical Company) were fed at 7 kg/hr feed rate to the hopper of the extruder and 0.91 wt % of a 10% solution of Luperox® 130 (di-tertiary butyl peroxide available from Atofina Chemical Incorporated) dissolved in Marcol® 52 oil (mineral oil available from ESSO Petroleum Company Limited) were added to the second barrel. The screw speed was set at 250 rpm and following temperature profile was used: 160° C., 185° C., 205° C., 210° C. with the die at 145° C. A final gelling level of 2.0 wt % MA was achieved. The maleated copolymer was dissolved in neutral oil to a concentration of 6 wt %. 100 parts of the maleated copolymer/oil mixture were charged to a stirred glass reactor and heated to about 160° C. 1.63 parts of an alcohol ethoxylate (Huntsman Surfonic® L24-7, a seven-mole ethoxylate of a linear, primary about C12 to about C14 alcohol) and 0.30 parts of NPPDA (1.05 moles of NPPDA per mole of grafted MA) were charged to the reactor. The reactor was held at about 160° C. for two hours and then cooled. The product was tested in the Mack T-11 engine test as described in the previous Examples. Upon completion of the test, the finished lubricating oil was found to contain 5.75 wt % soot when the finished lubricating oil composition viscosity increased 12 cSt above the initial viscosity.

Comparative Example D

[0182] A viscosity index improver having an ethylene-propylene copolymer with 68.4 mole % ethylene was prepared as specified in Example 1 except no amine was used and blended into a formulated lubricating oil composition to achieve a kinematic viscosity at about 100° C. equal to 14.5 cSt. This material is available commercially from Chevron Orontic Company, LLC. The finished lubricating oil composition was then run in the Mack T-11 engine test. The amount of soot present in the finished lubricating oil composition when the oil viscosity increased 12 cSt above the initial viscosity was 4.91 wt %.

[0183] The lubricating oil composition for each test is provided in Table 2 below.
TABLE 2

<table>
<thead>
<tr>
<th>Lubricating Oil Compositions*</th>
<th>Examples</th>
<th>Comparative Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Dispersant</td>
<td>7.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Viscosity Index Improver, wt %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinematic viscosity at 100°C, (ASTM D445), cSt</td>
<td>14.3</td>
<td>14.3</td>
</tr>
</tbody>
</table>

*The wt % balance of the lubricating oil composition comprised Group I and Group II base oil, detergents, dispersants, wear inhibitors, antioxidants, friction modifiers, metal deactivators, foam inhibitors, and pour point depressants.

Results of the Mack T-11 engine tests are presented in Table 3 below.

TABLE 3

<table>
<thead>
<tr>
<th>Mack T-11 Engine Test Results</th>
<th>Examples</th>
<th>Comparative Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Copolymer</td>
<td>Ethylene</td>
<td>Ethylene</td>
</tr>
<tr>
<td>Mole % Ethylene Octene</td>
<td>86.7</td>
<td>86.7</td>
</tr>
<tr>
<td>Number-average Mole Wt (Mn)</td>
<td>56,000</td>
<td>56,000</td>
</tr>
<tr>
<td>Weight-average Mole Wt (Mw)</td>
<td>115,000</td>
<td>115,000</td>
</tr>
<tr>
<td>Graffiti level, % MA</td>
<td>2.8</td>
<td>2.8</td>
</tr>
<tr>
<td>Extruder passes to achieve grafting</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Amines</td>
<td>NPPDA</td>
<td>4-PA</td>
</tr>
<tr>
<td>Soot wt %</td>
<td>7.18</td>
<td>6.02</td>
</tr>
</tbody>
</table>

[0184] The results of this data indicate that the dispersant viscosity index improvers of the present invention having high ethylene content, wherein the alpha-monoolefin has a monomer distribution resulting from a R₂R₈ product measured by ¹³C-NMR below 0.8 and a level of regio-inversions less than 2 per 1000 carbon atoms, provide superior soot dispersancy compared to lubricating oil compositions with viscosity index improvers having lower ethylene content.

What is claimed is:

1. A polymeric composition comprising an ethylene-alpha olefin copolymer backbone comprising at least 82 mole % ethylene and at most 18 mole % of an about C₁₂ to about C₂₈ alpha-monoolefin, wherein the alpha-monoolefin has a monomer distribution resulting from a R₂R₈ product measured by ¹³C-NMR below 0.8 and a level of regio-inversions atoms, or a secondary or tertiary amine, provided that at least one of X and X' is a secondary or tertiary amine, and Z is a tertiary amine, wherein Z and X and X', when X and X' are secondary or tertiary amines, are each independently derived from one or more of the following amines:

(a) an aromatic amine comprising two aromatic groups, linked by a group, L represented by the following formula:

![Aromatic Amino Group](image)

wherein P is the ethylene-alpha olefin copolymer backbone, R₁ is hydrogen or —CO—X', R₂ and R₃ are independently hydrogen or —CH₃, X and X' are independently —OH, alkoxyl of 1 to about 24 carbon atoms, or a secondary or tertiary amine, provided that at least one of X and X' is a secondary or tertiary amine, and Z is a tertiary amine, wherein Z and X and X', when X and X' are secondary or tertiary amines, are each independently derived from one or more of the following amines:

![Secondary or Tertiary Amino Group](image)
wherein L is selected from —O—, —N=N—, —NH—, —CH₂NH—, —C(O)NR—, —C(O)O—, —SO₂—, —SO₂NR₂— or —SO₂NH—; wherein R₄ and R₅ independently represent a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 18 carbon atoms;

wherein each Y₁, Y₂, Y₃, and Y₄ are independently N or CH provided that Y₁ and Y₂ may not both be N;

R₆ and R₇, independently represent a hydrogen, —OH, —NO₂, —SO₂H, —SO₂Na, —SO₂H or salt thereof —NH-aryl, —NH-alkyl, —NH-alkaryl, —NH-aralkyl having up to about 24 carbon atoms, or a branched or straight chain group having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyl, aralkyl, alkaryl, hydroxyalkyl or aminooalkyl;

R₈ and R₉ independently represent a hydrogen, an alkyl an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms, —OH, —SO₂H or —SO₂Na; and

R₁₀ represents —NH₂, —NH₄⁺, wherein R₁₀ is an alkyl or an alkenyl group having from about 1 to about 8 carbon atoms, —CH₃—(CH₂)₄—NH₂ or —CH₂-aryl-NH₂ and n is from 0 to about 10;

(b) an aminothiazole selected from the group consisting of aminothiazole, aminobenzothiazole, aminobenzothiadiazole and aminooalkylthiazole;

(c) an aminocarbazole represented by the formula:

\[
\begin{array}{c}
\text{NH}_2 \\
\text{H}
\end{array}
\]

wherein R₁₂ and R₁₃ independently represent a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(d) an aminoindole represented by the formula:

\[
\begin{array}{c}
\text{NH}_2 \\
\text{H}
\end{array}
\]

wherein R₁₄ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(e) an aminopyrrole represented by the formula:

\[
\begin{array}{c}
\text{NH}_2 \\
\text{H}
\end{array}
\]

wherein R₁₅ represents a divalent alkylene group having about 2 to about 6 carbon atoms and R₁₆ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms,

(f) an amino-indazolinone represented by the formula:

\[
\begin{array}{c}
\text{H}_2\text{N} \\
\text{R}_1 \text{R}_7
\end{array}
\]

wherein R₁₇ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(g) an aminomercaptotriazole represented by the formula:

\[
\begin{array}{c}
\text{NH}_2 \\
\text{H}
\end{array}
\]

(h) an aminopyrimidine represented by the formula:

\[
\begin{array}{c}
\text{NH}_2 \\
\text{H}
\end{array}
\]

wherein R₁₈ represents a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

(i) a ring substituted or unsubstituted aniline;

(j) an aminoquinoline;

(k) an aminobenzimidazole;

(l) a N,N-dialkylphenylenediamine and

(m) a benzylamine.

2. The polymeric composition according to claim 1, further comprising a polylene selected from non-conjugated dienes and trienes.

3. The polymeric composition according to claim 1, wherein the ethylene-alpha copolymer comprises at least 84 mole % ethylene and at most 16 mole % of an about C₃ to about C₂₈ alpha-monoolefin.

4. The polymeric composition according to claim 3, wherein the alpha-monoolefin is an about C₃ to about C₂₀ alpha-monoolefin.

5. The polymeric composition according to claim 4, wherein the alpha-monoolefin is an about C₆ to about C₁₂ alpha-monoolefin.

6. The polymeric composition according to claim 5, wherein the alpha-monoolefin is octene.

7. The polymeric composition according to claim 1, wherein the amine compound is an aromatic amine selected from the group consisting of
(a) an N-arylphenylenediamine represented by the formula:

\[ \text{R}_{10} - \text{H} \rightarrow \text{N} \rightarrow \text{R}_{20} \]

wherein \( R_{10} \) represents a hydrogen, -NH-aryl, -NH-alkyl, -NH-alkaryl, -NH-aralkyl having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxy, aralkyl, alkaryl, hydroxyalkyl or alminioalkyl;

\( R_{20} \) represents -NH, -CH\(_2\) - (CH\(_2\))\(_n\) - NH\(_2\), -CH\(_2\)-aryl-NH\(_2\) and \( n \) is from about 1 to about 10; and

\( R_{1} \) represents a hydrogen, an alkyl, an alkenyl, an alkoxyl, an aralkyl or an alkaryl group having about 4 to about 24 carbon atoms; and

(b) a phenoxyaniline represented by the formula:

\[ \text{R}_{1} - \text{O} \rightarrow \text{NH} \rightarrow \text{Y}_{1} \rightarrow \text{Y}_{2} \rightarrow \text{Y}_{3} \rightarrow \text{Y}_{4} \rightarrow \text{Y}_{5} \rightarrow \text{R}_{10} \]

wherein \( Y_{1} \rightarrow Y_{5} \) are independently N or CH, provided that \( Y_{1} \) and \( Y_{2} \) may not both be N.

8. The polymeric composition according to claim 7, wherein the N-arylphenylenediamine is N-phenylphenylenediamine.

9. The polymeric composition according to claim 8 wherein the N-phenylphenylenediamine is N-phenyl-1,4-phenylenediamine.

10. The polymeric composition according to claim 7 wherein the phenoxyanilines is 4-phenoxyaniline.

11. The polymeric compositions according to claim 1, further comprising an aliphatic amine having a single reactive amino group.

12. The polymeric composition according to claim 11, wherein the aliphatic amine having a single reactive amino group has from about 1 to about 8 carbon atoms.

13. The polymeric composition according to claim 12, wherein the aliphatic amine having a single reactive amino group is N,N-dimethylaminopropylamine or aminopropylmorpholine.

14. An oil-soluble product prepared by the process comprising grafting an ethylene-alpha olefin copolymer backbone comprising at least 82 mole % ethylene and at most 18 mole % of an about C\(_g\) alpha-olefin to about C\(_s\) alpha-olefin, wherein the alpha-olefin has a monomer distribution resulting from a \( R_{1} \rightarrow R_{10} \) product measured by \(^{13}\)C-NMR below 0.8 and a level of regio-inversions less than 2 per 1000 carbon atoms with an ethenically unsaturated acylating agent and subsequently reacting the resulting grafted copolymer with one or more of the following amines:

(a) an aromatic amine comprising two aromatic groups, linked by a group, \( L \) represented by the following formula:

\[ \text{R}_{1} \rightarrow \text{L} \rightarrow \text{R}_{2} \rightarrow \text{L} \rightarrow \text{R}_{3} \rightarrow \text{L} \rightarrow \text{R}_{4} \rightarrow \text{L} \rightarrow \text{R}_{5} \rightarrow \text{L} \rightarrow \text{R}_{6} \]

wherein \( L \) is selected from -O-, -N=N-, -NH-, -CH\(_2\)NH-, -C(O)NR-, -C(O)O-, -SO\(_2\)-, -SO\(_2\)NR-, or -SO\(_2\)NH-; and

\( R_{1} \) and \( R_{2} \) independently represent a hydrogen, an alkyl, an aralkyl, an alkoxyl, an alkenyl, an aromatic amine having up to about 8 carbon atoms; and

\( R_{3} \) and \( R_{4} \) independently represent a hydrogen, an alkyl, an aralkyl, an alkoxyl, an alkenyl, an aromatic amine having about 1 to about 8 carbon atoms, -OH, -SO\(_2\)H or -SO\(_2\)Na; and

\( R_{5} \) and \( R_{6} \) independently represent a hydrogen, an alkyl, an aralkyl, an alkoxyl, an alkenyl, an aromatic amine having about 1 to about 8 carbon atoms, -OH, -SO\(_2\)H or -SO\(_2\)Na; and

10. Represents -NH\(_2\), -NHR\(_1\), wherein \( R_{1} \) is an alkyl or an alkenyl group having from about 1 to about 8 carbon atoms, -CH\(_2\) - (CH\(_2\))\(_n\) - NH\(_2\) or -CH\(_2\)-aryl-NH\(_2\) and \( n \) is from 0 to about 10;

(b) an aminothiazole selected from the group consisting of aminothiazole, aminobenzothiazole, aminobenzothiazole- diazole and aminothiazole izole;

(c) an aminocarbazole represented by the formula:

\[ \text{R}_{12} \rightarrow \text{N} \rightarrow \text{H} \rightarrow \text{R}_{13} \]

wherein \( R_{12} \) and \( R_{13} \) independently represent a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(d) an aminooindole represented by the formula:
wherein \( R_{16} \) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(e) an aminopyrrole represented by the formula:

\[
\begin{array}{c}
\text{H} \\
\text{R}_{16} \\
\text{R}_{15} \\
\text{N} \\
\text{R}_{14} \\
\text{NH}_{2}
\end{array}
\]

wherein \( R_{14} \) represents a divalent alkylene group having about 2 to about 6 carbon atoms and \( R_{16} \) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(f) an amino-indazolinone represented by the formula:

\[
\begin{array}{c}
\text{H}_{2} \text{N} \\
\text{R}_{17} \\
\text{N} \\
\text{H}
\end{array}
\]

wherein \( R_{17} \) represents a hydrogen an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(g) an aminomercaptotriazole represented by the formula:

\[
\begin{array}{c}
\text{H} \\
\text{S} \\
\text{N} \\
\text{N} \\
\text{H}
\end{array}
\]

(h) an aminopyrimidine represented by the formula:

\[
\begin{array}{c}
\text{N} \\
\text{H}_{2} \\
\text{N}
\end{array}
\]

wherein \( R_{18} \) represents a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

(i) a ring substituted or unsubstituted aniline;

(j) an aminoquinoline;

(k) an aminobenzimidazole;

(l) a N,N-dialkylphenylenediamine and

(m) a benzylamine

to yield an oil-soluble product having an amide group with the formula (I) and/or an imide group having the formula (II)

\[
\begin{array}{c}
\text{P} \text{X} \text{O} \\
\text{R} \\
\text{X}
\end{array}
\]

wherein \( P \) is the ethylene-alpha olefin copolymer backbone, \( R_{1} \) is hydrogen or \(-\text{CO}--\text{X}'\), \( R_{2} \) and \( R_{3} \) are independently hydrogen or \(-\text{CH}_{3} \), \( X \) and \( X' \) are independently \(-\text{OH} \), alkoxyl of 1 to about 24 carbon atoms, or a secondary or tertiary amine, provided that at least one of \( X \) and \( X' \) is a secondary or tertiary amine, and \( Z \) is a tertiary amine, wherein \( Z \) and \( X \) and \( X' \), when \( X \) and \( X' \) are secondary or tertiary amines, are each independently derived from one or more of the amines in (a)-(m) above.

15. The oil-soluble product prepared by the process according to claim 14, further comprising a polyene selected from non-conjugated dienes and trienes.

16. The oil-soluble product prepared by the process according to claim 14, wherein the ethylene-alpha copolymer comprises at least 84 mole % ethylene and at most 16 mole % of an about \( C_{3} \), to about \( C_{20} \) alpha-monoolefin.

17. The oil-soluble product prepared by the process according to claim 16, wherein the alpha-monoolefin is an about \( C_{3} \) to about \( C_{20} \) alpha-monoolefin.

18. The oil-soluble product prepared by the process according to claim 17, wherein the alpha-monoolefin is an about \( C_{6} \) to about \( C_{12} \) alpha-monoolefin.

19. The oil-soluble product prepared by the process according to claim 18, wherein the alpha-monoolefin is o octene.

20. The oil-soluble product prepared by the process according to claim 14, wherein the ethylenically unsaturated acylating agent is maleic anhydride.

21. The oil-soluble product prepared by the process according to claim 14, wherein the amine is an aromatic amine selected from the group consisting of

(a) N-arylphenylenediamine represented by the formula:

\[
\begin{array}{c}
\text{R}_{22} \text{N} \\
\text{H} \\
\text{O} \\
\text{R}_{21} \\
\text{N}
\end{array}
\]

wherein \( R_{22} \) represents a hydrogen, \(-\text{NH}-\text{aryl}, \,-\text{NH}-\text{alkyl}, \,-\text{NH}-\text{alkaryl}, \,-\text{NH}-\text{aralkyl} \) having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyl, arylalkyl, hydroxyalkyl or aminoalkyl;

\( R_{20} \) represents \(-\text{NH}_{2} \), \,-\text{CH}_{2}-(\text{CH}_{2})_{m}-\text{NH}_{2} \), \,-\text{CH}_{2}-\text{aryl-NH}_{2} \) and \( n \) is from about 1 to about 10;
and \( R_{23} \) represents a hydrogen, an alkyl an alkenyl, an alkoxyl, an aralkyl or an alkaryl group having about 4 to about 24 carbon atoms; and

(b) a phenoxyaniline represented by the formula:

-continued

wherein \( R_{22} \) represents a hydrogen, an alkyl an alkenyl, an alkoxyl, an aralkyl or an alkaryl group having about 4 to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyl, aralkyl, alkaryl, hydroxyalkyl or aminooalkyl;

\( R_{23} \) represents \(-\text{NH}_2, -\text{CH}_2-(\text{CH}_2)_n-\text{NH}_2, -\text{CH}_2-\text{aryl-NH}_2 \) and \( n \) is from about 1 to about 10; and

\( R_{24} \) represents a hydrogen, an alkyl an alkenyl, an alkoxyl, an aralkyl or an alkaryl group having about 4 to about 24 carbon atoms.

22. The oil-soluble product prepared by the process according to claim 21, wherein the \( N \)-arylphenylenediamine is \( N \)-phenylenylenediamine.

23. The oil-soluble product prepared by the process according to claim 22, wherein the \( N \)-phenylenylenediamine is \( N \)-phenyl-1,4-phenylenediamine.

24. The oil-soluble product prepared by the process according to claim 21 wherein the phenoxyaniline is 4-phenoxyaniline.

25. The oil-soluble product prepared by the process according to claim 14, further comprising an aliphatic amine having a single reactive amino group.

26. The oil-soluble product prepared by the process according to claim 25, wherein the aliphatic amine having a single reactive amino group has from about 1 to about 8 carbon atoms.

27. The oil-soluble product prepared by the process according to claim 26, wherein the aliphatic amine having a single reactive amino group is \( N \),\( N \)-dimethylaminopropylamine or aminopropylmethacrylate.

28. A lubricating oil composition comprising a major amount of base oil of lubricating viscosity and a minor amount of a polymeric composition comprising an ethylene-alpha olefin copolymer backbone comprising at least 82 mole % ethylene and at most 18 mole % of an about \( C_3 \) to about \( C_{28} \) alpha-olefin, wherein the alpha-olefin has a monomer distribution resulting from a \( R_{10} \) product measured by \( ^{13} \text{C-NMR} \) below 0.8 and a level of regioinversions less than 2 per 1000 carbon atoms, and an amide group having the formula (I) and/or an imide group having the formula (II):

-continued

wherein \( P \) is the ethylene-alpha olefin copolymer backbone, \( R_1 \) is hydrogen or \(-\text{CO-\text{X'}} \), \( R_2 \) and \( R_3 \) are independently hydrogen or \(-\text{CH}_3 \), \( X \) and \( X' \) are independently \(-\text{OH}, \) alkoxyl of 1 to about 24 carbon atoms, or a secondary or tertiary amine, provided that at least one of \( X \) and \( X' \) is a secondary or tertiary amine, and \( Z \) is a tertiary amine, wherein \( Z \) and \( X \) and \( X' \) when \( X \) and \( X' \) are secondary or tertiary amines, are each independently derived from one or more of the following amines;

(a) an aromatic amine comprising two aromatic groups linked by a group, \( L \) represented by the following formula:

-continued
wherein $R_{12}$ and $R_{13}$ independently represent a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(d) an aminoindole represented by the formula:

wherein $R_{14}$ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(e) an aminopyrrole represented by the formula:

wherein $R_{15}$ represents a divalent alkylene group having about 2 to about 6 carbon atoms and $R_{16}$ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(f) an aminooindolinone represented by the formula:

wherein $R_{17}$ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(g) an aminomercaptotriazole: represented by the formula:

(h) an aminopyrimidine represented by the formula:

wherein $R_{18}$ represents a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

(i) a ring substituted or unsubstituted aniline;

(j) an aminquinoline;

(k) an aminobenzimidazole;

(l) a N,N-dialkylphenylenediamine and

(m) a benzyllamine.

29. The lubricating oil composition according to claim 28, further comprising a polyene selected from non-conjugated dienes and trienes.

30. The lubricating oil composition according to claim 28, wherein the ethylene-alpha copolymer comprises at least 84 mole % ethylene and at least 16 mole % of an about $C_5$ to about $C_{28}$ alpha-monoolefin.

31. The lubricating oil composition according to claim 30, wherein the alpha-monoolefin is a about $C_{9}$ to about $C_{20}$ alpha-monoolefin.

32. The lubricating oil composition according to claim 31, wherein the alpha-monoolefin is a about $C_{12}$ alpha-monoolefin.

33. The lubricating oil composition according to claim 32, wherein the z:2 alpha-monoolefin is octene.

34. The lubricating oil composition according to claim 28, wherein the amine is an aromatic amine selected from the group consisting of

(a) an N-arylphenylenediamine represented by the formula:

wherein $R_{19}$ represents a hydrogen, —NH-aryl, —NH-alkyl, —NH-alkaryl, —NH-aralkyl having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms; and

(b) a phenoxyaniline represented by the formula:

wherein $R_{20}$ represents —NH$_2$, —CH$_2$—(CH$_2$)$_n$—NH$_2$, —CH$_2$aryl-NH$_2$, and $n$ is from about 1 to about 10; and

$R_{21}$ represents a hydrogen, an alkyl an alkyl, an alkoxyl, an aralkyl, or an alkyloxyl or alkyl-NH$_2$ and

$R_{22}$ represents —NH$_2$, —CH$_2$—(CH$_2$)$_n$—NH$_2$, —CH$_2$aryl-NH$_2$, and $n$ is from about 1 to about 10; and
R₃₂ represents a hydrogen, an alkyl, an alkenyl, an alkoxy, an aralkyl or an alkaryl group having about 4 to about 24 carbon atoms.

35. The lubricating oil composition according to claim 34, wherein the N-aryl phenylenediamine is N-phenylphénylenediamine.

36. The lubricating oil composition according to claim 35, wherein the N-phenylenediamine is N-phenyl-1,4-phenylene diamine.

37. The lubricating oil composition according to claim 34, wherein the phenoxanline is 4-phenoxanline.

38. The lubricating oil composition according to claim 38, further comprising an amine having a single reactive amine group.

39. The lubricating oil composition according to claim 38, wherein the aliphatic amine having a single reactive amine group has from about 1 to about 8 carbon atoms.

40. The lubricating oil compositions according to claim 39, wherein the aliphatic amine having a single reactive amino group is N,N-dimethylaminopropylamine or amino-propylmorpholine.

41. The lubricating oil composition according to claim 38, wherein the polymeric composition is from about 2 wt % to about 30 wt %, based on the total weight of the lubricating oil composition.

42. The lubricating oil composition according to claim 41, wherein the polymeric composition is from about 4 wt % to about 20 wt %, based on the total weight of the lubricating oil composition.

43. The lubricating oil composition according to claim 42, wherein the polymeric composition is from about 6 wt % to about 12 wt %, based on the total weight of the lubricating oil composition.

44. A lubricating oil composition comprising a major amount of base oil of lubricating viscosity and a minor amount of an oil-soluble product prepared by the process comprising grafting an ethylene-alpha olefin copolymer backbone comprising at least 82 mole % ethylene and at most 18 mole % of an about C₈₉ alpha-monoolefin, wherein the alpha-monoolefin has a monomer distribution resulting from a R₉R₁₀ product measured by ¹³C-NMR below 0.8 and a level of regio-inversions less than 2: per 1000 carbon atoms with an ethylenically unsaturated acylating agent and subsequently reacting the resulting grafted copolymer with one or more of the following amines:

(a) an aromatic amine comprising two aromatic groups linked by a group, L, represented by the following formula;

wherein L is selected from —O—, —N=N—, —NH—, —CH₂NH—, —(O)NR₂—, —(O)O—, —SO₂—,

(b) an aminoindole represented by the formula:

wherein R₄ and R₅ independently represent a hydrogen, —OH, —NO₂, —SO₃H, —SO₃Na, —CO₂H or salt thereof, —NH-aryl, —NH-alkyl, —NH-alkaryl, —NH-aralkyl having up to about 24 carbon atoms or a branched or straight chain group having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxy, aralkyl, alkanil, hydroxyalkyl or aminokyl;

R₆ and R₇ independently represent a hydrogen, an alkyl an alkenyl or an alkyl group having from about 1 to about 8 carbon atoms, —OH, —SO₃H or —SO₃Na; and

R₈ represents —NH₂, —NR₁₁, wherein R₁₁ is an alkyl or an alkyl group having from about 1 to about 8 carbon atoms, —(CH₂)ₙ—NH₂ or —C₆₇aryl-NH₂ and n is from 0 to about 10;

(b) an aminothiazole selected from the group consisting of an aminothiazole, aminobenzothiazole, aminobenzothia diazole and aminoalkylthiazole;

(c) an aminocarbazole represented by the formula:

wherein R₁₂ and R₁₃ independently represent a hydrogen, an alkyl or an alkyl group having from about 1 to about 14 carbon atoms;

(d) an aminocarbazole represented by the formula:

wherein R₁₄ represents a hydrogen, an alkyl or an alkyl group having from about 1 to about 14 carbon atoms;

(e) an aminopyrrole represented by the formula:

wherein R₁₅ represents a divalent alkylene group having about 2 to about 6 carbon atoms and R₁₆ represents a hydrogen, an alkyl or an alkyl group having from about 1 to about 14 carbon atoms;

(f) an amino-indazolinone represented by the formula:
wherein \( R \) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(g) an aminomercaptotriazole represented by the formula:

(h) an aminopyrimidine represented by the formula:

wherein \( R_{18} \) represents a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

(i) a ring substituted or unsubstituted aniline;

(j) an aminooquinoline;

(k) an aminobenzimidazole;

(l) a \( N,N \)-dialkyphenylenediamine and

(m) a benzylamine
to yield an oil-soluble product having an amide group with the formula (I) and/or an imide group having the formula (II):

wherein \( P \) is the ethylene-alpha olefin copolymer backbone, \( R_1 \) is hydrogen or \(-\text{CO}-X_1\), \( R_2 \) and \( R_3 \) are independently hydrogen or \(-\text{CH}_2-X_2\), \( X \) and \( X' \) are independently \(-\text{OH}, \text{alkoxyl of } 1 \text{ to about } 24 \text{ carbon atoms, or a secondary or tertiary amine, provided that at least one of } X \text{ and } X' \text{ is a secondary or tertiary amine, and } Z \text{ is a tertiary amine, wherein } X \text{ and } X' \text{ are secondary or tertiary amines, are each independently derived from one or more of the amines in (a)-(m) above.}

45. The lubricating oil composition according to claim 44, further comprising a polyene selected from non-conjugated dienes and trienes.

46. The lubricating oil composition according to claim 44, wherein the ethylene-alpha copolymer comprises at least 83 mole % ethylene and at least 17 mole % of an about \( C_3 \) to about \( C_{28} \) alpha-monoolefin.

47. The lubricating oil composition according to claim 46, wherein the ethylene-alpha copolymer comprises at least 84 mole % ethylene and at least 16 mole % of an about \( C_3 \) to about \( C_{28} \) alpha-monoolefin.

48. The lubricating oil composition according to claim 47, wherein the alpha-monoolefin is an about \( C_{20} \) alpha-monoolefin.

49. The lubricating oil composition according to claim 48, wherein the alpha-monoolefin is an about \( C_6 \) to about \( C_{12} \) alpha-monoolefin.

50. The lubricating oil composition according to claim 49, wherein the alpha-monoolefin is octene.

51. The lubricating oil composition according to claim 44, wherein the ethylenically unsaturated acylating agent is maleic anhydride.

52. The lubricating oil composition according to claim 44, wherein the amine is an aromatic amine selected from the group consisting of:

(a) \( N \)-arylethenenediamine represented by the formula:

wherein \( R_{19} \) represents a hydrogen, \(-\text{NH-aryl}, -\text{NH-alkyl}, -\text{NH-alkaryl}, -\text{NH-aralkyl} \) having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyalkyl, alkyl, hydroxyalkyl or aminooalkyl;

\( R_{20} \) represents \(-\text{NH}_2-, -\text{CH}_2-(\text{CH}_3)_n-\text{NH}_2-, -\text{CH}_2-\text{aryl-NH}_2, \) and \( n \) is from 1 to about 10; and

\( R_{21} \) represents a hydrogen, an alkyl, an alkenyl, an alkoxyl, an aroyl or an alkaryl group having about 4 to about 24 carbon atoms; and

(b) a phenoxyaniline represented by the formula:

wherein \( R_{22} \) represents a hydrogen, \(-\text{NH-aryl}, -\text{NH-alkyl}, -\text{NH-alkaryl}, -\text{NH-aralkyl} \) having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyalkyl, alkyl, hydroxyalkyl or aminooalkyl;

\( R_{23} \) represents \(-\text{NH}_2-, -\text{CH}_2-(\text{CH}_3)_n-\text{NH}_2-, -\text{CH}_2-\text{aryl-NH}_2, \) and \( n \) is from 1 to about 10; and

\( R_{24} \) represents a hydrogen, an alkyl, an alkenyl an alkoxyl, an aroyl or an alkaryl group having about 4 to about 24 carbon atoms.

53. The lubricating oil composition according to claim 52, wherein the \( N \)-arylethenenediamine is \( N \)-phenylethenenediamine.
54. The lubricating oil composition according to claim 53, wherein the N-phenylphenylenediamine is N-phenyl-1,4-phenylenediamine.

55. The lubricating oil composition according to claim 52, wherein the phenoxyaniline is 4-phenoxyaniline.

56. The lubricating oil composition according to claim 44, further comprising an aliphatic amine having a reactive amino group.

57. The lubricating oil composition according to claim 56, wherein the aliphatic amine having a single reactive amine group has from about 1 to about 8 carbon atoms.

58. The lubricating oil composition according to claim 57, wherein the aliphatic amine having a single reactive amine group is N,N-dimethylaminopropylamine or aminopropylmorpholine.

59. The lubricating oil composition according to claim 44, wherein the oil-soluble product prepared by the process is from about 2 wt % to about 30 wt %, based on the total weight of the lubricating oil composition.

60. The lubricating oil composition according to claim 59, wherein the oil-soluble product prepared by the process is from about 4 wt % to about 20 wt %, based on the total weight of the lubricating oil composition.

61. The lubricating oil composition according to claim 60, wherein the oil-soluble product prepared by the process is from about 6 wt % to about 12 wt %, based on the total weight of the lubricating oil composition.

62. A method of improving the soot and/or sludge dispersancy in an internal combustion engine, said method comprising operating said internal combustion engine with a lubricating oil composition comprising a major amount of base oil of lubricating viscosity and a minor amount of a polymeric composition comprising an ethylene-alpha olefin copolymer backbone comprising at least 82 mole % ethylene and at most 18 mole % of an about C\textsubscript{3} to about C\textsubscript{28} alpha-olefin, wherein the alpha-olefin has a monomer distribution resulting from a R\textsubscript{6}R\textsubscript{8} product measured by \textsuperscript{13}C-NMR below 0.8 and a level of regio-inversions less than 2 per 1000 carbon atoms, and an amide group having the formula (I) and/or an imide group having the formula (II):

![Diagram](https://via.placeholder.com/150)

wherein P is the ethylene-alpha olefin copolymer backbone, R\textsubscript{1} is hydrogen or —CO—X', R\textsubscript{2} and R\textsubscript{3} are independently hydrogen or —CH\textsubscript{n}—X and X' are independently —OH, alkoxyl of 1 to about 24 carbon atoms, or a secondary or tertiary amine, provided that at least one of X and X' is a secondary or tertiary amine, and Z is a tertiary amine, wherein Z and X and X', when

X and X' are secondary or tertiary amines, are each independently derived from one or more of the following amines:

(a) an aromatic amine comprising two aromatic groups, linked by a group L represented by the following formula,

![Diagram](https://via.placeholder.com/150)

wherein L is selected from the group consisting of —O—, —N=N—, —NH—, —C\textsubscript{6}H\textsubscript{5}NH—, —CONR\textsubscript{2}—, —CONH—, —SO\textsubscript{2}—, —SO\textsubscript{2}NR— or —SO\textsubscript{2}NH—; wherein R\textsubscript{4} and R\textsubscript{5} independently represent a hydrogen, an alkyl, an alkelyl or an alkoxyl group having from about 1 to about 8 carbon atoms; wherein each Y\textsubscript{1}, Y\textsubscript{2}, Y\textsubscript{3} and Y\textsubscript{4} are independently N or CH provided that Y\textsubscript{1} and Y\textsubscript{2} may not both be N; R\textsubscript{6} and R\textsubscript{7} independently represent a hydrogen, an alkyl, an alkelyl or an alkoxyl group having from about 1 to about 8 carbon atoms; —OH, —SO\textsubscript{2}H or —SO\textsubscript{2}Na; and

R\textsubscript{10} represents —NH\textsubscript{2}, —NR\textsubscript{11} wherein R\textsubscript{11} is an alkyl or an alkelyl group having from about 1 to about 8 carbon atoms, —CH\textsubscript{2}—(CH\textsubscript{2})\textsubscript{n}—NH\textsubscript{2} or —CH\textsubscript{2}—(CH\textsubscript{2})\textsubscript{n}—NH\textsubscript{2} and n is from 0 to about 10;

(b) an aminothiazole selected from the group consisting of aminothiazole, aminobenzothiazole, aminobenzothia diazole and aminocarbazol y thiazole;

(c) an aminocarbazole represented by the formula:

![Diagram](https://via.placeholder.com/150)

wherein R\textsubscript{12} and R\textsubscript{13} represent a hydrogen, an alkyl or an alkelyl group having from about 1 to about 14 carbon atoms;

(d) an aminointolyl represented by the formula:

![Diagram](https://via.placeholder.com/150)
wherein R₁₄ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(e) an aminopyrrole represented by the formula:

wherein R₁₅ represents a divalent alkylene group having about 2 to about 6 carbon atoms and R₁₆ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(f) an amino-indazolinone represented by the formula:

wherein R₁₇ represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(g) an aminomercaptotriazole represented by the formula:

(h) an aminopyridine represented by the formula:

wherein R₁₈ represents a hydrogen, an alkyl, an alkenyl or an alkoxyl group having from about 1 to about 8 carbon atoms;

(i) a ring substituted or unsubstituted aniline;

(j) an aminosquoinoline;

(k) an aminobenzimidazole;

(l) a N,N-dialkylphenylenediamine and

(m) a benzylamine

63. A method of improving the soot and/or sludge dispersancy in an internal combustion engine, said method comprising operating said internal combustion engine with a lubricating oil composition comprising a major amount of base oil of lubricating viscosity and a minor amount of an oil-soluble product produced by the process comprising grafting an ethylene-alpha olefin copolymer backbone comprising at least 82 mole % ethylene and at most 138 mole % of an about: C₃ to about C₂₈ alpha-monoolefin, wherein the alpha-monoolefin has a monomer distribution resulting from a R₄R₅ product measured by ¹³C-NMR below 0.8 and a level of regio-inversions less than 2 per 1000 carbon atoms with an ethylenically unsaturated acylating agent and subsequently reacting the resulting grafted copolymer with one or more of the following amines:

(a) an aromatic amine comprising two aromatic groups, linked by a group L represented by the following formulas:

wherein L is selected from the group consisting of —O—, —N=—N—, —NH—, —CH₂NH—, —C(O)NR₄, —C(O)O—, —SO₂—, —SO₃NR₆—or —SO₂NH—;

wherein R₄ and R₆ independently represent a hydrogen, an alkyl a n alkenyl group having from about 1 to about 8 carbon atoms;

where each Y₁, Y₂, Y₃ and Y₄ are independently N or CH provided that Y₁ and Y₂ may not both be N;

R₅ and R₇ independently represent a hydrogen, —OH, —NO₂, —SO₃H, —SO₃Na, —CO₂H or salt thereof —NH-aryl, —NH-alkyl, —NH-alkaryl, —NH-amid having up to about 24 carbon atoms or a branched or straight chain having from about 4 to about 24 carbon atoms that can be alkyl, alkenyl, alkoxyl, aralkyl, alkaryl, hydroxyalkyl or aminalkyl;

R₄ and R₆ independently represent a hydrogen, an alkyl, an alkyl or an alkoxyl group having from about 1 to about 8 carbon atoms, —OH, —SO₃H or —SO₃Na; and

R₁₀ represents —NH₂, —NHR₁₁, wherein R₁₁ is an alkyl or an alkenyl group having from about 1 to about 8 carbon atoms, —CH₂—(CH₂)ₙ—NH₂ or —CH₂-aryl-NH₂ and n is from 0 to about 10;

(b) an aminothiazole selected from the group consisting of aminothiazole, aminobenzothiazole, aminobenzothiazole and aminoalkylthiazole;

(c) an aminocarbazole represented by the formula,
(d) an aminoindole represented by the formula:

\[
\begin{array}{c}
\text{R} \quad \text{R}_4 \\
\text{H}_2\text{N} \quad \text{N} \\
\text{NH} \quad \text{H}
\end{array}
\]

wherein \(R_4\) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(e) an aminopyrrole represented by the formula:

\[
\begin{array}{c}
\text{R}_{16} \\
\text{N} \\
\text{H}
\end{array}
\]

wherein \(R_{16}\) represents a divalent alkylene group having about 2 to about 6 carbon atoms and \(R_1\) represents a hydrogen, an alkyl or an alkenyl group having about 1 to about 14 carbon atoms;

(f) an amino-indazolinone represented by the formula:

\[
\begin{array}{c}
\text{R}_7 \\
\text{H}_2\text{N} \quad \text{N} \\
\text{NH} \quad \text{H}
\end{array}
\]

wherein \(R_7\) represents a hydrogen, an alkyl or an alkenyl group having from about 1 to about 14 carbon atoms;

(g) an aminomercaptotriazole represented by the formula:

\[
\begin{array}{c}
\text{HS} \\
\text{N} \\
\text{NH}_2
\end{array}
\]

(h) an aminopyrimidine represented by the formula:

\[
\begin{array}{c}
\text{NH}_2 \\
\text{N} \\
\text{H}
\end{array}
\]

wherein \(R_{18}\) represents a hydrogen, an alkyl, an alkenyl, or an alkoxyl group having from about 1 to about 8 carbon atoms;

(i) a ring substituted or unsubstituted aniline;

(j) an aminquinoline;

(k) an aminobenzimidazole;

(l) a N,N-dialkylphenylenediamine and

(m) a benzylamine

to yield an oil-soluble product having an amide group with the formula (I) and/or an imide group having the formula (II):

\[
\begin{array}{c}
\text{P} \\
\text{R}_1 \quad \text{O} \\
\text{X} \quad \text{cr} \\
\text{R}_2
\end{array}
\]

wherein \(P\) is the ethylene-alpha olefin copolymer backbone, \(R_1\) is hydrogen or \(-\text{CO}-\text{X}'\), \(R_2\) and \(R_3\) are independently hydrogen or \(-\text{CH}_n\), \(X\) and \(X'\) are independently \(-\text{OH}\), alkoxyl of 1 to about 24 carbon atoms, or a secondary or tertiary amine provided that at least one of \(X\) and \(X'\) is a secondary or tertiary amine, and \(Z\) is a tertiary amine, wherein \(Z\) and \(X\) and \(X'\), when \(X\) and \(X'\) are secondary or tertiaryamines, are each independently derived from one or more of the amines in (a)-(m) above.

* * * * *