

A LUBRICATING OIL ADDITIVE COMPOSITION AND METHOD OF MAKING THE SAME

FIELD OF THE INVENTION

The present invention is directed to an improved dispersant additive composition that is used in engine oils; and it is also directed to the process of making the same.

BACKGROUND OF THE INVENTION

It is known to employ nitrogen containing dispersants and/or detergents in the formulation of lubricating oil compositions. Many of the known dispersant/detergent compounds are based on the reaction of an alkenylsuccinic acid or anhydride with an amine or polyamine to produce an alkenylsuccinimide or an alkenyl succinamic acid as determined by selected conditions of reaction. One problem facing the lubricant manufacturer is dispersancy of particulate matter in internal combustion engines. Failure to have adequate particulate matter dispersancy may result in filter plugging, sludge accumulation, and oil thickening.

It has been discovered that the combination of certain aromatic anhydrides and ethylene post-treated dispersants provide improved dispersancy as shown in soot thickening bench tests and diesel engine fuel injector flow loss improvement tests.

DESCRIPTION OF THE RELATED ART

European Published Patent Application No. 0438848 discloses a lubricating oil containing a dispersant prepared by (i) reacting at least one polyamine with at least one acyclic hydrocarbyl substituted succinic acylating agent in which such acyclic hydrocarbyl substituent contains an average of at least 40 carbon atoms, such reaction being conducted using proportions such that the

acylating agent is reacted with the polyamine in a mole ratio of from 1.05 to 2.85 moles per mole of polyamine, and (ii) reacting the product so formed with (a) at least one aliphatic vicinal dicarboxylic acid acylating agent containing 4 to 30 carbon atoms in the molecule and in which the two carboxyl groups are separated from each other by two aliphatic carbon atoms, or (b) an anhydride, acid halide, or ester of at least one such dicarboxylic acid acylating agent, or (c) a combination of (a) and (b), using in the reaction of (ii) proportions such that the mole ratio of such acylating agent is from 0.10 to 2.50 moles per mole of said polyamine with the proviso that the total mole ratio of the acylating agents in (i) and (ii) per mole of said polyamine is in the range of 2.40 to 4.50.

JP51130408 discloses a lubricating oil composition that is prepared by adding an effective amount of the reaction product of about 0.05-1 in the weight ratio of boron to nitrogen obtained by treating (a) aromatic polybasic carboxylic acid (phthalic acid, terephthalic acid, trimesic acid, trimellitic acid pyromellitic acid, etc.) and its anhydride, (b) alkenyl-succinic acid, or its anhydride, having alkenyl group jointed of molecular weight about 300-3000 and (c) polyalkylenepolyamine in the molar ratio of (a):(b):(c)= 1:1-4:1-4 and treating then the resulting intermediate with boron.

Stuart et al., U.S. Patent No. 3,287,271 discloses lubricating oil compositions containing amine carboxylic acid products.

LeSuer, U.S. Patent No. 3,374,174 discloses nitrogen-containing compositions obtained from the reaction of an amine with a high molecular weight carboxylic acid such as a monocarboxylic acid and an alkylene or arylene dicarboxylic acid.

Liston, U.S. Patent No. 3,692,681 discloses terephthalic acid dispersed in a hydrocarbon medium containing highly hindered acylated alkylene polyamines.

Durand et al. U.S. Patent No. 4,747,964 discloses additive compositions that may be either (1) the products obtained by reacting alkenylsuccinimides with

aromatic dianhydrides, or (2) the products obtained by reacting alkenylsuccinimides with an anhydride or a dianhydride of mono- or polycarboxylic aliphatic, alicyclic or aromatic acid of low molecular weight, the obtained product being then reacted with at least one organic compound having several hydroxyl and/or amine groups. These dispersing additive compositions may be added to lubricating oils in a proportion, for example, from 0.1 to 20% by weight.

Clark et al., U.S. Patent No. 6,255,258 discloses oil-soluble dispersant obtainable by reacting the reaction product of a polyamine and a long-chain hydrocarbyl-substituted dicarboxylic acid, anhydride or ester thereof with a polyanhydride, characterized in that the dispersant restricts the viscosity increase in an oil to below 8 Pa.s in the Haake rheology test defined herein at 2% w/w active matter and a shear rate of 0.26 s^{-1} Pa.s, and lubricating oil and fuel compositions and additive concentrates containing such a dispersant.

Degonia et al., U.S. Patent No. 5,241,003 discloses succinimides, succinic esters, and succinic ester-amides are formed by (A) reacting (i) at least one substantially aliphatic polymer of at least one lower olefin, and (ii) an acidic reactant or a mixture of two or more acidic reactants represented by the general formula wherein R and R' are independently --OH, --O-lower alkyl, a halogen atom, or taken together are a single oxygen atom; and (B) reacting an acylating agent with at least one alcohol (preferably a polyhydric alcohol) or amine (preferably a polyamine having at least one primary amino group).

Wollenberg et al., U.S. Patent No. 4,612,132 discloses polyamino alkenyl or alkyl succinimides which contain carbamate functionalities which are useful as dispersants in lubricating oils, gasoline's, marine crankcase oils and hydraulic oils.

Wollenberg et al., U. S. Patent No. 4,747,850 discloses polyamino alkenyl or alkyl succinimides which contain carbamate functionalities which are useful as

dispersants in lubricating oils, gasolines, marine crankcase oils and hydraulic oils.

Harrison et al., U.S. Patent No. 5,334,321 discloses alkenyl or alkyl succinimide additives which are the reaction product of a high molecular weight alkenyl- or alkyl-substituted succinic anhydride and a polyalkylene polyamine having an average of greater than 4 nitrogen atoms per mole, wherein the reaction product is post-treated with a cyclic carbonate, are compatible with fluorocarbon engine seals and, for concentration levels at which fluorocarbon seal compatibility is achieved, possess improved dispersancy and/or detergency properties when employed in lubricating oils and fuels,

Harrison et al., U.S. Patent No. 5,356,552 discloses alkenyl or alkyl succinimide additives which are the reaction product of a high molecular weight alkenyl- or alkyl-substituted succinic anhydride and a polyalkylene polyamine having an average of greater than 4 nitrogen atoms per mole, wherein the reaction product is post-treated with a cyclic carbonate, are compatible with fluoroelastomer engine seals and, for concentration levels at which fluoroelastomer seal compatibility is achieved, possess improved dispersancy and/or detergency properties when employed in chlorine-free lubricating oils.

Harrison et al., U.S. Patent No. 5,716,912 discloses a succinimide composition is prepared by reacting a mixture of an alkenyl or alkylsuccinic acid derivative, an unsaturated acidic reagent copolymer, and a polyamine under reactive conditions; then treating the reaction product with either a cyclic carbonate or a linear mono- or polycarbonate or boron compound under reactive conditions.

Harrison et al., U. S. Patent No. 5,753,597 a polysuccinimide composition is prepared by reacting a mixture of a copolymer of a first unsaturated acidic reagent and a 1,1-disubstituted olefin; a copolymer of a second unsaturated acidic reagent and a 1-olefin, and a polyamine under reactive conditions; then

treating the reaction product with either a cyclic carbonate or a linear mono- or polycarbonate or boron compound under reactive conditions.

Harrison et al., U.S. Patent No. 5,849,676 discloses a succinimide composition is prepared by reacting a mixture of an alkenyl or alkylsuccinic acid derivative, an unsaturated acidic reagent copolymer, and a polyamine under reactive conditions.

Harrison et al., U. S. Patent No. 6,358,892 discloses a succinimide composition is prepared by reacting a mixture of an alkenyl or alkylsuccinic acid derivative, an unsaturated acidic reagent copolymer, and a polyamine under reactive conditions; then treating the reaction product with either a cyclic carbonate or a linear mono- or polycarbonate or boron compound under reactive conditions.

Harrison et al., U. S. Patent No. 6,451,920 discloses a process is provided for preparing a mixture of (1) a copolymer of a polyalkene and an unsaturated acidic reagent and (2) a polyalkenyl derivative of an unsaturated acidic reagent, said process comprising (a) copolymerizing (1) a polyalkene containing alkylvinylidene isomer and non-alkylvinylidene isomers and (2) an unsaturated acidic reagent under polymerization conditions in the presence of a free radical initiator; and (b) reacting the product of step (a) with an unsaturated acidic reagent at elevated temperature in the presence of a strong acid.

Harrison, U. S. Patent No. 6,214,775 discloses a haze-free post-treated succinimide prepared by treating an alkenyl or alkyl succinimide with an oil-soluble, strong acid and contacting the treated succinimide with a cyclic carbonate to form the haze-free post-treated succinimide.

SUMMARY OF THE DISCLOSURE

In its broadest embodiment, the present disclosure is directed to a lubricating oil additive composition prepared by the process which comprises the steps of:

- (A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof;
- (B) reacting the product of step (A) with a phthalic anhydride or naphthalic anhydride post-treating agent or mixtures thereof, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and
- (C) reacting the product of step (B) with a cyclic carbonate thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.

In one aspect, there is provided a concentrate comprising from 10 to 90 wt% of the lubricating oil additive composition as defined above and from 90 to 10 wt% of an organic diluent.

The present disclosure is also directed to a lubricating oil composition comprising a major amount of an oil of lubricating viscosity and a minor amount of a lubricating oil additive composition prepared by the process which comprises the steps of:

- (A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof;
- (B) reacting the product of step (A) with a phthalic anhydride or naphthalic anhydride post-treating agent or mixtures thereof, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and
- (C) reacting the product of step (B) with a cyclic carbonate thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.

In another aspect, there is provided a method of improving soot dispersancy in an internal combustion engine which comprises operating the engine with the lubricating oil composition as defined above.

The present disclosure is also directed to a method of making a lubricating oil additive composition which comprises the steps of:

- (A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof;
- (B) reacting the product of step (A) with a phthalic anhydride or naphthalic anhydride post-treating agent or mixtures thereof, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and
- (C) reacting the product of step (B) with a cyclic carbonate thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.

Accordingly, the present disclosure relates to multi-functional lubricating oil additives which are useful as dispersants in an internal combustion engine.

DETAILED DESCRIPTION OF THE INVENTION

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

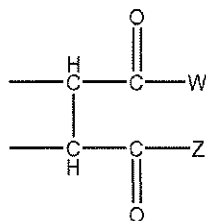
Definitions

The following terms used with the description are defined as such:

The term "PIB" is an abbreviation for polyisobutene.

The term "PIBSA" is an abbreviation for polyisobutenyl succinic anhydride.

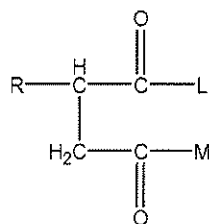
The term "succinic group" refers to a group having the formula:



wherein W and Z are independently selected from the group consisting of --OH, --Cl, --O-- lower alkyl or taken together are --O-- to form a succinic anhydride group. The term "--O--lower alkyl" is meant to include alkoxy of 1 to 6 carbon atoms.

The term "succinimide" is understood in the art to include many of the amide, imide, etc. species which are also formed by the reaction of a succinic anhydride with an amine. The predominant product, however, is succinimide and this term has been generally accepted as meaning the product of a reaction of an alkenyl- or alkyl-substituted succinic acid or anhydride with an amine. Alkenyl or alkyl succinimides are disclosed in numerous references and are well known in the art. Certain fundamental types of succinimides and related materials encompassed by the term of art "succinimide" are taught in U.S. Patent Nos. 2,992,708; 3,018,291; 3,024,237; 3,100,673; 3,219,666; 3,172,892; and 3,272,746, the disclosures of which are hereby incorporated by reference.

The term "alkenyl or alkylsuccinic acid derivative" refers to a structure having the formula:



wherein L and M are independently selected from the group consisting of --OH, --Cl, --O--, lower alkyl or taken together are --O-- to form an alkenyl or alkylsuccinic anhydride group.

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

The term "high molecular weight olefins" refers to olefins (including polymerized olefins having a residual unsaturation) of sufficient molecular weight and chain length to lend solubility in lubricating oil to their reaction products. Typically olefins having about 30 carbons or more suffice.

The term "alkyl" refers to both straight- and branched-chain alkyl groups.

The term "polyalkyl" refers to an alkyl group that is generally derived from polyolefins which are polymers or copolymers of mono-olefins, particularly 1-mono-olefins, such as ethylene, propylene, butylene, and the like. Preferably, the mono-olefin employed will have 2 to about 24 carbon atoms, and more preferably, about 3 to 12 carbon atoms. More preferred mono-olefins include propylene, butylene, particularly isobutylene, 1-octene and 1-decene. Preferred, polyolefins prepared from such mono-olefins include polypropylene, polybutene, especially polyisobutene.

The term "basic nitrogen" refers to a nitrogen atom that is capable of accepting a proton.

The terms "alkenyl succinic acid or anhydride" and "alkyl succinic acid or anhydride" may be used interchangeably.

One embodiment of the present invention is a post-treated oil-soluble lubricating oil additive composition. In one embodiment the composition is prepared by the process which comprises the steps of (A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof; (B) reacting the product of step (A) with a first post-treating agent, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and (C) reacting the product of step (B) with a second post-treating agent thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.

In one embodiment the composition is prepared by the process which comprises the steps of (A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof; (B) reacting the product of step (A) with a phthalic anhydride or naphthalic anhydride post-treating agent or mixtures thereof, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and (C) reacting the product of step (B) with a cyclic carbonate thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.

(A) Polyalkenyl Succinic Acid or Polyalkenyl Succinic Anhydride

The polyalkenyl succinic acid or polyalkenyl succinic anhydride is the reaction product of a polyalkenyl reactant and an unsaturated acidic reagent. The

polyalkenyl succinic acid or anhydride is formed either by the chlorination reaction process or the thermal reaction process.

THE POLYALKENE

The polyalkenyl reactant is a polyalkene that can be a polymer of a single type of olefin or it can be a copolymer of two or more types of olefins. The principal sources of the polyalkenyl radical include olefin polymers, particularly polymers made from mono-olefins having from 2 to about 30 carbon atoms. Especially useful are the polymers of 1-mono-olefins such as ethylene, propene, 1-butene, and isobutene. Polymers of isobutene are preferred.

In addition to the pure polyalkenyl substituents described above, it is intended that the term "polyalkenyl" as used in this specification and in the claims, include those materials which are substantially polyalkenyl. As used herein, the term "substantially polyalkenyl" means that the polyalkenyl group contains no non-hydrocarbyl substituents or non-carbon atoms which significantly affect the polyalkenyl properties of such polyalkenyl substituents relative to their uses in this invention. For example, a polyalkenyl substituent may contain one or more ether, oxo, nitro, thia, carbohydrocarbyloxy, or other non-hydrocarbyl groups as long as these groups do not significantly affect the polyalkenyl characteristics of the substituent.

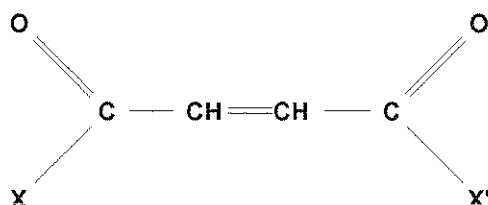
Another important aspect of this invention is that the polyalkenyl substituent of the polyalkenyl succinic compound should be substantially saturated, i.e., at least about 95% of the total number of carbon-to-carbon covalent linkages should be saturated linkages. An excessive proportion of unsaturated linkages render the molecule susceptible to oxidation, deterioration, and polymerization and results in products unsuitable for use in hydrocarbon oils in many applications.

The size of the polyalkenyl substituent of the succinic compound appears to determine the effectiveness of the additives of this invention in lubricating oils. Olefin polymers (i.e., polyalkenes) having a molecular weight of about 500 to

5000 are preferred. More preferred, the olefin polymer has a molecular weight of from about 700 to 3000. In a preferred embodiment, the olefin polymer has a molecular weight of about 1000. In another preferred embodiment, the olefin has a molecular weight of about 2300. The most common sources of these polyalkenes are the polyolefins such as polyethylene, polypropylene, polyisobutene, etc. A particularly preferred polyolefin is polyisobutene having a molecular weight from about 900 to about 2500.

THE UNSATURATED ACIDIC REAGENT

The term "unsaturated acidic reagent" refers to maleic or fumaric reactants of the general formula:



wherein X and X' are the same or different, provided that at least one of X and X' is a group that is capable of reacting to esterify alcohols, form amides, or amine salts with ammonia or amines, form metal salts with reactive metals or basically reacting metal compounds and otherwise function as acylating agents. Typically, X and/or X' is --OH, --O-hydrocarbyl, --OM⁺ where M⁺ represents one equivalent of a metal, ammonium or amine cation, --NH₂, --Cl, --Br, and taken together X and X' can be --O-- so as to form an anhydride. Preferably, X and X' are such that both carboxylic functions can enter into acylation reactions. Maleic anhydride is a preferred unsaturated acidic reactant. Other suitable unsaturated acidic reactants include electron-deficient olefins such as monophenyl maleic anhydride; monomethyl, dimethyl, monochloro, monobromo, monofluoro, dichloro and difluoro maleic anhydride, N-phenyl maleimide and other substituted maleimides; isomaleimides; fumaric acid, maleic acid, alkyl hydrogen maleates and fumarates, dialkyl fumarates

and maleates, fumaronilic acids and maleanic acids; and maleonitrile, and fumaronitrile.

THE PROCESS FOR PREPARING POLYALKENYL DERIVATIVES

In general, polyalkenyl succinic acids and anhydrides can be prepared by two different types of reactions or processes.

The first type of reaction or process involves either pre-reacting the polyalkene with a halogen, e.g., chlorine, and reacting the halogenated polyalkene with maleic acid or anhydride, or contacting the polyalkene and maleic anhydride or acid in the presence of a halogen, e.g., chlorine. This type of reaction or process is known in the art as the "chlorination" reaction and is described in U.S. Pat. No. 3,172,892, issued Mar. 9, 1965 to LeSuer et al., which is hereby incorporated by reference herein in its entirety.

The second type of reaction or process which may be used to prepare polyalkenyl succinic anhydrides or acids involves simply contacting the hydrocarbon and the maleic anhydride or acid (in the absence of halogen) at an elevated temperature. This type of reaction or process is known in the art as the thermal reaction. For the purposes of this specification and claims, the terms "thermal process" and "thermal reaction" include processes such as that disclosed in U.S. Pat. No. 3,361,673, issued Jan. 2, 1968 to Stuart et al., which is hereby incorporated by reference in its entirety. In addition, U.S. Pat. No. 3,912,764, issued Oct. 14, 1975 to Palmer, involves a combination of the thermal and chlorination processes, as by reacting a substantial portion of the hydrocarbon and maleic anhydride or acid by the thermal process and then completing the reaction via a chlorination reaction. U.S. Pat. No. 3,912,764 is also incorporated by reference herein in its entirety.

(B) Amine Compound

In an embodiment of the present invention, an amine is reacted with the polyalkenyl succinic acid or anhydride described herein. Preferably, the amine is a polyalkylene polyamine, which contains at least two primary amines. More preferred the polyalkylene polyamine compound has at least 3 nitrogen atoms.

In one embodiment, the polyalkylene polyamine is diethylenetriamine (DETA), triethylenetetramine (TETA), tetraethylene pentamine (TEPA), pentaethylenhexamine (PEHA),, heavy polyamine (HPA), or mixtures thereof. Higher molecular weight polyethyleneamines may also be employed. The polyalkylene polyamines may contain branched, cyclic structures or mixtures thereof.

In one embodiment, the polyalkylene polyamine may be a polyether amine that contains both primary and secondary amines.

Both initial and final post-treating agents require a primary or secondary nitrogen site with which to react. After both post-treatment steps, it is preferred that some of the nitrogen atoms are basic nitrogens.

(C) Post-Treatment of the Succinimide

In one embodiment of the present invention, the succinimide is post-treated with at a first post-treating agent, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof. The initial post-treated succinimide or succinamide or mixtures thereof is subsequently reacted with a second post-treating agent.

In one embodiment, the initial post-treated succinimide is prepared by reacting a succinimide with an aromatic carboxylic acid anhydride. The aromatic carboxylic acid anhydrides may be substituted (i.e., methyl, nitro-,

hydroxyl groups depending from the aromatic ring). Typical aromatic anhydrides include trimellitic anhydride, phthalic anhydride and naphthalic anhydride. Preferably, the aromatic anhydride is phthalic anhydride or naphthalic anhydride.

In one embodiment the final post-treated succinimide is prepared by reacting the initial post-treated succinimide with second post-treating agent, which preferably is a cyclic carbonate.

Typical cyclic carbonates for use in this invention include the following: 1,3-dioxolan-2-one (ethylene carbonate); 4-methyl-1,3-dioxolan-2-one (propylene carbonate); 4-ethyl-1,3-dioxolan-2-one (butylene carbonate); 4-hydroxymethyl-1,3-dioxolan-2-one; 4,5-dimethyl-1,3-dioxolan-2-one; 4-ethyl-1,3-dioxolan-2-one; 4,4-dimethyl-1,3-dioxolan-2-one; 4-methyl-5-ethyl-1,3-dioxolan-2-one; 4,5-diethyl-1,3-dioxolan-2-one; 4,4-diethyl-1,3-dioxolan-2-one; 1,3-dioxan-2-one; 4,4-dimethyl-1,3-dioxan-2-one; 5,5-dimethyl-1,3-dioxan-2-one; 5,5-dihydroxymethyl-1,3-dioxan-2-one; 5-methyl-1,3-dioxan-2-one; 4-methyl-1,3-dioxan-2-one; 5-hydroxy-1,3-dioxan-2-one; 5-hydroxymethyl-5-methyl-1,3-dioxan-2-one; 5,5-diethyl-1,3-dioxan-2-one; 5-methyl-5-propyl-1,3-dioxan-2-one; 4,6-dimethyl-1,3-dioxan-2-one; 4,4,6-trimethyl-1,3-dioxan-2-one and spiro[1,3-oxa-2-cyclohexanone-5,5'-1',3'-oxa-2'-cyclohexanone]. Other suitable cyclic carbonates may be prepared from saccharides such as sorbitol, glucose, fructose, galactose and the like and from vicinal diols prepared from C₁-C₃₀ olefins by methods known in the art.

Several of these cyclic carbonates are commercially available such as 1,3-dioxolan-2-one or 4-methyl-1,3-dioxolan-2-one. Cyclic carbonates may be readily prepared by known reactions. For example, reaction of phosgene with a suitable alpha alkane diol or an alkan-1,3-diol yields a carbonate for use within the scope of this invention as for instance in U.S. Pat. No. 4,115,206 which is incorporated herein by reference.

Likewise, the cyclic carbonates useful for this invention may be prepared by transesterification of a suitable alpha alkane diol or an alkan-1,3-diol with, e.g., diethyl carbonate under transesterification conditions. See, for instance, U.S. Pat. Nos. 4,384,115 and 4,423,205 which are incorporated herein by reference for their teaching of the preparation of cyclic carbonates.

Typical linear mono-carbonates include diethyl carbonate, dimethyl carbonate, dipropyl carbonate and the like. Typical linear poly-carbonates include poly(propylene carbonate) and the like.

Typical aromatic carboxylic anhydrides include 2,3 – pyrazinedicarboxylic anhydride; 2,3 – pyridinedicarboxylic anhydride; 3,4 – pyridinedicarboxylic anhydride; diphenic anhydride; isatoic anhydride; phenyl succinic anhydride; 1- naphthalene acetic anhydride; 1, 2, 4 - benzene tricarboxylic anhydride and the like. Typical aromaticcarboxylic acids include the acids of the aforementioned anhydrides.

Typical aromatic carboxylic acid esters include dimethyl phthalate, diethyl phthalate, dimethylhexyl phthalate, mono methylhexyl phthalate, mono ethyl phthalate, and mono methyl phthalate.

In one embodiment, the second post-treating agent is a cyclic carbonate or a linear monocarbonate. In one embodiment, the first post-treating agent is an aromatic carboxylic acid, acid anhydride or ester.

Typically, the first post-treating agent (i.e., phthalic anhydride, or 1,8-naphthalic anhydride) is added to a reactor containing the succinimide and heated, thereby producing an initial post-treated succinimide. The initial post-treated succinimide is reacted further with a second post-treating agent, such as ethylene-carbonate.

(D) Method of Making the Post-treated Succinimide

A succinimide is prepared by a process comprising charging the polyalkenyl succinic acid or polyalkenyl succinic anhydride in a reactor, optionally under a nitrogen purge, and heating at a temperature of from about 80°C to about 170°C. Optionally, a diluent oil may be charged under a nitrogen purge in the same reactor. An amine compound is charged, optionally under a nitrogen purge, to the reactor. This mixture is heated under a nitrogen purge to a temperature in range from about 130°C to about 200°C. Optionally, a vacuum is applied to the mixture for about 0.5 to about 2.0 hours to remove any water formed in the reaction.

The succinimide can also be made using a process comprising simultaneously charging all the reactants – the polyalkenyl succinic acid or polyalkenyl succinic anhydride and the amine compound at the desired ratios into the reactor. One or more of the reactants can be charged at an elevated temperature to facilitate mixing and reaction. A static mixer can be used to facilitate mixing of the reactants as they are being charged to the reactor. The reaction is carried out for about 0.5 to 2 hours at a temperature from about 130°C to 200°C. Optionally a vacuum is applied to the reaction mixture during the reaction period to remove any water formed in the reaction.

An initial post-treated succinimide is prepared by a process comprising charging the succinimide in a reactor, optionally under a nitrogen purge, and heating at a temperature of from about 80°C to about 170°C. Optionally, a diluent oil may be charged under a nitrogen purge in the same reactor. An aromatic carboxylic acid anhydride is charged, optionally under a nitrogen purge, to the reactor. This mixture is heated under a nitrogen purge to a temperature in range from about 130°C to about 200°C. Optionally, a vacuum is applied to the mixture for about 0.5 to about 2.0 hours to remove any water formed in the reaction. An initial post-treated succinimide is formed.

A final post-treated succinimide is prepared by a process comprising charging the initial post-treated succinimide in a reactor, optionally under a nitrogen purge, and heating at a temperature of from about 80°C to about 200°C. Optionally, a diluent oil may be charged under a nitrogen purge in the same reactor. A cyclic carbonate is charged, optionally under a nitrogen purge, to the reactor, thereby producing a final post-treated succinimide.

(E) Lubricating Oil Composition

The final post-treated succinimide described above is generally added to a base oil that is sufficient to lubricate moving parts, for example internal combustion engines, gears, and transmissions. Typically, the lubricating oil composition of the present invention comprises a major amount of oil of lubricating viscosity and a minor amount of the lubricating oil additive composition.

The base oil employed may be any of a wide variety of oils of lubricating viscosity. The base oil of lubricating viscosity used in such compositions may be mineral oils or synthetic oils. A base oil having a viscosity of at least 2.5 cSt at 40°C and a pour point below 20°C, preferably at or below 0°C, is desirable. The base oils may be derived from synthetic or natural sources. Mineral oils for use as the base oil in this invention include, for example, paraffinic, naphthenic and other oils that are ordinarily used in lubricating oil compositions. Synthetic oils include, for example, both hydrocarbon synthetic oils and synthetic esters and mixtures thereof having the desired viscosity. Hydrocarbon synthetic oils may include, for example, oils prepared from the polymerization of ethylene, polyalphaolefin or PAO oils, or oils prepared from hydrocarbon synthesis procedures using carbon monoxide and hydrogen gases such as in a Fisher-Tropsch process. Useful synthetic hydrocarbon oils include liquid polymers of alpha olefins having the proper viscosity. Especially useful are the hydrogenated liquid oligomers of C₆ to C₁₂ alpha olefins such as 1-decene trimer. Likewise, alkyl benzenes of proper viscosity, such as didodecyl benzene, can be used. Useful synthetic esters include the esters of

monocarboxylic acids and polycarboxylic acids, as well as mono-hydroxy alkanols and polyols. Typical examples are didodecyl adipate, pentaerythritol tetracaprate, di-2-ethylhexyl adipate, dilaurylsebacate, and the like. Complex esters prepared from mixtures of mono and dicarboxylic acids and mono and dihydroxy alkanols can also be used. Blends of mineral oils with synthetic oils are also useful.

Thus, the base oil can be a refined paraffin type base oil, a refined naphthenic base oil, or a synthetic hydrocarbon or non-hydrocarbon oil of lubricating viscosity. The base oil can also be a mixture of mineral and synthetic oils.

(F) Concentrates

Lubricating oil concentrates are also envisioned. These concentrates usually include from about 90 wt% to about 10 wt%, preferably from about 90 wt% to about 50 wt%, of an oil of lubricating viscosity and from about 10 wt% to about 90 wt% of the final post-treated succinimide described herein. Typically, the concentrates contain sufficient diluent to make them easy to handle during shipping and storage. Suitable diluents for the concentrates include any inert diluent, preferably an oil of lubricating viscosity, so that the concentrate may be readily mixed with lubricating oils to prepare lubricating oil compositions. Suitable lubricating oils that may be used as diluents typically have viscosity in the range from about 35 to about 500 Saybolt Universal Seconds (SUS) at 100 degrees F (38 degrees C), although any oil of lubricating viscosity may be used.

(G) Other Additives

In one embodiment of the present invention, the following additive components are examples of some of the components that may be favorably employed in the lubricating oil composition.

These examples of additives are provided to illustrate the present invention, but they are not intended to limit it:

1. Metal Detergents

Sulfurized or unsulfurized alkyl or alkenyl phenates, alkyl or alkenyl aromatic sulfonates, borated sulfonates, sulfurized or unsulfurized metal salts of multi-hydroxy alkyl or alkenyl aromatic compounds, alkyl or alkenyl hydroxy aromatic sulfonates, sulfurized or unsulfurized alkyl or alkenyl naphthenates, metal salts of alkanolic acids, metal salts of an alkyl or alkenyl multiacid, and chemical and physical mixtures thereof.

2. Anti-Oxidants

Anti-oxidants reduce the tendency of oils to deteriorate upon exposure to oxygen and heat. This deterioration is evidenced by the formation of sludge and varnish-like deposits, an increase in viscosity of the oil, and by an increase in corrosion or wear. Examples of anti-oxidants useful in the present invention include, but are not limited to, phenol type (phenolic) oxidation inhibitors, such as

4,4'-methylene-bis(2,6-di-tert-butylphenol), 4,4'-bis(2,6-di-tert-butylphenol), 4,4'-bis(2-methyl-6-tert-butylphenol), 2,2'-methylene-bis(4-methyl-6-tert-butylphenol), 4,4'-butylidene-bis(3-methyl-6-tert-butylphenol), 4,4'-isopropylidene-bis(2,6-di-tert-butylphenol), 2,2'-methylene-bis(4-methyl-6-nonylphenol), 2,2'-isobutylidene-bis(4,6-dimethylphenol), 2,2'-5-methylene-bis(4-methyl-6-cyclohexylphenol), 2,6-di-tert-butyl-4-methylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,4-dimethyl-6-tert-butyl-phenol, 2,6-di-tert-l-dimethylamino-p-cresol, 2,6-di-tert-4-(N,N'-dimethylaminomethylphenol), 4,4'-thiobis(2-methyl-6-tert-butylphenol), 2,2'-thiobis(4-methyl-6-tert-butylphenol),

bis(3-methyl-4-hydroxy-5-tert-10-butylbenzyl)-sulfide, and bis(3,5-di-tert-butyl-4-hydroxybenzyl). Diphenylamine-type oxidation inhibitors include, but are not limited to, alkylated diphenylamine, phenyl-alpha-naphthylamine, and alkylated-alpha-naphthylamine. Sulfur-containing oxidation inhibitors include ashless sulfides and polysulfides, metal dithiocarbamate (e.g., zinc dithiocarbamate), and 15-methylenebis(dibutyldithiocarbamate). Phosphorus compounds especially the alkyl phosphites, sulfur-phosphorus compounds, and copper compounds may also be used as antioxidants.

3. Anti-Wear Agents

Anti-wear agents reduce wear of moving metallic parts in conditions of continuous and moderate loads. Examples of such agents include, but are not limited to, phosphates and thiophosphates and salts thereof, carbamates, esters, and molybdenum complexes. Especially preferred antiwear compounds are the amine phosphates.

4. Rust Inhibitors (Anti-Rust Agents)

Rust inhibitors correct against the corrosion of ferrous metals. These include (a) Nonionic polyoxyethylene surface active agents such as polyoxyethylene lauryl ether, polyoxyethylene higher alcohol ether, polyoxyethylene nonyl phenyl ether, polyoxyethylene octyl phenyl ether, polyoxyethylene octyl stearyl ether, polyoxyethylene oleyl ether, polyoxyethylene sorbitol monostearate, polyoxyethylene sorbitol monooleate, and polyethylene glycol monooleate; and (b) miscellaneous other compounds such as 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 phosphoric ester.

5. Demulsifiers

Demulsifiers promote the separation of oil from water which may come into contact with the oil through contamination. Demulsifiers include addition product of alkylphenol and ethylene oxide, polyoxyethylene alkyl ether, and polyoxyethylene sorbitan ester.

6. Extreme Pressure Agents (EP Agents)

Extreme pressure agents reduce wear of moving metallic parts in conditions of high loads. Examples of EP agents include sulfurized olefins, zinc dialkyl-1-dithiophosphate (primary alkyl, secondary alkyl, and aryl type), diphenyl sulfide, methyl trichlorostearate, chlorinated naphthalene, fluoroalkylpolysiloxane, lead naphthenate, neutralized or partially neutralized phosphates, dithiophosphates, and sulfur-free phosphates.

7. Friction Modifiers

Fatty alcohol, fatty acid (stearic acid, isostearic acid, oleic acid and other fatty acids or salts thereof), amine, borated ester, other esters, phosphates, other phosphites besides tri- and di-hydrocarbyl phosphites, and phosphonates.

8. Multifunctional Additives

Some additives function to provide many functionalities simultaneously. In particular, the zinc aryl and alkyl dithiophosphates can simultaneously provide antiwear, extreme pressure, and oxidation inhibition. Especially preferred are the alkaryl, primary alkyl, and secondary alkyl zinc dithiophosphates. Primary alkyl zinc dithiophosphates are especially preferred.

9. Viscosity Index Improvers

Viscosity index improvers are used to increase the viscosity index of lubricating oils, thereby reducing the viscosity decrease of an oil with increasing temperature. Polymethacrylate polymers, ethylene-propylene copolymers, styrene-isoprene copolymers, hydrated styrene-isoprene copolymers, and polyisobutylene are all used as viscosity index improvers. Nitrogen- and oxygen-functionalized polymers, the so-called dispersant viscosity index improvers, may also be used.

10. Pour Point Depressants

Pour point depressants lower the temperature at which waxes precipitate out of lubricating oils, thus extending the temperature range in which the lubricating oil can operate before oil flow is impeded. Pour point depressants include polymethyl methacrylates, ester-olefin copolymers especially ethylene vinyl acetate copolymers, and others

11. Foam Inhibitors

Foam inhibitors work to accelerate the release of gas entrained in a lubricant during operation. Common foam inhibitors include alkyl methacrylate polymers and dimethylsiloxane polymers.

12. Metal Deactivators

Metal deactivators hinder corrosion of metal surfaces, and chelate metal ions in solution in lubricating oils, thereby reducing oxidation caused by the catalytic effect of the metal ion. Common metal deactivators includes salicylidene propylenediamine, triazole derivatives, mercaptobenzothiazoles, thiadiazole derivatives, and mercaptobenzimidazoles.

13. Dispersants

Alkenyl succinimides, alkenyl succinimides modified with other organic compounds, alkenyl succinimides modified by post-treatment with ethylene carbonate or boric acid, esters of polyalcohols and polyisobutenyl succinic anhydride, phenate-salicylates and their post-treated analogs, alkali metal or mixed alkali metal, alkaline earth metal borates, dispersions of hydrated alkali metal borates, dispersions of alkaline-earth metal borates, polyamide ashless dispersants and the like or mixtures of such dispersants.

(H) Method of Use of the Present Invention

The final post-treated succinimide of the present invention is added to an oil of lubricating viscosity thereby producing a lubricating oil composition. The final post-treated succinimide, added to an oil of lubricating viscosity, is used in an internal combustion engine, thereby improving dispersancy of soot, sludge and the like.

The following examples are presented to illustrate specific embodiments of this invention and are not to be construed in any way as limiting the scope of the invention.

Examples

EXAMPLE 1

Mono-succinimide Derived from 1000 MW PIBSA and Diethylenetriamine
(Amine:PIBSA Charge Mole Ratio of 0.90:1)

A 1 L reactor was charged with 549.94 g of 1000 MW PIBSA (available from Chevron Oronite, LLC) and 263 g of Chevron RLOP 100N base oil. A distillation head fitted with a condenser and 250 mL round bottom flask was attached to the 1 L reactor. The system was placed under a nitrogen atmosphere and the mixture was heated to 160°C. Diethylenetriamine (41.80

g; available from Sigma-Aldrich) was then added to the mixture over a 30 minute period. The mixture was heated at 160°C for an additional 90 minutes. A vacuum was then applied at < 0 mm Hg for 30 minutes. The product had the following properties:

TBN = 31.2 mg KOH/g

Nitrogen = 1.85 wt. %

EXAMPLE 2

Phthalic Anhydride Post-Treated Mono-succinimide Derived from 1000 MW
PIBSA and DETA
(Phthalic Anhydride:PIBSA Charge Mole Ratio of 0.80:1)

The product of Example 1 was heated to 160°C in the apparatus as described in Example 1 under a nitrogen atmosphere. Phthalic anhydride (53.25 g; available from Sigma-Aldrich) was added over the course of 15 minutes. The reaction mixture was heated at 160°C for an additional 90 minutes. A vacuum was then applied at ≤ 0 mm Hg for 30 minutes. The product had the following properties:

TBN = 16.5 mg KOH/g

Nitrogen = 1.85 wt. %

EXAMPLE 3

Mono-succinimide Derived from 1000 MW PIBSA and Heavy Polyamine
(Amine:PIBSA Charge Mole Ratio of 0.90:1)

A 2 L reactor was charged with 1030.1 g of 1000 MW PIBSA and 321.3 g of Chevron RLOP 100N base oil and placed under a nitrogen atmosphere. The mixture was heated to 160°C. Heavy polyamine (208.33 g) was then added to the mixture over a 20 minute period. The mixture was heated at 160°C for an additional 90 minutes. A vacuum was then applied at 10 mm Hg for 30 minutes. The product had the following properties:

TBN = 125.3 mg KOH/g

Nitrogen = 4.58 wt. %

EXAMPLE 4

Phthalic Anhydride Post-Treated Mono-succinimide Derived from 1000 MW
PIBSA and HPA

(Phthalic Anhydride:PIBSA Charge Mole Ratio of 0.80:1)

A 1 L reactor was charged with 899.95 g of the mono-succinimide as prepared in Example 3 and was heated to 160°C under a nitrogen atmosphere. Phthalic anhydride (58.12 g) was then added. The reaction mixture was heated at 160°C for an additional 90 minutes. A vacuum was then applied at 20 mm Hg for 30 minutes. The product had the following properties:

TBN = 102.1 mg KOH/g

Nitrogen = 4.51 wt. %

EXAMPLE 5

Ethylene Carbonate and Phthalic Anhydride Post-Treated Mono-succinimide
Derived from 1000 MW PIBSA and HPA

A 500 mL reactor was charged with 466.45 g of the phthalic anhydride post-treated mono-succinimide as prepared in Example 4 and was heated to 160°C under a nitrogen atmosphere. Ethylene carbonate (79.58 g) was then added over the course of 1 hour via a syringe pump. The reaction mixture was heated at 160°C for an additional 2 hours. The product had the following properties:

TBN = 48.0 mg KOH/g

Nitrogen = 3.99 wt. %

EXAMPLE 6

Mono-succinimide Derived from 2300 MW PIBSA and Heavy Polyamine (Amine:PIBSA Charge Mole Ratio of 0.90:1)

A 2 L reactor was charged with 1163.7 g of 2300 MW PIBSA (available from Chevron Oronite, LLC) and 251.3 g of Chevron RLOP 100N base oil. The system was placed under a nitrogen atmosphere and the mixture was heated to 160°C. Heavy polyamine (91.37 g) was then added to the mixture over a 10 minute period. The mixture was heated at 160°C for an additional 90 minutes. A vacuum was then applied at 10 mm Hg for 30 minutes. The product had the following properties:

TBN = 83.9 mg KOH/g

Nitrogen = 2.12 wt. %

EXAMPLE 7

Phthalic Anhydride Post-Treated Mono-succinimide Derived from 2300 MW PIBSA and HPA (Phthalic Anhydride:PIBSA Charge Mole Ratio of 0.80:1)

A 1 L reactor was charged with 890.44 g of Example 6 and was heated to 160°C under a nitrogen atmosphere. Phthalic anhydride (25.97 g) was added. The reaction mixture was heated at 160°C for an additional 90 minutes. A vacuum was then applied at 10 mm Hg for 30 minutes. The product had the following properties:

TBN = 40.94 mg KOH/g

Nitrogen = 2.05 wt. %

EXAMPLE 8

Ethylene Carbonate and Phthalic Anhydride Post-Treated Mono-succinimide Derived from 2300 MW PIBSA and HPA

A 500 mL reactor was charged with 404.05 g of the phthalic anhydride post-treated mono-succinimide as prepared in Example 7 and was heated to 160°C under a nitrogen atmosphere. Ethylene carbonate (32.1 g) was then added over the course of 1 hour via a syringe pump. The reaction mixture was heated at 160°C for an additional 2 hours. The product had the following properties:

TBN = 26.0 mg KOH/g

Nitrogen = 1.89 wt. %

EXAMPLE 9

Mono-succinimide Derived from 2300 MW PIBSA and Heavy Polyamine
(Amine:PIBSA Charge Mole Ratio of 0.60:1)

A 2 L reactor was charged with 1000.9 g of 2300 MW PIBSA (available from Chevron Oronite, LLC). The system was placed under a nitrogen atmosphere and the mixture was heated to 160°C. Heavy polyamine (52.24 g) was then added to the mixture over a 20 minute period. The mixture was heated at 160°C for an additional 60 minutes. Vacuum was then applied (<20 mm Hg (absolute)) for 30 minutes. The product had the following properties:

TBN = 43.8 mg KOH/g

Nitrogen = 1.68 wt. %

EXAMPLE 10

Naphthalic Anhydride Post-Treated Mono-succinimide Derived from 2300 MW
PIBSA and HPA
(Naphthalic Anhydride:PIBSA Charge Mole Ratio of 0.60:1)

A 1 L reactor was charged with 513.9 g of succinimide made in Example 9 and was heated to 140°C under a nitrogen atmosphere. Naphthalic anhydride (18.47 g) was added over 5 minutes. The reaction mixture was heated to 160°C and the conditions were maintained at 160°C for an additional 60

minutes. Vacuum was then applied (<20 mm Hg (absolute)) for 30 minutes. The product had the following properties:

TBN = 36.0 mg KOH/g

Nitrogen = 1.62 wt. %

EXAMPLE 11

Ethylene Carbonate and Naphthalic Anhydride Post-Treated Mono-succinimide Derived from 2300 MW PIBSA and HPA

A 1 L reactor was charged with 325.80 g of succinimide made in Example 10 and was heated to 160°C under a nitrogen atmosphere. Ethylene carbonate (17.68 g) was then added over the course of 1 hour via a syringe pump. The reaction mixture was heated at 160°C for an additional 60 minutes. The product had the following properties:

TBN = xx mg KOH/g

Nitrogen = 1.62 wt. %

EXAMPLE 12

Ethylene Carbonate Post-Treated Mono-succinimide Derived from 2300 MW PIBSA and HPA

A 500 mL reactor was charged with 278.84 g of succinimide made in Example 9 and was heated to 160°C under a nitrogen atmosphere. Ethylene carbonate (20.08 g) was added. The reaction mixture was heated at 160°C for an additional 60 minutes. A vacuum (<10 mm Hg (absolute)) was then applied for 30 minutes. The product had the following properties:

TBN = 24.4 mg KOH/g

Nitrogen = 1.52 wt. %

EXAMPLE 13

Phthalic Anhydride Post-Treated Mono-succinimide Derived from 2300 MW
PIBSA and HPA

(Phthalic Anhydride:PIBSA Charge Mole Ratio of 0.60:1)

A 4 L reactor was charged with 1592.0 g of succinimide as prepared in Example 9 (except reaction hold time was 90 instead of 60 minutes) and was heated to 160°C under a nitrogen atmosphere. Phthalic anhydride (44.76 g) was added. The reaction mixture was heated at 160°C for an additional 90 minutes. A vacuum (<20 mm Hg (absolute)) was then applied for 30 minutes. The product had the following properties:

TBN = 30.5 mg KOH/g

Nitrogen = 1.66 wt. %

EXAMPLE 14

Ethylene Carbonate and Phthalic Anhydride Post-Treated Mono-succinimide
Derived from 2300 MW PIBSA and HPA

A 500 mL reactor was charged with 247.17 g of succinimide made in Example 13 and was heated to 160°C under a nitrogen atmosphere. Ethylene carbonate (13.53 g) was then added over the course of 1 hour via a syringe pump. The reaction mixture was heated at 160°C for an additional 1 hours. The product had the following properties:

TBN = xx mg KOH/g

Nitrogen = 1.61 wt. %

Soot Thickening Bench Test Results

The mono-succinimides and post-treated mono-succinimides from Examples 1-10 were reacted in the soot thickening bench test. In this test, 98.0 g of the test sample was weighed and placed into a 250 mL beaker. The test sample contained 8 wt. % based on 50% actives of the test dispersant, 50 millimoles of an overbased phenate detergent, 18 millimoles of a zinc dithiophosphate wear inhibitor and 7.3 wt. % of a VI improver, in 85% 150N oil, 15% 600N oil. To this was added 2.0 g Vulcan XC-72[®] carbon black from Cabot Co. The mixture was stirred and then stored for 16 hours in a dessicator. A second sample without the carbon black was mixed for 60 seconds using a Willems Polytron Homogenizer-Model PF 45/6 and then degassed in a vacuum oven for 30 minutes at 50 to 55°C. The viscosity of the two samples was then measured at 100°C using a capillary viscometer. The percent viscosity increase was calculated by comparing the viscosity of the samples with and without carbon black. Thus the lower the percent viscosity increase the better the dispersancy of the dispersant. The results from the soot thickening bench test are shown in Table 1.

TABLE 1

Example	Description	Post-Treatment	Dispersant Treat Rate %	Soot Thickening % Visc. Increase
1	1000 MW PIBSA/DETA	-		233
2	1000 MW PIBSA/DETA	PA		25
3	1000 MW PIBSA/HPA	-		31
4	1000 MW PIBSA/HPA	PA		18
5	1000 MW PIBSA/HPA	PA & EC		15
6	2300 MW PIBSA/HPA	-		69
7	2300 MW PIBSA/HPA	PA		20
8	2300 MW PIBSA/HPA	PA & EC		15
9	2300 MW PIBSA/HPA	-	2	167
			6	110
10	2300 MW PIBSA/HPA	NA	2	27
			6	15
11	2300 MW PIBSA/HPA	NA & EC	2	19
			6	15
12	2300 MW PIBSA/HPA	EC	2	60
			6	43
13	2300 MW PIBSA/HPA	PA	2	60
			6	42
14	2300 MW PIBSA/HPA	PA & EC	2	41
			6	22
NA:	Naphthalic Anhydride			
PA:	Phthalic Anhydride			
EC:	Ethylene Carbonate			

The results of the soot thickening bench test indicate that the percent viscosity increase of formulated oils, which employed mono-succinimides that were

post-treated with (ii) phthalic anhydride and ethylene carbonate or (ii) naphthalic anhydride and ethylene carbonate, were typically lower than the percent viscosity increase in a formulated oil that did not contain phthalic anhydride/ ethylene carbonate or naphthalic anhydride/ethylene carbonate post-treated mono-succinimides. This test indicates that the lubricating oil additive composition of the present invention has good dispersant properties.

It is understood that although modifications and variations of the invention can be made without departing from the spirit and scope thereof, only such limitations should be imposed as are indicated in the appended claims.

WHAT IS CLAIMED IS:

1. A lubricating oil additive composition prepared by a process which comprises the steps of:

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(A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof;

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(B) reacting the product of step (A) with a phthalic anhydride or naphthalic anhydride post-treating agent or mixtures thereof, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and

15

(C) reacting the product of step (B) with a cyclic carbonate thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.

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2. The lubricating oil additive composition of claim 1 wherein the polyalkenyl succinic acid or the polyalkenyl succinic anhydride is derived from a polyisobutene having a number average molecular weight (M_n) of from 500 to 5000.

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3. The lubricating oil additive composition of claim 2 wherein the polyalkenyl succinic acid or the polyalkenyl succinic anhydride is derived from a polyisobutene having a number average molecular weight (M_n) of from 700 to 3000.

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4. The lubricating oil additive composition of claim 1 wherein the polyalkylene polyamine is selected from diethylenetriamine, triethylenetetraamine, tetraethylenepentamine, pentaethylenehexamine, heavy polyamine, or mixtures thereof.

5. The lubricating oil additive composition of claim 4 wherein the polyalkylene polyamine is heavy polyamine.
6. The lubricating oil additive composition of claim 4 wherein the polyalkylene polyamine is tetraethylenepentamine.
7. The lubricating oil additive composition of claim 1 wherein the cyclic carbonate is selected from ethylene carbonate, propylene carbonate, or butylene carbonate.
8. A lubricating oil composition comprising a major amount of an oil of lubricating viscosity and a minor amount of a lubricating oil additive composition prepared by the process which comprises the steps of:
- (A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof;
- (B) reacting the product of step (A) with a phthalic anhydride or naphthalic anhydride post-treating agent or mixtures thereof, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and
- (C) reacting the product of step (B) with a cyclic carbonate thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.
9. The lubricating oil composition of claim 8 wherein the polyalkenyl succinic acid or the polyalkenyl succinic anhydride is derived from a polyisobutene having a number average molecular weight (M_n) of from 500 to 5000.

10. The lubricating oil composition of claim 8 wherein the polyalkylene polyamine is selected from diethylenetriamine, triethylenetetraamine, tetraethylenepentamine, pentaethylenehexamine, heavy polyamine, or mixtures thereof.

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11. The lubricating oil composition of claim 10 wherein the polyalkylene polyamine is heavy polyamine.

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12. The lubricating oil composition of claim 10 wherein the polyalkylene polyamine is tetraethylenepentamine.

13. A method of making a lubricating oil additive composition which comprises the steps of:

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(A) reacting a polyalkenyl succinic acid or a polyalkenyl succinic anhydride with at least one polyalkylene polyamine, having at least three nitrogen atoms, thereby producing a succinimide or succinamide or mixtures thereof;

20

(B) reacting the product of step (A) with a phthalic anhydride or naphthalic anhydride post-treating agent or mixtures thereof, thereby producing an initial post-treated succinimide or succinamide or mixtures thereof; and

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(C) reacting the product of step (B) with a cyclic carbonate thereby producing a final post-treated succinimide or succinamide or mixtures thereof, wherein at least one basic nitrogen remains in the final post-treated succinimide or succinamide or mixtures thereof.

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14. The method of making a lubricating oil additive composition of claim 13 wherein the polyalkenyl succinic acid or the polyalkenyl succinic anhydride is derived from a polyisobutene having a number average molecular weight (M_n) of from 500 to 5000.

15. A method of improving soot dispersancy in an internal combustion engine which comprises operating the engine with the lubricating oil composition of claim 8.
- 5 16. A concentrate comprising from 10 to 90 wt% of the lubricating oil additive composition of claim 1 and from 90 to 10 wt% of an organic diluent.