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<p>(54) Title: CONCENTRATES WITH HIGH MOLECULAR WEIGHT DISPERSANTS AND THEIR PREPARATION</p>		
<p>(57) Abstract</p> <p>Concentrates for lubricating oil compositions are prepared by mixing at elevated temperature: (i) at least one high molecular weight ashless dispersant; (ii) at least one oil-soluble overbased metal detergent; and (iii) at least one other concentrate additive provided that the additive is first mixed with the detergent or the dispersant.</p>		

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**CONCENTRATES WITH HIGH MOLECULAR WEIGHT DISPERSANTS  
AND THEIR PREPARATION**

**FIELD OF THE INVENTION**

5           This invention relates to oleaginous compositions useful in fuel and lubricating oil compositions. More particularly, this invention relates to oleaginous concentrates containing high molecular weight dispersants and their preparation thereof.

**BACKGROUND OF THE INVENTION**

10           This invention relates to lubricating oil compositions, e.g. automatic transmission fluids, heavy duty oils suitable for gasoline and diesel engines and crankcase oils. These lubricating oil formulations conventionally contain several different types of additives that will supply the  
15           characteristics that are required in the formulations. Among these types of additives are included viscosity index improvers, antioxidants, corrosion inhibitors, detergents, dispersants, pour point depressants, antiwear agents, etc.

          In the preparation of lubricating oil compositions, it is common  
20           practice to introduce the additives in the form of 10 to 80 mass %, e.g. 20 to 80 mass % active ingredient concentrates in hydrocarbon oil, e.g. mineral lubricating oil, or other suitable solvent. Usually these concentrates are subsequently diluted with 3 to 100, e.g. 5 to 40 parts by weight of lubricating oil, per part by weight of the concentrate to form  
25           finished lubricating oil compositions.

          It is convenient to provide a so-called "additive package" comprising two or more of the above mentioned additives in a single concentrate in a hydrocarbon oil or other suitable solvent. However, a problem with preparing additive packages is that some additives tend to interact with  
30           each other. For example, dispersants having a high molecular weight or a high functionality ratio, for example, of 1.3 or higher, have been found to interact with other additives in additive packages, particularly overbased metal detergents. This interaction causes a viscosity increase upon

blending, which may be followed by subsequent growth or increase of viscosity with time. In some instances, the interaction results in gelation. The viscosity increase can hamper pumping, blending and handling of the additive package. Although the additive package can be further diluted  
5 with more diluent oil to reduce viscosity in order to offset the effect of interaction, dilution reduces the economy of using an additive package by increasing shipping, storage and other handling costs.

U.S. Patent No. 4,398,880 describes a process for improving the stability of oleaginous concentrates in the form of additive packages  
10 comprising ashless dispersants, particularly polyisobutylene containing dispersants, in combination with overbased metal detergents in which the additives are contacted in a lubricating oil basestock at a temperature of from 100°C to 160°C for 1 to 10 hours. The resultant heat-treated blend is then cooled to a temperature of 85°C or below and further mixed with  
15 copper antioxidant additives, zinc dihydrocarbyldithiophosphate antiwear additives and, optionally, other additives useful in lubricating oil compositions. The process enables the stability of the additive package to be improved to the extent that the tendency for phase separation is substantially reduced.

20 However, the molecular weight of the dispersant used in U.S. Patent No. 4,398,880 is relatively low. The number average molecular weight of the polyisobutylene polymer used in the examples to make the dispersant is only 1725. The resulting dispersant number average molecular weight can be calculated to be approximately 3900 (e.g., 2 moles isobutylene  
25 polymer (MW=1725)+ 2 moles maleic anhydride (MW=98) + 1 mole polyethyleamine (MW=250) = 2(1725)+2(98)+1(250) ~3900). The significant increase in viscosity due to the dispersant/detergent interaction, which will be described in more detail below, does not occur until the molecular weight of the polyisobutylene derivatized dispersant is much  
30 higher (i.e., approximately 7000).

Another problem with concentrates containing high molecular weight dispersants is their stability. As dispersant size increase, concentrates

containing these high molecular weight dispersants are unstable and have a tendency to phase separate resulting in sediments. The phase separation reduces the performance of the concentrate, and the sediments increase the cost of shipping and handling.

5           There is a trend in the industry to go to higher molecular weight dispersants because they have improved dispersant properties to satisfy more rigorous performance requirements in the automobile industry. However, when higher molecular weight dispersants are used in concentrates, they interact with the colloidal overbased detergents to form  
10 a complex. This complex substantially increases the viscosity of the concentrate, which could result in blending difficulties unless the blending procedure is carefully designed.

          Below is a simplified description of a concentrate containing an overbased detergent and an ashless dispersant. When an overbased  
15 detergent is added to an oil-based solvent, a colloidal structure forms containing hydrophilic groups and lipophilic groups, where the lipophilic groups extend out in the oil-based solvent. The ashless dispersant also contains hydrophilic groups and lipophilic groups. At sufficiently high concentrations, the dispersant could interact with the overbased detergent  
20 colloidal structure to form a dispersant/detergent complex where the hydrophilic groups of the overbased metal detergent colloidal structure interacts with the hydrophilic groups of the ashless dispersant.

          Not wishing to be bound by any theory, it is believed that a dispersant/detergent complex could cause an increase in viscosity  
25 because lipophilic groups of the ashless dispersant of one complex can interact with lipophilic groups of another complex. This results in an effective high molecular weight aggregate complex that increases the viscosity of the concentrate. The viscosity may rise uncontrollably to the extent that gels may form that are impossible to blend into a finished  
30 lubricating oil composition. The latter effect can evidence itself as the Weissenberg Effect. The Weissenberg Effect occurs when the viscosity of

the concentrate significantly increases such that composition is seen to rise up the shaft of the mixing blades during blending.

It should be noted that the increase in viscosity would not occur if the concentration of the complex, or the molecular weight of the ashless dispersant in the concentrate is low. If the concentration of the complex is low (i.e., if the concentrate is dilute), there is sufficient space between the complexes such that the lipophilic groups of the dispersants will not interact. Likewise, if the molecular weight of the ashless dispersants is low, the lipophilic groups are too small to interact with each other. Thus, for example, a high molecular weight dispersant in a concentrate that is sufficiently dilute may not have a blending problem because there is sufficient space between the complexes such that an aggregate complex will not form. In contrast, a low molecular weight dispersant could have a blending problem in a highly concentrated composition because the space between the complexes is small. At typical additive package concentrations, the blending problems will not typically occur until the number average molecular weight of the dispersant is over about 7000 for polyisobutylene derivatized dispersants and over about 3000 for poly(alpha-olefin) derivatized dispersants.

Therefore, it is an objective of the present invention to provide a concentrated additive package composition that contains a higher molecular weight ashless dispersant and an overbased metal detergent than previously has been available due to viscosity considerations. It is another object of the present invention to provide a concentrate containing a high molecular weight ashless detergent and an overbased metal detergent that has good stability and does not phase separate. It is also an object of the present invention to provide a process for preparing the concentrate composition.

### **SUMMARY OF THE INVENTION**

This invention relates to a phase stable, oleaginous additive concentrate comprising a diluent oil, at least one borated or unborated

ashless dispersant where the ashless dispersant has a hydrodynamic radius of about 8 to 40 nm, at least one overbased metal detergent, and at least one other concentrate additive. The weight ratio of the ashless dispersant to the overbased metal detergent is about 1:1 to 8:1, and the  
5 sum of the ashless dispersant and the overbased metal detergent on an active ingredient basis is about 25 to 50 wt.% based upon the total weight of said concentrate. In the present invention, unless otherwise specified, the amount of ashless detergent, overbased detergent and other concentrate additives are on an active ingredient basis.

10 This invention also relates to a process for preparing the additive concentrate described above. The inventors of the present invention have surprisingly discovered that when the high molecular weight ashless dispersant or overbased detergent are first mixed with at least one of the concentrate additives, the concentrate is readily blendable and no  
15 Weissenberg effect is observed. In addition, when the ashless dispersant is first mixed with the other additives and the detergent is blended last, the tendency for phase separation is significantly reduced. It is believed that the present invention provides a concentrated additive package composition that contains a higher molecular weight ashless dispersant  
20 than previously has been available due to viscosity and phase separation concerns.

#### DETAILED DESCRIPTION

25 The present invention solves the problem of increased viscosity and phase separation concerns when a high molecular weight dispersants and overbased metal detergents are blended to form a concentrate. The concentrate comprises a diluent oil, at least borated or unborated one ashless dispersant where the ashless dispersant has a hydrodynamic radius of about 8 to 40 nm, at least one overbased metal detergent and at  
30 least one other concentrate additive. The weight ratio of the ashless dispersant to the metal detergent is about 1:1 to 8:1, and the sum of the

ashless dispersant and the metal detergent is about 25 to 50 wt.% based upon the total weight of said concentrate.

The inventors have discovered that when the ashless dispersant or the overbased detergent is first mixed with at least one other additive, they  
5 are readily blendable and do not show a Weissenberg effect. In addition, when the dispersant is first blended with at least one other additive, and the detergent is blended last, the concentrate is stable with minimal or no phase separation.

Although not wishing to be bound by any theory, it is believed that  
10 when other additives are first mixed with either the dispersant or the detergent, they compete with the binding sites on the detergent or dispersant, and block the complex between the detergent and the dispersant from forming. It is also believed that the additives aid in breaking up the aggregate complexes that do form. Therefore, it is not  
15 dilution that prevents the formation of the aggregate complex, but the specific properties of the concentrate additives of this invention that prevents the complexes from forming.

The hydrodynamic radius of the present invention is a convenient way to measure the size of the dispersant. The hydrodynamic radius is a  
20 measure of the volume of space occupied by the dispersant. The longer the hydrodynamic radius of the dispersant, the more likely it will interact with other dispersants that are complexed with the overbased metal detergent.

The concept of hydrodynamic radius is a more useful measure of  
25 the volume occupied by the dispersant than just molecular weight. This is because the volume occupied by the dispersant, depends, in part, on the amount and length of branches in the polymer dispersant. A dispersant that has many branches may have a high molecular weight, but its hydrodynamic radius may not be large because a significant part of the  
30 molecular weight is concentrated in the branches. In contrast, a low molecular weight polymer dispersant may have a large hydrodynamic radius because it contains few branches, and has a long polymer

backbone. Therefore, a better indication of the tendency of polymer dispersants to interact is hydrodynamic radius rather than molecular weight. It is believed that the hydrodynamic radius of the dispersants used in the present invention is larger than those that have been previously used  
5 in concentrate additive packages.

The hydrodynamic radius of the dispersants may be measured by the technique of dynamic light scattering (hereinafter "DLS") which is described in B.J. Berne and R. Pecora, Dynamic Light Scattering (Krieger, Malabar, FL, 1990) and in D.E. Dahneke, Measurement of Suspended  
10 Particles by Quasielastic Light Scattering (Wiley, New York, 1983). The dispersants of the present invention should be measured in heptane or other comparable solvents in concentrations of 0.1 to 1 Wt.%. For most dispersants, the measurement temperature has little impact on the measurement results, and the temperature can range from room  
15 temperature to 60°C. However, with ethylene based dispersants, the hydrodynamic radius measurement should be performed at 60°C to eliminate association of ethylene segments.

The additives, as components of the concentrate, may be mixed in any order, provided that the additives are first mixed with either the  
20 dispersant or the detergent. For example, the dispersant and other concentrate additives are first mixed together and the detergent is added last, or the detergent and other concentrate additives are first mixed together and then the dispersant is added. Preferably, the detergent is added last because this improves the stability of the concentrate.

25 In order for the concentrate to be oleaginous, the additives may be in solution in an oleaginous carrier or such a carrier may be provided separately or both. Examples of suitable carriers are oils of lubricating viscosity, such as described in detail hereinafter, and aliphatic, naphthenic and aromatic hydrocarbons.

30 The dispersant, detergent and other additives of the present invention must be "oil-soluble" or "oil-dispersible" in the oleaginous carrier or oil of lubricating viscosity, but these descriptions do not mean that they

are soluble, dissolvable, miscible or capable of being suspended in the oil in all proportions. They do mean, however, that they are stable and soluble in the oil to an extent sufficient to exert their intended effect in the environment in which the lubricating oil composition is employed.

- 5 Moreover, the additional incorporation of other additives such as those described hereinafter may affect their oil-solubility or dispersability.

The concentrate of the present invention is prepared at elevated temperatures, i.e. above ambient temperature. The blending temperature should be about 50° to 150°C, preferably about 50° to 120°C, more  
10 preferably about 60° to 120°C and even more preferably about 60° to 100°C. Although energy is saved at low temperatures, practical considerations dictate the most convenient temperature that can be used. Thus, where any additive is used that is solid at ambient temperature, it is usually more convenient to raise its temperature to a temperature at which  
15 it flows, rather than dissolving it in oil prior to addition to the other additives. Temperatures of 100°C or more can be employed if any additive is more conveniently handled at such temperatures.

The components are advantageously held at the mixing temperature for a time sufficient to achieve a homogenous mixture thereof. This can  
20 usually be effected within 2 hours with the present invention.

One or more further lubricating oil additives, desirable for conferring a full range of properties may be added to the concentrate. These additives preferably include corrosion inhibitors, metal dihydrocarbyl dithiophosphates, antioxidants, antiwear agents, friction modifiers, viscosity  
25 modifiers, a low base number metal detergent having a TBN less than 50, and mixtures thereof. The temperature at which these further additives are added will depend on the stability of the particular additives. Preferably, the temperature for blending further additives is about 50 to 85°C. For example, when one of the additives is zinc dihydrocarbyl dithiophosphate,  
30 the blending temperature should be about 60° to 85°C.

Boron may usefully be provided in the concentrate, for example in the form of a borated ashless dispersant, or in the form of an additional boron-containing compound or both.

The concentrate of the present invention can be incorporated into a lubricating oil composition in any convenient way. Thus, they can be added directly to an oil of lubricating viscosity by dispersing or dissolving them in the oil at the desired concentrations of the dispersant and detergent, respectively. Such blending can occur at ambient temperature or elevated temperatures. Alternatively, the composite can be blended with a suitable oil-soluble solvent and base oil to form a further concentrate which is then blended with an oil of lubricating viscosity to obtain the final lubricating oil composition.

The concentrate of the present invention will typically contain (on an active ingredient (A.I.) basis) from 3 to 50 mass %, and preferably from 10 to 40 mass % dispersant additive, from 3 to 45 mass %, and preferably from 5 to 30 mass %, overbased metal detergent based on the concentrate weight. The concentrate will typically contain an ashless dispersant to overbased metal detergent weight ratio on an active ingredient basis of about 0.1:1 to 12:1, preferably about 0.5:1 to 10:1, more preferably about 1:1 to 8:1, and even still more preferably about 1:1 to 4:1.

The sum of the detergent and dispersant on an active ingredient basis is typically from 20 to 70 wt.%, preferably about 25 to 60 wt.%, more preferably about 25 to 55 wt.%, even more preferably about 30 to 55 wt.%, still more preferably about 30 to 50 wt.% and even still more preferably about 35 to 50 wt.% based on the total weight of the concentrate.

The practical concentration (sum of the detergent and dispersant) will depend, in part, on the size of the dispersant. If the dispersant size is large, e.g., a hydrodynamic radius of 15 to 40 nm, the practical concentration in the present invention will typically range from about 25 to 40 wt.%. If the size of the dispersant is smaller, e.g., a hydrodynamic radius of about 8 to 40 nm, the practical concentration will typically be about 30 to 50 wt.%.

In a preferred embodiment, the overbased detergent is pre-treated, prior to introduction to the blending process, with about 1 to 50 wt.%, relative to the overbased detergent, of a pretreatment additive selected from the group consisting of an polyamine-derivatized poly(isobutylene) ashless dispersant having a number average molecular weight of about 500 to 6000 and a poly(isobutylene) succinic anhydride with a molecular weight of about 300 to 2500. Preferably, the pretreatment additive is a poly(isobutylene) succinic anhydride with a molecular weight of about 300 to 2500.

The components of the invention will now be discussed in further detail as follows:

#### ASHLESS DISPERSANTS

The high molecular weight ashless dispersants in the concentrate of the present invention include the range of ashless dispersants known as effective for adding to lubricant oils for the purpose of reducing the formation of deposits in gasoline or diesel engines. Preferably, "high molecular weight" dispersant means having a number average molecular weight of greater than 3000, such as between 3000 and 20,000. The exact molecular weight ranges will depend on the type of polymer used in the dispersants. For example, for a polyisobutylene derivatized dispersant, a high molecular weight dispersant means having a number average molecular weight of about 7000 to 20,000. A high molecular weight poly(alpha -olefin) derivatized dispersant means having a molecular weight from about 3000 to 20,000. It is believed that the high molecular dispersants of the present invention have not previously been used with overbased metal detergents in the concentrations needed to prepare a concentrate due to stability problems and the uncontrollable rise in viscosity during blending.

As previously discussed, a useful measure of the size of the dispersant is hydrodynamic radius ( $R_H$ ). In the present invention, the hydrodynamic radius may range from about 8 to 40 nm, such as 10, 12 or

15 to 40 nm. It is believed that the above ranges for the dispersants are higher than those that have been previously used in concentrates.

Typical commercially available polyisobutylene based dispersants contain polyisobutylene polymers having a number average molecular weight ranging from 900 to 2300, functionalized by maleic anhydride, (MW = 98), and derivatized with polyamines having a molecular weight of about 100 to 350. Each dispersant contains 1.5 to 2.5 polyisobutylene polymers per dispersant. Thus, the molecular weight of the polyisobutylene derivatized dispersant can be calculated and ranges from about 1600 to 6300. For example, with a dispersant averaging about 2.5 polymers per dispersant, the molecular weight of the dispersant can be calculated to be: 2.5 moles polyisobutylene (MW=2300) + 2.5 moles maleic anhydride (MW=98)+ 1 mole polyamine (350) which gives a molecular weight of about 6300. For comparison, a polyisobutylene based dispersant having a number average molecular weight of about 5000 has a hydrodynamic radius of about 5.5 nm. In cases where the molecular weight of the dispersant can not be readily estimated from the molecular weight of the starting materials, e.g., in more complex chain extended systems, an empirical measurement of molecular weight and hydrodynamic radius must be made.

The ashless dispersant of the present invention includes an oil soluble polymeric long chain hydrocarbon backbone having functional groups that are capable of associating with particles to be dispersed. Typically, the dispersants comprise amine, alcohol, amide, or ester polar moieties attached to the polymer backbone often via a bridging group. The ashless dispersant may be, for example, selected from oil soluble salts, esters, amino-esters, amides, imides, and oxazolines of long chain hydrocarbon substituted mono and dicarboxylic acids or their anhydrides; thiocarboxylate derivatives of long chain hydrocarbons; long chain aliphatic hydrocarbons having a polyamine attached directly thereto; and Mannich condensation products formed by condensing a long chain substituted phenol with formaldehyde and polyalkylene polyamine.

The long chain hydrocarbyl substituted mono- or dicarboxylic acid material, i.e. acid, anhydride, or ester, used in the invention includes long chain hydrocarbon, generally a polyolefin, substituted with an average of at least about 0.8, (e.g., about 0.8 to 2.0) generally from about 1.0 to 2.0,  
5 preferably 1.05 to 1.25, 1.1 to 1.2, moles per mole of polyolefin, of an alpha or beta unsaturated C<sub>4</sub> to C<sub>10</sub> dicarboxylic acid, or anhydride or ester thereof, such as fumaric acid, itaconic acid, maleic acid, maleic anhydride, chloromaleic acid, dimethyl fumarate, chloromaleic anhydride, acrylic acid, methacrylic acid, crotonic acid, cinnamic acid, etc.

10 Preferred olefin polymers for reaction with the unsaturated dicarboxylic acids are polymers comprising a major molar amount of C<sub>2</sub> to C<sub>10</sub>, e.g. C<sub>2</sub> to C<sub>5</sub> monoolefin. Such olefins include ethylene, propylene, butylene, isobutylene, pentene, octene-1, styrene, etc. The polymers can be homopolymers such as polyisobutylene, as well as copolymers of two or  
15 more of such olefins such as copolymers of: ethylene and propylene; butylene and isobutylene; propylene and isobutylene; etc. Other copolymers include those in which a minor molar amount of the copolymer monomers, e.g., 1 to 10 mole %, is a C<sub>4</sub> to C<sub>18</sub> non-conjugated diolefin, e.g., a copolymer of isobutylene and butadiene; or a copolymer of  
20 ethylene, propylene and 1,4-hexadiene; etc.

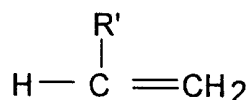
Processes for reacting polymeric hydrocarbons with unsaturated carboxylic acids, anhydrides or esters and the preparation of derivatives from those compounds are disclosed in US-A-3087936, US-A-3172892, US-A-3215707, US-A-3231587, US-A-3231587, US-A-3272746, US-A-  
25 3275554, US-A-3381022, US-A-3442808, US-A-356804, US-A-3912764, US-A-4110349, US-A-4234435 and GB-A-1440219.

A preferred class of ashless dispersants are ethylene alpha-olefin copolymers and alpha-olefin homo-, co- and terpolymers prepared using new metallocene catalyst chemistry, which may have a high degree (e.g.  
30 >30%) of terminal vinylidene unsaturation is described in US-A-5128056, 5151204, 5200103, 5225092, 5266223, 5334775; WO-A-94/19436, 94/13709; and EP-A-440506, 513157, 513211. These dispersants are

described as having superior viscometric properties as expressed in a ratio of CCS viscosity to  $\eta_{sp}/c$  at 100°C.

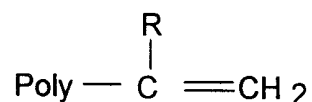
The term "alpha-olefin" is used herein to denote an olefin of the formula

5



wherein R' is preferably a C<sub>1</sub>-C<sub>18</sub> alkyl group. The requirement for terminal vinylidene unsaturation refers to the presence in the polymer of the

10 following structure:



wherein Poly is the polymer chain and R is typically a C<sub>1</sub>-C<sub>18</sub> alkyl group, typically methyl or ethyl. Preferably the polymers will have at least 50%, and most preferably at least 60%, of the polymer chains with terminal vinylidene unsaturation. As indicated in WO-A-94/19426, ethylene/1-butene copolymers typically have vinyl groups terminating no more than about 10 percent of the chains, and internal mono-unsaturation in the balance of the chains. The nature of the unsaturation may be determined by FTIR spectroscopic analysis, titration or C-13 NMR.

The oil-soluble polymeric hydrocarbon backbone may be a homopolymer (e.g., polypropylene) or a copolymer of two or more of such olefins (e.g., copolymers of ethylene and an alpha-olefin such as propylene or butylene, or copolymers of two different alpha-olefins). Other copolymers include those in which a minor molar amount of the copolymer monomers, e.g., 1 to 10 mole %, is an  $\alpha,\omega$ -diene, such as a C<sub>3</sub> to C<sub>22</sub> non-conjugated diolefin (e.g., a copolymer of isobutylene and butadiene, or a copolymer of ethylene, propylene and 1,4-hexadiene or 5-ethylidene-2-

norbornene). Atactic propylene oligomers of the present invention have a number average molecular weight of from about 3000 to 10000 may also be used as well as heteropolymers such as polyepoxides.

One preferred class of olefin polymers is polybutenes and  
5 specifically poly-n-butenes, such as may be prepared by polymerization of a C<sub>4</sub> refinery stream. Other preferred classes of olefin polymers are ethylene alpha-olefins (EAO) copolymers that preferably contain 1 to 50  
10 mole % ethylene, and more preferably 5 to 48 mole % ethylene. Such polymers may contain more than one alpha-olefin and may contain one or more C<sub>3</sub> to C<sub>22</sub> diolefins. Also useable are mixtures of EAO's of varying ethylene content. Different polymer types, e.g., EAO, may also be mixed or blended, as well as polymers differing in number average molecular weight components derived from these also may be mixed or blended.

Particularly preferred copolymers are ethylene butene copolymers.

15 Preferably, the olefin polymers and copolymers may be prepared by various catalytic polymerization processes using metallocene catalysts which are, for example, bulky ligand transition metal compounds of the formula:



where L is a bulky ligand; A is a leaving group, M is a transition metal, and m and n are such that the total ligand valency corresponds to the transition metal valency. Preferably the catalyst is four co-ordinate such that the  
25 compound is ionizable to a 1<sup>+</sup> valency state.

Such polymerizations, catalysts, and cocatalysts or activators are described, for example, in US-A-4530914, 4665208, 4808561, 4871705, 4897455, 4937299, 4952716, 5017714, 5055438, 5057475, 5064802, 5096867, 5120867, 5124418, 5153157, 5198401, 5227440, 5241025; EP-  
30 A-129368, 277003, 277004, 420436, 520732; and WO-A-91/04257, 92/00333, 93/08199, 93/08221, 94/07928 and 94/13715, herein incorporated by reference.

The oil-soluble polymeric hydrocarbon backbone may be functionalized to incorporate a functional group into the backbone of the polymer, or as one or more groups pendant from the polymer backbone. The functional group typically will be polar and contain one or more hetero  
5 atoms such as P, O, S, N, halogen, or boron. It can be attached to a saturated hydrocarbon part of the oil-soluble polymeric hydrocarbon backbone via substitution reactions or to an olefinic portion via addition or cycloaddition reactions. Alternatively, the functional group can be incorporated into the polymer in conjunction with oxidation or cleavage of  
10 the polymer chain end (e.g., as in ozonolysis).

Useful functionalization reactions include: halogenation of the polymer at an olefinic bond and subsequent reaction of the halogenated polymer with an ethylenically unsaturated functional compound (e.g., maleation where the polymer is reacted with maleic acid or anhydride);  
15 reaction of the polymer with an unsaturated functional compound by the "ene" reaction absent halogenation; reaction of the polymer with at least one phenol group (this permits derivatization in a Mannich base-type condensation); reaction of the polymer at a point of unsaturation with carbon monoxide using a Koch-type reaction to introduce a carbonyl group  
20 in an iso or neo position; reaction of the polymer with the functionalizing compound by free radical addition using a free radical catalyst; copolymerization of the polymer with the functionalizing compound, (e.g., maleic anhydride), with or without low molecular weight olefins via free radical initiation; reaction with a thiocarboxylic acid derivative; and reaction  
25 of the polymer by air oxidation methods, epoxidation, chloroamination, or ozonolysis.

The functionalized oil-soluble polymeric hydrocarbon backbone is then further derivatized with a nucleophilic reactant such as an amine, amino-alcohol, alcohol, metal compound or mixture thereof to form a  
30 corresponding derivative. Useful amine compounds for derivatizing functionalized polymers comprise at least one amine and can comprise one or more additional amine or other reactive or polar groups. These

amines may be hydrocarbyl amines or may be predominantly hydrocarbyl amines in which the hydrocarbyl group includes other groups, e.g., hydroxy groups, alkoxy groups, amide groups, nitriles, imidazoline groups, and the like. Particularly useful amine compounds include mono- and polyamines, 5 e.g. polyalkylene and polyoxyalkylene polyamines of about 2 to 60, conveniently 2 to 40 (e.g., 3 to 20), total carbon atoms and about 1 to 12, conveniently 3 to 12, and preferably 3 to 9 nitrogen atoms in the molecule. Mixtures of amine compounds may advantageously be used such as those prepared by reaction of alkylene dihalide with ammonia. Preferred amines 10 are aliphatic saturated amines, including, e.g., 1,2-diaminoethane; 1,3-diaminopropane; 1,4-diaminobutane; 1,6-diaminohexane; polyethylene amines such as diethylene triamine; triethylene tetramine; tetraethylene pentamine; and polypropyleneamines such as 1,2-propylene diamine; and di-(1,2-propylene)triamine.

15 Other useful amine compounds include: alicyclic diamines such as 1,4-di(aminomethyl) cyclohexane, and heterocyclic nitrogen compounds such as imidazolines. A particularly useful class of amines are the polyamido and related amido-amines as disclosed in US 4,857,217; 4,956,107; 4,963,275; and 5,229,022. Also usable is 20 tris(hydroxymethyl)amino methane (THAM) as described in US 4,102,798; 4,113,639; 4,116,876; and UK 989,409. Dendrimers, star-like amines, and comb-structure amines may also be used. Similarly, one may use the condensed amines disclosed in US 5,053,152. The functionalized polymer is reacted with the amine compound according to conventional techniques 25 as described in EP-A 208,560; US 4,234,435 and US 5,229,022 .

The functionalized oil-soluble polymeric hydrocarbon backbones also may be derivatized with hydroxy compounds such as monohydric and polyhydric alcohols or with aromatic compounds such as phenols and naphthols. Polyhydric alcohols are preferred, e.g., alkylene glycols in 30 which the alkylene radical contains from 2 to 8 carbon atoms. Other useful polyhydric alcohols include glycerol, mono-oleate of glycerol, monostearate of glycerol, monomethyl ether of glycerol, pentaerythritol, dipentaerythritol,

and mixtures thereof. An ester dispersant may also be derived from unsaturated alcohols such as allyl alcohol, cinnamyl alcohol, propargyl alcohol, 1-cyclohexane-3-ol, and oleyl alcohol. Still other classes of the alcohols capable of yielding ashless dispersants comprise the ether-  
5 alcohols and including, for example, the oxy-alkylene, oxy-arylene. They are exemplified by ether-alcohols having up to 150 oxy-alkylene radicals in which the alkylene radical contains from 1 to 8 carbon atoms. The ester dispersants may be di-esters of succinic acids or acidic esters, i.e., partially esterified succinic acids, as well as partially esterified polyhydric alcohols  
10 or phenols, i.e., esters having free alcohols or phenolic hydroxyl radicals. An ester dispersant may be prepared by one of several known methods as illustrated, for example, in US 3,381,022.

One preferred group of dispersant is poly(alpha olefin) dispersants. They are preferably employed in the invention as polyamine-derivatized  
15 poly(alpha-olefin) dispersants having a number average molecular weight of about 3000 to 20,000, preferably about 4000 to 15,000 and more preferably about 5000 to 10,000, or a weight average molecular weight of about 6,000 to 50,000, preferably about 8,000 to 40,000 and more preferably 10,000 to 30,000. One convenient method to measure  
20 molecular weight is gel permeation chromatography (GPC), which additionally provides molecular weight distribution information (see W. W. Yau, J. J. Kirkland and D. D. Bly, "Modern Size Exclusion Liquid Chromatography", John Wiley and Sons, New York, 1979). Another useful method, particularly for lower molecular weight polymers, is vapor pressure  
25 osmometry (see, e.g., ASTM D3592).

In a preferred embodiment the poly(alpha olefin) dispersant is derived from an ethylene/butene alpha-olefin polymer having a number average molecular weight of about 4,000 to 15000 or a weight average molecular weight of about 8,000 to 40,000.

30 Another preferred group of ashless dispersants are those derived from polyisobutylene substituted with succinic anhydride groups and reacted with polyethylene amines, e.g. tetraethylene pentamine,

pentaethylene e.g. polyoxypropylene diamine, trimethylolaminomethane and pentaerythritol, and combinations thereof. One particularly preferred dispersant combination involves a combination of (A) polyisobutylene substituted with succinic anhydride groups and reacted with (B) a hydroxy  
5 compound, e.g. pentaerythritol, (C) a polyoxyalkylene polyamine, e.g. polyoxypropylene diamine, or (D) a polyalkylene polyamine, e.g. polyethylene diamine and tetraethylene pentamine using about 0.3 to about 2 moles either (B), (C) or (D) per mole of A. Another preferred dispersant combination involves the combination of (A) polyisobutenyl  
10 succinic anhydride with (B) a polyalkylene polyamine, e.g. tetraethylene pentamine, and (C) a polyhydric alcohol or polyhydroxy-substituted aliphatic primary amine, e.g. pentaerythritol or trimethylolaminomethane as described in U.S. Pat. No. 3,632,511.

Preferably, the polyamine-derivatized polyisobutylene dispersant  
15 has a number average molecular weight of about 7000 to 20000, preferably about 9000 to 20,000 and more preferably about 12,000 to 20,000, or a weight average molecular weight of about 17,000 to 50,000, preferably about 20,000 to 40,000 and more preferably about 25,000 to 40,000.

20 The above polyisobutylene-derivatized dispersant may also be used as a pretreatment additive for the overbased detergent when the number average molecular weight is about 500 to 6000. In addition, the polyisobutylene substituted anhydride may also be used as a pretreatment additive when the number average molecular weight is about 300 to 2500.

25 Another class of ashless dispersants comprises Mannich base condensation products. Generally, these are prepared by condensing about one mole of an alkyl-substituted mono- or polyhydroxy benzene with about 1 to 2.5 moles of carbonyl compounds (e.g., formaldehyde and paraformaldehyde) and about 0.5 to 2 moles polyalkylene polyamine as  
30 disclosed, for example, in US 3,442,808. Such Mannich condensation products may include a polymer product of a metallocene catalyzed polymerization as a substituent on the benzene group or may be reacted

with a compound containing such a polymer substituted on a succinic anhydride, in a manner similar to that shown in US 3,442,808.

Examples of functionalized and/or derivatized olefin polymers based on polymers synthesized using metallocene catalyst systems are described in publications identified above.

The dispersant can be further post-treated by a variety of conventional post treatments such as boration, as generally taught in US 3,087,936 and 3,254,025. This is readily accomplished by treating an acyl nitrogen-containing dispersant with a boron compound selected from the group consisting of boron oxide, boron halides, boron acids and esters of boron acids, in an amount to provide from about 0.1 atomic proportion of boron for each mole of the acylated nitrogen composition to about 20 atomic proportions of boron for each atomic proportion of nitrogen of the acylated nitrogen composition. Usefully the dispersants contain from about 0.05 to 2.0 wt. %, e.g. 0.05 to 0.7 wt. % boron based on the total weight of the borated acyl nitrogen compound. The boron, which appears to be in the product as dehydrated boric acid polymers (primarily  $(HBO_2)_3$ ), is believed to attach to the dispersant imides and diimides as amine salts e.g., the metaborate salt of the diimide. Boration is readily carried out by adding from about 0.05 to 4, e.g., 1 to 3 wt. % (based on the weight of acyl nitrogen compound) of a boron compound, preferably boric acid, usually as a slurry, to the acyl nitrogen compound and heating with stirring at from 135° to 190° C, e.g., 140°-170° C, for from 1 to 5 hours followed by nitrogen stripping. Alternatively, the boron treatment can be carried out by adding boric acid to a hot reaction mixture of the dicarboxylic acid material and amine while removing water.

Also, boron may be provided separately, for example as a boron ester or as a boron succinimide, made for example from a polyisobutylene succinic anhydride, where the polymer has a molecular weight of from 450 to 700.

#### OIL-SOLUBLE METAL DETERGENT

Metal-containing or ash-forming detergents function both as detergents to reduce or remove deposits and as acid neutralizers or rust inhibitors, thereby reducing wear and corrosion and extending engine life. Detergents generally comprise a polar head with a long hydrophobic tail, with the polar head comprising a metal salt of an acidic organic compound. The salts may contain a substantially stoichiometric amount of the metal in which case they are usually described as normal or neutral salts, and would typically have a total base number or TBN (as may be measured by ASTM D2896) of from 0 to 80. It is possible to include large amounts of a metal base by reacting an excess of a metal compound such as an oxide or hydroxide with an acidic gas such as carbon dioxide. The resulting overbased detergent comprises neutralized detergent as the outer layer of a metal base (e.g. carbonate) micelle. The detergents of the present invention are overbased detergents that have a TBN of 150 or greater, and typically about 250 to 450 or more.

Detergents that may be used in the present invention include oil-soluble overbased sulfonates, phenates, sulfurized phenates, thiophosphonates, salicylates, and naphthenates and other oil-soluble carboxylates of a metal, particularly the alkali or alkaline earth metals, e.g., sodium, potassium, lithium, calcium, and magnesium. The most commonly used metals are calcium and magnesium, which may both be present in detergents used in a lubricant, and mixtures of calcium and/or magnesium with sodium. Particularly convenient metal detergents are overbased calcium sulfonates, calcium phenates and sulfurized phenates and salicylates having a TBN of about 150 to 450. In the practice of the present invention, combinations of surfactants, e.g., sulfonates and phenates, and combination of overbased and neutral detergents may also be used.

Sulfonates may be prepared from sulfonic acids which are typically obtained by the sulfonation of alkyl substituted aromatic hydrocarbons such as those obtained from the fractionation of petroleum or by the alkylation of aromatic hydrocarbons. Examples included those obtained by

alkylating benzene, toluene, xylene, naphthalene, diphenyl or their halogen derivatives such as chlorobenzene, chlorotoluene and chloronaphthalene. The alkylation may be carried out in the presence of a catalyst with alkylating agents having from about 3 to more than 70 carbon atoms. The alkaryl sulfonates usually contain from about 9 to about 80 or more carbon atoms, preferably from about 16 to about 60 carbon atoms per alkyl substituted aromatic moiety.

The oil soluble sulfonates or alkaryl sulfonic acids may be neutralized with oxides, hydroxides, alkoxides, carbonates, carboxylate, sulfides, hydrosulfides, nitrates, borates and ethers of the metal. The amount of metal compound is chosen having regard to the desired TBN of the final product but typically ranges from about 100 to 220 wt % (preferably at least 125 wt %) of that stoichiometrically required.

Metal salts of phenols and sulfurized phenols are prepared by reaction with an appropriate metal compound such as an oxide or hydroxide and neutral or overbased products may be obtained by methods well known in the art. Sulfurized phenols may be prepared by reacting a phenol with sulfur or a sulfur containing compound such as hydrogen sulfide, sulfur monohalide or sulfur dihalide, to form products which are generally mixtures of compounds in which 2 or more phenols are bridged by sulfur containing bridges.

The detergent may have a particle diameter size in the range of about 4 to 40 nm, preferably about 4 to 30 nm and more preferably about 6 to 20 nm. The overbased metal dispersant diameter size can be measured using the small angle neutron scattering technique as described in I. Markovic, R.H. Ottewill, D.J Cebula, I. Field and J.F. Marsh, "Small angle neutron scattering studies on non-aqueous dispersions of calcium carbonate", Colloid & Polymer Science, 262:648-656 (1984).

### 30 OIL OF LUBRICATING VISCOSITY

The oil of lubricating viscosity, useful for making concentrates of the invention or for making lubricating oil compositions therefrom, may be

selected from natural (vegetable, animal or mineral) and synthetic lubricating oils and mixtures thereof. It may range in viscosity from light distillate mineral oils to heavy lubricating oils such as gas engine oil, mineral lubricating oil, motor vehicle oil, and heavy duty diesel oil.

5 Generally, the viscosity of the oil ranges from 2 centistokes to 30 centistokes, especially 5 centistokes to 20 centistokes, at 100°C.

Natural oils include animal oils and vegetable oils (e.g., castor, lard oil) liquid petroleum oils and hydrotreated, solvent-treated or acid-treated mineral lubricating oils of the paraffinic, naphthenic and mixed paraffinic-naphthenic types. Oils of lubricating viscosity derived from coal or shale are also useful base oils.

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

Alkylene oxide polymers and interpolymers and derivatives thereof where the terminal hydroxyl groups have been modified by esterification, etherification, etc., constitute another class of known synthetic lubricating oils. These are exemplified by polyoxyalkylene polymers prepared by polymerization of ethylene oxide or propylene oxide, the alkyl and aryl ethers of these polyoxyalkylene polymers (e.g., methylpolyisopropylene glycol ether having an average molecular weight of 1000, diphenyl ether of poly-ethylene glycol having a molecular weight of 500-1000, diethyl ether of polypropylene glycol having a molecular weight of 1000-1500); and mono- and polycarboxylic esters thereof, for example, the acetic acid esters, mixed C<sub>3</sub>-C<sub>8</sub> fatty acid esters and C<sub>13</sub> Oxo acid diester of tetraethylene glycol.

Another suitable class of synthetic lubricating oils comprises the esters of dicarboxylic acids (e.g., phthalic acid, succinic acid, alkyl succinic acids and alkenyl succinic acids, maleic acid, azelaic acid, suberic acid, sebacic acid, fumaric acid, adipic acid, linoleic acid dimer, malonic acid, 5 alkylmalonic acids, alkenyl malonic acids) with a variety of alcohols (e.g., butyl alcohol, hexyl alcohol, dodecyl alcohol, 2-ethylhexyl alcohol, ethylene glycol, diethylene glycol monoether, propylene glycol). Specific examples of these esters include dibutyl adipate, di(2-ethylhexyl) sebacate, di-n-hexyl fumarate, dioctyl sebacate, dilsooctyl azelate, disodecyl azelate, dioctyl 10 phthalate, didecyl phthalate, dieicosyl sebacate, the 2-ethylhexyl diester of linoleic acid dimer, and the complex ester formed by reacting one mole of sebacic acid with two moles of tetraethylene glycol and two moles of 2-ethylhexanoic acid.

Esters useful as synthetic oils also include those made from C<sub>5</sub> to 15 C<sub>12</sub> monocarboxylic acids and polyols and polyol ethers such as neopentyl glycol, trimethylolpropane, pentaerythritol, dipentaerythritol and tripentaerythritol.

Silicon-based oils such as the polyalkyl-, polyaryl-, polyalkoxy-, or polyaryloxysiloxane oils and silicate oils comprise another useful class of 20 synthetic lubricants; they include tetraethyl silicate, tetraisopropyl silicate, tetra-(2-ethylhexyl)silicate, tetra-(4-methyl-2-ethylhexyl)silicate, tetra-(p-tert-butyl-phenyl)silicate, hexa-(4-methyl-2-pentoxy)disiloxane, poly(methyl)siloxanes and poly(methylphenyl)siloxanes. Other synthetic lubricating oils include liquid esters of phosphorus-containing acids (e.g., 25 tricresyl phosphate, trioctyl phosphate, diethyl ester of decylphosphonic acid) and polymeric tetrahydrofurans.

Unrefined, refined and rerefined oils can be used in the lubricants of the present invention. Unrefined oils are those obtained directly from a natural or synthetic source without further purification treatment. For 30 example, a shale oil obtained directly from retorting operations, a petroleum oil obtained directly from distillation or ester oil obtained directly from an esterification process and used without further treatment would be

an unrefined oil. Refined oils are similar to the unrefined oils except they have been further treated in one or more purification steps to improve one or more properties. Many such purification techniques, such as distillation, solvent extraction, acid or base extraction, filtration and percolation are known to those skilled in the art. Rerefined oils are obtained by processes similar to those used to obtain refined oils applied to refined oils which have been already used in service. Such rerefined 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.

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### OTHER ADDITIVE COMPONENTS

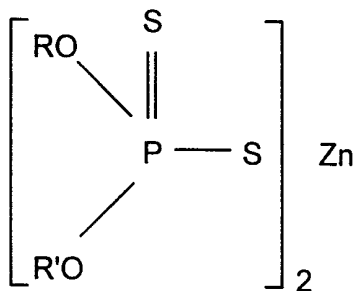
As indicated above, additional additives may be incorporated in the composites of the invention to enable them to meet particular requirements. Examples of additives which may be included in the lubricating oil compositions are metal rust inhibitors, viscosity index improvers, corrosion inhibitors, other oxidation inhibitors, friction modifiers, other dispersants, anti-foaming agents, anti-wear agents, pour point depressants, and rust inhibitors. Some are discussed in further detail below.

Dihydrocarbyl dithiophosphate metal salts are frequently used as antiwear and antioxidant agents. The metal may be an alkali or alkaline earth metal, or aluminum, lead, tin, molybdenum, manganese, nickel or copper. The zinc salts are most commonly used in lubricating oil in amounts of 0.1 to 10, preferably 0.2 to 2 wt %, based upon the total weight of the lubricating oil composition. They may be prepared in accordance with known techniques by first forming a dihydrocarbyl dithiophosphoric acid (DDPA), usually by reaction of one or more alcohol or a phenol with  $P_2S_5$  and then neutralizing the formed DDPA with a zinc compound. For example, a dithiophosphoric acid may be made by reacting mixtures of primary and secondary alcohols. Alternatively, multiple dithiophosphoric acids can be prepared where the hydrocarbyl groups on one are entirely secondary in character and the hydrocarbyl groups on the others are

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entirely primary in character. To make the zinc salt, any basic or neutral zinc compound could be used but the oxides, hydroxides and carbonates are most generally employed. Commercial additives frequently contain an excess of zinc due to use of an excess of the basic zinc compound in the neutralization reaction.

The preferred zinc dihydrocarbyl dithiophosphates are oil soluble salts of dihydrocarbyl dithiophosphoric acids and may be represented by the following formula:



wherein R and R' may be the same or different hydrocarbyl radicals containing from 1 to 18, preferably 2 to 12, carbon atoms and including radicals such as alkyl, alkenyl, aryl, arylalkyl, alkaryl and cycloaliphatic radicals. Particularly preferred as R and R' groups are alkyl groups of 2 to 8 carbon atoms. Thus, the radicals may, for example, be ethyl, n-propyl, i-propyl, n-butyl, i-butyl, sec-butyl, amyl, n-hexyl, l-hexyl, n-octyl, decyl, dodecyl, octadecyl, 2-ethylhexyl, phenyl, butylphenyl, cyclohexyl, methylcyclopentyl, propenyl, butenyl. In order to obtain oil solubility, the total number of carbon atoms (i.e. R and R') in the dithiophosphoric acid will generally be about 5 or greater. The zinc dihydrocarbyl dithiophosphate can therefore comprise zinc dialkyl dithiophosphates.

Oxidation inhibitors or antioxidants reduce the tendency of mineral oils to deteriorate in service. Oxidative deterioration can be evidenced by sludge in the lubricant, varnish-like deposits on the metal surfaces, and by viscosity growth. Such oxidation inhibitors include hindered phenols, alkaline earth metal salts of alkylphenolthioesters having preferably C<sub>5</sub> to

C<sub>12</sub> alkyl side chains, calcium nonylphenol sulphide, oil soluble phenates and sulfurized phenates, phosphosulfurized or sulfurized hydrocarbons, phosphorous esters, metal thiocarbamates, oil soluble copper compounds as described in US 4,867,890, and molybdenum-containing compounds.

5           Aromatic amines having at least two aromatic groups attached directly to the nitrogen constitute another class of compounds that is frequently used for antioxidancy. While these materials may be used in small amounts, preferred embodiments of the present invention are free of these compounds. They are preferably used in only small amounts, i.e.,  
10 up to 0.4 wt %, or more preferably avoided altogether other than such amount as may result as an impurity from another component of the composition.

          Typical oil soluble aromatic amines having at least two aromatic groups attached directly to one amine nitrogen contain from 6 to 16 carbon  
15 atoms. The amines may contain more than two aromatic groups. Compounds having a total of at least three aromatic groups in which two aromatic groups are linked by a covalent bond or by an atom or group (e.g., an oxygen or sulphur atom, or a -CO-, -SO<sub>2</sub>- or alkylene group) and two are directly attached to one amine nitrogen also considered aromatic  
20 amines having at least two aromatic groups attached directly to the nitrogen. The aromatic rings are typically substituted by one or more substituents selected from alkyl, cycloalkyl, alkoxy, aryloxy, acyl, acylamino, hydroxy, and nitro groups. The amount of any such oil soluble aromatic amines having at least two aromatic groups attached directly to  
25 one amine nitrogen should preferably not exceed 0.4 wt % active ingredient.

          Representative examples of suitable viscosity modifiers are polyisobutylene, copolymers of ethylene and propylene, polymethacrylates, methacrylate copolymers, copolymers of an unsaturated dicarboxylic acid  
30 and a vinyl compound, interpolymers of styrene and acrylic esters, and partially hydrogenated copolymers of styrene/ isoprene, styrene/butadiene,

and isoprene/butadiene, as well as the partially hydrogenated homopolymers of butadiene and isoprene.

Friction modifiers and fuel economy agents which are compatible with the other ingredients of the final oil may also be included. Examples  
5 of such materials are glyceryl monoesters of higher fatty acids, for example, glyceryl mono-oleate; esters of long chain polycarboxylic acids with diols, for example, the butane diol ester of a dimerized unsaturated  
10 fatty acid; oxazoline compounds; and alkoxyated alkyl-substituted monoamines, diamines and alkyl ether amines, for example, ethoxylated tallow amine and ethoxylated tallow ether amine.

A viscosity index improver dispersant functions both as a viscosity index improver and as a dispersant. Examples of viscosity index improver dispersants include reaction products of amines, for example polyamines, with a hydrocarbyl-substituted mono -or dicarboxylic acid in which the  
15 hydrocarbyl substituent comprises a chain of sufficient length to impart viscosity index improving properties to the compounds. In general, the viscosity index improver dispersant may be, for example, a polymer of a C<sub>4</sub> to C<sub>24</sub> unsaturated ester of vinyl alcohol or a C<sub>3</sub> to C<sub>10</sub> unsaturated mono-carboxylic acid or a C<sub>4</sub> to C<sub>10</sub> di-carboxylic acid with an unsaturated  
20 nitrogen-containing monomer having 4 to 20 carbon atoms; a polymer of a C<sub>2</sub> to C<sub>20</sub> olefin with an unsaturated C<sub>3</sub> to C<sub>10</sub> mono- or di-carboxylic acid neutralized with an amine, hydroxyamine or an alcohol; or a polymer of ethylene with a C<sub>3</sub> to C<sub>20</sub> olefin further reacted either by grafting a C<sub>4</sub> to C<sub>20</sub> unsaturated nitrogen - containing monomer thereon or by grafting an  
25 unsaturated acid onto the polymer backbone and then reacting carboxylic acid groups of the grafted acid with an amine, hydroxy amine or alcohol.

Examples of dispersants and viscosity index improver dispersants may be found in European Patent Specification No. 24146 B.

Pour point depressants, otherwise known as lube oil flow improvers,  
30 lower the minimum temperature at which the fluid will flow or can be poured. Such additives are well known. Typical of those additives which improve the low temperature fluidity of the fluid are C<sub>8</sub> to C<sub>18</sub> dialkyl

fumarate/vinyl acetate copolymers, and polymethacrylates. Foam control can be provided by an antifoamant of the polysiloxane type, for example, silicone oil or polydimethyl siloxane.

Some of the above-mentioned additives can provide a multiplicity of effects; thus for example, a single additive may act as a dispersant-oxidation inhibitor. This approach is well known and need not be further elaborated herein.

When lubricating concentrate contain one or more of the above-mentioned additives, each additive is typically blended into the base oil in an amount, which enables the additive to provide its desired function.

The amount of the above mentioned additives, other than the overbased metal detergent, ashless dispersant and diluent oil, can range from about 0.1 to 50 wt.%, preferably about 0.2 to 40 wt.%, more preferably about 0.5 to 30 wt. % and even more preferably about 1 to 20 wt.%.

The concentrate may be further added to a lubricating oil in concentration resulting in a final lubricating oil composition which may employ from 5 to 25 mass %, preferably 5 to 18 mass %, typically 10 to 15 mass % of the concentrate, the remainder being oil of lubricating viscosity. Representative effected amounts of such additives, when used in crankcase lubricants, are listed below. All the values listed are stated as mass percent active ingredient.

ADDITIVE	MASS % (Broad)	MASS % (Preferred)
Ashless Dispersant	0.1 - 20	1 - 8
Metal Detergents	0.1 - 15	0.2 - 9
Corrosion Inhibitor	0 - 5	0 - 1.5
Metal Dihydrocarbyl Dithiophosphate	0.1 - 6	0.1 - 4
Antioxidant	0 - 5	0.01 - 2
Pour Point Depressant	0.01 - 5	0.01 - 1.5

Antifoaming Agent	0 - 5	0.001 - 0.15
Supplemental Antiwear Agents	0 - 1.0	0 - 0.5
Friction Modifier	0 - 5	0 - 1.5
Viscosity Modifier	0.01 - 10	0.25 - 3
Basestock	Balance	Balance

All weight percents expressed herein (unless otherwise indicated) are based on active ingredient (A.I.) content of the additive, and/or upon the total weight of any additive-package, or formulation which will be the sum of the A.I. weight of each additive plus the weight of total oil or diluent.

This invention is explained below in further detail with references to examples, which are not by way of limitation, but by way of illustration.

### Example 1

#### Blend components

In the following example, oleaginous additive concentrates were made by blending the following dispersant, detergent and additives. A dispersant was made by functionalizing an ethylene-butene copolymer (46 wt. % ethylene) with a carbonyl group introduced by Koch reaction, derivatized with polyamine and borated according to the procedure described in WO-A-94/13709. The number average molecular weight of the dispersant was approximately 6000 and the hydrodynamic radius, as measured by the dynamic light scattering technique at 60°C, was approximately 30 to 40 nm. A overbased detergent containing magnesium sulfonate with a TBN of 400 and a diameter of 10±2 nm as measured the small angle neutron scattering technique. The weight ratio of the dispersant to the detergent was 3:1 on an active ingredient basis and the sum of the overbased detergent and ashless dispersant on an active ingredient basis is about 27 wt. % based on the total weight of the concentrate.

The concentrate additives used in this example included an antifoam agent, anti-oxidants, a demulsifier, zinc dihydrocarbyl dithiophosphates and friction modifiers.

5

## Example 2

### Blending Procedure

The oleaginous concentrate blending procedures were performed at 60°C. In the dispersant last procedure, the overbased detergent was mixed with the concentrate additives listed in Example 1 and allowed to mix for about 1 hour. The dispersant was then added and blended for a further hour. The blend was observed for the Weissenberg effect. The blend was stored at 60°C for 8 weeks and then tested for sediment content, which is an indication of phase separation.

The same methods were used in the detergent last procedure except that the dispersant was first mixed with the concentrate additives for about one hour, followed by the detergent.

In addition to the above procedures, the detergent was optionally mixed with a pretreatment additives for 8 hours at 95°C before being mixed with the blend. The pretreatment additive was a poly(isobutylene) succinic anhydride having a number average molecular weight of approximately 2300. The pretreatment additive was blended at 10 wt.% based on the total weight of the detergent.

The blending results for the concentrates are shown in Table 1 below.

25

Table 1

Blending procedure	Pretreatment additive	Blendability (Weissenberg)	Wt. % sediments (8 weeks at 60°C)
Dispersant last	No	Blendable, (No Weissenberg)	1.7%
Dispersant last	Yes	Blendable, (No Weissenberg)	0.2%

Detergent last	No	Blendable (No Weissenberg)	0.01%
Detergent last	Yes	Blendable, (No Weissenberg)	Trace
Control (conventional according to US Patent No. 4,938,880)	No	Unblendable (Large Weissenberg)	N/A (unblendable) —

The results in Table 1 show that when the conventional method is used (i.e., the dispersant and detergent are mixed together before adding the additives), the concentrate is unblendable. However, when the  
5 additives are first mixed with either the detergent or the dispersant, the concentrate is blendable. In addition, the results surprisingly and unexpectedly show that when the detergent is blended last, the amount of the sediments are greatly reduced. Furthermore, the results also show that the amount of sediments is reduced by pretreating the detergent with  
10 polyisobutylene succinic anhydride. Therefore, due to the procedure of the present method, it is now possible to used high molecular weight dispersants and overbased detergents at concentrations used in additive packages.

The foregoing is illustrative of the present invention and is not  
15 construed as limiting thereof. The invention is defined by the following claims with equivalents of the claims to be included therein.

CLAIMS:

1. A process for preparing an oleaginous additive concentrate comprising:
- 5 a diluent oil;  
an unborated ashless dispersant, wherein said ashless dispersant has a hydrodynamic radius of about 8 to 40 nm;  
an overbased metal detergent; and  
10 at least one other concentrate additive;  
said process comprising the steps of:  
adding said at least one other concentrate additive with either of said overbased metal detergent or said ashless dispersant in said diluent oil to form a blend; and  
15 adding to said blend either said overbased detergent or said ashless dispersant which was not added in the prior step;
- wherein the weight ratio of said ashless dispersant to said metal detergent is about 1:1 to 8:1, the sum of said ashless dispersant and said metal detergent on an active ingredient basis is about 25 to  
20 50 wt.% based upon the total weight of said concentrate, and blending temperature is about 60° to 120°C.
2. The process of claim 1 wherein said at least one other concentrate additive is selected from the group consisting of: corrosion inhibitors, metal dihydrocarbyl dithiophosphates, antioxidants, antiwear agents, friction modifiers, a low base number metal detergent having a TBN less than 50, and mixtures thereof.
- 30 3. The process of claim 2 wherein when said at least one other additive is zinc dihydrocarbyl dithiophosphate, and the temperature is about 60° to 85°C.

4. The process of claim 2 wherein said ashless dispersant is blended with said at least one concentrate additive before blending with said overbased metal detergent.
- 5  
5. The process of claim 4 wherein said dispersant has a hydrodynamic radius of about 10 to 40 nm.
6. The process of claim 4 wherein said dispersant has a hydrodynamic  
10 radius of about 15 to 40 nm.
7. The process of claim 4 wherein said overbased metal detergent has a diameter of about 4 to 40 nm.
- 15 8. The process of claim 4 wherein said overbased metal detergent is pre-treated, prior to introduction to the blending process, with about 1 to 50 wt.%, relative to said overbased detergent, of a pretreatment additive selected from the group consisting of a polyamine-derivatized poly(isobutylene) ashless dispersant having a dispersant  
20 number average molecular weight of 500 to 6000 and a poly(isobutylene) succinic anhydride with a number molecular weight of 300 to 2500.
9. The process of claim 8 wherein said pretreatment additive is a  
25 poly(isobutylene) succinic anhydride.
10. The process of claim 4 wherein said ashless dispersant is borated instead of unborated and has a hydrodynamic radius of 15 to 40 nm.
- 30 11. The process of claim 4 wherein said metal detergent is an alkali or alkaline earth metal salt of sulfonates, phenates, sulfurized

phenates, thiophosphonates, salicylates, naphthenates or other oil soluble carboxylates or mixtures thereof.

- 5 12. The process of claim 4 wherein the amount of said at least one concentrate additive is about 0.1 to 40 wt.% based on the total weight of the concentrate.
- 10 13. A lubricating oil composition prepared by admixing said concentrate prepared by the process of claim 4 with a basestock of lubricating viscosity.
14. A oleaginous concentrate comprising:  
a diluent oil;  
an unborated ashless dispersant, wherein said ashless dispersant  
15 has a hydrodynamic radius of about 8 to 40 nm;  
an overbased metal detergent; and  
at least one other concentrate additive;
- 20 wherein the weight ratio of said ashless dispersant to said metal detergent is about 1:1 to 8:1, and the sum of said ashless dispersant and said metal detergent is about 25 to 50 wt.% based upon the total weight of said concentrate.
- 25 15. The concentrate of claim 15 wherein said dispersant is borated instead of unborated and has a hydrodynamic radius of 15 to 40 nm.
16. A process for preparing an oleaginous additive concentrate comprising:
- 30 a diluent oil;  
a borated or unborated polyamine-derivatized ashless dispersant selected from the group consisting of a poly(isobutylene)

dispersant having a number average molecular weight of about 7000 to 20,000 or a weight average molecular weight of about 17,000 to 50,000, and a poly(alpha-olefin) dispersant having a number average molecular weight of about 3000 to 20,000 or a weight average molecular weight of about 6000 to 50,000;

5 an overbased metal detergent; and  
at least one other concentrate additive;  
said process comprising the steps of:  
adding said at least one other additive with either of said  
10 overbased detergent or said ashless dispersant to form a blend; and  
adding to said blend either said overbased detergent or said ashless dispersant which was not added in the prior step;

wherein the weight ratio of said ashless dispersant to said overbased metal detergent is about 1:1 to 8:1, the sum of said ashless dispersant and said overbased metal detergent on an active ingredient basis is about 25 to 50 wt.% based upon the total weight of said concentrate, and the blending temperature is about 60° to 120°C.

20

17. The process of claim 16 wherein said at least other concentrate additive is additive selected from the group consisting of: corrosion inhibitors, metal dihydrocarbyl dithiophosphates, antioxidants, antiwear agents, friction modifiers, viscosity modifiers, a low base number metal detergent having a TBN less than 50, and mixtures thereof.

25

18. The process of claim 17 wherein when said at least one other additive is zinc dihydrocarbyl dithiophosphate, and the temperature is from about 60° to 85°C.

30

19. The process of claim 16 wherein said ashless dispersant is blended with said concentrate additive before blending with said overbased metal detergent solution.
- 5 20. The process of claim 19 wherein said poly(alpha-olefin) dispersant has a number average molecular weight of about 5,000 to 10,000 or a weight average molecular weight of 10,000 to 30,000. —
- 10 21. The process of claim 19 wherein said poly(alpha olefin) dispersant is derived from an ethylene/butene alpha-olefin polymer, wherein said dispersant has a number average molecular weight of about 4,000 to 15,000 or a weight average molecular weight of 8,000 to 40,000.
- 15 22. The process of claim 19 wherein the overbased metal detergent has a diameter of about 4 to 40 nm.
- 20 23. The process of claim 19 wherein said overbased metal detergent is pre-treated, prior to introduction to the blending process, with about 1 to 50 wt.%, relative to said overbased metal detergent, of a pretreatment additive selected from the group consisting of an polyamine-derivatized poly(isobutylene) ashless dispersant having a number average molecular weight of 500 to 6000 and a poly(isobutylene) succinic anhydride with a molecular weight of 300 to 2500.
- 25 24. The process of claim 23 wherein said pretreatment additive is a poly(isobutylene) succinic anhydride with a molecular weight of 300 to 2500.
- 30 25. The process of claim 19 wherein said dispersant is borated and has a hydrodynamic radius of 15 to 40 nm.

26. The process of claim 19 wherein said metal detergent is an alkali or alkaline earth metal salt of sulfonates, phenates, sulfurized phenates, thiophosphonates, salicylates, naphthenates or other oil soluble carboxylates.
- 5
27. A lubricating oil composition prepared by admixing said concentrate prepared by the process of claim 19 with a basestock of lubricating viscosity. —
- 10 28. A oleaginous concentrate comprising:
- a diluent oil;
  - a polyamine-derivatized ashless dispersant selected from the group consisting of a poly(isobutylene) dispersant having a number average molecular weight of about 7000 to 20,000 or a weight average molecular weight of about 17,000 to 50,000, and a poly(alpha-olefin) dispersant having a number average molecular weight of about 3000 to 20,000 or a weight average molecular weight of about 6000 to 50,000;
  - 20 an overbased metal detergent; and
  - at least one other concentrate additive;
  - wherein the weight ratio of said ashless dispersant to said overbased metal detergent is about 1:1 to 8:1, and the sum of said ashless dispersant and said overbased metal detergent on an active
  - 25 ingredient basis is about 25 to 50 wt.% based upon the total weight of said concentrate.

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US 99/07794
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**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 6 C10M171/06 C10M163/00 //(C10M163/00,133:54,133:56,159:20,  
 159:22,159:24),C10N60:14

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
 IPC 6 C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 938 880 A (WADDOUPS MALCOLM ET AL) 3 July 1990 cited in the application	16-27
X	see abstract see column 3, line 7 - column 3, line 34 see column 6, line 58 - column 6, line 61 see column 11, line 54 - column 11, line 60 see column 16, line 25 - column 16, line 37 see column 23, line 43 - column 24, line 11  --- -/--	28

Further documents are listed in the continuation of box C.       Patent family members are listed in annex.

° Special categories of cited documents :

<p>*A* document defining the general state of the art which is not considered to be of particular relevance</p> <p>*E* earlier document but published on or after the international filing date</p> <p>*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>*O* document referring to an oral disclosure, use, exhibition or other means</p> <p>*P* document published prior to the international filing date but later than the priority date claimed</p>	<p>*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>*Z* document member of the same patent family</p>
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Date of the actual completion of the international search  <b>13 July 1999</b>	Date of mailing of the international search report  <b>23. 07. 99</b>
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer  <b>Perakis, N</b>

Form PCT/ISA/210 (second sheet) (July 1992)

page 1 of 2

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/07794

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 440 508 A (EXXON CHEMICAL PATENTS INC) 7 August 1991	16-27
X	see abstract see page 2, line 1 - page 2, line 14 see page 3, line 18 - page 3, column 21 see page 3, line 35 - page 3, line 39 see page 17, line 15 - page 17, line 30 see page 19, line 7 - page 19, line 18 see page 20, line 10 - page 20, line 16 see page 20, line 59 - page 22, line 49 see page 23, line 50 - page 23, line 54 -----	28

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US 99/07794

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: 1-15  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
see FURTHER INFORMATION sheet PCT/ISA/210
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

Claims Nos.: 1-15

Unusual parameter

The subject-matter of claims 1-15 includes an unusual parameter which is "said ashless dispersant has a hydrodynamic radius of about 8 to 40 nm". The ISA considers that this parameter renders a meaningful comparison of these claims with the prior art impossible (cf. Article 17(2)a)ii) PCT). By using this parameter the claims lack clarity and support in the description (Articles 5 and 6 PCT). The unusual parameter taken alone, and not in combination with the molecular weight of the ashless dispersant, firstly does not provide an enabling disclosure to the person skilled in the art (Article 5 PCT) and secondly does not solve the technical problem set (Article 6 PCT: essential features are missing). There is a non ambiguous statement in the application, page 6, line 24 to page 7, line 5 considered under the light of the statements at page 4, lines 3-5 and page 5, lines 11-15, which explains (i) that the technical problem to be solved concerns exclusively the higher molecular weight dispersants since the set technical problem does not exist for the lower molecular weight dispersants and (ii) that lower molecular weight dispersant may have a hydrodynamic radius of about 8 to 40, depending on the branching of the chains. Since no meaningful search can be carried out for claims 1-15, the search is limited to claims 16-28.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/07794

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