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(54) An anti-shudder additive composition and lubricating oil composition containing the same

(57) An anti-shudder additive composition comprising at least one neutral phosphite and at least one phosphorous-free hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the additive is used in transmission fluids to decrease shudder.

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Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention is directed to an improved anti-shudder additive composition that is used in automatic transmission fluids and continuously variable transmissions; and it is also directed to the process of making the same.

DESCRIPTION OF THE RELATED ART

[0002] Srinivasan et al., U.S. Publication No. 2002/0151441, is directed to an automatic transmission fluid with improved anti-shudder properties. The automatic transmission fluids described contain at least 0.2 wt% of a metal-containing detergent, a dispersant, and a mixture of friction modifiers. This automatic transmission fluid is used in electronically controlled converter clutch applications.

[0003] Ohtani et al., U.S. Patent Number 5,441,656 is directed to an automatic transmission fluid (ATF) that is used to overcome shudder. This ATF consists essentially of (i) an N-aliphatic hydrocarbyl-substituted diethanolamine in which the N-aliphatic hydrocarbyl substituent is at least one straight chain aliphatic hydrocarbyl group free of acetylenic unsaturation and having in the range of 14 to 20 carbon atoms, and (ii) an N-aliphatic hydrocarbyl-substituted trimethylenediamine in which the N-aliphatic hydrocarbyl-substituent is at least one straight chain aliphatic hydrocarbyl group free of acetylenic unsaturation and having in the range of about 14 to about 20 carbon atoms.

[0004] Kugimiya, Takanori, "Effects of Additives of ATF and Components of Friction Material for AT on μ-v Characteristics", Japanese Journal of Tribology, Vol. 45, Number 3, 2000. This article describes the effects of typical additives applied to automatic transmission fluids and of each component (graphite, cashew dust, aramid fiber and carbon filter) applied to paper-based friction materials on friction coefficient versus sliding velocity (μ-v) characteristics.

[0005] Watts et al., U.S. Patent No. 6,660,695 discloses a power transmission fluid comprising a mixture of a major amount of a lubricating oil and an effective amount of a performance enhancing additive combination comprising: (a) at least one organic phosphite; (b) a calcium detergent and (c) a friction modifier.

[0006] Watts et al., U.S. Patent No. 5,942,472 discloses a power transmission fluid that is formed which comprise a major amount of lubricating oil and an additive combination comprising (a) a viscosity modifier having a molecular weight no greater than about 175, 000 atomic mass units, and (b) a selected friction modifier.

[0007] Watts et al., U.S. Patent No. 6,337,309 discloses a lubricating composition for a continuously variable transmission. This composition is zinc free and comprises an (a) ashless polyisobutenyl succinimide dispersant; (b) at least one organic thioether phosphite; (c) a calcium phenate overbased detergent at a concentration such that the total amount of calcium in the fluid is less than about 500 ppm; (d) friction modifiers comprising one or more succinimides and one or more ethoxylated amines; and (e) a primary amide of a long chain carboxylic acid.

[0008] Jaffe, U.S. Patent No. 4,342,709 discloses a process of producing diethyl phosphite by reacting an excess of triethyl phosphite with phosphorous acid.

[0009] Watts et al., U.S. Patent No. 6,127,323 discloses a composition and method of improving the anti-shudder durability of power transmitting fluids, particularly those in automatic transmission fluids. This composition comprises a mixture of (1) a major amount of a lubricating oil and (2) an anti-shudder improving effective amount of an additive composition comprising (a) an oil-soluble alkyl phosphonate, (b) an ashless dispersant, and (c) a metallic detergent.

[0010] Watts et al., U.S. Patent No. 6,225,266 discloses a continuously variable transmission fluid that is zinc-free and comprises (a) an additive dispersant; (b) at least one organic phosphite; (c) a calcium detergent; (d) one or more friction modifiers selected from the group consisting of: succinimides and ethoxylated amines; and (e) a primary amide of a long chain carboxylic acid.

BRIEF SUMMARY OF THE INVENTION

[0011] Accordingly, in its broadest embodiment, the present invention is directed to an anti-shudder additive composition comprising:

(a) At least one neutral phosphite compound; and

(b) At least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms,

wherein the additive composition does not comprise an ethoxylated amine, and wherein the additive composition does not comprise a primary amide of a long chain carboxylic acid, and provided that if the lubricating oil composition also contains a monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.

[0012] The present invention is further directed to a lubricating oil composition comprising:

a major amount of an oil of lubricating viscosity;

(b) an effective amount of an anti-shudder additive composition comprising:

(i) At least one neutral phosphite compound, and

(ii) At least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms; and

wherein the additive composition does not comprise an ethoxylated amine, and wherein the additive composition does not comprise a primary amide of a long chain carboxylic acid, and provided that if the lubricating oil composition also contains a monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.

[0013] The present invention is further directed to a method of making an anti-shudder additive composition comprising:

mixing from about 0.1 wt% to about 90.9 wt% of at least one neutral phosphite compound with from about 9.1 wt% to about 99.9 wt% of at least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, in the absence of an ethoxylated amine and a primary amide of a long chain carboxylic acid, and provided that if the additive composition also contains a monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.

[0014] The present invention is further directed to a method of making a transmission fluid comprising:

mixing from about 0.11 wt% to about 11.0 wt% of the anti-shudder additive composition of claim 2 with a major amount of an oil of lubricating viscosity.

[0015] A method of reducing shudder in a transmission comprising:

(a) mixing an oil of lubricating viscosity with a shudder reducing effective amount of an anti-shudder additive composition comprising:

(i) at least one neutral phosphite compound;
(ii) at least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms;
in the absence of an ethoxylated amine and a primary amide of a long chain carboxylic acid; and provided that if the lubricating oil composition also contains monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.

(b) adding the mixture of (a) to a transmission.

[0016] It is therefore an object of the invention to provide an improved shudder control additive to be used in an oil of lubricating viscosity.

DETAILED DESCRIPTION OF THE INVENTION

[0017] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and 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.

[0018] Vehicular transmissions supply the power created by the engine to the wheels of the vehicle. Not only is the transmission's function important to the working of the vehicle, but also it is very complex. The transmission is comprised of numerous components, such as clutches with plates or bands, a torque converter, gears, and optionally, a wet clutch among others. Transmissions are usually either manual, automatic, or continuosly variable. Because of the variety of functions performed by the ATF, it is essential to carefully select ATF additives. Transmission fluid may comprise numerous additives such as dispersants, friction modifiers, anti-wear agents, oxidation inhibitors, detergents, and others to name a few. Friction modifiers are often used to control shudder. Without a suitable fluid, the transmission would not operate at its peak, and the cost of operating the car would may be increased.

[0019] Until recently, the clutch mechanism used in most automatic transmissions was a continuous slipping torque converter clutch (CSTCC). The CSTCC require specific friction requirements that must be maintained in order to achieve fuel efficiency and a smooth ride. However, if the friction does not increase with the speed, as required with a CSTCC, then "stick-slip" occurs. "Stick-slip" is oscillatory relative motion of two or more surfaces in contact due to fluctuations in the frictional forces as the contact time or the velocity of the surfaces change. In transmissions, stick-slip can result in vibrations in the driveline that are detected in the ride of the vehicle; such vibrations are referred to as shudder. Automatic transmission fluids often contain anti-shudder additives to decrease the stick-slip phenomenon.

[0020] A common way to reduce shudder is by adding friction modifiers to the fluid. Friction modifiers are components that reduce friction between surfaces when mild sliding occurs. In general, these components consists of a long linear hydrocarbon chain and a small polar functional group. Examples of friction modifiers include: fatty acids, fatty amines, fatty amides, and esters of fatty acids. Often, friction modifiers are corrosive towards Pb and Cu, common materials in bushings. Also, friction modifiers can cause an undesirable decrease in clutch capacity.

[0021] Now, however, automobile manufacturers have begun to use an electronically controlled converter clutch (ECCC) as the clutch mechanism. This type of clutch mechanism is configured differently from the CSTCC and has different energy densities and higher operating temperatures. Similarly to the CSTCC, shudder must also be minimized in the ECCC in order to maintain optimum operating conditions. Accordingly, transmission fluids must also be suitable for this type of clutch mechanism.

[0022] Accordingly, a novel, non-obvious transmission fluid has been discovered that may be used to decrease stick-slip and, thereby, control shudder without adding a friction modifier. The transmission fluids (TF) of the present invention are particularly effective controlling initial shudder when used in automatic transmissions or continuously variable transmissions.

Definitions

[0023] The following terms used with the description are defined as such:

> The term "shudder" describes friction-induced vibration. The vibration is caused by a stick-slip phenomena and is related to the behavior of the friction coefficient relative to the velocity of metal surfaces sliding on each other.
>
> The term "finished oil" describes a lubricating oil composition that comprises additives.
>
> The term "succinimide," which includes alkenyl or alkyl mono-, bis-succinimides and other higher analogs, has been generally accepted as meaning the product of a reaction of an alkenyl substituted succinic acid or anhydride with a polyamine.
>
> The term "bissuccinimide" describes the reaction product that is primarily a bissuccinimide that may contain up to about 5 wt% monosuccinimide.

The Anti-Shudder Additive Composition

[0024] The anti-shudder additive composition of the present invention comprises an oil-soluble additive composition. This anti-shudder additive composition may be used in lubricating oils, such as but not limited to, automatic transmission fluids and continuously variable transmission fluids, and are particularly effective when used in transmission fluids for electronically controlled converter clutches. The anti-shudder additive composition of the present invention comprises (a) at least one neutral phosphite compound and least one phosphorous-free dispersant selected from (b) at least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms, in a proportion that drastically reduces shudder, or friction induced vibration, that is caused by stick-slip phenomena. Because the present invention reduces frictionally induced vibration, a friction modifier is optionally added to the additive composition and/ or the lubricating oil composition. All types of friction modifiers may be added to the anti-shudder additive composition and/or the lubrication oil composition except for ethoxylated amines. The anti-shudder additive composition or the lubricating oil composition does not comprise a primary amide of a long chain carboxylic acid. Furthermore, if the lubricating oil composition also contains monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7: 3. More preferred, the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7.5: 2.5. Even more preferred, the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 8:2. Most preferred, the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 9:1.

Hydrocarbyl Substituted Succinic Dispersant

[0025] In the present invention, a hydrocarbyl substituted succinic dispersant is mixed with a neutral phosphite compound thereby producing an anti-shudder additive composition. In one embodiment of the invention, the hydrocarbyl substituted succinic dispersant is a hydrocarbyl bissucinimide. More preferred the bissuccinimide is a borated bissuccinimide.

[0026] The bissucciminide is the completed reaction product from reaction between one or more polyamine reactants and a hydrocarbon substituted succinic acid or anhydride (or like succinic acylating agent), and is intended to encompass compounds wherein the product may have amide, amidine, and/or salt linkages in addition to the imide linkage of the type that results from the reaction of a primary amino group and anhydride moiety. The bissuccinimide is prepared according to methods that are well known in the art, including but not limited to, the following:

> Certain fundamental types of succinimides and related materials encompassed by the term of art "succinimide" are taught in U.S. Pat. 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 "succinimide" is understood in the art to include many of the amide, imide and amidine species which

are also formed by this reaction. The predominant product however is succinimide and this term has been generally accepted as meaning the product of a reaction of an alkenyl substituted succinic acid or anhydride with a polyamine as shown in reaction (1) above.

[0027] As used herein, included within this term are the alkenyl or alkyl mono-, bis-succinimides and other higher analogs.

A(1) Succinic Anhydride

[0028] The preparation of the alkenyl-substituted succinic anhydride by reaction with a polyolefin and maleic anhydride has been described, e.g., U.S. Pat. Nos. 3,018,250 and 3,024,195. Such methods include the thermal reaction of the polyolefin with maleic anhydride and the reaction of a halogenated polyolefin, such as a chlorinated polyolefin, with maleic anhydride. Reduction of the alkenyl-substituted succinic anhydride yields the corresponding alkyl derivative. Alternatively, the alkenyl substituted succinic anhydride may be prepared as described in U.S. Pat. Nos. 4,388,471 and 4,450,281 which are totally incorporated herein by reference.

[0029] Polyolefin polymers for reaction with the maleic anhydride are polymers comprising a major amount of C_2 to C_5 mono-olefin, e.g., ethylene, propylene, butylene, isobutylene and pentene. The polymers can be homopolymers such as polyisobutylene as well as copolymers of 2 or more such olefins such as copolymers of: ethylene and propylene, butylene, and isobutylene, etc. Other copolymers include those in which a minor amount of the copolymer monomers, e.g., 1 to 20 mole percent is a C_4 to C_8 nonconjugated diolefin, e.g., a copolymer of isobutylene and butadiene or a copolymer of ethylene, propylene and 1,4-hexadiene, etc.

[0030] The polyolefin polymer, the alkenyl or alkyl moiety which is represented as R, usually contains from about 10 to 300 carbon atoms, although preferably 10 to 200 carbon atoms; more preferably 12 to 100 carbon atoms and most preferably 20-100 carbon atoms.

[0031] A particularly preferred class of olefin polymers comprises the polybutenes, which are prepared by polymerization of one or more of 1-butene, 2-butene and isobutene. Especially desirable are polybutenes containing a substantial proportion of units derived from isobutene. The polybutene may contain minor amounts of butadiene which may or may not be incorporated in the polymer. Most often the isobutene units constitute 80%, preferably at least 90%, of the units in the polymer. These polybutenes are readily available commercial materials well known to those skilled in the art. Disclosures thereof will be found, for example, in U.S. Pat. Nos. 3,215,707; 3,231,587; 3,515,669; and 3,579,450, as well as 3,912,764. The above are incorporated by reference for their disclosures of suitable polybutenes.

[0032] In addition to the reaction of a polyolefin with maleic anhydride, many other alkylating hydrocarbons may likewise be used with maleic anhydride to produce alkenyl succinic anhydride. Other suitable alkylating hydrocarbons include cyclic, linear, branched and internal or alpha olefins with molecular weights in the range 100-4,500 or more with molecular weights in the range of 200-2,000 being more preferred. For example, alpha olefins obtained from the thermal cracking of paraffin wax. Generally, these olefins range from 5-20 carbon atoms in length. Another source of alpha olefins is the ethylene growth process which gives even number carbon olefins. Another source of olefins is by the dimerization of alpha olefins over an appropriate catalyst such as the well known Ziegler catalyst. Internal olefins are easily obtained by the isomerization of alpha olefins over a suitable catalyst such as silica.

A(2) Polyamine

[0033] The polyamine employed to prepare the alkenyl or alkyl succinimides is preferably a polyamine having from 2 to about 12 amine nitrogen atoms and from 2 to about 40 carbon atoms. The polyamine is reacted with an alkenyl or alkyl succinic anhydride to produce the polyamino alkenyl or alkyl succinimide, employed in this invention. The polyamine is so selected so as to provide at least one basic amine per succinimide. Since the reaction of a nitrogen of a polyamino alkenyl or alkyl succinimide to form a hydrocarbyl oxycarbonyl, a hydroxy hydrocarbyl oxycarbonyl or a hydroxy polyoxyalkylene oxycarbonyl is believed to efficiently proceed through a secondary or primary amine, at least one of the basic amine atoms of the polyamino alkenyl or alkyl succinimide must either be a primary amine or a secondary amine. Accordingly, in those instances in which the succinimide contains only one basic amine, that amine must either be a primary amine or a secondary amine. The polyamine preferably has a carbon-to-nitrogen ratio of from about 1:1 to about 10:1.

[0034] The polyamine portion of the polyamino alkenyl or alkyl succinimide may be substituted with substituents selected from (A) hydrogen, (B) hydrocarbyl groups of from 1 to about 10 carbon atoms, (C) acyl groups of from 2 to about 10 carbon atoms, and (D) monoketo, monohydroxy, mononitro, monocyano, lower alkyl and lower alkoxy derivatives of (B) and (C). "Lower", as used in terms like lower alkyl or lower alkoxy, means a group containing from 1 to about 6 carbon atoms. At least one of the substituents on one of the amines of the polyamine is hydrogen, e.g., at least one of the basic nitrogen atoms of the polyamine is a primary or secondary amino nitrogen atom.

[0035] Hydrocarbyl, as used in describing the polyamine components of this invention, denotes an organic radical composed of carbon and hydrogen which may be aliphatic, alicyclic, aromatic or combinations thereof, e.g., aralkyl. Preferably, the hydrocarbyl group will be relatively free of aliphatic unsaturation, i.e., ethylenic and acetylenic, particularly acetylenic unsaturation. The substituted polyamines of the present invention are generally, but not necessarily, N-substituted polyamines. Exemplary hydrocarbyl groups and substituted hydrocarbyl groups include alkyls such as methyl, ethyl, propyl, butyl, isobutyl, pentyl, hexyl, octyl, etc., alkenyls such as propenyl, isobutenyl, hexenyl, octenyl, etc., hydroxyalkyls, such as 2-hydroxyethyl, 3-hydroxypropyl, hydroxyisopropyl, 4-hydroxybutyl, etc., ketoalkyls, such as 2-ketopropyl, 6-ketooctyl, etc., alkoxy and lower alkenoxy alkyls, such as ethoxyethyl, ethoxypropyl, propoxyethyl, propoxypropyl, 2-(2-ethoxyethoxy)ethyl, 2-(2-(2-ethoxyethoxy)ethoxy)ethyl, 3,6,9,12-tetraoxatetradecyl, 2-(2-ethoxyethoxy)hexyl, etc. The acyl groups of the aforementioned (C) substituents are such as propionyl, acetyl, etc. The more preferred substituents are hydrogen, C_1 -C_6 alkyls and C_1 -C_6 hydroxyalkyls.

[0036] In a substituted polyamine the substituents are found at any atom capable of receiving them. The substituted atoms, e.g., substituted nitrogen atoms, are generally geometrically inequivalent, and consequently the substituted amines finding use in the present invention can be mixtures of mono- and polysubstituted polyamines with substituent groups situated at equivalent and/or inequivalent atoms.

[0037] The more preferred polyamine finding use within the scope of the present invention is a polyalkylene polyamine, including alkylene diamine, and including substituted polyamines, e.g., alkyl substituted polyalkylene polyamine. Preferably, the alkylene group contains from 2 to 6 carbon atoms, there being preferably from 2 to 3 carbon atoms between the nitrogen atoms. Such groups are exemplified by ethylene, 1,2-propylene, 2,2-dimethylpropylene, trimethylene, etc. Examples of such polyamines include ethylene diamine, diethylene triamine, di(trimethylene)triamine, dipropylene triamine, triethylene tetramine, tripropylene tetramine, tetraethylene pentamine, and pentaethylene hexamine. Such amines encompass isomers such as branched-chain polyamines and the previously mentioned substituted polyamines, including hydrocarbyl-substituted polyamines. Among the polyalkylene polyamines, those containing 2-12 amine nitrogen atoms and 2-24 carbon atoms are especially preferred, and the C_2 -C_5 alkylene polyamines are most preferred, in particular, the lower polyalkylene polyamines, e.g., ethylene diamine, dipropylene triamine, etc.

[0038] The polyamine component also may contain heterocyclic polyamines, heterocyclic substituted amines and substituted heterocyclic compounds, wherein the heterocycle comprises one or more 5-6 membered rings containing oxygen and/or nitrogen. Such heterocycles may be saturated or unsaturated and substituted with groups selected from the aforementioned (A), (B), (C) and (D). The heterocycles are exemplified by piperazines, such as 2-methylpiperazine, N-(2-hydroxyethyl) piperazine, 1,2-bis-(N-piperazinyl)ethane, and N,N'-bis (N-piperazinyl)piperazine, 2-methylimidazoline, 3-aminopiperidine, 2-aminopyridine, 2-(3-aminoethyl)-3-pyrroline, 3-aminopyrrolidine, N-(3-aminopropyl)-morpholine, etc. Among heterocyclic compounds, the piperazines are preferred.

[0039] Typical polyamines that can be used to form the compounds of this invention include the following: ethylene diamine, 1,2-propylene diamine, 1,3-propylene diamine, diethylene triamine, triethylene tetramine, hexamethylene diamine, tetraethylene pentamine, methylaminopropylene diamine, N-(betaaminoethyl)piperazine, N,N'-di(betaaminoethyl)piperazine, N,N'-di(beta-aminoethyl)-imidazolidone-2, N-(beta-cyanoethyl) ethane-1,2-diamine, 1,3,6,9-tetraaminooctadecane, 1,3,6-triamino-9-oxadecane, N-(beta-aminoethyl)diethanolamine, N-methyl-1,2-propanediamine, 2-(2-aminoethylamino)-ethano1,2-[2-(2- aminoethylamino) ethylamino]-ethanol.

[0040] Another group of suitable polyamines are the propyleneamines, (bisaminopropylethylenediamines). Propyleneamines are prepared by the reaction of acrylonitrile with an ethyleneamine, for example, an ethyleneamine having the formula $H_2 N(CH_2 CH NH)_z H$ wherein Z is an integer from 1 to 5, followed by hydrogenation of the resultant intermediate. Thus, the product prepared from ethylene diamine and acrylonitrile would be $H_2 N (CH_2)_3 NH(CH_2)_2 NH(CH_2)_3 NH_2$.

[0041] In many instances the polyamine used as a reactant in the production of succinimides of the present invention is not a single compound but a mixture in which one or several compounds predominate with the average composition indicated. For example, tetraethylene pentamine prepared by the polymerization of aziridine or the reaction of dichloroethylene and ammonia will have both lower and higher amine members, e.g., triethylene tetramine, substituted piperazines and pentaethylene hexamine, but the composition will be largely tetraethylene pentamine and the empirical formula of the total amine composition will closely approximate that of tetraethylene pentamine. Finally, in preparing the succinimide for use in this invention, where the various nitrogen atoms of the polyamine are not geometrically equivalent, several substitutional isomers are possible and are encompassed within the final product. Methods of preparation of polyamines and their reactions are detailed in Sidgewick's "The Organic Chemistry of Nitrogen", Clarendon Press, Oxford, 1966; Noller's "Chemistry of Organic Compounds", Saunders, Philadelphia, 2nd Ed., 1957; and Kirk-Othmer's "Encyclopedia of Chemical Technology", 2nd Ed., especially Volumes 2, pp. 99-116.

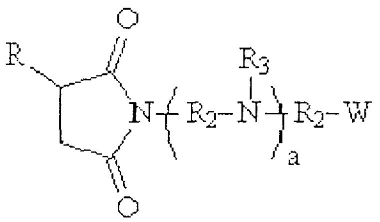
[0042] Examples of suitable polyamines include tetraethylene pentamine, pentaethylene hexamine, and Dow HPA-X heavy polyamine (number average molecular weight of 275, available from Dow Chemical Company, Midland, Michigan). Such amines encompass isomers, such as branched-chain polyamines, and the previously mentioned substituted polyamines, including hydrocarbyl-substituted polyamines. HPA-X heavy polyamine ("HPA-X") contains an average of approximately 6.5

amine nitrogen atoms per molecule. Such heavy polyamines generally afford excellent results.

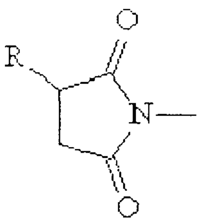
[0043] The reaction of a polyamine with an alkenyl or alkyl succinic anhydride to produce the polyamino alkenyl or alkyl succinimides is well known in the art and is disclosed in U.S. Pat. Nos. 2,992,708; 3,018,291; 3,024,237; 3,100,673; 3,219,666; 3,172,892 and 3,272,746. The above are incorporated herein by reference for their disclosures of preparing alkenyl or alkyl succinimides.

[0044] As noted above, the term "polyamino alkenyl or alkyl succinimide" refers to both polyamino alkenyl or alkyl mono- and bis-succinimides and to the higher analogs of alkenyl or alkyl poly succinimides. Preparation of the bis- and higher analogs may be accomplished by controlling the molar ratio of the reagents. For example, a product comprising predominantly mono- or bissuccinimide can be prepared by controlling the molar ratios of the polyamine and succinic anhydride. Thus, if one mole of polyamine is reacted with one mole of an alkenyl or alkyl substituted succinic anhydride, a predominantly mono-succinimide product will be prepared. If two moles of an alkenyl or alkyl substituted succinic anhydride are reacted per mole of polyamine, a bissuccinimide is prepared. Higher analogs may likewise be prepared.

[0045] A particularly preferred class of polyamino alkenyl or alkyl succinimides employed in the process of the instant invention may be represented by Formula II:



wherein R is alkenyl or alkyl of from 10 to 300 carbon atoms; R_2 is alkylene of 2 to 10 carbon atoms; R_3 is hydrogen, lower alkyl or lower hydroxy alkyl; a is an integer from 0 to 10; and W is $--NH_2$ or represents a group of Formula III:



wherein R is alkenyl or alkyl of from 10 to 300 carbon atoms; with the proviso that when W is the group of Formula III above, then a is not zero and at least one of R_3 is hydrogen.

[0046] As indicated above, the polyamine employed in preparing the succinimide is often a mixture of different compounds wherein the resulting succinimide has an average composition indicated as the Formula II. Accordingly, in Formula II each value of R_2 and R_3 may be the same as or different from other R_2 and R_3.

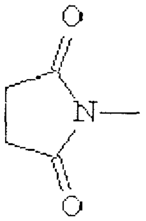
[0047] Preferably R is alkenyl or alkyl, more preferably 10 to 200 carbon atoms, and most preferably 20 to 100 carbon atoms.

[0048] Preferably R_2 is alkylene of 2 to 6 carbon atom and most preferably is either ethylene or propylene.

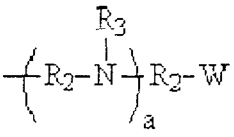
[0049] Preferably, R_3 is hydrogen.

[0050] Preferably, a is an integer from 1 to 6.

[0051] In formula II, the polyamino alkenyl or alkyl succinimides may be conveniently viewed as being composed of three moieties that is the alkenyl or alkyl moiety R, the succinimide moiety represented by the formula:



and the poiyamino moiety represented by the group



$$-\left(R_2-\overset{R_3}{\overset{|}{N}}\right)_a R_2-W$$

[0052] The preferred alkylene polyamines employed in this reaction are generally represented by the formula:

$$H_2\,N\text{-}(R'\text{-}NH)_a\text{-}R'\text{-}NH_2$$

wherein R' is an alkylene moiety of 2 to 10 carbon atoms and a is an integer from about 0 to 10. However, the preparation of these alkylene polyamines do not produce a single compound and cyclic heterocycles, such as piperazine, may be included to some extent in the alkylene diamines.

[0053] Additionally, the succinimide may be prepared by other methods including, but not limited to, those described in the following: Harrison et al., U.S. Patent No. 5,616,668; Harrison et al., U.S. Patent No. 5,565,528; Harrison et al., U.S. Patent No. 5,753,597; Harrison et al., U.S. Patent No. 6,617,396; Harrison et al., U.S. Patent No. 6,451,920; and Wollenberg et al., U.S. Patent No. 4,746,446. The contents of these references are herein incorporated by reference in their entireties.

[0054] The post-treated succinimide is made in accordance with methods that are well known in the art including, but not limited to the following: Harrison et al., U.S. Patent No. 5,716,912; Harrison et al., U.S. Patent No. 5,821,205; Harrison et al., U.S. Patent No. 5,849,676; Harrison et al., U.S. Patent No. 5,872,083; Harrison et al., U.S. Patent No. 6,015,776; Harrison et al., U.S. Patent No. 6,107,450; Harrison et al., U.S. Patent No. 6,146,431; Harrison et al., U.S. Patent No. 6,358,892. Essentially, the phosphorous-free nitrogen containing dispersant may also be post treated, such as by reacting them with boric acid or a similar boron compound to form borated dispersants. In addition to boric acid (boron acid), examples of suitable boron compounds include boron oxides, boron halides and esters of boric acid. Generally from about 0.1 equivalents to 10 equivalents of boron compound to the phosphorous-free nitrogen containing dispersant may be employed.

Hydrocarbyl Substituted Succinic Ester of a Polyol

[0055] In another embodiment of the present invention, a hydrocarbyl substituted succinic ester of a polyol may be mixed with the neutral phosphite compound. Such succinic esters are usually the reaction product of hydrocarbyl substituted succinic acids or anhydrides (e.g. polyisobutenylsuccinic anhydride) with polyols (e.g. pentaerythritol). The hydrocarbyl substituted ester of a polyol may be prepared as described in U.S. Patent No. 3,381,022, which is herein incorporated by reference, and U.S. Patent No. 4,173,540, which is herein incorporated by reference.

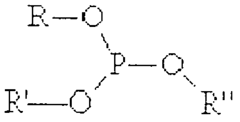
[0056] Suitable polyols include ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, dipropylene glycol, tripropylene glycol, dibutylene glycol, tributylene glycol, and other alkylene glycols in which the alkylene group contains from two to eight carbon atoms. Other useful polyhydric alcohols include glycerol, pentaerythritol, 1,2-butanediol, 2,3-hexanediol, 2,4-hexanediol, pinacol, erythritol, arabitol, sorbitol, mannitol, 1,2 - cyclohexanediol, and xylene glycol. An especially preferred class of polyhydric alcohols are those having at least three hydroxyl groups, such as pentaerythritol, dipentaerythritol, tripentaerythritol, sorbitol and mannitol. Most preferred is pentaerythritol.

[0057] Additionally, the ester of pentaerythritol, used in this invention may be purchased from Chevron Oronite Company, LLC San Ramon, California and may also be purchased from The Lubrizol Corporation, Wycliffe, Ohio.

Neutral Phosphite

[0058] In the present invention, preferred neutral phosphite compounds include trihydrocarbyl phosphites. More preferred trihydrocarbyl phosphites include trialkyl phosphites. Most preferred trialkyl phosphites include trilauryl phosphite. In addition to processes that are well known in the art, trilauryl phosphite is manufactured and sold by Rhodia, Inc., Cranbury, New Jersey and is marketed under the trade name Duraphos TLP. According to the MSDS for Duraphos TLP, this compound contains about 90 wt% trilauryl phosphite, 7.5 wt% of dilauryl hydrogen phosphite and less than 0.5 wt% of phenol.

[0059] A neutral phosphite compound, such as trialkyl phosphite, is represented by the following formula:



wherein R, R', and R" are independently hydrocarbyl groups having from about 1 to 24 carbon atoms, preferably from about 4 to about 18 carbon atoms, and more preferably from about 6 to 16 carbon atoms. The R, R', and R" groups may be saturated or unsaturated, and straight or branched chain aliphatic hydrocarbyl radical. Representative examples of suitable R, R', and R" groups include methyl, ethyl, n-propyl, i-propyl, n-butyl, i-butyl, t-butyl, n-propenyl, n-butenyl, n-hexyl, nonylphenyl, n-dodecyl, n-dodecenyl, hexadecyl, octadecenyl, stearyl, i-stearyl, hydroxystearyl, and the like. Preferably, R, R' and R" are each alkyl or aryl.

[0060] Preferred neutral phosphite compounds include trihydrocarbyl phosphites. More preferred trihydrocarbyl phosphites include trialkyl phosphites. Most preferred trialkyl phosphites include trilauryl phosphite, which is manufactured and sold by Rhodia, Inc. and is marketed under the trade name Duraphos TLP.

[0061] In addition to being purchased from Rhodia, Inc., trialkyl phosphite may be synthesized from well known processes such as that described in U.S. Patent No. 2,848,474 which is herein incorporated by reference.

The Lubricating Oil Composition

[0062] The lubricating oil composition of the present invention contains a major amount of oil of lubricating viscosity and a minor amount of the anti-shudder additive composition, which comprises (a) at least one neutral phosphite compound and at least one dispersant selected from and (b) at least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms, wherein the additive composition does not comprise an ethoxylated amine; and wherein the additive composition does not comprise a primary amide of a long chain carboxylic acid, provided that if the lubricating oil composition also contains monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3. More preferred the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7.5:2.5. Even more preferred, the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 8:2. Most preferred, the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is 9:1.

[0063] An effective amount of the anti-shudder additive composition is added to a base oil that is sufficient to lubricate gears and other components which are present in automatic and continuously variable transmissions, as well as reduce the shudder that is caused by friction induced vibration. Typically, the lubricating oil composition of the present invention comprises a major amount of oil of lubricating viscosity and a minor amount of the anti-shudder additive package.

[0064] Specifically, the lubricating oil composition comprises (a) at least one neutral phosphite compound comprising preferably from about 0.01 wt% to about 1.00 wt% trihydrocarbyl phosphite, such as trialkyl phosphite, such as trilauryl phosphite. More preferably, from about 0.10 wt% to about 0.85 wt% trihydrocarbyl phosphite, such as trialkyl phosphite, such as trilauryl phosphite, is present in the lubricating oil composition. Even more preferably, from about 0.20 wt% to about 0.70 wt% trihydrocarbyl phosphite, such as trialkyl phosphite, such as trilauryl phosphite, is present in the lubricating oil composition. Most preferably, from about 0.30 wt% to about 0.65 wt% trihydrocarbyl phosphite, such as trialkyl phosphite, such as trilauryl phosphite, is present in the lubricating oil composition.

[0065] In one embodiment, component (b) of the lubricating oil composition is a hydrocarbyl bissuccinimide, wherein the hydrocarbyl substituent has at least 50 carbon atoms, comprising preferably from about 0.10 wt% to about 10.0 wt% of bissuccinimide, such as post-treated bissuccinimide, such as borated bissucinimide. More preferably, from about 0.20 wt% to about 8.0 wt% of bissuccinimide, such as post-treated bisuccinimde, such as borated bissuccinimide is in the lubricating oil composition. More preferably, from about 0.3 wt% to about 6.0 wt% of bissuccinimde, such as post-treated bissuccinimide, such as borated bissuccinimide is in the lubricating oil composition. Most preferably, from about 0.4 wt% to about 5.0 wt% of bissucnimide, such as post-treated bissuccinimide, such as borated bissuccinimide is in the lubricating oil composition.

[0066] In another embodiment, component (b) of the lubricating oil composition is a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms, comprising from about 0.10 wt% to about 10.0 wt% of an ester of polyalcohol, such as an ester of pentaerythritol. More preferably, from about 0.20 wt% to about 8.0 wt% of an ester of polyalcohol, such as an ester of pentaerythritol is in the lubricating oil composition. More preferably, from about 0.3 wt% to about 5.0 wt% of an ester of polyalcohol, such as an ester of pentaerythritol is in the lubricating oil composition. Most preferably, from about 0.4 wt% to about 5.0 wt% of an ester of polyalcohol, such as an ester of pentaerythritol is in the lubricating oil composition.

[0067] In a further embodiment of the present invention, component (b) of the lubricating oil composition may be a mixture of the hydrocarbyl bissuccinimide and the hydrocarbyl substituted succinic ester of a polyol.

[0068] 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 C_6 to C_{12} 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 tetracaproate, 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.

[0069] 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, Groups I-IV and mixtures thereof. Most preferred base oils are Group II, III and mixtures thereof. Preferred base oils include a blend of Chevron Phillips PAO 4 cSt, which may be purchased from Chevron Phillips, Woodlands, Texas, and RLOP 100 N, which may be purchased from ChevronTexaco Corporation, San Ramon, California. Another preferred base oil is Petro-Canad 4 which may be purchased from Petro-Canada, Calgary-Alberta, Canada.

[0070] Additionally, other additives well known in lubricating oil compositions may be added to the additive composition of the present invention to complete a finished oil.

Other Additives

[0071] The following additive components are examples of some of the components that can be favorably employed in the present invention. These examples of additives are provided to illustrate the present invention, but they are not intended to limit it:

2. Metal Detergents

[0072] Sulfurized or unsulfurized alkyl or alkenyl phenates, alkyl or alkenyl aromatic sulfonates, borated sulfonates, sulfurized or unsulfurized metal salts of multihydroxy alkyl or alkenyl aromatic compounds, alkyl or alkenyl hydroxy aromatic sulfonates, sulfurized or unsulfurized alkyl or alkenyl naphthenates, metal salts of alkanoic acids, metal salts of an alkyl or alkenyl multiacid, and chemical and physical mixtures thereof.

3. Anti-Oxidants

[0073] Anti-oxidants reduce the tendency of mineral oils to deteriorate in service which deterioration is evidenced by the products of oxidation such as sludge and varnish-like deposits on the metal surfaces and by an increase in viscosity. 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-butylphenol, 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. Other types of oxidation inhibitors include metal dithiocarbamate (e.g., zinc dithiocarbamate), and 15-methylenebis(dibutyldithiocarbamate).

4. Anti-Wear Agents

[0074] As their name implies, these agents reduce wear of moving metallic parts. Examples of such agents include, but are not limited to, phosphates which comprise no more than 0.08 wt% of the lubricating oil composition , carbarmates, esters, and molybdenum complexes.

5. Rust Inhibitors (Anti-Rust Agents)

[0075]

a) Nonionic polyoxyethylene surface active agents: 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 mono-oleate, and polyethylene glycol monooleate.

b) Other compounds: stearic acid and other fatty acids, dicarboxylic acids, metal soaps, fatty acid amine salts, metal salts of heavy sulfonic acid, partial carboxylic acid ester of polyhydric alcohol, and phosphoric ester.

6. Demulsifiers

[0076] Addition product of alkylphenol and ethylene oxide, polyoxyethylene alkyl ether, and polyoxyethylene sorbitan ester.

7. Extreme Pressure Anti-Wear Agents (EP/AW Agents)

[0077] Zinc dialky-1-dithiophosphate (primary alkyl, secondary alkyl, and aryl type), diphenyl sulfide, methyl trichlorostearate, chlorinated naphthalene, fluoroalkylpolysiloxane, lead naphthenate, neutralized phosphates, dithiophosphates, and sulfur-free phosphates.

8. Friction Modifiers

[0078] Fatty alcohol, fatty acid, amine, borated ester, other esters, phosphates, phosphites and phosphonates, excluding ethoxylated amines.

9. Multifunctional Additives

[0079] Sulfurized oxymolybdenum dithiocarbamate, sulfurized oxymolybdenum organo phosphorodithioate, oxymolybdenum monoglyceride, oxymolybdenum diethylate amide, amine-molybdenum complex compound, and sulfur-containing molybdenum complex compound.

10. Viscosity Index Improvers

[0080] Polymethacrylate type polymers, ethylene-propylene copolymers, styrene-isoprene copolymers, hydrated styrene-isoprene copolymers, polyisobutylene, and dispersant type viscosity index improvers.

11. Pour Point Depressants

[0081] Polymethyl methacrylate.

12. Foam Inhibitors

[0082] Alkyl methacrylate polymers and dimethyl silicone polymers.

13. Metal Deactivators

[0083] Disalicylidene propylenediamine, triazole derivatives, thiadiazole derivatives, and mercaptobenzimidazoles.

13. Dispersants

[0084] Alkenyl succinimides, alkenyl succinimides modified with other organic compounds, alkenyl succinimides modified by post-treatment with ethylene carbonate or boric acid, pentaerythritols, 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.

Method of Making Anti-Shudder Additive Composition

[0085] The anti-shudder additive composition is prepared by mixing the following two components at elevated temperatures of about 70°F to 195°F, for example, at about 140°F: (a) at least one neutral phosphite compound, such as trihydrocarbyl phosphite, such as trialkyl phosphite, such as trilauryl phosphite; and (b) at least one phosphorous-free hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms. Preferably, from about 0.10 wt% to about 90.9 wt% of at least one neutral phosphite compound is used in the additive composition. More preferably, from about 1.2 wt% to about 81.0 wt% of at least one neutral phosphite compound is used in the additive composition. Even more preferably, from about 3.9 wt% to about 70.0 wt%, and most preferably from about 5.7 wt% to about 61.9 wt%, of at least one neutral phosphite compound is used in the additive composition. Preferably, from about 9.1 wt% to about 99.9 wt% of at least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimde and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 atoms is used in the additive composition. More preferably, from about 19.0 wt% to about 98.8 wt% of at least one hydrocarbyl substituted succinic dispersant is used in the additive composition. Even more preferably, from about 30.0 wt% to about 96.1 wt%, and most preferably from about 38.1 wt% to about 94.3 wt%, of at least one hydrocarbyl substituted succinic dispersant is used in the additive composition.

The Finished Oil of the Present Invention

[0086] A first process for making the finished lubricating oil composition comprises the addition of the anti-shudder additive composition described above to a major amount of an oil of lubricating viscosity, with or without other additives present, wherein the major amount is greater than 50 wt%, provided that if the lubricating oil composition also contains monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3. More preferred, the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7.5:2.5. Even more preferred, the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 8:2. Most preferred the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 9:1. Preferably, the anti-shudder additive composition is present in the lubricating oil composition in the range of about 0.11 wt% to about 11.00 wt%, more preferably from about 0.30 wt% to about 8.85 wt%, even more preferably from about 0.50 wt% to about 6.70 wt%, and most preferably from about 0.70 wt% to about 5.65 wt%, based on the total weight of the lubricating oil composition.

[0087] A second process for making the finished lubricating oil composition comprises the separate addition of either component (a) and component (b) of the anti-shudder additive composition to the oil of lubricating viscosity.

[0088] A third process for making the finished oil comprises mixing the anti-shudder additive composition, or the individual components of the anti-shudder additive composition, with a second additive package thereby producing a combined additive package. The combined additive package is then added to a majority amount of an oil of lubricating viscosity, wherein the majority amount is greater than 50 wt%.

Method of Use of the Present Invention

[0089] The present invention is used to decrease shudder in transmissions, including but not limited to automatic and continuously variable transmissions. Specifically, the lubricating oil of the present invention contacts metal components in transmissions to reduce shudder. Preferably, the anti-shudder additive composition is present in the lubricating oil composition in the range of about 0.11 wt% to about 11.00 wt%, more preferably from about 0.30 wt% to about 8.85 wt%, even more preferably from about 0.50 wt% to about 6.70 wt%, and most preferably from about 0.70 wt% to about 5.65 wt%, based on the total weight of the lubricating oil composition. The anti-shudder additive composition will optionally comprise sufficient inorganic liquid diluent to make it easy to handle during shipping and storage. Typically, the anti-shudder additive composition will comprise from about 0.5 wt% to 45 wt% of the organic liquid diluent and preferably about 2 wt% to 20 wt%. Suitable organic diluents which can be used include, for example, solvent refined 100N (i.e., Cit-con 100N), and hydrotreated 100N (i.e., Chevron 100N), and the like. The organic diluent preferably has a viscosity of about 10 to 20 cSt at 100°C.

Performance Testing

[0090] The anti-shudder lubricating oil composition of the present invention typically meets the General Motors Corporation (GM) added anti-shudder test requirements to the DEXRON®-III specification (DEXRON®-III, H Revision, Automatic Transmission Fluid Specification, GMN10055), using the Electronically Controlled Converter Clutch (ECCC or EC^3) Test, which may be purchased from IHS Engineering, Inc. at http://www.global.ihs.com. The ECCC Vehicle Performance Test evaluates torque converter shudder and slip speed hunting characteristics by running the vehicle to be tested on a dynamometer through a series of pre-determined speed and load conditions. Actual road tests may also be used to detect whether there is shudder in the transmission.

[0091] 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

[0092] An anti-shudder additive package was prepared by adding 5.25 wt% borated bissuccinimide (from polyisobutenyl [1300 MW] succinic anhydride and a heavy polyamine, HPA-X, available from Dow Chemical Company) dispersant (which comprises about 99 wt% bissuccinimide), 0.033 wt% high overbased (HOB) calcium sulfonate, 0.04 wt% Durad 310 M (which comprises a mixture of organophosphate esters), 0.565 wt% Duraphos TLP (which comprises about 90 wt% trilauryl phosphite and 7.5 w% dilauryl hydrogen phosphite), 0.50 wt% phenolic oxidation inhibitor, 0.40 wt% aminic oxidation inhibitor, 0.1 wt% thiadiazole derivative, 0.75 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor, 0.020 wt% Unisol Red BHF, and 2.6 wt% Polyalkyl Methacrylate viscosity index improver (PMA-VII - 350,000 MW average) to a base oil composition comprised of a base oil blend comprised of about 88.77 wt% RLOP 100 N which may be purchased from ChevronTexaco Corporation, San Ramon, California and about 11.23 wt% Chevron Phillips PAO 4 cSt which may be purchased from Chevron Phillips Company, Woodlands, Texas. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. The lubricating oil comprising this anti-shudder additive package passed the GM DEXRON®-II ECCC Test.

Example 2

[0093] An anti-shudder additive package was prepared by adding 4.5 wt% succinate ester of pentaerythritol and polyisobutenyl (1000 MW) succinic anhydride (PIBSA) dispersant, 0.0022 wt% calcium sulfonate, 0.1 wt% polyamide of tetraethylenepentamine (TEPA) and isostearic acid, 0.565 wt% Duraphos TLP (which comprises about 90 wt% trilauryl phosphite and 7.5 wt% dilauryl hydrogen phosphite), 0.02 wt% Duraphos AP 230 (dilauryl hydrogen phosphite), 0.9 wt% phenolic oxidation inhibitor, 0.05 wt% thiadiazole derivative, 0.05 wt% primary aliphatic amine with highly branched alkyl chains (C12-C14), 0.5 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor, 0.020 wt% Unisol Red BHF, and 2.6 wt% PMA-VII (350,000 MW average) to a base oil blend comprised of about 88.77 wt% RLOP 100 N which may be purchased from ChevronTexaco Corporation, San Ramon, California and about 11.23 wt% Chevron Phillips PAO 4 cSt which may be purchased from Chevron Phillips Company, Woodlands, Texas. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. The lubricating oil comprising this anti-shudder additive package passed the GM DEXRON®-III ECCC Test.

Example 3

[0094] An anti-shudder additive package was prepared by adding 1.25 wt% borated bissuccinimide dispersant from polyisobutenyl (1300 MW) succinic anhydride and heavy polyamine, HPA-X (which dispersant comprises about 99 wt% bissuccinimide), 3.0 wt% succininate ester of pentaerythritol and polyisobutenyl (1000 MW) succinic anhydride (PIBSA) dispersant dispersant, 0.0022 wt% HOB calcium sulfonate, 0.1 wt% polyamide of TEPA and isostearic acid, 0.565 wt% Duraphos TLP (90 wt% trilauryl phosphite and 7.5 wt% dilauryl hydrogen phosphite), 0.02 wt% Duraphos AP 230 (dilauryl hydrogen phosphite), 0.5 wt% phenolic oxidation inhibitor, 0.4 wt% aminic oxidation inhibitor, 0.1 wt% thiadiazole derivative, 0.1 wt% primary aliphatic amine with highly branched alkyl chains (C12-C14), 0.5 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor, 0.020 wt% Unisol Red BHF, and 2.6 wt% PMA - VII (350,000 MW average) to a base oil composition comprised of a base oil blend comprised of about 88.77 wt% RLOP 100 N which may be purchased from ChevronTexaco Corporation, San Ramon, California and about 11.23 wt% Chevron Phillips PAO 4 cSt which may be purchased from Chevron Phillips Company, Woodlands, Texas. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. The lubricating oil comprising this anti-shudder additive package passed the GM DEXRON®-III ECCC Test.

Example 4

[0095] An anti-shudder additive package was prepared by adding 1.5 wt% horated bissuccinimide dispersant from polyisobutenyl (1300 MW) succinic anhydride and heavy polyamine, HPA-X (which dispersant comprises about 99 wt% bissuccinimide), 1.5 wt% succininate ester of pentaerythritol and polyisobutenyl (1000 MW) succinic anhydride (PIBSA) dispersant, 0.0022 wt% HOB calcium sulfonate, 0.1 wt% polyamide of TEPA and isostearic acid, 0.565 wt% Duraphos TLP (90 wt% trilauryl phosphite and 7.5 wt% dilauryl hydrogen phosphite), 0.02 wt% Duraphos AP 230 (dilauryl hydrogen phosphite), 0.5 wt% phenolic oxidation inhibitor, 0.4 wt% aminic oxidation inhibitor, 0.1 wt% thiadiazole derivative, 0.1 wt% primary aliphatic amine with highly branched alkyl chains (C12-C14), 0.5 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor, 0.020 wt% Unisol Red BHF, and 2.6 wt% PMA - VII (350,000 MW average) to a base oil blend comprised of about 88.77 wt% RLOP 100 N which may be purchased from ChevronTexaco Corporation, San Ramon, California and about 11.23 wt% Chevron Phillips PAO 4 cSt which may be purchased from Chevron Phillips Chemical Company, LLC, Woodlands, Texas. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. The lubricating oil comprising this anti-shudder additive package passed the GM DEXRON®-III ECCC Test.

COMPARATIVE EXAMPLES

Comparative Example A

[0096] An anti-shudder additive package was prepared by adding 5.25 wt% monosuccinimide dispersant from polyisobutenyl (1000 MW) succinic anhydride and a mixture of diethylene triamine and HPA-X (which dispersant comprises about 50 wt% monosuccinimide and about 50 wt% bissuccinimide), 0.033 wt% HOB calcium sulfonate, 0.04 wt% Durad 310M (mixture of organophosphate esters), 0.565 wt% Duraphos TLP (which comprises about 90 wt% trilauryl phosphite and about 7.5 wt% dilauryl hydrogen phosphite), 0.50 wt% phenolic oxidation inhibitor, 0.40 wt% aminic oxidation inhibitor, 0.1 wt% thiadiazole derivative, 0.75 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor, 0.020 wt% Unisol Red BHF, and 2.6 wt% PMA-VII to a base oil blend comprised of about 88.77 wt% RLOP 100 N which may be purchased from ChevronTexaco Corporation, San Ramon, California and about 11.23 wt% Chevron Phillips PAO 4 cSt which may be purchased from Chevron Phillips Company, Woodlands, Texas. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. The lubricating oil comprising this anti-shudder additive package failed the GM DEXRON®-III ECCC Test.

Comparative Example B

[0097] An anti-shudder additive package was prepared by adding 5.25 wt% borated bissuccinimide (from polyisobutenyl [1300 MW] succinic anhydride and a heavy polyamine, HPA-X, available from Dow Chemical Company) dispersant (which comprises about 99 wt% bissuccinimide), 0.033 wt% HOB calcium sulfonate, 0.45 wt% Durad 310M (which comprises a mixture of organophosphate esters), 0.50 wt% phenolic oxidation inhibitor, 0.40 wt% aminic oxidation inhibitor, 0.1 wt% thiadiazole derivative, 0.75 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor, 0.020 wt% Unisol Red BHF, and 2.6 wt% PMA-VII (350,000 MW average) to a base oil composition comprised of a base oil blend comprised of about 88.77 wt% RLOP 100 N which may be purchased from ChevronTexaco Corporation, San Ramon, California and about 11.23 wt% Chevron Phillips PAO 4 cSt which may be purchased from Chevron Phillips Company, Woodlands, Texas. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. The lubricating oil comprising this anti-shudder additive package failed the GM DEXRON®-III ECCC Test.

Comparative Example C

[0098] An anti-shudder additive package was prepared by adding 4.23 wt% monosuccinimide dispersant from polyisobutenyl (1000 MW) succinic anhydride and a mixture of diethylene triamine and HPA-X (which dispersant comprises about 50 wt% monosuccinimide and about 50 wt% bissuccinimide), 1.00 wt% borated bissuccinimide (from polyisobutenyl [1300 MW] succinic anhydride and a heavy polyamine, HPA-X, available from Dow Chemical Company) dispersant (which comprises about 99 wt% bissuccinimide), 0.033 wt% HOB calcium sulfonate, 0.565 wt% Duraphos TLP (which comprises about 90 wt% trilauryl phosphite and about 7.5 wt% dilauryl hydrogen phosphite), 0.02 Duraphos AP-230 (which comprises dilauryl hydrogen phosphite), 0.30 wt% phenolic oxidation inhibitor, 0.5 wt% aminic oxidation inihibitor, 0.08 wt% thiadiazole derivative, 0.50 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor and 2.6 wt% PMA- VII (350,000 MW average) to approximately a base oil composition comprised of a base oil blend comprised of about 88.77 wt% RLOP 100 N which may be purchased from ChevronTexaco Corporation, San Ramon, California and about 11.23 wt% Chevron Phillips PAO 4 cSt which may be purchased from Chevron Phillips Company, Woodlands, Texas. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. In this example, the ratio of bissuccinimide to monosuccinimide is 6:4. The lubricating oil comprising this anti-shudder additive package failed the GM DEXRON®-III ECCC Test.

Comparative Example D

[0099] An anti-shudder additive package was prepared by adding 4.23 wt% monosuccinimide dispersant from polyisobutenyl (1000 MW) succinic anhydride and a mixture of diethylene triamine and HPA-X (which dispersant comprises about 50 wt% monosuccinimide and about 50 wt% bissuccinimide), 1.00 wt% borated bissuccinimide (from polyisobutenyl [1300 MW] succinic anhydride and a heavy polyamine, HPA-X, available from Dow Chemical Company) dispersant (which comprises about 99 wt% bissuccinimide), 0.0022 wt% HOB calcium sulfonate, 0.41 wt% Durad 310 M (which comprises a mixture of organophosphate esters), 0.2 wt% polyamide of TEPA and isostearic acid, 0.30 wt% phenolic oxidation inhibitor, 0.5 wt% aminic oxidation inhibitor, 0.1 wt% thiadiazole derivative, 0.50 wt% benzoate ester, 0.002 wt% silicon based foam inhibitor, 0.0125 wt% Unisol Red BHF, and 2.15 wt% PMA-VII (350,000 MW average) to a base oil composition comprised of 100 wt% PetroCanada 4 which may be purchased from Petro- Canada, Calgary, Alberta, Canada. The components were blended for approximately two hrs at a temperature of from about 120° F to about 140° F. In this example, the ratio of bissuccinimide to monosuccinimide is 6:4. The lubricating oil comprising this anti-shudder additive package failed the GM DEXRON®-III ECCC Test.

[0100] 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.

Claims

1. An anti-shudder additive composition comprising:

    (a) At least one neutral phosphite compound; and
    (b) At least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms,

    wherein the additive composition does not comprise an ethoxylated amine, and wherein the additive composition does not comprise a primary amide of a long chain carboxylic acid, and provided that if the lubricating oil composition also contains a monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.

2. The anti-shudder additive composition according to claim 1, wherein the neutral phosphite compound is trihydrocarbyl phosphite.

3. The anti-shudder additive composition according to 2, wherein the trihydrocarbyl phosphite is trialkyl phosphite.

4. The anti-shudder additive composition according to claim 3, wherein the trialkyl phosphite is trilauryl phosphite.

5. The anti-shudder additive composition according to claim 1, wherein the hydrocarbyl bissuccinimide is a borated hydrocarbyl bissuccinimide.

6. The anti-shudder additive composition according to claim 1, wherein the hydrocarbyl substituted succinic ester of a polyol is an ester of pentaerythritol.

7. The lubricating oil composition according to claim 1, wherein the lubricating oil composition also contains monosuccinimide and the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7.5:2.5.

8. The lubricating oil composition according to claim 7, wherein the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 8:2.

9. The lubricating oil composition according to claim 8, wherein the ration of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 9:1.

10. A lubricating oil composition comprising:

    (a) a major amount of an oil of lubricating viscosity;
    (b) an effective amount of an anti-shudder additive composition comprising:

        (i) At least one neutral phosphite compound, and
        (ii) At least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms; and

    wherein the additive composition does not comprise an ethoxylated amine, and wherein the additive composition does not comprise a primary amide of a long chain carboxylic acid, and provided that if the lubricating oil composition also contains a monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.

11. The lubricating oil composition according to claim 10, wherein the transmission fluid is an automatic transmission fluid.

12. The lubricating oil composition according to claim 10, wherein the transmission fluid is a continuously variable transmission fluid.

13. The lubricating oil composition according to claim 10, wherein the at least one neutral phosphite compound is a trihydrocarbyl phosphite.

14. The lubricating oil composition according to claim 13, wherein the trihydrocarbyl phosphite is a trialkyl phosphite.

15. The lubricating oil composition according to claim 14, wherein the trialkyl phosphite is trilauryl phosphite.

16. The lubricating oil composition according to claim 10, wherein the hydrocarbyl bissuccinimide is a borated hydrocarbyl bissuccinimide.

17. The lubricating oil composition according to claim 10, wherein the hydrocarbyl substituted succinic ester of a polyol is an ester of pentaerythritol.

18. The lubricating oil composition according to claim 10, wherein the lubricating oil composition also contains monosuccinimide and the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7.5:2.5.

19. The lubricating oil composition according to claim 18, wherein the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 8:2.

20. The lubricating oil composition according to claim 19, wherein the ration of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 9:1.

21. A method of making an anti-shudder additive composition comprising:

mixing from about 0.1 wt% to about 90.9 wt% of at least one neutral phosphite compound with from about 9.1 wt% to about 99.9 wt% of at least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, in the absence of an ethoxylated amine and a primary amide of a long chain carboxylic acid, and provided that if the additive composition also contains a monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.

22. The method of making an anti-shudder additive composition according to claim 21, wherein the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimde is at least 7.5:2.5.

23. The method of making an anti-shudder additive composition according to claim 22, wherein the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 8:2.

24. The method of making an anti-shudder additive composition according to claim 23, wherein the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 9:1.

25. A method of making a transmission fluid comprising:

mixing from about 0.11 wt% to about 11.0 wt% of the anti-shudder additive composition of claim 2 with a major amount of an oil of lubricating viscosity.

26. A method of reducing shudder in a transmission comprising:

(a) mixing an oil of lubricating viscosity with a shudder reducing effective amount of an anti-shudder additive composition comprising:

(i) at least one neutral phosphite compound;
(ii) at least one hydrocarbyl substituted succinic dispersant selected from the group consisting of a hydrocarbyl bissuccinimide and a hydrocarbyl substituted succinic ester of a polyol and mixtures thereof, wherein the hydrocarbyl substituent has at least 50 carbon atoms;

in the absence of an ethoxylated amine and a primary amide of a long chain carboxylic acid; and provided that if the lubricating oil composition also contains monosuccinimide, then the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7:3.
(b) adding the mixture of (a) to a transmission.

27. The method of reducing shudder according to claim 26, wherein the lubricating oil composition also contains monosuccinimide and the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 7.5:2.5.

28. The method of reducing shudder according to claim 27, wherein the lubricating oil composition also contains monosuccinimide and the ratio of the hydrocarbyl substituted succinic dispersant to monosuccinimide is at least 8:2.

29. The method of reducing shudder according to claim 28, wherein the lubricating oil composition also contains monosuccinimide and the ration of the hydrocarbyl substituted succinic dispersant to monosuccimide is at least 9:1.

30. The method of reducing shudder according to claim 26, wherein the transmission is an automatic transmission or a continuously variable transmission.