

HYDRAULIC FLUID COMPOSITIONS FOR AGRICULTURAL MACHINERY

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims the priority benefit of U.S. Provisional Application No. 63/494,587, filed April 6, 2023, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[002] This disclosure relates to hydraulic fluid compositions for use in agricultural machinery. More specifically, this disclosure describes tractor hydraulic fluid compositions for noise reduction and enhancement of frictional performance.

BACKGROUND

[003] Hydraulic fluids used in agricultural machinery, *e.g.*, tractors, are multi-purpose products used to lubricate various parts of the machinery. These lubricating applications may include lubrication of gearboxes, power take-off and clutch(es), rear axles, reduction gears, wet brakes and hydraulic accessories. The components included in a tractor hydraulic fluid are chosen so that the final resulting fluid composition will provide all the necessary characteristics required in the different applications. Such characteristics include the ability to provide proper frictional properties for preventing wet brake and/clutch chatter of oil-immersed brakes and clutches while simultaneously providing the ability to actuate wet brakes and clutches, particularly to provide power take-off clutch performance. A tractor hydraulic fluid composition must provide sufficient anti-wear and extreme pressure properties as well as water tolerance/filterability capabilities.

[004] Tractor hydraulic fluids must have sufficient friction for the system to operate effectively. A wet clutch is often used for switching gears and after long term use, shifting shock and/or clutch slippage may occur due to loss of frictional performance. It is important that the tractor hydraulic fluid maintains its frictional

performance over a long period of time to ensure optimal operation of brakes and clutches.

[005] Wet or oil-immersed brakes suffer from brake chatter, or brake noise, which is a phenomenon where the torque variation of the friction material or reaction plate is large, so as to create harmonic vibrations in the equipment. These vibrations convert to objectionable sound that occurs upon application of the brake. Water contamination in the fluid increases brake noise. As agricultural machinery is often operated in environments where water is present, e.g., rice paddies and humid climates, tractor hydraulic fluid compositions must be formulated to provide desirable lubricating properties while minimizing the impact of water contamination.

[006] Thus, there is a need for tractor hydraulic fluid compositions that provide desirable friction properties and minimize brake noise in the presence of water.

SUMMARY

[007] In one aspect, there is provided a tractor hydraulic fluid composition comprising:

[008] (i) a major amount of an oil of lubricating viscosity;

[009] (ii) one or more dispersants; and

[010] (iii) one or more phosphate esters or amine salts of phosphate esters.

[011] In certain embodiments, the compositions comprise one or more succinimide dispersants.

[012] In another aspect, there is provided a method of reducing brake noise in a tractor, comprising: applying the tractor hydraulic fluid composition to a braking component or system in a tractor; and operating the tractor.

[013] In another aspect, there is provided a method of maintaining frictional performance in a tractor, comprising: applying the tractor hydraulic fluid composition to one or more components selected from the group consisting of: gearboxes, power take-off and clutch(es), rear axles, reduction gears, wet brakes and hydraulic accessories; and operating the tractor.

[014] In certain embodiments, the tractor is operated in the presence of water or in wet environments.

DETAILED DESCRIPTION

[015] This disclosure provides hydraulic fluid compositions for reducing brake noise and maintaining frictional performance in agricultural machinery, in particular, tractors. The compositions comprise: (i) a major amount of an oil of lubricating viscosity; (ii) one or more dispersants; and (iii) one or more phosphate esters or amine salts of phosphate esters.

[016] In addition to providing lubrication to various parts of the machinery, the tractor hydraulic fluid compositions disclosed herein are particularly useful for reducing brake noise in the presence of water. The tractor hydraulic fluid compositions disclosed herein also provide enhanced frictional durability. The compositions provide improvements in the stability of frictional coefficients of comparative compositions, e.g., compositions which do not comprise the dispersants and phosphate esters or amine salts of phosphate esters of the exemplary compositions.

Definitions

[017] As used herein, "hydrocarbyl" refers to groups containing hydrogen and carbon, e.g., alkyl, alkenyl, alkynyl, and aryl groups. Hydrocarbyl groups can be cyclic, acyclic, branched, or straight-chained groups.

[018] As used herein, "alkyl" refers to a straight or branched hydrocarbon group containing carbon atoms. In some embodiments, the alkyl group contains at least 1, 5, 10, 15, 20, 25, 30, 50, 100, 500, 1000, or 2000 carbon atoms.

[019] As used herein, "alkenyl" refers to a straight or branched hydrocarbon group containing at least 2 carbon atoms and one or more carbon-carbon double bonds. As used herein, "alkynyl" refers to a straight or branched hydrocarbon group containing at least 2 carbon atoms and one or more carbon-carbon triple bonds. In

some embodiments, the alkenyl or alkynyl group contains at least 1, 5, 10, 15, 20, 25, 30, 50, 100, 500, 1000, or 2000 carbon atoms.

[020] As used herein, "aryl" refers to an aromatic monocyclic or multicyclic hydrocarbon group having 6 or more carbon atoms. The aryl group is optionally substituted with one or more hydrocarbyl groups. In some embodiments, the aryl group has 6 to 14 carbon atoms. Aryl groups include, but are not limited to phenyl, naphthyl, and fluorenyl groups. An exemplary substituted aryl group includes, but is not limited to, a tolyl group.

[021] As used herein, "alkaryl" refers to an aryl group substituted with one or more alkyl groups.

[022] As used herein, "major amount" refers to an amount that is greater than about 50 and less than 100 weight percent of the tractor hydraulic fluid composition described herein. In some embodiments, the amount is at least 60, at least 70, at least 80, or at least 90 weight percent.

[023] As used herein, "minor amount" refers to an amount that is less than about 50 and more than 0 weight percent of the tractor hydraulic fluid composition described herein. In some embodiments, the amount is less than 40, less than 30, less than 20, or less than 10 weight percent.

[024] As used herein, "TBN" refers to "total base number" and is a measure of reserve alkalinity. In general terms, TBN is the neutralization capacity of one gram of a lubricating composition expressed as a number equal to the mg of potassium hydroxide providing the equivalent neutralization. Thus, a TBN of 10 means that one gram of the composition has a neutralization capacity equal to 10 mg of potassium hydroxide. The TBN of a sample can be determined by ASTM Test No. D2896, incorporated herein by reference in its entirety, or any other equivalent procedure.

[025] The term "overbased" refers to salts wherein the metal counterion, e.g., calcium, present exceeds the stoichiometric amount. Overbased salts are said to have conversion levels in excess of 100% (i.e., they comprise more than 100% of the theoretical amount of metal needed to convert the acid to its "normal", "neutral" salt).

The expression "metal ratio," often abbreviated as MR, designates the ratio of total chemical equivalents of metal in the overbased salt to chemical equivalents of the metal in a neutral salt according to known chemical reactivity and stoichiometry. Thus, in a normal or neutral salt, the metal ratio is one and in an overbased salt, MR, is greater than one.

[026] The term "low overbased" or "LOB" refers to overbased salts having a total base number of less than 200.

[027] The term "high overbased" or "HOB" refers to overbased salts having a total base number of 200 or greater.

[028] 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.

[029] The term "bissuccinimide" describes the reaction product that is primarily a bissuccinimide but may contain monosuccinimides. In some embodiments, the amount of monosuccinimide is no more than about 5 wt %.

Compositions

[030] The compositions of the present invention are hydraulic fluids suitable for use in of agricultural machinery, e.g., tractors. The compositions can be used to lubricate various parts of the agricultural machinery, for example wet brakes or oil-immersed brakes, gearboxes, power take-off and clutch(es), rear axles, reduction gears, and hydraulic accessories.

[031] In one aspect, the tractor hydraulic fluid composition comprises: (i) a major amount of an oil of lubricating viscosity; (ii) one or more dispersants; and (iii) one or more phosphate esters or amine salts of phosphate esters.

[032] In one embodiment, the tractor hydraulic fluid composition comprises: (i) a major amount of an oil of lubricating viscosity; (ii) one or more succinimide dispersants; and (iii) one or more phosphate esters or amine salts of phosphate esters.

[033] The compositions, which can be used to provide lubricity to various parts of the agricultural machinery, are effective for maintaining frictional performance over time and/or in the presence of water. The compositions are also effective for reducing brake noise or brake chatter and, in particular, for maintaining sufficient brake noise reduction in the presence of water.

[034] When the compositions are applied to agricultural machinery, e.g., tractors, or used in the presence of water or wet environments, the compositions may come into contact or mix with small amounts of water. A key advantage is that the compositions of this disclosure maintain frictional and brake noise reduction performance at operation temperatures in dry or wet conditions.

[035] In certain embodiments, the compositions provide improvements in the stability of frictional coefficients, i.e., provide lower increasing ratios of μ_s . This improvement is particularly noticeable when compared vis-à-vis against comparative compositions which do not comprise the dispersants and phosphate esters or amine salts of phosphate esters of the exemplary compositions. In certain embodiments, the compositions provide an increasing ratio of about 4.2 or less, or an increasing ratio in the range of about 2.9 to about 4.2.

Oil of Lubricating Viscosity

[036] The oil of lubricating viscosity (also referred to as "base stock" or "base oil") is the primary liquid constituent of a lubricant, into which additives and possibly other oils are blended, for example to produce a final lubricant (or lubricant composition). A base oil is useful for making concentrates as well as for making lubricating oil compositions therefrom, and may be selected from natural and synthetic lubricating oils and combinations thereof.

[037] Natural oils include animal and vegetable oils, liquid petroleum oils and hydrorefined, solvent-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.

[038] Synthetic lubricating oils include hydrocarbon oils such as polymerized and interpolymers of 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; polyphenols (e.g., biphenyls, terphenyls, alkylated polyphenols); and alkylated diphenyl ethers and alkylated diphenyl sulfides and the derivatives, analogues and homologues thereof.

[039] Another suitable class of synthetic lubricating oils comprises the esters of dicarboxylic acids (e.g., malonic acid, alkyl malonic acids, alkenyl malonic acids, succinic acid, alkyl succinic acids and alkenyl succinic acids, maleic acid, fumaric acid, azelaic acid, suberic acid, sebacic acid, adipic acid, phthalic acid) 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, hexyl fumarate, dihexyl fumarate dioctyl sebacate, diisooctyl azelate, diisodecyl azelate, dioctyl 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.

[040] Esters useful as synthetic oils also include those made from C5 to C12 monocarboxylic acids and polyols, and polyol ethers such as neopentyl glycol, trimethylolpropane, pentaerythritol, dipentaerythritol and tripentaerythritol.

[041] The base oil may be derived from Fischer-Tropsch synthesized hydrocarbons.

[042] Fischer-Tropsch synthesized hydrocarbons are made from synthesis gas containing Fh and CO using a Fischer-Tropsch catalyst. Such hydrocarbons typically require further processing in order to be useful as the base oil. For example, the hydrocarbons may be hydroisomerized; hydrocracked and hydroisomerized; dewaxed; or hydroisomerized and dewaxed; using processes known to those skilled in the art.

[043] Unrefined, refined and re-refined oils can be used in the present lubricating oil composition. Unrefined oils are those obtained directly from a natural or synthetic source without further purification treatment. For 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 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.

[044] Re-refined 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 re-refined oils are also known as reclaimed or reprocessed oils and often are additionally processed by techniques for approval of spent additive and oil breakdown products.

[045] Hence, the base oil which may be used to make the present composition may be selected from any of the base oils in Groups I-V as specified in the American Petroleum Institute (API) Base Oil Interchangeability Guidelines (API Publication 1509). Such base oil groups are summarized in Table 1 below:

[046] Table 1

	Base Oil Properties		
Group	Saturates^(a), wt. %	Sulfur^(b), wt. %	Viscosity Index^(c)
I	<90 and/or	<0.03	80 to <120
II	≥90	≤0.03	80 to <120
III	≥90	≤0.03	≥120
IV	Polyalphaolefins (PAOs)		
V	All other base stocks not included in Groups I, II, III, or IV		

[047] ^(a)Determined in accordance with ASTM D2007.

[048] ^(b)Determined in accordance with ASTM D2622, ASTM D3120, ASTM D4294 or ASTM D4927.

[049] ^(c)Determined in accordance with ASTM D2270.

[050] Base oils suitable for use herein are any of the variety corresponding to API Group II, Group III, Group IV, and Group V oils and combinations thereof, preferably the Group III to Group V oils due to their exceptional volatility, stability, viscometric and cleanliness features.

[051] The oil of lubricating viscosity for use in the lubricating oil compositions of this disclosure, also referred to as a base oil, is typically present in a major amount, e.g., an amount of greater than about 50 wt. %, preferably greater than about 70 wt. %, more preferably from about 80 to about 99.5 wt. % and most preferably from about 85 to about 98 wt. %, based on the total weight of the composition. The expression "base oil" as used herein shall be understood to mean a base stock or blend of base stocks which is a lubricant component that is produced by a single manufacturer to the same specifications (independent of feed source or manufacturer's location); that meets the same manufacturer's specification; and that is identified by a unique formula, product identification number, or both. The base oil for use herein can be any presently known or later-discovered oil of lubricating viscosity used in formulating lubricating oil compositions for any and all such applications, e.g., engine oils, marine cylinder oils, functional fluids such as hydraulic oils, gear oils, transmission fluids, etc. Additionally, the base oils for use herein can optionally contain viscosity index improvers, e.g., polymeric alkylmethacrylates; olefinic copolymers, e.g., an ethylene-propylene copolymer or a styrene-butadiene copolymer; and the like and mixtures thereof.

[052] As one skilled in the art would readily appreciate, the viscosity of the base oil is dependent upon the application. Accordingly, the viscosity of a base oil for use herein will ordinarily range from about 2 to about 2000 centistokes (cSt) at 100° Centigrade (C.). Generally, individually the base oils used as engine oils will have a kinematic viscosity range at 100° C. of about 2 cSt to about 30 cSt, preferably about 3

cSt to about 16 cSt, and most preferably about 4 cSt to about 12 cSt and will be selected or blended depending on the desired end use and the additives in the finished oil to give the desired grade of engine oil, e.g., a composition having an SAE Viscosity Grade of 70W-75, 70W-80, 70W-85, 70W-90, 75W-75, 75W-80, 75W-85, 75W-90, 80W-75, 80W-80, 80W-85, 80W-90, 85W-75, 85W-80, 85W-85, 85W-90, monograde 80, 90, 140, ISO VG32, ISO VG46, ISO VG68 and the like. Also, oils could be blended in viscosity grades specific to tractor hydraulic fluids such as J20C and/or J20D.

Dispersants

[053] The composition disclosed herein comprises one or more dispersants. Dispersants maintain in suspension materials resulting from oxidation that are insoluble in oil, thus preventing sludge flocculation and precipitation or deposition on metal parts. Dispersants useful herein include nitrogen-containing, ashless (metal-free) dispersants known to be effective to reduce formation of deposits upon use in gasoline and diesel engines.

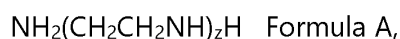
[054] Suitable dispersants include hydrocarbyl succinimides, hydrocarbyl succinimides, mixed ester/amides of hydrocarbyl-substituted succinic acid, hydroxyesters of hydrocarbyl-substituted succinic acid, and Mannich condensation products of hydrocarbyl-substituted phenols, formaldehyde and polyamines. Also suitable are condensation products of polyamines and hydrocarbyl-substituted phenyl acids. Mixtures of these dispersants can also be used. Basic nitrogen-containing ashless dispersants are well-known lubricating oil additives and methods for their preparation are extensively described in the patent literature.

[055] In certain embodiments, the composition comprises one or more succinimide- or bisuccinimide-containing dispersants.

[056] In certain embodiments, the composition comprises alkenyl succinimides. In certain embodiments, the alkenyl-substituent of the alkenyl succinimide is a long-chain, e.g., greater than 40 carbon atoms. These materials are readily made by reacting a hydrocarbyl-substituted dicarboxylic acid material with a molecule containing amine functionality. Examples of suitable amines are polyamines

such as polyalkylene polyamines, hydroxy-substituted polyamines and polyoxyalkylene polyamines.

[057] In certain embodiments, the composition comprises ashless dispersants, such as polyisobutenyl succinimides. Polyisobutenyl succinimides formed from polyisobutenyl succinic anhydride and a polyalkylene polyamine such as a polyethylene polyamine of formula A:



[058] wherein z is 1 to 11. The polyisobutenyl group is derived from polyisobutene and preferably has a number average molecular weight (M_n) in a range of 700 to 3000 Daltons (e.g., 900 to 2500 Daltons). For example, the polyisobutenyl succinimide may be a mono-succinimide or a bis-succinimide derived from a polyisobutenyl group having a MW of 900 to 2500 Daltons. As is known in the art, the dispersants may be post-treated (e.g., with a boronating agent or a cyclic carbonate, ethylene carbonate etc). In certain embodiments, the succinimide dispersant is a borated succinimide dispersant.

[059] Nitrogen-containing ashless (metal-free) dispersants are basic, and contribute to the TBN of a composition to which they are added, without introducing additional sulfated ash.

[060] In one embodiment, the composition comprises one or more bisuccinimide dispersants, e.g., a hydrocarbyl bisuccinimide.

[061] The bisuccinimide 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 bisuccinimide is prepared according to methods that are well known in the art, including but not limited to, the following:

[062] 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.

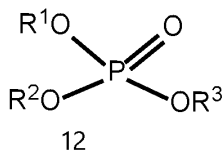
[063] As used herein, included within this term are the alkenyl or alkyl mono-, bis-succinimides and other higher analogs.

[064] In certain embodiments, the amount of one or more dispersants in the composition is in the range of about 0.1 to about 5 wt %, such as from about 0.1 to about 4.5 wt%, about 0.1 to about 4.0 wt%, about 0.1 to about 3.5 wt%, about 0.1 to about 3.0 wt%, about 0.1 to about 2.5 wt%, about 0.1 to about 2.0 wt%, about 0.1 to about 1.5 wt%, about 0.1 to about 1.0 wt%, about 0.2 to about 5.0 wt%, about 0.2 to about 4.5 wt%, about 0.2 to about 4.0 wt%, about 0.2 to about 3.5 wt%, about 0.2 to about 3.0 wt%, about 0.2 to about 2.5 wt%, about 0.2 to about 2.0 wt%, about 0.2 to about 1.5 wt%, about 0.2 to about 1.0 wt%, about 0.3 to about 5.0 wt%, about 0.3 to about 4.5 wt%, about 0.3 to about 4.0 wt%, about 0.3 to about 3.5 wt%, about 0.3 to about 3.0 wt%, about 0.3 to about 2.5 wt%, about 0.3 to about 2.0 wt%, about 0.3 to about 1.5 wt%, about 0.3 to about 1.0 wt%, about 0.4 to about 5.0 wt%, about 0.4 to about 4.5 wt%, about 0.4 to about 4.0 wt%, about 0.4 to about 3.5 wt%, about 0.4 to about 3.0 wt%, about 0.4 to about 2.5 wt%, about 0.4 to about 2.0 wt%, about 0.4 to about 1.5 wt%, about 0.4 to about 1.0 wt%, about 0.5 to about 5.0 wt%, about 0.5 to about 4.5 wt%, about 0.5 to about 4.0 wt%, about 0.5 to about 3.5 wt%, about 0.5 to about 3.0 wt%, about 0.5 to about 2.5 wt%, about 0.5 to about 2.0 wt%, about 0.5 to about 1.5 wt%, or about 0.5 to about 1.0 wt% of the total composition.

[065] *Phosphate Esters and Amine Salts of Phosphate Esters*

[066] The composition disclosed herein comprises one or more phosphate esters or amine salts of phosphate esters.

[067] In one embodiment, the phosphate ester is a compound according to Formula 1:



Formula 1

[068] Wherein each of R^1 , R^2 and R^3 is independently selected from H, C_3 - C_{30} alkyl, and C_3 - C_{30} alkenyl, and at least one of R^1 , R^2 and R^3 is not H.

[069] In certain embodiments, at least one of R^1 , R^2 and R^3 is C_{10} - C_{30} alkyl. In certain embodiments, at least two of R^1 , R^2 and R^3 are C_{10} - C_{30} alkyl. In certain embodiments, at least one of R^1 , R^2 and R^3 is C_{12} - C_{18} alkyl. In certain embodiments, at least two of R^1 , R^2 and R^3 is C_{12} - C_{18} alkyl.

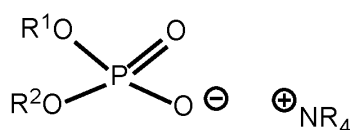
[070] In certain embodiments, at least one of R^1 , R^2 and R^3 is C_{10} - C_{30} alkenyl. In certain embodiments, at least two of R^1 , R^2 and R^3 are C_{10} - C_{30} alkenyl. In certain embodiments, at least one of R^1 , R^2 and R^3 is C_{12} - C_{18} alkenyl. In certain embodiments, at least two of R^1 , R^2 and R^3 is C_{12} - C_{18} alkenyl.

[071] In certain embodiments, the alkyl group is straight-chain or unbranched.

[072] In certain embodiments, the alkenyl group is straight-chain or unbranched.

[073] In certain embodiments, the one or more phosphate esters comprises a mixture of phosphate esters. In certain embodiments, the one or more phosphate esters comprises alkyl (C_{12} - C_{18}) acid phosphate. In certain embodiments, the one or more phosphate esters comprises oleyl acid phosphate.

[074] In one embodiment, the amine salt of the phosphate ester is a compound according to Formula 2:



Formula 2

[075] Wherein each of R^1 and R^2 are independently selected from H, C_3 - C_{30} alkyl, and C_3 - C_{30} alkenyl, and at least one of R^1 and R^2 is not H; and wherein each R is independently selected from H, C_1 - C_{30} alkyl, and C_1 - C_{30} alkenyl. As described herein, $^+NR_4$ can be a primary amine, a secondary amine, tertiary amine, or quaternary amine.

[076] In certain embodiments, at least one of R¹ and R² is C₁₀-C₃₀ alkyl. In certain embodiments, at least two of R¹ and R² are C₁₀-C₃₀ alkyl. In certain embodiments, at least one of R¹ and R² is C₁₂-C₁₈ alkyl. In certain embodiments, at least two of R¹ and R² is C₁₂-C₁₈ alkyl.

[077] In certain embodiments, at least one of R¹ and R² is C₁₀-C₃₀ alkenyl. In certain embodiments, at least two of R¹ and R² are C₁₀-C₃₀ alkenyl. In certain embodiments, at least one of R¹ and R² is C₁₂-C₁₈ alkenyl. In certain embodiments, at least two of R¹ and R² is C₁₂-C₁₈ alkenyl.

[078] In certain embodiments, one R is H. In certain embodiments, two R's are H. In certain embodiments, three R's are H. In certain embodiments, four R's are H.

[079] In certain embodiments, at least one R is C₃-C₃₀ alkyl. In certain embodiments, at least one R is C₃-C₃₀ alkenyl.

[080] In certain embodiments, the alkyl group is straight-chain or unbranched.

[081] In certain embodiments, the alkenyl group is straight-chain or unbranched.

[082] In certain embodiments, the one or more amines salts of phosphate esters comprises an alkyl phosphate ester amine salt.

[083] In certain embodiments, the alkyl and alkenyl groups are not substituted aryl groups.

[084] In certain embodiments, the amount of one or more phosphate esters or amine salts of phosphate esters in the composition is in the range of about 0.1 to about 2 wt %, about 0.1 to about 1 wt %, or about 0.1 to about 0.5 wt% of the total composition.

[085] *Detergents*

[086] In one embodiment, the composition comprises one or more low overbased detergents. In certain embodiments, the total concentration of the one or more low overbased detergents is in the range of about 5 to about 20 mM.

[087] In one embodiment, the composition comprises one or more high overbased detergents. In certain embodiments, the total concentration of the one or more high overbased detergents is in the range of about 45 to about 180 mM.

[088] In one embodiment, the composition comprises one or more low overbased detergents and one or more high overbased detergents. In certain embodiments, the total concentration of the one or more detergents is in the range of about 50 to about 200 mM.

Low Overbased (LOB) Detergent

[089] In one embodiment, the composition comprises one or more low overbased (LOB) detergents, such as a LOB sulfonate, salicylate, or phenate detergent.

[090] In some embodiments, the LOB sulfonate detergent is a salt derived from an alkali metal, an alkaline earth metal, or mixtures thereof. In certain embodiments, the LOB sulfonate detergent is a calcium sulfonate detergent.

[091] In certain embodiments, the composition comprises one or more LOB alkaryl sulfonate salts. In some embodiments, the composition comprises a LOB alkaryl sulfonate calcium salt, for example an alkyl-substituted benzene or alkyl-substituted toluene sulfonate calcium salt.

[092] The alkali metal or an alkaline earth metal (e.g., calcium) content accounted for by the one or more LOB detergent present in the tractor hydraulic fluid composition is 0.001 to 0.1 weight percent of the composition. In some embodiments, the alkali metal or an alkaline earth metal (e.g., calcium) content accounted for by the one or more LOB detergent is 0.01 to 0.09, 0.01 to 0.08, 0.01 to 0.07, or 0.01 to 0.06, 0.01 to 0.05, 0.01 to 0.04 weight percent of the composition.

[093] In some embodiments, the LOB detergent has a TBN of less than 200, less than 150, less than 140, less than 130, less than 120, less than 110, less than 100, less than 90, less than 80, less than 70, less than 60, less than 50, or less than 40mg KOH/g on an actives basis. In some embodiments, the TBN is in the range of about 2-100, 2-80, or 2-60 mg KOH/g on an actives basis.

High Overbased (HOB) Detergent

[094] In one embodiment, the composition comprises one or more high overbased (HOB) detergents, such as an HOB sulfonate detergent or an HOB phenate detergent. In certain embodiments, the composition comprises one or more HOB sulfonate detergents. In certain embodiments, the composition comprises one or more HOB phenate detergents.

[095] In some embodiments, the HOB sulfonate detergent is a salt derived from an alkali metal, an alkaline earth metal, or mixtures thereof. In certain embodiments, the HOB sulfonate detergent is a calcium sulfonate detergent.

[096] In certain embodiments, the composition comprises one or more HOB alkaryl sulfonate salts. In some embodiments, the composition comprises a HOB alkaryl sulfonate calcium salt, for example an alkyl-substituted benzene or alkyl-substituted toluene sulfonate calcium salt.

[097] The alkali metal or an alkaline earth metal (e.g., calcium) content accounted for by the one or more HOB detergent present in the tractor hydraulic fluid composition is 0.001 to 2.0 weight percent of the composition. In some embodiments, the alkali metal or an alkaline earth metal (e.g., calcium) content accounted for by the one or more HOB detergent is 0.001 to 2.0, 0.01 to 1.0, 0.01 to 0.90, 0.01 to 0.70, or 0.01 to 0.50, 0.01 to 0.40, weight percent of the composition.

[098] In some embodiments, the HOB detergent has a TBN of greater than 200, greater than 300, greater than 400, greater than 500, greater than 600, or greater than 700 mg KOH/g on an actives basis. In some embodiments, the TBN is in the range of about 300-800, such as 400-800, 400-700, 450-700, 500-700, 500-700, or 500-600 mg KOH/g on an actives basis.

[099] 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. 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, preferably about 16 to 30 carbon atoms, and more preferably 20-24 carbon atoms per alkyl substituted aromatic moiety.

[0100] In one embodiment, the HOB phenate detergent is a phenolic-based detergent. In another aspect of the present disclosure, the phenolic-based detergent is an isomerized olefin phenate detergent.

[0101] In one embodiment, the phenolic-based detergent is an alkylated phenate detergent wherein the alkyl group is derived from an isomerized normal alpha olefin having from about 10 to about 40 carbon atoms per molecule.

[0102] In one embodiment, the phenolic-based detergent has an isomerization level (I) of the normal alpha olefin is between from about 0.10 to about 0.40, preferably from about 0.10 to about 0.30, preferably from about 0.12 to about 0.30, and more preferably from about 0.22 to about 0.30.

[0103] In one embodiment, the phenate detergent is a sulfurized phenate detergent.

[0104] In one embodiment, the isomerized olefin phenate detergent can be prepared as described in US Patent 8,580,717 which is herein incorporated in its entirety.

[0105] In one embodiment, the alkyl group is derived from an isomerized alpha olefin having from about 14 to about 30, from about 16 to about 30, from about 18 to about 30, from about 20 to about 28, 2.0 to about 24, or from about 18 to about 28 carbon atoms per molecule.

[0106] In another embodiment, the isomerization level of the alpha olefin is about 0.26, and having from about 20 to about 24 carbon atoms. [0056] In some embodiments, the calcium content of the HOB phenate detergent is from 0.005 to 0.08, 0.01 to 0.08, 0.01 to 0.07, 0.01 to 0.06, 0.01 to 0.05, 0.01 to 0.045 weight percent, based on the weight of the composition.

Other Detergents

[0107] Other detergents that may be used include oil-soluble overbased sulfonate, salixarate, salicylate, saligenin, complex detergents and naphthenate detergents and other oil-soluble alkylhydroxybenzoates of a metal, particularly the alkali or alkaline earth metals, e.g., barium, 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.

[0108] Overbased metal detergents are generally produced by carbonating a mixture of hydrocarbons, detergent acid, for example: sulfonic acid, alkylhydroxybenzoate etc., metal oxide or hydroxides (for example calcium oxide or calcium hydroxide) and promoters such as xylene, methanol and water. For example, for preparing an overbased calcium sulfonate, in carbonation, the calcium oxide or hydroxide reacts with the gaseous carbon dioxide to form calcium carbonate. The sulfonic acid is neutralized with an excess of CaO or Ca(OH)₂, to form the sulfonate.

[0109] Overbased detergents may be low overbased, e.g., an overbased salt having a TBN below 100 on an actives basis. In one embodiment, the TBN of a low overbased salt may be from about 30 to about 100. In another embodiment, the TBN of a low overbased salt may be from about 30 to about 80. Overbased detergents may be medium overbased, e.g., an overbased salt having a TBN from about 100 to about 250. In one embodiment, the TBN of a medium overbased salt may be from about 100 to about 200. In another embodiment, the TBN of a medium overbased salt may be from about 125 to about 175. Overbased detergents may be high overbased, e.g., an overbased salt having a TBN above 250. In one embodiment, the TBN of a high overbased salt may be from about 250 to about 800 on an actives basis.

[0110] In one embodiment, the detergent can be one or more alkali or alkaline earth metal salts of an alkyl-substituted hydroxyaromatic carboxylic acid. Suitable hydroxyaromatic compounds include mononuclear monohydroxy and polyhydroxy aromatic hydrocarbons having 1 to 4, and preferably 1 to 3, hydroxyl groups. Suitable

hydroxyaromatic compounds include phenol, catechol, resorcinol, hydroquinone, pyrogallol, cresol, and the like. The preferred hydroxyaromatic compound is phenol.

[0111] The alkyl substituted moiety of the alkali or alkaline earth metal salt of an alkyl-substituted hydroxyaromatic carboxylic acid is derived from an alpha olefin having from about 10 to about 80 carbon atoms. The olefins employed may be linear, isomerized linear, branched or partially branched linear. The olefin may be a mixture of linear olefins, a mixture of isomerized linear olefins, a mixture of branched olefins, a mixture of partially branched linear or a mixture of any of the foregoing.

Antiwear Agents

[0112] In one embodiment, the composition comprises one or more antiwear agents. Antiwear agents reduce wear of metal parts. Suitable anti -wear agents include dihydrocarbyl dithiophosphate metal salts such as zinc dihydrocarbyl dithiophosphates (ZDDP) of formula (Formula C):

[0113] $\text{Zn}[\text{S}-\text{P}(=\text{S})(\text{OR}^1)(\text{OR}^2)]_2$ Formula C,

[0114] wherein R^1 and R^2 may be the same or different hydrocarbyl radicals having from 1 to 18 (e.g., 2 to 12) carbon atoms and including radicals such as alkyl, alkenyl, aryl, arylalkyl, alkaryl and cycloaliphatic radicals. Particularly preferred as R^1 and R^2 groups are alkyl groups having from 2 to 8 carbon atoms (e.g., the alkyl radicals may be ethyl, «-propyl, isopropyl, «- butyl, isobutyl, sec-butyl, «-pentyl, isopentyl, «-hexyl, isohexyl, 2-ethylhexyl). In order to obtain oil solubility, the total number of carbon atoms (i.e., $\text{R}^1 + \text{R}^2$) will be at least 5. The zinc dihydrocarbyl dithiophosphate can therefore comprise zinc dialkyl dithiophosphates. The zinc dialkyl dithiophosphate is a primary, secondary zinc dialkyl dithiophosphate, or a combination thereof. ZDDP may be present at 3 wt. % or less (e.g., 0.1 to 1.5 wt. %, or 0.5 to 1.25 wt %) of the composition.

[0115] In certain embodiments, the total concentration of the antiwear agents in the composition is in the range of about 5 to about 30 mM. In certain embodiments, the total concentration of the dihydrocarbyl dithiophosphates in the composition is in the range of about 5 to about 30 mM. In certain embodiments, the composition

comprises zinc dihydrocarbyl dithiophosphate in a concentration of about 5 to about 30mM, or about 10 to about 20 mM.

Antioxidants

[0116] The composition disclosed herein can comprise one or more antioxidant. Antioxidants reduce the tendency of mineral oils during to deteriorate during service. Oxidative deterioration can be evidenced by sludge in the lubricant, varnish-like deposits on the metal surfaces, and by viscosity growth. Suitable antioxidants include hindered phenols, aromatic amines, hindered amines (also known as HALS-Hindered Amine light Stabilizers) and sulfurized alkylphenols and alkali and alkaline earth metals salts thereof.

[0117] The hindered amines used in this invention are of many types, with three types predominating: pyrimidines, piperidines and stable nitroxide compounds. Many more are described in the book "Nitrones, Nitronates, and Nitroxides", E. Breuer, et al, 1989, John Wiley & Sons and in patents such as US9315760.

[0118] The hindered phenol antioxidant often contains a secondary butyl and/or a tertiary butyl group as a sterically hindering group. The phenol group may be further substituted with a hydrocarbyl group (typically linear or branched alkyl) and/or a bridging group linking to a second aromatic group. Examples of suitable hindered phenol antioxidants include 2,6-di-tert-butylphenol; 4-methyl-2,6-di-tert-butylphenol; 4-ethyl-2,6-di-tert-butylphenol; 4-propyl-2,6-di-tert-butylphenol; 4-butyl-2,6-di-tert-butylphenol; and 4-dodecyl-2,6-di-tert-butylphenol. Other useful hindered phenol antioxidants include 2, 6-di-alkyl-phenolic propionic ester derivatives such as IRGANOX® L-135 from BASF and bis-phenolic antioxidants such as 4,4-bis(2,6-di-tert-butylphenol) and 4,4-methylenebis(2,6-di-tert-butylphenol).

[0119] Typical aromatic amine antioxidants have at least two aromatic groups attached directly to one amine nitrogen. Typical aromatic amine antioxidants have alkyl substituent groups of at least 6 carbon atoms. Particular examples of aromatic amine antioxidants useful herein include 4,4'-dioctyldiphenylamine, 4,4'-dinonyldiphenylamine, *N*-phenyl-1-naphthylamine; *N*-(4-tert-octylphenyl)-l-

naphthylamine, and *N*-(4-octylphenyl)-1-naphthylamine. Antioxidants may be present at 0.01 to 5 wt. % (e.g., 0.1 to 2 wt. %) of the composition.

[0120] In certain embodiments, the composition comprises one or more antioxidants, for example one or more aminic (e.g., amine-containing) antioxidants. In certain embodiments, the amount of one or more antioxidants in the composition is in the range of about 0.01 to about 1 wt % of the total composition.

Friction Modifiers

[0121] The composition disclosed herein can comprise one or more friction modifiers, including hydrocarbyl polyalcohols, amines, amides, or esters.

[0122] In some embodiments, the hydrocarbyl polyalcohol have the formula $R(OH)_x$, wherein x is an integer from 2 to 6 and R is a hydrocarbyl group. In some embodiments, the hydrocarbyl polyalcohol is an alkyl polyalcohol or alkenyl polyalcohol. In some embodiments, the hydrocarbyl polyalcohol is a diol. In some embodiments, the diol is a 1,2-diol. In some embodiments, the hydrocarbyl group or the hydrocarbyl alcohol has 12 to 30, 14 to 20, or 16 to 18 carbon atoms.

[0123] In some embodiments, the hydrocarbyl polyalcohol is an alkane 1,2-diol or alkene 1,2-diol, wherein the hydrocarbyl polyalcohol has 12 to 30 carbon atoms. In certain embodiments, the hydrocarbyl polyalcohol has 14 to 20 carbon atoms. In some embodiments, the hydrocarbyl polyalcohol is 1,2-hexadecanediol or 1,2-octadecanediol.

[0124] In some embodiments, the compositions contain two or more hydrocarbyl polyalcohols.

[0125] The at least one hydrocarbyl polyalcohol is 0.01 to 5 weight percent of the oil composition. In some embodiments, the at least one hydrocarbyl polyalcohol is 0.01 to 4, 0.01 to 3, 0.01 to 2, 0.01 to 1, 0.1 to 1, 0.3 to 0.8, 0.4 to 0.7, or 0.5 weight percent of the oil composition.

[0126] In certain embodiments, the composition comprises one or more friction modifiers, for example one or more hydrocarbyl polyalcohol (e.g., a hydrocarbyl polyalcohol such as C16-C18 diol). In certain embodiments, the amount of one or more

friction modifiers in the composition is in the range of about 0.1 to about 5 wt %, such as about 0.1 to about 2 wt %, about 0.1 to about 1 wt %, 0.3 to 2 wt%, or about 0.4 to about 0.7 wt% of the total composition.

[0127] In certain embodiments, the composition comprises glycerol monooleate in an amount of about 0.1 to about 0.5 wt% of the total composition.

Foam Inhibitors

[0128] The composition disclosed herein can comprise one or more foam inhibitor that can break up foams in oils. Non-limiting examples of suitable foam inhibitors or anti-foam inhibitors include silicone oils or polydimethylsiloxanes, fluorosilicones, alkoxyated aliphatic acids, polyethers (e.g., polyethylene glycols), branched polyvinyl ethers, alkyl acrylate polymers, alkyl methacrylate polymers, polyalkoxyamines and combinations thereof.

[0129] In certain embodiments, the composition comprises one or more foam inhibitors, for example one or more silicone foam inhibitor. In certain embodiments, the amount of one or more foam inhibitors in the composition is in the range of about 10 to about 500 ppm, such as about 10 to 300 ppm, or 10 to 200 ppm of the total composition.

Additional Co-Additives

[0130] The compositions of the present disclosure may also contain other conventional additives that can impart or improve any desirable property of the composition in which these additives are dispersed or dissolved. Any additive known to a person of ordinary skill in the art may be used in the compositions disclosed herein. Some suitable additives have been described in Mortier et al., "Chemistry and Technology of Lubricants", 2nd Edition, London, Springer, (1996); and Leslie R. Rudnick, "Lubricant Additives: Chemistry and Applications", New York, Marcel Dekker (2003), both of which are incorporated herein by reference. For example, the compositions can be blended with antioxidants, anti-wear agents, detergents such as metal detergents, rust inhibitors, dehazing agents, demulsifying agents, metal deactivating agents, friction modifiers, pour point depressants, antifoaming agents, co-solvents,

corrosion-inhibitors, ashless dispersants, multifunctional agents, dyes, extreme pressure agents and the like and mixtures thereof. A variety of the additives are known and commercially available. These additives, or their analogous compounds, can be employed for the preparation of the compositions of the disclosure by the usual blending procedures.

[0131] In certain embodiments, the composition comprises a diluent oil in an amount of about 0.1 to about 1 wt% of the total composition.

[0132] In the preparation of compositions, it is common practice to introduce the additives in the form of 10 to 100 wt. % active ingredient concentrates in hydrocarbon oil, e.g. mineral lubricating oil, or other suitable solvent. The concentrates may be diluted with 3 to 100, e.g., 5 to 40, parts by weight of lubricating oil per part by weight of the additive package in forming finished compositions, e.g. tractor hydraulic fluids.

[0133] Each of the foregoing additives, when used, is used at a functionally effective amount to impart the desired properties to the composition.

[0134] In general, the concentration of each of the additives in the composition, when used, may range from about 0.001 wt. % to about 20 wt. %, from about 0.01 wt. % to about 15 wt. %, or from about 0.1 wt. % to about 10 wt. %, from about 0.005 wt.% to about 5 wt.%, or from about 0.1 wt.% to about 2.5 wt.%, based on the total weight of the composition. Further, the total amount of the additives in the composition may range from about 0.001 wt.% to about 20 wt.%, from about 0.01 wt.% to about 10 wt.%, or from about 0.1 wt.% to about 5 wt.%, based on the total weight of the composition.

[0135] In certain embodiments, the composition does not comprise a phosphite compound.

Methods of Use

[0136] The compositions described herein can be used advantageously in methods for improving brake noise reduction in agricultural machinery, particularly in the presence of water or in wet environments. Brake noise or brake chatter in

agricultural machinery, such as tractors, can be reduced by the application of the compositions described herein to the brake system of the agricultural machinery.

[0137] The compositions described herein can be used advantageously in methods for improving frictional performance in agricultural machinery, particularly in the presence of water or in wet environments. The compositions provide maintain frictional performance longer, particularly in the presence of water or in wet environments.

[0138] The compositions can be applied by any suitable means to gearboxes, power take-off and clutch(es), rear axles, reduction gears, wet brakes and hydraulic accessories to provide lubricity with improved noise reduction and/or frictional performance.

[0139] In one embodiment, a method of reducing brake noise in a tractor comprises: applying a tractor hydraulic fluid composition as described herein to a braking component or system in a tractor; and operating the tractor. In certain embodiments, the tractor is operated in the presence of water or in wet environments.

[0140] In one embodiment, a method of maintaining frictional performance in a tractor, comprising: applying a tractor hydraulic fluid composition as described herein to one or more components selected from the group consisting of: gearboxes, power take-off and clutch(es), rear axles, reduction gears, wet brakes and hydraulic accessories; and operating the tractor.

[0141] In certain embodiments, the tractor is operated in the presence of water or in wet environments.

[0142] The following examples are presented to exemplify embodiments of the invention but are not intended to limit the invention to the specific embodiments set forth. Unless indicated to the contrary, all parts and percentages are by weight. All numerical values are approximate. When numerical ranges are given, it should be understood that embodiments outside the stated ranges may still fall within the scope

of the invention. Specific details described in each example should not be construed as necessary features of the invention.

EXAMPLES

[0143] Exemplary and Comparative Tractor Hydraulic Fluid Compositions

[0144] Exemplary tractor hydraulic fluid compositions were evaluated against comparative compositions using the JASO SAE #2 Friction Test and Wet Clutch Anti-Shudder Performance Test. Three exemplary (Ex. 1-3) and four comparative (Comp. 1-4) compositions were formulated using the components listed in Table 1 and base oil (common tractor hydraulic fluid additives may also be included at fixed concentrations in each sample). Exemplary phosphate esters or amine salts of phosphate esters include alkyl phosphate ester amine salt, alkyl(C12-C18) acid phosphate, and oleyl acid phosphate. An exemplary dispersant is the bissuccinimide dispersant. Each sample also includes same amounts of commonly used THF additives such as detergent(s), anti-wear agent(s), antioxidant(s), friction modifier(s), and foam inhibitor(s).

[0145] **Table 1. Tractor Hydraulic Fluid Compositions**

Composition	Conc.	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Ex. 1	Ex. 2	Ex. 3
FM - C16-18 Diol	wt%	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Alkyl phosphate ester Amine salt	wt%	0	0	0	0	0	0	0.2
Alkyl (C12-C18) acid phosphate	wt%	0	0	0.2	0	0.2	0	0
Oleyl acid phosphate	wt%	0	0	0	0	0	0.26	0
Diolel hydrogen phosphite	wt%	0	0	0	0.31	0	0	0
Bissuccinimide Dispersant	wt%	0	0.5	0	0.5	0.5	0.5	0.5
Other additives	wt%	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Base Oil	wt%	85.5	85.0	85.3	84.69	84.8	84.74	84.8

[0146] Example 1. Dynamic Friction Test and Static Friction Test

[0147] Dynamic and static friction tests were carried out with the compositions described in Table 1 by means of SAE No.2 Test according to Friction Test Method for Automobiles and Automobile Automatic Transmission Fluid (defined in JASO M348.2002). The friction material for both tests was FZ127-24-Y12, Steel plate (FZ132-8Y2). The conditions for each test are provided below:

[0148] *Dynamic Friction Measurement*

[0149] Inertial moment of inertia disc: 0.343 kgm Oil temperature: 100° C.

[0150] Rotation: 3,600 rpm Surface pressure of friction plate: 785 MPa

[0151] Test cycle: 30 sec./cycle, Test number: 5,000 cycles

[0152] *Static Friction Measurement*

[0153] Rotation: 0.7 rpm Oil temperature: 100° C.

[0154] Surface pressure of friction plate: 785 MPa

[0155] Test period: 3 min. after initiation of rotation

[0156] Test cycle: after 1, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 3000, 4000, and 5000 cycles

[0157] *Measurement*

[0158] Static friction coefficient (μ_s) at the maximum torque 20 caused when the rotation at 0.7 rpm starts.

[0159] The minimum and maximum static friction coefficients for each composition are provided in Table 2.

[0160] **Table 2. Static friction Coefficients and ratio**

Composition	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Ex. 1	Ex. 2	Ex. 3
μ_s max (50-5000 cycle)	0.075	0.072	0.077	0.072	0.07	0.072	0.073
μ_s min (50-5000 cycle)	0.07	0.069	0.071	0.068	0.068	0.069	0.07
Increasing ratio, μ_s	6.7	4.2	7.8	5.6	2.9	4.2	4.1

[0161] As shown in Table 2, the static friction results show that the exemplary compositions comprising a succinimide dispersant and a phosphate ester or amine salt of a phosphate ester, provide enhanced frictional properties compared to the comparative compositions, which do not contain both the succinimide dispersant and a phosphate ester or amine salt of a phosphate ester .

[0162] **Example 2. Wet Clutch Anti-Shudder Performance Test**

[0163] The anti-shudder performance durability of the compositions was determined by means of a low velocity friction apparatus according to "Road vehicles Test method for anti-shudder performance of automatic transmission fluids" described in JASO M-349:2012. In this test, a positive value for the friction coefficient $d\mu/dV$ is

indicative of anti-shudder performance. Details of the testing method are described below.

[0164] *Testing Conditions*

[0165] Friction material: cellulose disc/steel plate

[0166] Amount of oil: approx. 150 mL

[0167] *Break-In Conditions*

[0168] Contact pressure: 1 MPa

[0169] Oil temperature: 80° C.

[0170] Sliding velocity: 0.6 m/s

[0171] Sliding time: 30 minutes

[0172] The results are shown in Table 3.

[0173] **Table 3.**

Composition	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Ex. 1	Ex. 2	Ex. 3
$\mu(150\text{rpm}) - \mu(50\text{rpm})$ 40 deg.C							
0.1 vol% water	0.0027	0.0003	0.0027	0.0023	0.0003	0.0010	0.0030
0.3 vol% water	0.0003	0.0043	0.0030	0.0020	0.0043	0.0020	0.0063
0.5 vol% water	-0.0013	-0.0020	0.0057	0.0030	0.0010	0.0060	0.0080
1.0 vol% water	-0.0020	-0.0050	0.0033	0.0017	0.0003	0.0060	0.0030
$\mu(150\text{rpm}) - \mu(50\text{rpm})$ 80 deg.C							
0.1 vol% water	0.0020	0.0010	0.0063	0.0030	0.0023	0.0043	0.0063
0.3 vol% water	-0.0010	-0.0007	-0.0007	0.0003	0.0013	0.0000	0.0000
0.5 vol% water	-0.0013	-0.0010	-0.0017	-0.0010	0.0007	0.0007	0.0013
1.0 vol% water	-0.0020	-0.0040	-0.0010	-0.0033	0.0000	0.0010	0.0000

[0174] Table 3 shows that the exemplary compositions are more effective in reducing brake noise when water is present than the comparative compositions.

[0175] Stick-slip phenomenon is known to occur when the friction coefficient decreases with an increase in sliding speed, causing brake noise.

[0176] For example, Comp. 1-4 shows negative values for the difference between μ at 150 rpm and μ at 50 rpm under water contaminated conditions. This means that the friction coefficient decreased with an increase in sliding speed, which means that brake noise is likely to occur.

[0177] On the other hand, Ex.1-3 shows positive values under water contaminated conditions. This means that the friction coefficient increased with an increase in sliding speed. Based on the results, brake noise is considered less likely to occur.

[0178] All documents described herein are incorporated by reference herein, including any priority documents and/or testing procedures to the extent they are not inconsistent with this text. As is apparent from the foregoing general description and the specific embodiments, while forms of the present disclosure have been illustrated and described, various modifications can be made without departing from the spirit and scope of the present disclosure. Accordingly, it is not intended that the present disclosure be limited thereby.

[0179] For the sake of brevity, only certain ranges are explicitly disclosed herein. However, ranges from any lower limit may be combined with any upper limit to recite a range not explicitly recited, as well as, ranges from any lower limit may be combined with any other lower limit to recite a range not explicitly recited, in the same way, ranges from any upper limit may be combined with any other upper limit to recite a range not explicitly recited. Additionally, within a range includes every point or individual value between its end points even though not explicitly recited. Thus, every point or individual value may serve as its own lower or upper limit combined with any other point or individual value or any other lower or upper limit, to recite a range not explicitly recited.

[0180] Likewise, the term "comprising" is considered synonymous with the term "including." Likewise whenever a composition, an element or a group of elements is preceded with the transitional phrase "comprising," it is understood that we also contemplate the same composition or group of elements with transitional phrases "consisting essentially of," "consisting of," "selected from the group of consisting of," or "is" preceding the recitation of the composition, element, or elements and vice versa.

[0181] The terms "a" and "the" as used herein are understood to encompass the plural as well as the singular.

[0182] Various terms have been defined above. To the extent a term used in a claim is not defined above, it should be given the broadest definition persons in the pertinent art have given that term as reflected in at least one printed publication or issued patent. Furthermore, all patents, test procedures, and other documents cited in this application are fully incorporated by reference to the extent such disclosure is not inconsistent with this application and for all jurisdictions in which such incorporation is permitted.

[0183] The foregoing description of the disclosure illustrates and describes the present disclosure. Additionally, the disclosure shows and describes only the preferred embodiments but, as mentioned above, it is to be understood that the disclosure is capable of use in various other combinations, modifications, and environments and is capable of changes or modifications within the scope of the concept as expressed herein, commensurate with the above teachings and/or the skill or knowledge of the relevant art. While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

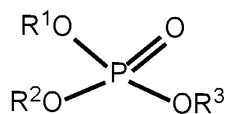
[0184] It is understood that when combinations, subsets, groups, etc. of elements are disclosed (e.g., combinations of components in a composition, or combinations of steps in a method), that while specific reference of each of the various individual and collective combinations and permutations of these elements may not be explicitly disclosed, each is specifically contemplated and described herein.

[0185] The embodiments described hereinabove are further intended to explain best modes known of practicing it and to enable others skilled in the art to utilize the disclosure in such, or other, embodiments and with the various modifications required by the particular applications or uses. Accordingly, the description is not intended to

limit it to the form disclosed herein. Also, it is intended that the appended claims be construed to include alternative embodiments.

CLAIMS

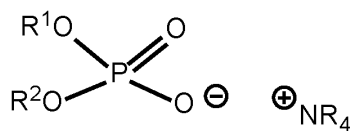
1. A tractor hydraulic fluid composition comprising:
 - (i) a major amount of an oil of lubricating viscosity;
 - (ii) one or more dispersants; and
 - (iii) one or more phosphate esters or amine salts of phosphate esters.
2. The tractor hydraulic fluid composition of claim 1, wherein the one or more dispersants comprise succinimide dispersants.
3. The tractor hydraulic fluid composition of claim 2, wherein the succinimide dispersants comprise bissuccinimide dispersants.
4. The tractor hydraulic fluid composition of claim 1, wherein the phosphate ester is a compound of Formula 1:



Formula 1

wherein each of R^1 , R^2 and R^3 is independently selected from H, C_3 - C_{30} alkyl, and C_3 - C_{30} alkenyl, and at least one of R^1 , R^2 and R^3 is not H.

5. The tractor hydraulic fluid composition of claim 1, wherein the amine salt of a phosphate ester is a compound of Formula 2:



Formula 2

wherein each of R¹ and R² are independently selected from H, C₃-C₃₀ alkyl, and C₃-C₃₀ alkenyl, and at least one of R¹ and R² is not H; and wherein each R is independently selected from H, C₁-C₃₀ alkyl, and C₁-C₃₀ alkenyl.

6. The tractor hydraulic fluid composition of claim 5, wherein the ⁺NR₄ is a primary amine.

7. The tractor hydraulic fluid composition of claim 1, wherein the composition further comprises one or more friction modifiers.

8. The tractor hydraulic fluid composition of claim 7, wherein the one or more friction modifiers includes polyol or polyol ester.

9. The tractor hydraulic fluid composition of claim 1, wherein the amount of one or more dispersants in the composition is in the range of about 0.1 to about 5 wt% of the total composition.

10. The tractor hydraulic fluid composition of claim 1, wherein the amount of one or more phosphate esters or amine salts of phosphate esters in the composition is in the range of about 0.1 to about 2 wt % of the total composition.

11. A method of reducing brake noise in a tractor, comprising: applying a tractor hydraulic fluid composition according to claim 1 to a braking component or system in a tractor; and operating the tractor.

12. The method of claim 11, wherein the tractor is operated in the presence of water or in wet environments.

13. A method of maintaining frictional performance in a tractor, comprising:
applying a tractor hydraulic fluid composition according to claim 1 to one or more
components selected from the group consisting of:
gearboxes, power take-off and clutch(es), rear axles, reduction gears, wet brakes and
hydraulic accessories;
and operating the tractor.

14. The method of claim 13, wherein the tractor is operated in the presence of water
or in wet environments.