[0009] The metal salts of dialkyl dithio phosphates are often used in lubricants as antiwear agents. One example of such use is found in U.S. Patent No. 8,084,403. However, use of these additives may alter the friction characteristics of the lubricants.

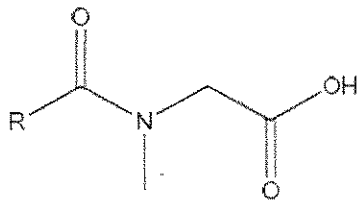
[00010] In recent years there has been a growing desire to employ lubricants that provide higher energy-efficiency, especially lubricants that reduce friction. Also, there is a desire to provide improved additive combinations that achieve multiple goals while still providing the desired performance levels.

SUMMARY

[00011] ~~In a first aspect, t~~The present disclosure provides an engine oil comprising a major amount of a base oil and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component selected from:

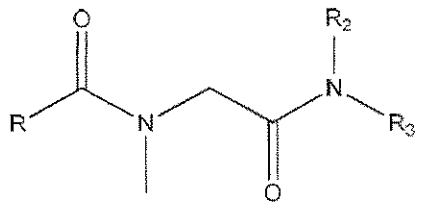
(a) one or more a reaction products of an alcohol with a compound of the formula IV:



(IV)

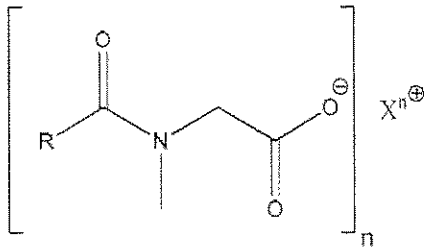
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having about 8 to about 22 carbon atoms; and

(b) one or more compounds of the Formulae II-III:



(II)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having about 8 to about 22 carbon atoms and R2 and R3 are independently selected from hydrogen, C1-C18 hydrocarbyl groups, and C1-C18 hydrocarbyl groups containing one or more heteroatoms;



(III)

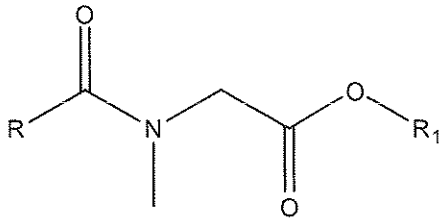
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having about 8 to about 22 carbon atoms; and X is an alkali metal, alkaline earth metal, or ammonium cation and n is the valence of cation X; and

(B) at least one metal dialkyl dithio phosphate salt.

[00012] The one or more reaction products of an alcohol with a compound of the formula IV may be esters.

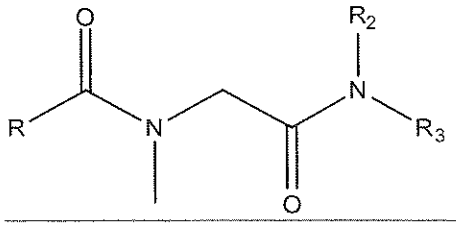
[00012a] In one aspect of the present disclosure, there is provided an engine oil composition comprising greater than 50 wt.% of a base oil selected from a Group II, Group III, Group IV and Group V base oil and mixtures thereof, wherein the base oils of Group II and Group III have at least 90% saturates, and an additive package, wherein the additive package comprises:

(A) a friction modifier component selected fromone or more compounds of the Formulae I-III:



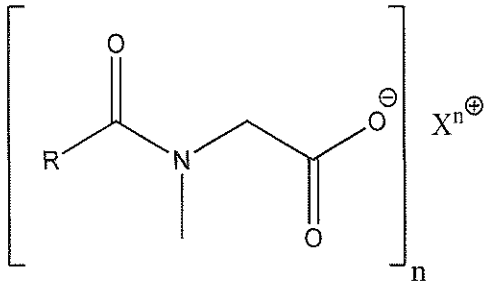
(I)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having 8 to 22 carbon atoms and R_1 is hydrogen, a hydrocarbyl having from 1 to 8 carbon atoms, or a C_1-C_8 hydrocarbyl group containing one or more heteroatoms;



(II)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having 8 to 22 carbon atoms and R_2 and R_3 are independently selected from hydrogen, C_1-C_{18} hydrocarbyl groups, and C_1-C_{18} hydrocarbyl groups containing one or more heteroatoms;



(III)

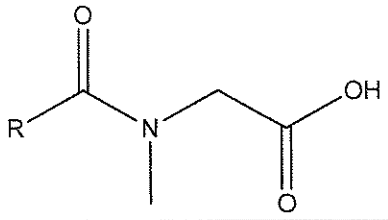
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having 8 to 22 carbon atoms; and X is an alkali metal, alkaline earth metal, or ammonium cation and n is the valence of cation X; and

(B) at least one metal dialkyl dithio phosphate salt; and

wherein the engine oil composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-1000 ppm and the engine oil composition contains 0.1 to 2.0 wt.% of the friction modifier component, based on a total weight of the composition, and when the friction modifier component is a compound of the formula (III), the engine oil composition comprises a major amount of a base oil having at least 90% saturates and being selected from a Group II, Group III and Group IV base oil and mixtures thereof.

[00012b] In a second aspect of the present disclosure, there is provided an engine oil composition comprising greater than 50 wt.% of base oil selected from a Group II, Group III, Group IV and Group V base oil and mixtures thereof, wherein the base oils of Group II and Group III have at least 90% saturates, and an additive package, wherein the additive package comprises:

(A) a friction modifier component selected from one or more ester reaction products of an alcohol with a compound of the formula IV:



(IV)

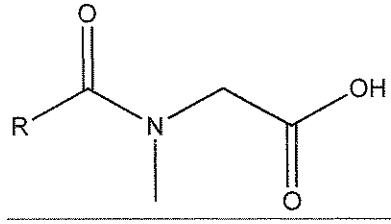
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having 8 to 22 carbon atoms; and

(B) at least one metal dialkyl dithio phosphate salt; and

wherein the engine oil composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-1000 ppm and the engine oil composition contains 0.1 to 2.0 wt.% of the friction modifier component, based on a total weight of the composition.

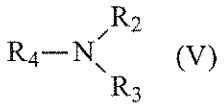
[00012c] In a third aspect of the present disclosure, there is provided an engine oil composition comprising greater than 50 wt.% of base oil selected from a Group II, Group III, Group IV and Group V base oil and mixtures thereof, wherein the base oils of Group II and Group III have at least 90% saturates, and an additive package, wherein the additive package comprises:

(A) a friction modifier component selected from one or more amide reaction products of a compound of the formula IV:



(IV)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having 8 to 22 carbon atoms, and an amine of the formula V:



(V)

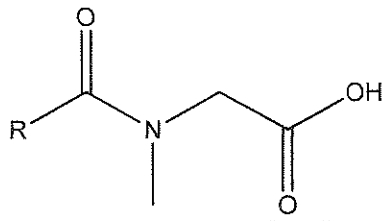
wherein R_2, R_3, and R_4 are independently selected from hydrogen, C_1-C_{18} hydrocarbyl groups, and hydrocarbons containing C_3-C_{12} hydrocarbyl groups and one or more heteroatoms; and

(B) at least one metal dialkyl dithio phosphate salt; and

wherein the engine oil composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-1000 ppm and the engine oil composition contains 0.1 to 2.0 wt.% of the friction modifier component, based on a total weight of the composition.

[00012d] In a fourth aspect of the present disclosure, there is provided an engine oil composition comprising greater than 50 wt.% of a base oil selected from a Group II, Group III and Group IV base oil and mixtures thereof, wherein the base oils of Group II and Group III have at least 90% saturates, and an additive package, wherein the additive package comprises:

(A) a friction modifier component selected from one or more salts that are reaction products of one or more compounds of the formula IV:



(IV)

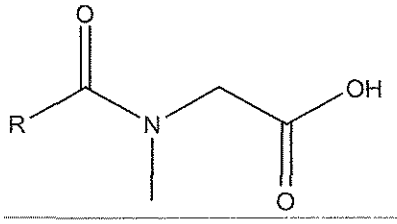
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having 8 to 22 carbon atoms, and an alkali metal hydroxide, and alkaline earth metal hydroxide, an alkali metal oxide, an alkaline earth metal hydroxide, ammonia, an amine or mixtures thereof; and

(B) at least one metal dialkyl dithio phosphate salt; and

wherein the engine oil composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-1000 ppm and the engine oil composition contains 0.1 to 2.0 wt.% of the friction modifier component, based on a total weight of the composition.

[00012e] In a fifth aspect of the present disclosure, there is provided an engine oil composition comprising greater than 50 wt.% of a base oil selected from a Group II, Group III, Group IV and Group V base oil and mixtures thereof, wherein the base oils of Group II and Group III have at least 90% saturates, and an additive package, wherein the additive package comprises:

(A) a friction modifier component selected from one or more ester or amide reaction products of one or more compounds of the formula IV:



(IV)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having 8 to 22 carbon atoms, and one or more amine alcohol(s); and

(B) at least one metal dialkyl dithio phosphate salt; and

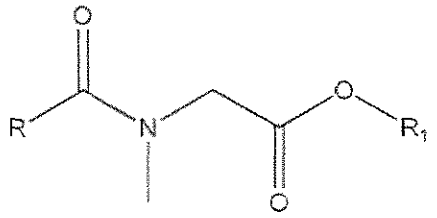
wherein the engine oil composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-1000 ppm and the engine oil composition contains 0.1 to 2.0 wt.% of the friction modifier component, based on a total weight of the composition.

[00012f] In a sixth aspect of the present disclosure, there is provided a method for reducing thin film and boundary layer friction in an engine comprising the step of lubricating the engine with the engine oil composition disclosed herein.

[00012g] In a seventh aspect of the present disclosure, there is provided a method for reducing boundary layer friction in an engine, comprising the step of lubricating the engine with the engine oil composition disclosed herein.

[00012h] In an eighth aspect of the present disclosure, there is provided a method for reducing thin film friction in an engine, comprising the step of lubricating the engine with the engine oil composition disclosed herein.

[00013] In one embodiment, the reaction products of an alcohol with a compound of the formula IV comprise one or more compounds of the formula I:



(I)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having about 8 to about 22 carbon atoms and R1 is hydrogen, a hydrocarbyl having from about 1 to about 8 carbon atoms, or a C1-C8 hydrocarbyl group containing one or more

heteroatoms.

[00014] The hydroxyl moiety of the Formula IV may be replaced by a suitable leaving group, if desired, prior to reaction with the alcohol. The alcohol may be represented by R1-OH, where R1 comprises a hydrocarbyl group containing about 1 to about 8 carbon atoms or a C1-C8 hydrocarbyl group containing one or more heteroatoms.

[00015] The one or more compounds may be amides of the formula II.

[00016] The one or more compounds may comprise at least one salt of the formula III.

[00017] The additive package may comprise at least two different compounds independently selected from the formulae I-III.

[00018] R may have from about 10 to about 20 carbon atoms. Alternatively, R may have from about 12 to about 18 carbon atoms.

[00019] R1 may be a hydrocarbyl group having from about 1 to about 8 carbon atoms. Alternatively, R1 may be a hydrocarbyl group containing a C1-C8 hydrocarbyl group containing one or more heteroatoms.

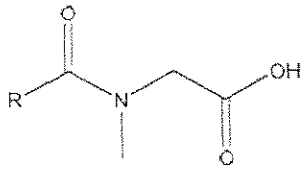
[00020] R2 and R3 may be independently selected from hydrogen, C1-C18 hydrocarbyl groups, and C1-C18 hydrocarbyl groups containing one or more heteroatoms. Alternatively, R2 and R3 may be independently selected from hydrogen and C4-C8 hydrocarbyl groups.

[00021] The one or more compounds of the formula III are salts of one or more cations selected from sodium, lithium, potassium, calcium, magnesium, and an amine.

[00022] The additive package may further comprise at least one additive selected from the group consisting of antioxidants, antifoam agents, molybdenum-containing compounds, titanium-containing compounds, phosphorus-containing compounds, viscosity index improvers, pour point depressants, and diluent oils.

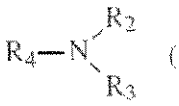
[00023] ~~In another aspect, t~~The present ~~invention~~ disclosure also provides a lubricating oil comprising a major amount of base oil and a minor amount of an additive package, wherein the additive package comprises:

(A) one or more reaction products of a compound of the formula IV:



(IV)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having about 8 to about 22 carbon atoms, and an amine of the formula V:



(V)

(V)

wherein R2, R3, and R4 are independently selected from hydrogen, C1-C18 hydrocarbyl groups, and hydrocarbons containing C3-C12 hydrocarbyl groups and one or more heteroatoms; and

(B) at least one metal dialkyl dithio phosphate salt

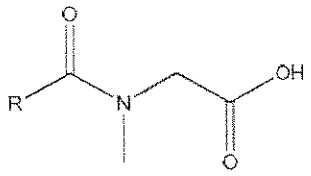
[00024] R of the formula IV may have from about 10 to about 20 carbon atoms.

[00025] R2, R3, and R4 may be independently selected from hydrogen, C3-C12 hydrocarbyl groups, and heteroatom containing C3-C12 hydrocarbyl groups.

[00026] Suitable amines include, for example, ammonia, 2-ethyl hexyl amine, n-butyl amine, t-butyl amine, isopropyl amine, pentyl amines including n-pentyl amine, isopentyl amine, 2-ethyl propyl amine, octyl amines, dibutylamine, and dimethylaminopropylamine. Suitable amides include, for example, the reaction products of compounds of the formula IV with one or more of methoxyethylamine, tris-hydroxymethyl amino-methane (THAM), and diethanolamine. Another suitable amide reaction product is the reaction product of 2-(N-methyloctadeca-9-enamido)acetic acid and 2-ethyl hexyl amine.

[00027] ~~In another aspect, t~~The present disclosure also provides a lubricating oil comprising a major amount of a base oil and a minor amount of an additive package, wherein the additive package comprises:

(A) one or more salts that are reaction products of one or more compounds of the formula IV:



(IV)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having about 8 to about 22 carbon atoms and the hydrogen atom, on the acid group, may also be replaced by a suitable leaving group; and an alkali or alkaline earth metal hydroxide, an alkali or alkaline earth metal oxide, an amine or mixtures thereof; and

(B) at least one metal dialkyl dithio phosphate salt.

[00028] Suitable alkali or alkaline earth metal hydroxides or corresponding oxides include, but are not limited to, sodium hydroxide, potassium hydroxide, lithium hydroxide, calcium hydroxide, calcium oxide, magnesium hydroxide, barium hydroxide, and the like.

[00029] Salts suitable as friction modifiers for use in the present disclosure include, for example, monovalent salts such as the sodium salt of 2-(N-methyldodecanamido)acetic acid, the potassium salt of 2-(N-methyloctadecanamido)acetic acid, divalent salts such as the calcium, magnesium, and barium salts.

[00030] ~~In another aspect, t~~The present disclosure also provides a lubricating oil comprising a major amount of a base oil and a minor amount of an additive package, wherein the additive package comprises:

(A) one or more reaction products of one or more compounds of the formula IV:

alkyl, alkenyl, aryl, arylalkyl, alkaryl, and cycloaliphatic moieties. Thus, the moieties may, for example, be ethyl, n-propyl, i-propyl, n-butyl, i-butyl, sec-butyl, amyl, n-hexyl, i-hexyl, noctyl, decyl, dodecyl, octadecyl, 2-ethylhexyl, phenyl, butylphenyl, cyclohexyl, methylcyclopentyl, propenyl, or butenyl.

[00036] ~~In yet another aspect, t~~The present disclosure also provides a method for improving thin film and boundary layer friction between surfaces in contact moving relative to one another, comprising the step of lubricating the surface with a lubricating oil composition as disclosed herein. In some embodiments, the surfaces are the contacting surfaces of an engine.

[00037] ~~In yet another aspect, t~~The present disclosure further provides a method for improving boundary layer friction between surfaces in close proximity moving relative to one another, comprising the step of lubricating the surface with a lubricating oil composition as disclosed herein. In some embodiments, the surfaces are the contacting surfaces of an engine.

[00038] ~~In yet another aspect, t~~The present disclosure also provides a method for improving thin film friction between surfaces in close proximity relative to one another, comprising the step of lubricating the surface with a lubricating oil composition as disclosed herein. In some embodiments, the surfaces are the contacting surfaces of an engine.

[00039] ~~In another aspect, t~~The present disclosure further provides a method for improving thin film and boundary layer friction in an engine comprising the step of lubricating the engine with the lubricating or engine oils described herein.

[00040] The improved thin film and boundary layer friction may be determined relative to a same composition in the absence of the one or more friction modifier components as described herein.

[00041] ~~In another aspect, t~~The present disclosure also provides a method for improving boundary layer friction in an engine, comprising the step of lubricating the engine with the lubricating or engine oils described herein.

[00042] The improved boundary layer friction may be determined relative to a same composition in the absence of the one or more friction modifier components as described herein.

[00043] ~~In another aspect, t~~The present disclosure further provides a method for improving thin film friction in an engine, comprising the step lubricating the engine the lubricating or engine oils as described herein.

[00044] The improved thin film friction may be determined relative to a same composition in the absence of the one or more friction modifier components as described herein.