basic calcium sulphonate detergent (TBN=300), P_2S_5 – polybutene barium phenate/sulphonate detergent, a dispersant that is a reaction product of polybutenyl succinic anhydride with an Mw=900 PIB group and tetraethylenepentamine, zinc dihexyldithiophosphate, dioleylphosphite, sperm oil, and sulphurised polybutene.

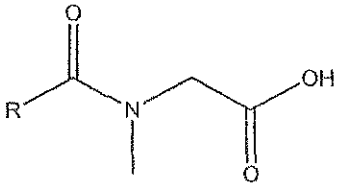
[00010] In recent years there has been a growing desire to employ lubricants that provide higher energy-efficiency, especially lubricants that reduce friction by employment of friction modifiers in the lubricants. The present disclosure provides an improved lubricant composition that may reduce one or both of thin film friction and boundary layer friction.

SUMMARY

[00011] ~~In one aspect,~~ the present disclosure 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) a friction modifier component selected from:

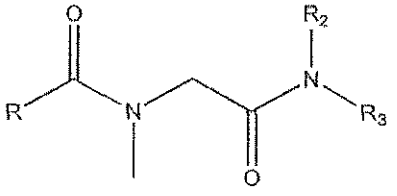
(a) one or more a reaction products of an alcohol with a compound of the formula IV:



(IV)

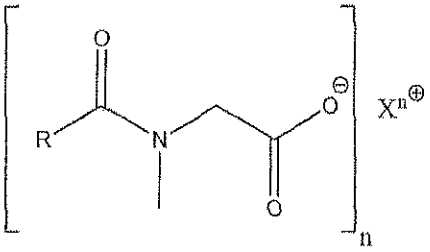
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having about 8 to about 22 carbon atoms; and

(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 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; and



(III)

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

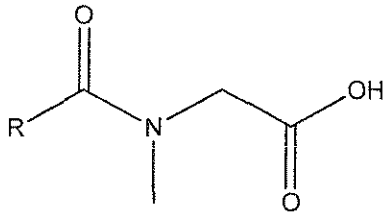
(B) at least one friction modifier that is different from the one or more compounds (A).

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

[00012a] In a first aspect of the present disclosure, there is provided an engine oil composition comprising at least 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:

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



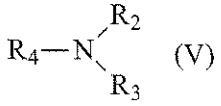
(IV)

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

(i) one or more alcohols to form an ester reaction product;

(ii) one or more amine alcohols to form an ester or amide reaction product;

(iii) one or more amines of the formula V:

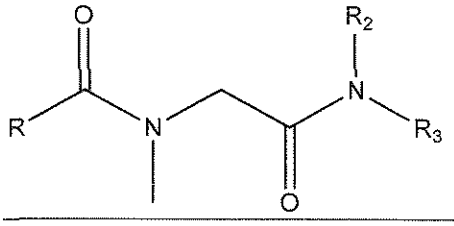


(V)

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 to form an amide reaction product; or

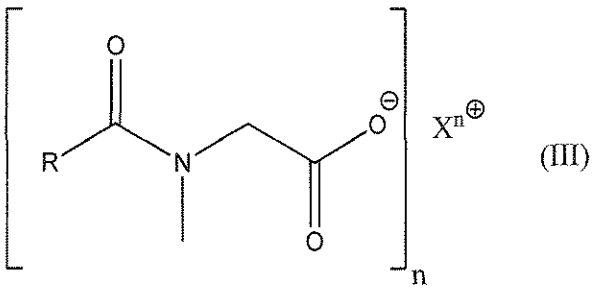
(iv) an alkali metal hydroxide, an alkaline earth metal hydroxide, an alkali metal oxide, an alkaline earth metal hydroxide, ammonia, an amine or mixtures thereof, wherein the reaction product is in the form of a salt; and

(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 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)

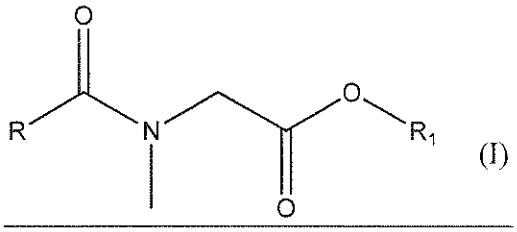
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having 8 to 22 carbon atoms; and X is an alkali metal, alkaline earth metal or ammonium cation and n is the valence of cation X; and

(B) at least one friction modifier that is different from the one or more compounds (A) and which comprises at least one compound selected from alcohols, glycerol esters, amines, ethoxylated amines, amides, ethoxylated amides, dimer acids, polyesters, zinc dithiocarbamates, molybdenum dithiocarbamates, and sulfur-free molybdenum compounds; 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 0.1-2.0 wt.% of the friction modifier component (A), based on the total weight of the engine oil composition, and when the friction modifier component (A) 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 at least 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 compounds of the formula I:



(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; and

(B) at least one friction modifier that is different from the one or more compounds (A) and which comprises at least one compound selected from alcohols, glycerol esters, amines, ethoxylated amines, amides, ethoxylated amides, dimer acids, polyesters, zinc dithiocarbamates, molybdenum dithiocarbamates, and sulfur-free molybdenum compounds; and

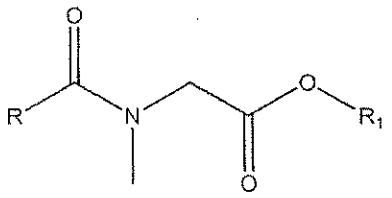
wherein the engine oil composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-1000 ppm and the engine oil composition contains 0.1-2.0 wt.% of the friction modifier component (A), based on the total weight of the engine oil composition.

[00012c] In a third 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 as defined herein.

[00012d] In a fourth 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 as defined herein.

[00012e] In a fifth 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 as defined 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 R_1 is hydrogen, a hydrocarbyl having from about 1 to about 8 carbon atoms, or a C_1-C_8 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 R_1-OH, where R_1 comprises a hydrocarbyl group containing about 1 to about 8 carbon atoms or a C_1-C_8 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] R_1 may be a hydrocarbyl group having from about 1 to about 8 carbon atoms. Alternatively, R_1 may be a hydrocarbyl group containing a C_1-C_8 hydrocarbyl group containing one or more heteroatoms.

[00020] R_2 and R_3 may be independently selected from hydrogen, C_1-C_{18} hydrocarbyl groups, and C_1-C_{18} hydrocarbyl groups containing one or more heteroatoms. Alternatively, R_2 and R_3 may be independently selected from hydrogen and C_4-C_8 hydrocarbyl groups.

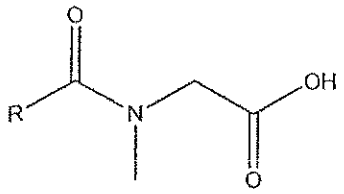
[00021] The one or more compounds of the formula III are salts of one or more cations selected from sodium, lithium, potassium, calcium, magnesium, and an amine.

[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] The foregoing lubricating oil may comprise an engine oil.

[00024] ~~TIn another aspect, 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:

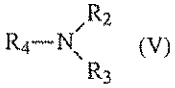
(A) one or more reaction products of one or more compounds of the Formula IV:



(IV)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having about 8 to about 22 carbon atoms, and the hydroxyl moiety on the acid group may be replaced by a suitable leaving group, if desired, prior to the reaction and

one or more amines 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 C_1-C_{18} hydrocarbyl groups containing one or more heteroatoms; and

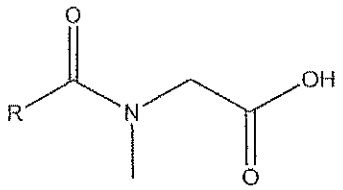
(B) at least one friction modifier that is different from the one or more reaction products of one or more compounds of the Formula IV with one or more amines of the

the potassium salt of 2-(N-methyloctadecanamido)acetic acid, divalent salts such as the calcium, magnesium, and barium salts.

[00032] The foregoing lubricating oil may comprise an engine oil.

[00033] ~~TIn another aspect, t~~he 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:



(IV)

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

(B) at least one friction modifier that is different from the one or more reaction products of one or more compounds of the Formula IV with one or more amines of the Formula V.

[00034] The amine alcohols may be selected from ethanolamine, diethanolamine, aminoethyl ethanolamine, tris-hydroxymethyl amino-methane, and mixtures thereof.

[00035] The at least one friction modifier that is different from the one or more compounds (A) may comprises at least one compound selected from alcohols, glycerol esters, amines, ethoxylated amines, amides, ethoxylated amides, dimer acids, polyesters, zinc dithiocarbamates, molybdenum dithiocarbamates, and sulfur-free molybdenum compounds.

[00036] The total amount of compounds (A) and the at least one friction modifier (B) may comprise from about 0.1 wt.% to about 10 wt.% of a total weight of the lubricating oil.

[00037] The at least one friction modifier (B) may comprise at least two compounds independently selected from alcohols, glycerol esters, amines, ethoxylated amines, amides, ethoxylated amides, dimer acids, polyesters, zinc dithiocarbamates, molybdenum dithiocarbamates, and sulfur-free molybdenum compounds.

[00038] The at least one friction modifier (B) may comprise at least one glycerol ester.

[00039] The at least one friction modifier (B) may comprise at least one molybdenum dithiocarbamate.

[00040] The at least one friction modifier (B) may comprise at least one polyester.

[00041] The at least one friction modifier (B) may comprise at least one glycerol ester and at least one molybdenum dithiocarbamate.

[00042] ~~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.

[00043] ~~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.

[00044] ~~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.

[00045] ~~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.

[00046] 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.

[00047] ~~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.

[00048] 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.

[00049] ~~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.

[00050] 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.