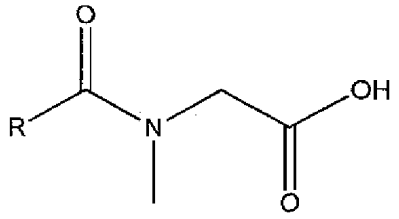
[0009] In recent years there has been a growing desire to employ lubricants that provide higher energy-efficiency, especially lubricants that reduce friction. Also, there is a desire to provide improved additive combinations that achieve multiple goals while still providing the desired performance levels.

SUMMARY

[00010] 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:

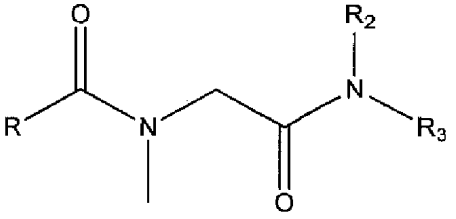
(a) one or more a reaction products of an alcohol with a compound of the formula IV:



(IV)

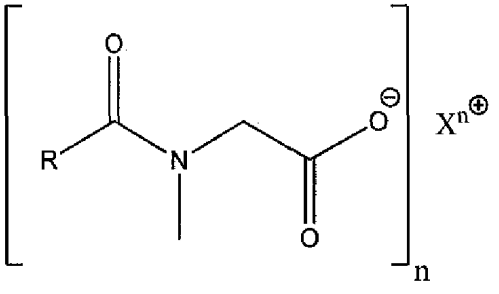
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having about 8 to about 22 carbon atoms; and

(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 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;



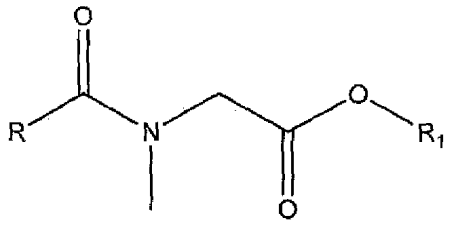
(III)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl having 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 dispersant.

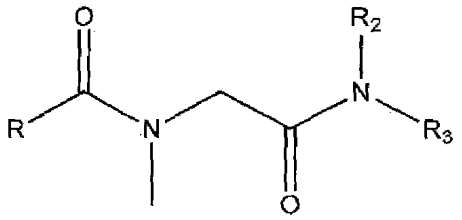
[00010a] In a first aspect of the present disclosure, there is provided an engine oil composition comprising a major amount of a base oil selected from the group consisting of a Group II, Group III, Group IV and Group V base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component selected from the group consisting of one or more compounds of the Formulae I-III



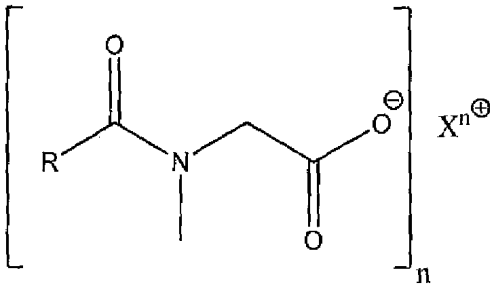
(I)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group 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 selected from the group consisting of sulfur, oxygen and nitrogen;



(II)

wherein R is as defined above; and R_2 and R_3 are independently selected from the group consisting of hydrogen, C_1-C_{18} hydrocarbyl groups, and C_1-C_{18} hydrocarbyl groups containing one or more heteroatoms selected from the group consisting of sulfur, oxygen and nitrogen; and



(III)

wherein R is as defined above; X is an alkali metal, alkaline earth metal, or ammonium cation and n is the valence of cation X; and

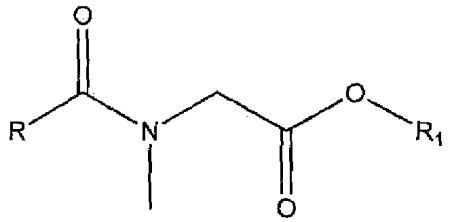
(B) at least one dispersant selected from the group consisting of succinimide dispersants made from a polyamine, Mannich dispersants and mixtures thereof;

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, the engine oil composition contains from 0.1 to 2.0 wt. % of the friction modifier component (A),

with the proviso that when the friction modifier component is a compound of formula (III), the engine oil composition comprises a major amount of a base oil selected from the group consisting of a Group II, Group III and Group IV base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates.

[00011] The one or more reaction products of an alcohol with a compound of the formula IV may be esters.

[00012] 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.

[00013] The one or more compounds may be amides of the formula II.

[00014] The one or more compounds may comprise at least one salt of the formula III.

[00015] The additive package may comprise at least two different compounds independently selected from the formula I-III.

[00016] R may have from about 10 to about 20 carbon atoms. Alternatively, R may have from about 12 to about 18 carbon atoms.

[00017] 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.

[00018] 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.

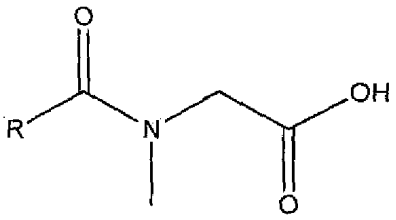
[00019] The one or more compounds of the formula III are salts of one or more cations selected from sodium, lithium, potassium, calcium, magnesium, and an amine.

[00020] 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.

[00021] 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 on or more reaction products of:

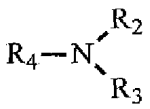
one or more compounds for the Formula IV:



(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:



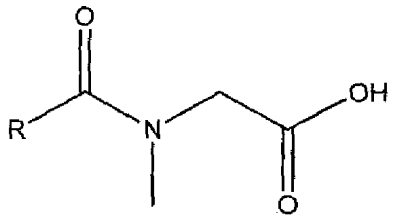
(V)

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 dispersant.

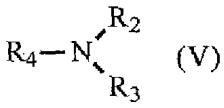
[00021a] In a second aspect of the present disclosure, there is provided an engine oil composition comprising a major amount of base oil selected from the group consisting of a Group II, Group III, Group IV and Group V base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component comprising 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 the group consisting of hydrogen, C_1-C_{18} hydrocarbyl groups, and C_3-C_{12} hydrocarbyl groups containing one or more heteroatoms selected from the group consisting of sulfur, oxygen, and nitrogen; and

(B) at least one dispersant selected from the group consisting of succinimide dispersants made from a poly amine, Mannich dispersants and mixtures thereof; 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 wt. % of the friction modifier component (A).

[00022] The foregoing lubricating oil composition may comprise an engine oil.

[00023] R of the formula IV may have from about 10 to about 20 carbon atoms.

[00024] R_2, R_3, and R_4 may be independently selected from hydrogen, C_3-C_{12} hydrocarbyl groups, and heteroatom containing C_3-C_{12} hydrocarbyl groups.

[00025] 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-ema,odp)acetic acid and 2-ethyl hexyl amine.

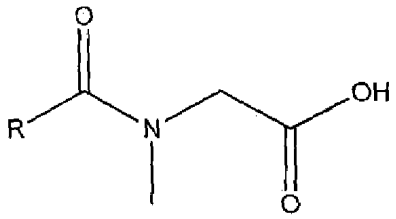
[00026] The hydroxyl moniety on the compound of the formula IV may be replaced by a suitable leaving group, if desired, prior to reaction with the alcohol. The alcohol may be represented by R_1-OH, where R_1 comprises a C_1-C_8hydrocarbyl group or a C_1-C_8hydrocarbyl

group containing one or more heteroatoms.

[00027] The foregoing lubricating oil composition may comprise an engine oil.

[00028] 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:



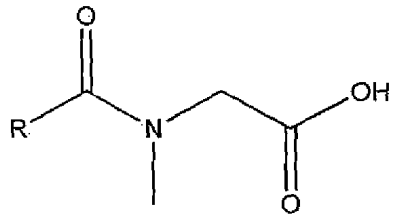
(IV)

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 dispersant.

[00028a] In a third aspect of the present disclosure, there is provided an engine oil composition comprising a major amount of a base oil selected from the group consisting of a Group II, Group III and Group IV base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component comprising 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 oxide, ammonia, an amine or mixtures thereof; and

(B) at least one dispersant selected from the group consisting of succinimide dispersants made from a polyamine, Mannich dispersants and mixtures thereof;

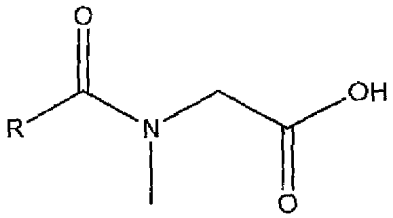
wherein the engine oil is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-1000 ppm, and the engine oil composition contains 0.1 to 2 wt.% of the friction modifier component (A).

[00029] 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.

[00030] 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.

[00031] 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:



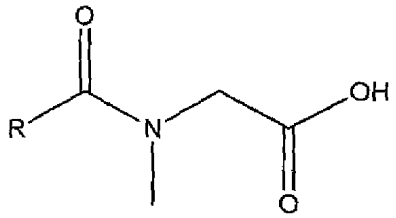
(IV)

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

(B) at least one dispersant.

[00031a] In a fourth aspect of the present disclosure, there is provided an engine oil composition comprising a major amount of a base oil selected from the group consisting of a Group II, Group III, Group IV and Group V base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component comprising one or more amide or ester 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 dispersant selected from the group consisting of succinimide dispersants made from a polyamine, Mannich dispersants and mixtures thereof; and

wherein the composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-800 ppm and the engine oil composition contains 0.1 to 2 wt.% of the friction modifier component (A).

[00032] In each of the foregoing lubricating oils the at least one dispersant may comprise a polyalkylene succinimide. Alternatively, the at least one dispersant may comprise a polyisobutylene succinimide prepared from a polyisobutylene having a number average molecular weight or greater than 900. The at least one dispersant may alternatively comprise a polyisobutylene succinimide prepared from a polyisobutylene having a number average molecular weight of from about 1200 to about 5000.

[00033] The at least one polyalkylene succinimide may be post-treated with one or more compounds selected from boron compounds, anhydrides, aldehydes, ketones, phosphorus compounds, epoxides, and carboxylic acids. Alternatively, the at least one polyisobutylene succinimide may be post-treated with a boron compound and wherein the boron content of the lubricating oil is from about 200 to 500 ppm boron.

[00034] The at least one dispersant may comprise a polyisobutylene succinimide prepared from a polyisobutylene having greater than 50% terminal vinylidene.

[00035] The at least one polyisobutylene succinimide dispersant may be derived from an amine selected from trialkyleneaminetetramine and tetralkylene pentamine.

[00036] A total amount of dispersant is less than about 20 wt. % of a total weight of the lubricating oil. Alternatively, the total amount of dispersant is in a range of from 0.1 wt. % to 15 wt. % of a total weight of the lubricating oil.

[00037] Tthe present disclosure further 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.

[00038] The present disclosure also 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.

[00039] The present disclosure further 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.

[00039a] In a fifth aspect of the present disclosure, there is provided a method for improving thin film and boundary layer friction in an engine comprising the step of lubricating the engine with the engine oil composition as claimed any one of the first to fourth aspects.

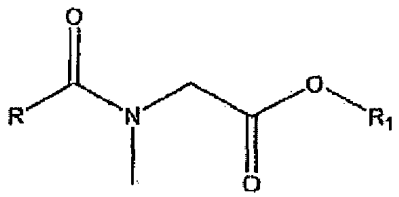
[00039b] In a sixth aspect of the present disclosure, there is provided a method for improving boundary layer friction in an engine, comprising the step of lubricating the engine with the engine oil composition as claimed in any one of the first to fourth aspects.

[00039c] In a seventh aspect of the present disclosure, there is provided a method for improving thin film friction in an engine, comprising the step of lubricating the engine with the engine oil composition as claimed in any one of the first to fourth aspects.

CLAIMS:

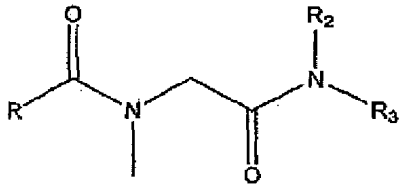
1. An engine oil composition comprising a major amount of a base oil selected from the group consisting of a Group II, Group III, Group IV and Group V base oil and mixtures thereof wherein the Group II and Group III oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component selected from the group consisting of one or more compounds of the Formulae I-III



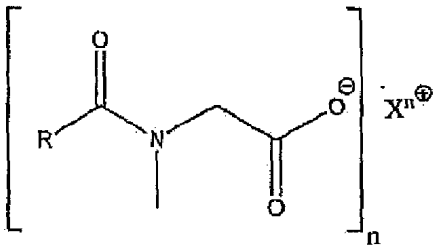
(I)

wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group 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 selected from the group consisting of sulfur, oxygen, and nitrogen;



(II)

wherein R is as defined above; and R_2 and R_3 are independently selected from the group consisting of hydrogen, C_1-C_{18} hydrocarbyl groups, and C_1-C_{18} hydrocarbyl groups containing one or more heteroatoms selected from the group consisting of sulfur, oxygen, and nitrogen; and



(III)

wherein R is as defined above; X is an alkali metal, alkaline earth metal, or ammonium cation; and n is the valence of cation X; and

(B) at least one dispersant selected from the group consisting of succinimide dispersants made from a polyamine, Mannich dispersants and mixtures thereof;

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, the engine oil composition contains from 0.1 to 2.0 wt. % of the friction modifier component (A),

with the proviso that when the friction modifier component is a compound of formula (III), the engine oil composition comprises a major amount of a base oil selected from the group consisting of a Group II, Group III and Group IV base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates.

2. The engine oil composition of claim 1, wherein the additive package comprises at least one compound of the formula I.

3. The engine oil composition of claim 1, wherein the additive package comprises one or more compounds of the formula II.

4. The engine oil composition of claim 1, wherein the additive package comprises at least one salt of the formula III.

5. The engine oil composition of claim 1, wherein the additive package comprises at least two different compounds independently selected from the group consisting of the compounds of the formulae I-III.

6. The engine oil composition of claim 1 or 2, wherein R_1 is hydrocarbyl group having from 1 to 8 carbon atoms.

7. The engine oil composition of claim 1 or 2, wherein R_1 is a hydrocarbyl group containing a C_1-C_8 hydrocarbyl group containing one or more heteroatoms selected from the group consisting of sulfur, oxygen, and nitrogen.

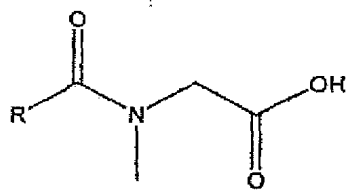
8. The engine oil composition of claim 1 or 3, wherein R_2 and R_3 are independently selected from the group consisting of hydrogen, C_1-C_{18} hydrocarbyl groups, and C_1-C_{18} hydrocarbyl groups containing one or more heteroatoms selected from the group consisting of sulfur, oxygen, and nitrogen.

9. The engine oil composition of claim 1 or 3, wherein R_2 and R_3 are independently selected from the group consisting of hydrogen and C_4-C_8 hydrocarbyl groups.

10. The engine oil composition of claims 1 or 4, wherein the one or more compounds of the formula III are salts of one or more cations selected from the group consisting of sodium, lithium, potassium, calcium, magnesium, and an amine.

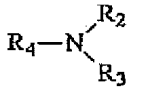
11. An engine oil composition comprising a major amount of base oil selected from the group consisting of a Group II, Group III, Group IV and Group V base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component comprising 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)

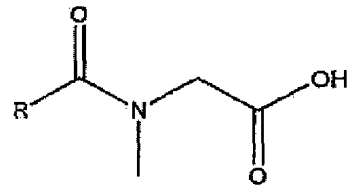
wherein R_2, R_3, and R_4 are independently selected from the group consisting of hydrogen, C_1-C_{18} hydrocarbyl groups, and C_3-C_{12} hydrocarbyl groups containing one or more heteroatoms selected from the group consisting of sulfur, oxygen, and nitrogen; and

(B) at least one dispersant selected from the group consisting of succinimide dispersants made from a poly amine, Mannich dispersants and mixtures thereof; 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 wt. % of the friction modifier component (A).

12. An engine oil composition comprising a major amount of a base oil selected from the group consisting of a Group II, Group III and Group IV base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

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



(IV)

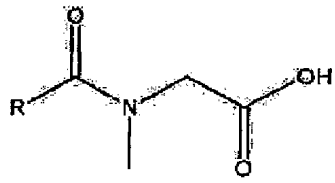
wherein R is a linear or branched, saturated, unsaturated, or partially saturated hydrocarbyl group having 8 to 22 carbon atoms, and an alkali metal hydroxide, an alkaline earth metal hydroxide, an alkali metal oxide, an alkaline earth metal oxide, ammonia, an amine or mixtures thereof; and

(B) at least one dispersant selected from the group consisting of succinimide dispersants made from a polyamine, Mannich dispersants and mixtures thereof;

wherein the engine oil 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 wt.% of the friction modifier component (A).

13. An engine oil composition comprising a major amount of a base oil selected from the group consisting of a Group II, Group III, Group IV and Group V base oil and mixtures thereof wherein the Group II and Group III base oils have at least 90% saturates, and a minor amount of an additive package, wherein the additive package comprises:

(A) a friction modifier component comprising one or more amide or ester 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 dispersant selected from the group consisting of succinimide dispersants made from a polyamine, Mannich dispersants and mixtures thereof; and

wherein the composition is adapted for use as an engine oil, the engine oil composition has a phosphorus content of 50-800 ppm and the engine oil composition contains 0.1 to 2 wt.% of the friction modifier component (A).

14. The engine oil composition of any one of claims 1-13, wherein R has from 10 to 20 carbon atoms.

15. The engine oil composition of any one of claims 1-13, wherein R has from 12 to 18 carbon atoms.

16. The engine oil composition of any one of claims 1-15, wherein the additive package further comprises 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.

17. The engine oil composition of any one of claims 1-16, wherein the at least one dispersant comprises a polyalkylene succinimide.

18. The engine oil composition of claim 17, wherein the at least one polyalkylene succinimide is post-treated with one or more compounds selected from the group consisting of boron compounds, anhydrides, aldehydes, ketones, phosphorus compounds, epoxides, and carboxylic acids.

19. The engine oil composition of any one of claims 1-16, wherein the at least one dispersant comprises a polyisobutylene succinimide prepared from a polyisobutylene having a number average molecular weight of greater than 900.

20. The engine oil composition of any one of claims 1-16, wherein the at least one dispersant comprises a polyisobutylene succinimide prepared from a polyisobutylene having a number average molecular weight of from 1200 to 5000.

21. The engine oil composition of any one of claims 1-13, wherein the at least one dispersant comprises a polyisobutylene succinimide prepared from a polyisobutylene having greater than 50% terminal vinylidene.

22. The engine oil composition of any one of claims 1-13, wherein the at least one polyisobutylene succinimide dispersant is derived from an amine selected from the group consisting of trialkyleneaminetetramine and tetraalkylene pentamine.

23. The engine oil composition of claim 19, wherein the at least one polyisobutylene succinimide is post-treated with a boron compound and wherein the boron content of the engine oil is from 200 to 500 ppm boron.

24. The engine oil composition of any one of claims 1-23, wherein the total amount of dispersant is less than 20 wt. % of the total weight of the engine oil.

25. The engine oil composition of any one of claims 1-23, wherein the total amount of dispersant is in a range of from 0.1 wt. % to 15 wt. % of the total weight of the engine oil.

26. A method for improving thin film and boundary layer friction in an engine comprising the step of lubricating the engine with the engine oil composition as claimed any one of claims 1-25.

27. The method as claimed in claim 26, wherein the improved thin film and boundary layer friction is determined relative to a same composition in the absence of the one or more friction modifier components.

28. A method for improving boundary layer friction in an engine, comprising the step of lubricating the engine with the engine oil composition as claimed in any one of claims 1-25.

29. The method as claimed in claim 28, wherein the improved boundary layer friction is determined relative to a same composition in the absence of the one or more friction modifier components.

30. A method for improving thin film friction in an engine, comprising the step of lubricating the engine with the engine oil composition as claimed in any one of claims 1-25.

31. The method as claimed in claim 30, wherein the improved thin film friction is determined relative to a same composition in the absence of the one or more friction modifier components.