PHOSPHOROUS CONTAINING COMPOUNDS AND USES THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/415,492, filed October 31, 2016, the entire contents of which are hereby incorporated herein by reference.

FIELD OF THE INVENTION

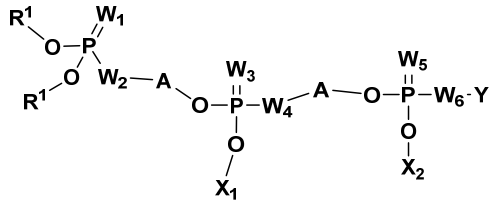
[0002] The invention relates to phosphorous-containing compounds useful as antiwear additive components, lubricant additive compositions and lubricant compositions each comprising such compounds, and methods for making and using the same.

BACKGROUND OF THE INVENTION

[0003] Traditionally, anti-wear components of lubricating compositions comprise acidic organophosphates salted with amines and/or metal ions. These components provide good anti-wear protection but other performance attributes can suffer including poor seal durability, reduced oxidative stability, and inadequate corrosion inhibition. Phosphorus- and sulfur-containing compounds are understood to be essential in lubricating fluids to protect surfaces from wear as a result of the extreme pressures encountered by the surfaces. As a result, these fluids have traditionally been harmful to seals (dynamic and static) and yellow metals. In addition, there is increasing pressure from regulatory agencies to remove amines and metal ions from lubricating fluids to decrease the environmental impact of such components. Due to these increasing environmental concerns, the presence of amines and metal ions in antiwear additives is becoming less desirable. Accordingly, there is a need to develop novel antiwear compounds contain little or no amines or metal ions.

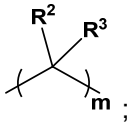
BRIEF SUMMARY

[0003a] In a first aspect of the present disclosure, there is provided a compound of formula (I)



(I),

or a tribologically acceptable salt thereof,

wherein A is:  ;

each R^1 is the same or different and is independently selected from alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl ;

each R^2 and R^3 are independently selected from H, alkyl, alkenyl, cycloalkyl and cycloalkylalkyl;

Y is $–R^4\text{-}R^5\text{-}R^6$;

R^4 is alkylene;

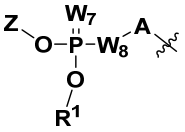
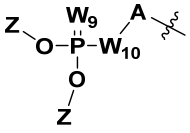
R^5 is -C(O);

R^6 is hydroxy or alkoxy;

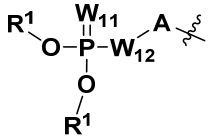
R^7 is hydroxy;

m is an integer from 2 to 8;

X_1 is R^8 or Z;

X_2 is selected from the group consisting of R^8, , and  ;

R^8 is alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl; and

Z is  ,

wherein when X_2 is R^8, X_1 is Z; and

wherein W_1-W_{12} are each independently O or S, and at least one of W_1-W_{12} is O.

[0003b] In a second aspect of the present disclosure, there is provided a lubricant additive composition comprising a compound of the first aspect.

[0003c] In a third aspect of the present disclosure, there is provided a lubricant composition comprising:

a) a base oil; and
b) a compound of the first aspect, and

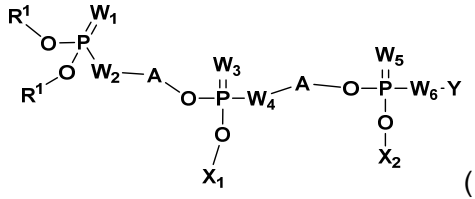
wherein the base oil is a major amount of the composition.

[0003d] In a fourth aspect of the present disclosure, there is provided a method of lubricating moving metal surfaces comprising lubricating the metal surfaces with a lubricant composition of the third aspect.

[0003e] In a fifth aspect of the present disclosure, there is provided a method of reducing wear between moving metal surfaces of a machine part comprising lubricating the machine part with a lubricant composition comprising:

a) a major amount of an oil of lubricating viscosity; and
b) an effective amount of a compound of the first aspect.

[0004] In one example, the present disclosure also relates to a compound of formula (I)



(I),

wherein when X_2 is R^8, X_1 is Z;

W_1-W_{12} are each independently O or S, and at least one of W_1-W_{12} is O.

[0005] In a second example, the present disclosure provides a lubricant additive composition comprising the compound of formula (I).

[0006] In a third example, the present disclosure provides a lubricant composition comprising a major amount of an oil of lubricating viscosity or a grease prepared therefrom and a minor amount of the compound of formula (I).

[0007] In as fourth example, the present disclosure provides a lubricant composition comprising a major amount of an oil of lubricating viscosity or a grease prepared therefrom and a minor amount of a lubricant additive composition of the present invention.

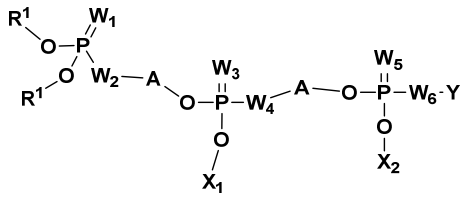
[0008] In a fifth example, the present disclosure provides a method of lubricating moving metal surfaces comprising lubricating the metal surfaces with a lubricant composition of the present invention.

[0009] In a sixth example, the present disclosure provides a method of extending the functional life of an elastomeric seal that contacts a lubricating or functional fluid composition, the method comprising contacting the seal with an effective amount of a lubricating composition of the present invention

DETAILED DESCRIPTION OF THE INVENTION

[0010] The invention disclosed herein relates to novel phosphate and thiophosphate compounds that are useful as antiwear agents and methods for preparing the same. The invention also provides lubricant additive compositions and lubricant compositions comprising the compounds, and methods of using the same.

[0011] The compounds of the present invention include compounds of formula (I)

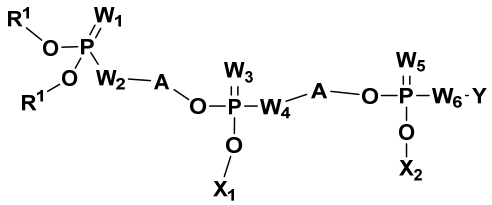


(I),

or a tribologically acceptable salt thereof,

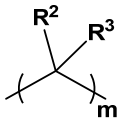
CLAIMS

1. A compound of formula (I)



(I),

or a tribologically acceptable salt thereof,

wherein A is:  ;

each R^1 is the same or different and is independently selected from alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl ;

each R^2 and R^3 are independently selected from H, alkyl, alkenyl, cycloalkyl and cycloalkylalkyl;

Y is $–R^4\text{-}R^5\text{-}R^6$;

R^4 is alkylene;

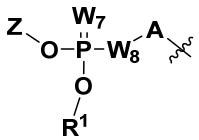
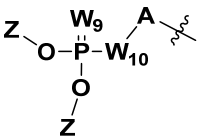
R^5 is -C(O);

R^6 is hydroxy or alkoxy;

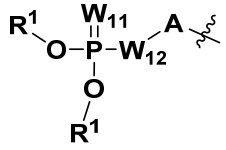
R^7 is hydroxy;

m is an integer from 2 to 8;

X_1 is R^8 or Z;

X_2 is selected from the group consisting of R^8,  , and  ;

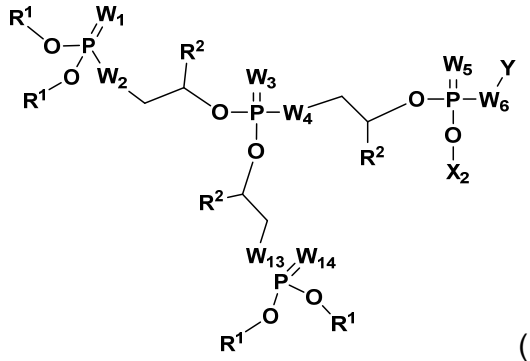
R^8 is alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl; and

Z is ,

wherein when X_2 is R^8, X_1 is Z; and

wherein W_1-W_{12} are each independently O or S, and at least one of W_1-W_{12} is O.

2. The compound of claim 1, wherein the compound is a compound of formula (Ia)



(Ia)

or a tribologically acceptable salt thereof,

each R^1 is the same or different and is independently selected from alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl;

each R^2 is independently selected from alkyl, alkenyl, cycloalkyl and cycloalkylalkyl;

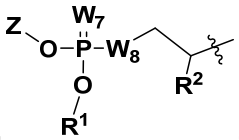
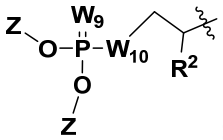
Y is $–R^4$-R^5-R^6;

R^4 is alkylene;

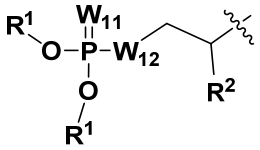
R^5 is -C(O)-;

R^6 is hydroxy or alkoxy;

R^7 is hydroxy;

X_2 is selected from the group consisting of R^8,  , and  ;

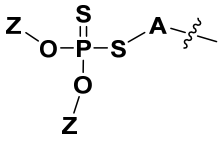
R^8 is alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl;

Z is  ; and

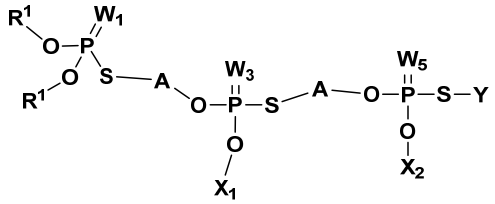
W_1-W_{14} are each independently O or S, and at least one of W_1-W_{14} is O.

3. The compound of claim 1 or 2, wherein each R^1 is the same or different and is independently selected from C_1-C_{30}alkyl, C_2-C_{30}alkenyl, cycloalkyl, cycloalkylalkyl, aryl and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from C_1-C_{10}alkyl and C_2-C_{10}alkenyl.

4. The compound of claim 1 wherein R^2 is C_1-C_{10}alkyl.

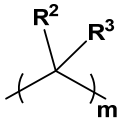
5. The compound of claim 1, wherein X_2 is  or R^8.

6. The compound of claim 1, wherein the compound is a compound of formula (II)



(II),

or a tribologically acceptable salt thereof,

wherein A is:  ;

each R^1 is the same or different and is independently selected from alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl ;

each R^2 and R^3 are independently selected from H, alkyl, alkenyl, cycloalkyl and cycloalkylalkyl;

Y is $–R^4\text{-}R^5\text{-}R^6$;

R^4 is alkylene;

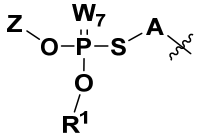
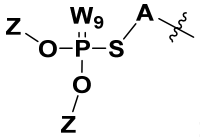
R^5 is -C(O)-;

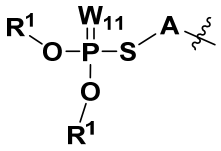
R^6 is hydroxy or alkoxy;

R^7 is hydroxy;

m is an integer from 2 to 8;

X_1 is R^8 or Z;

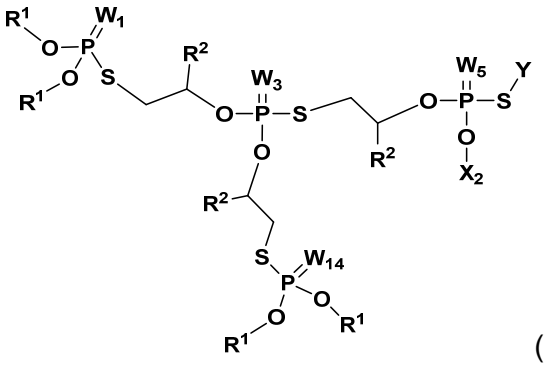
X_2 is selected from the group consisting of R^8,  , and  ; R^8 is alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl; and

Z is  ,

wherein when X_2 is R^8, X_1 is Z; and

wherein W_1, W_3, W_5, W_7, W_9, and W_{11} are each independently O or S, and at least one of W_1, W_3, W_5, W_7, W_9, and W_{11} is O.

7. The compound of claim 6, wherein the compound of formula (II) is a compound of formula (IIa):



(IIa)

or a tribologically acceptable salt thereof,

each R^1 is the same or different and is independently selected from alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl;

each R^2 is independently selected from alkyl, alkenyl, cycloalkyl and cycloalkylalkyl;

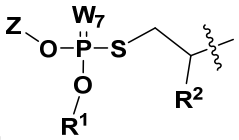
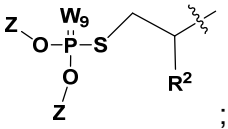
Y is R^4-R^5-R^6;

R^4 is alkylene;

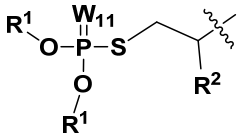
R^5 is -C(O)-;

R^6 is hydroxy or alkoxy;

R^7 is hydroxy;

X_2 is selected from the group consisting of R^8, , and ;

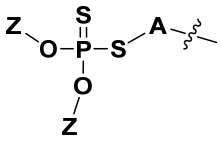
R^8 is alkyl, alkenyl, cycloalkyl, cycloalkylalkyl, aryl, and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from alkyl and alkenyl; and

Z is ;

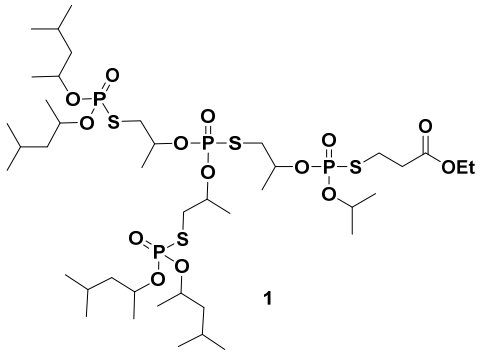
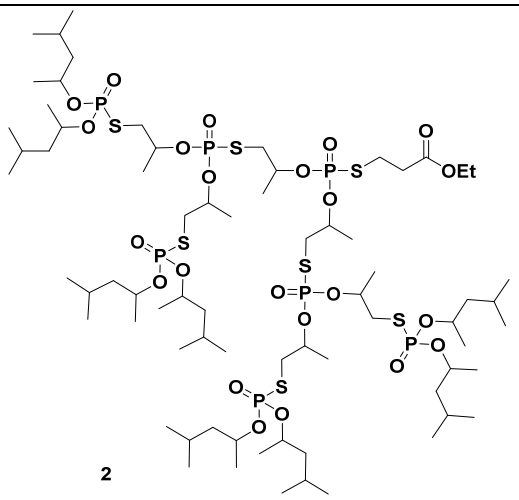
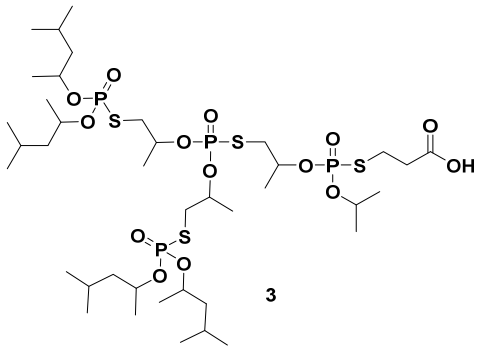
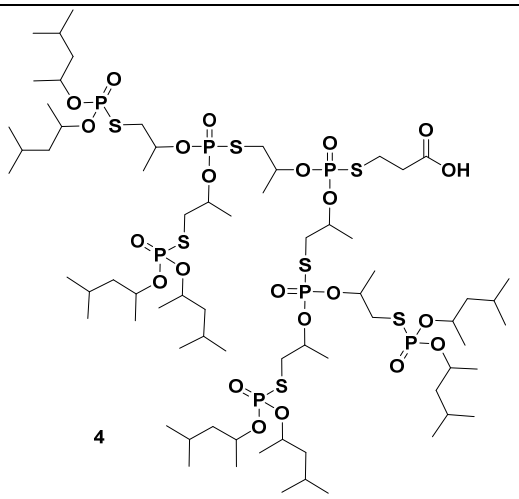
W_1, W_3, W_5, W_7, W_9, W_{11} and W_{14} are each independently O or S, and at least one of W_1, W_3, W_5, W_7, W_9, W_{11} and W_{14} is O.

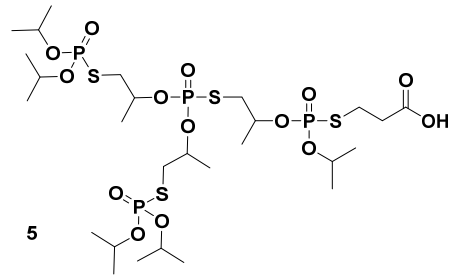
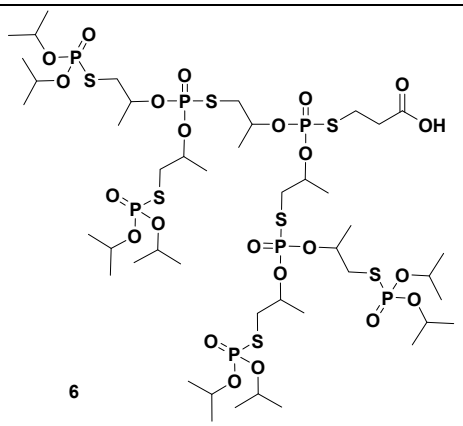
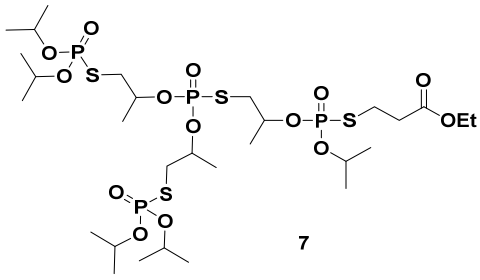
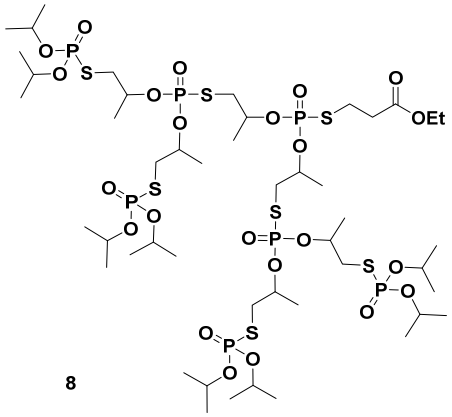
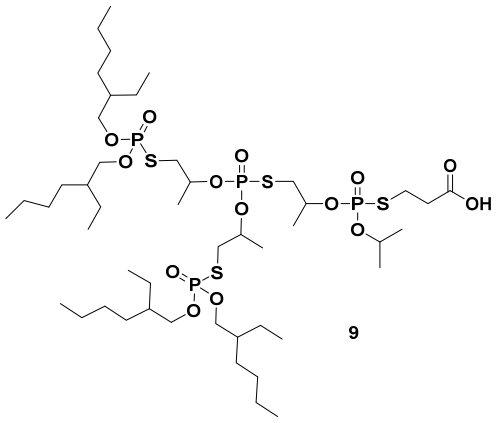
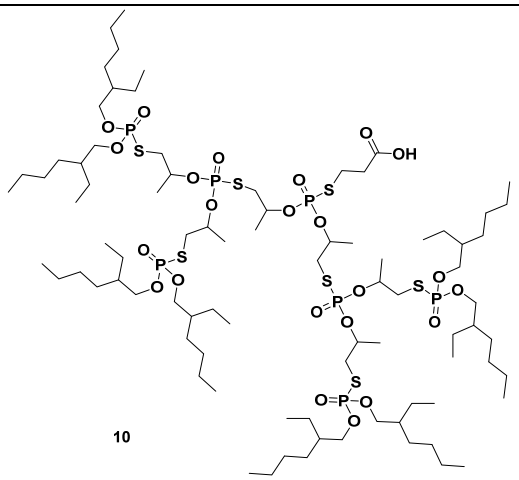
8. The compound of claim 6, wherein each R^1 is the same or different and is independently selected from C_1-C_{30}alkyl, C_2-C_{30}alkenyl, cycloalkyl, cycloalkylalkyl, aryl and aralkyl, wherein said aryl and aralkyl are optionally substituted with one to three substituents each independently selected from C_1-C_{10}alkyl and C_2-C_{10}alkenyl.

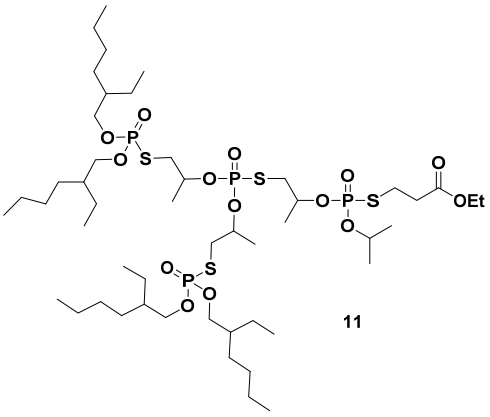
9. The compound of claim 6, wherein R^2 is C_1-C_{10}alkyl.

10. The compound of claim 6, wherein X_2 is  or R^8.

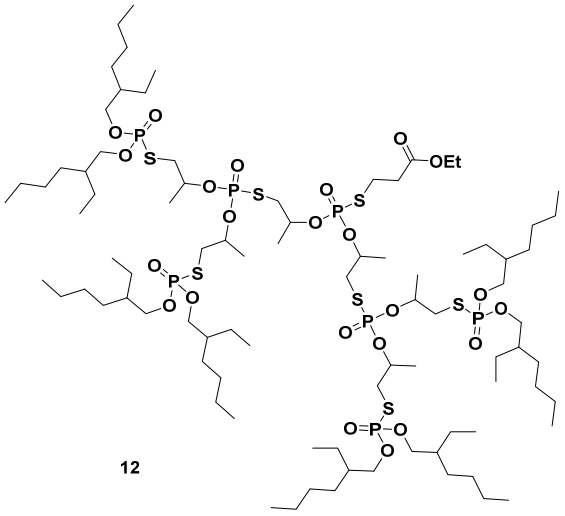
11. The compound of claim 1, selected from

 1	 2
 3	 4

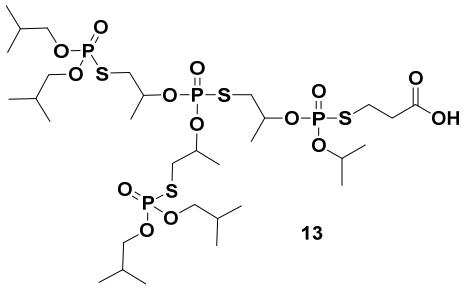
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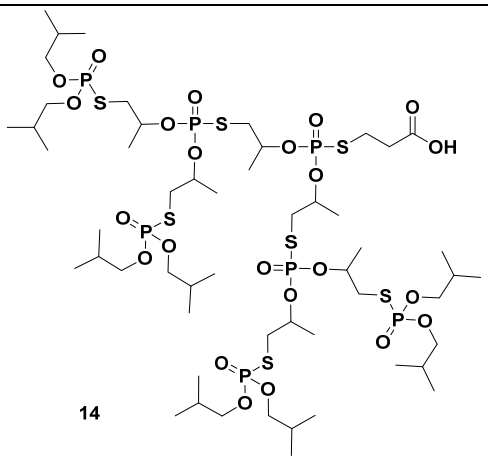
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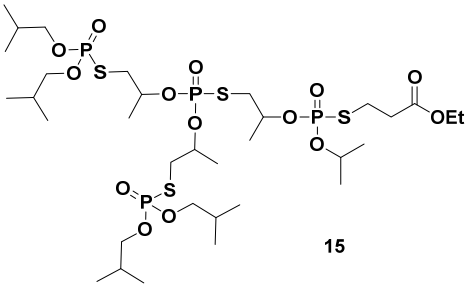
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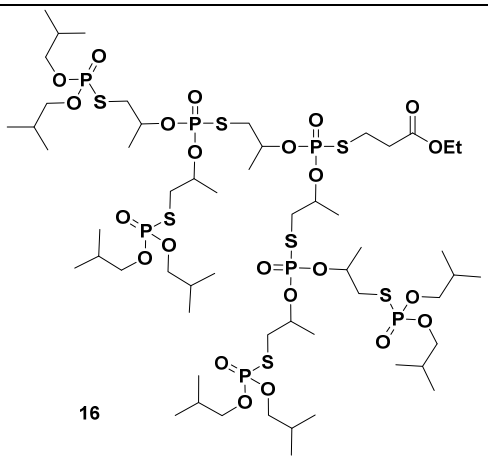
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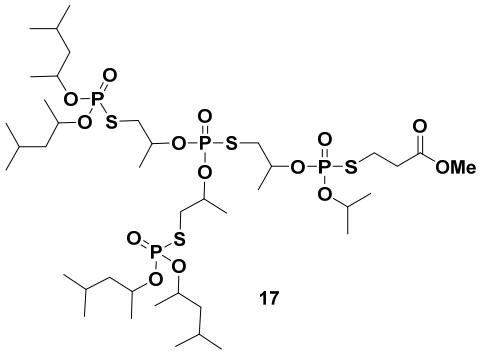
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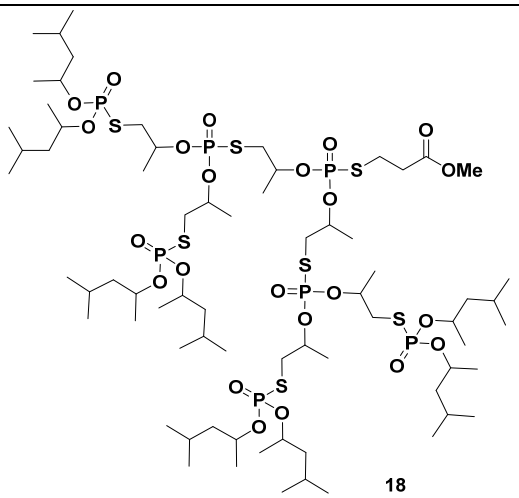
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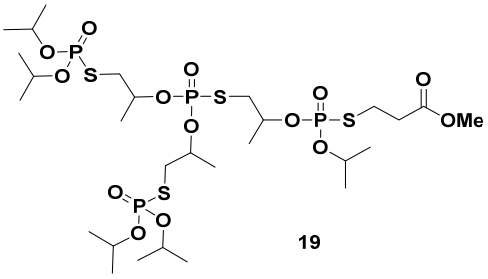
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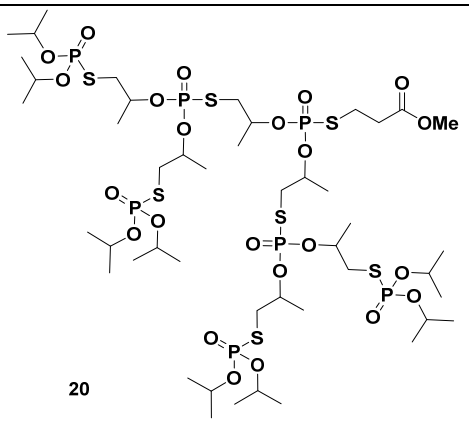
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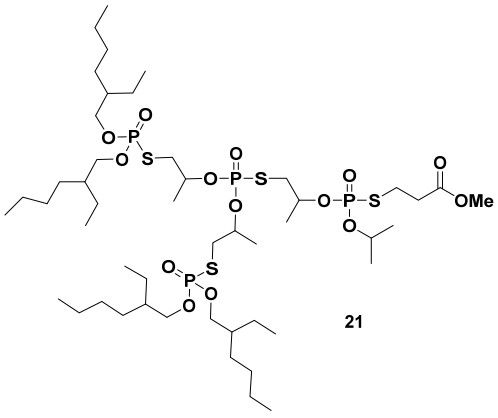
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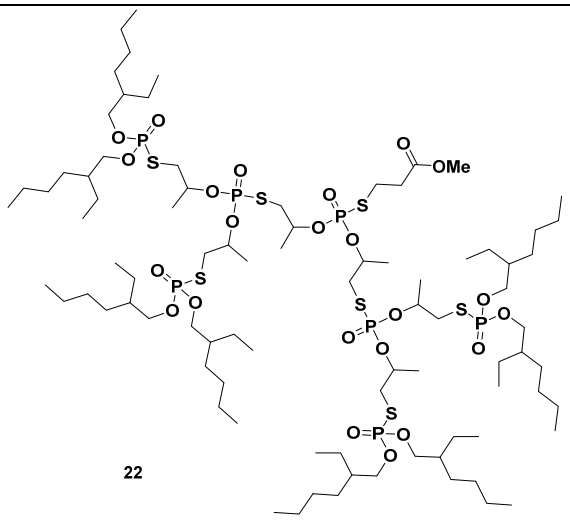
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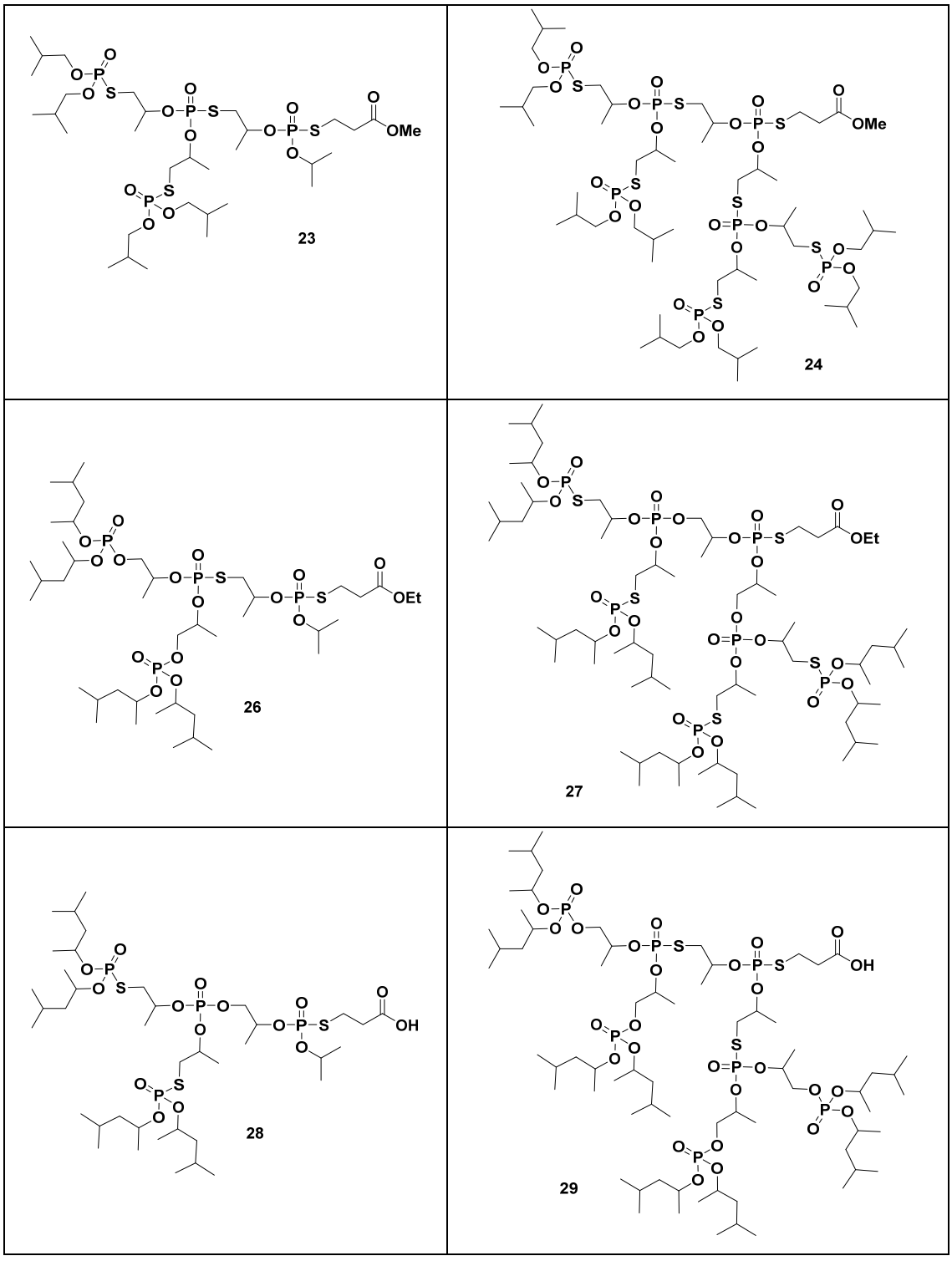
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21



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12. A lubricant additive composition comprising a compound of claim 1.

13. A lubricant composition comprising:

a) a base oil; and

b) a compound of claim 1, and

wherein the base oil is a major amount of the composition.

14. A method of lubricating moving metal surfaces comprising lubricating the metal surfaces with a lubricant composition of claim 13.

15. A method of reducing wear between moving metal surfaces of a machine part comprising lubricating the machine part with a lubricant composition comprising:

a) a major amount of an oil of lubricating viscosity; and

b) an effective amount of a compound of claim 1.