NOVEL AMINOBISPHOSPHONATE ANTIWEAR ADDITIVES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/396,465, filed September 19, 2016, and U.S. Patent Application No. 15/706,498, filed September 15, 2017, the entire contents of which are hereby incorporated herein by reference.

FIELD

[0002] The present invention relates to novel aminobisphosphonate compounds useful as antiwear and/or friction modifier additive components, lubricant additive compositions and lubricant compositions each comprising such compounds, and methods for making and using the same.

BACKGROUND OF THE INVENTION

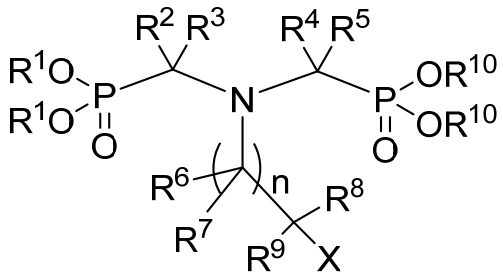
[0003] Industrial and automotive gears are often subjected to pressures and loads that cause wear on the gear surface and/or roller bearing elements. In some cases, the stress imposed on a gear contributes to micropitting, a form of gear fatigue and a common gear failure mode.

[0004] Typically, gear systems require a specially formulated fluid to meet performance requirements. To reduce, or even prevent wear, antiwear additives are commonly added to lubricating compositions used to lubricate the gears. When under pressure, these additives form a protective layer on a gear surface. This protective layer separates the gear contact surfaces from one another and thus, reduces wear on those surfaces. However, not all antiwear additives provide effective surface protection.

[0005] The present invention provides novel antiwear additives and/or friction modifiers that can be used in lubricant compositions for industrial gears, windturbines, hydraulic devices, and automotive gears to provide reduced wear and/or friction on the gear surface and reduced micropitting of the gears.

SUMMARY

[0006] The present disclosure relates to a compound of formula (I):



(I) ,

wherein each R^1 and R^{10} is the same or different and is independently selected from C_1-C_{20} linear alkyl, C_2-C_{20} linear alkenyl, C_3-C_{20} branched alkyl, and C_3-C_{20} branched alkenyl;

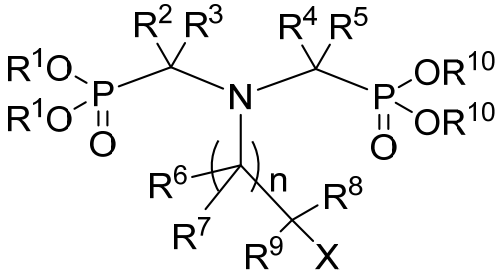
n is an integer from 1 to 7;

each of R^2, R^3, R^4, R^5, R^6, R^7, R^8, and R^9 is the same or different and is each independently selected from H, C_1-C_{10} linear alkyl, C_2-C_{10} linear alkenyl, C_3-C_{10} branched alkyl, and C_3-C_{10} branched alkenyl;

X is selected from the group consisting of H, hydroxy, and $N(R^{11})(R^{12})$; and

R^{11} and R^{12} are the same or different and are each independently selected from the group consisting of H, hydroxy, alkyl, alkenyl, and alkynyl.

[0006a] In one aspect, the present disclosure refers to a compound of formula (I)



(I) ,

wherein each of R^1 and R^{10} is the same or different and independently selected from C_1-C_{20} linear alkyl, C_2-C_{20} linear alkenyl, C_3-C_{20} branched alkyl, and C_3-C_{20} branched alkenyl;

n is an integer from 1 to 7;

each of R^2, R^3, R^4, R^5, R^6, R^7, R^8, and R^9 is the same or different and is each independently selected from H, C_1-C_{10} linear alkyl, C_2-C_{10} linear alkenyl, C_3-C_{10} branched alkyl, and C_3-C_{10} branched alkenyl;

X is selected from the group consisting of hydroxy and $N(R^{11})(R^{12})$;

R^{11} and R^{12} are the same or different and are each independently selected from the group consisting of H, hydroxy, alkyl, alkenyl, and alkynyl, and wherein R^1 and R^{10} are not both ethyl.

[0007] In a second aspect, the present disclosure provides a lubricant additive concentrate comprising at least one compound of formula (I).

[0008] The present disclosure also provides a lubricant additive concentrate comprising at least one compound of formula (I) and one or more additional additives.

[0009] In a third aspect, the present disclosure provides a lubricant composition comprising a majority amount of base oil and at least one compound of formula (I).

[0010] In a fourth aspect, the present disclosure provides a method of lubricating moving metal surfaces of a machine part with a lubricant composition comprising at least one compound of formula (I).

[0011] The present disclosure also provides a method of reducing wear on a moving metal surface of a machine part comprising lubricating the

machine part with a lubricant composition comprising at least one compound of formula (I).

[0012] The present disclosure further provides a method of reducing friction on a moving metal surface of a machine part comprising lubricating the machine part with a lubricant composition comprising at least one compound of formula (I).

[0013] In another embodiment the present disclosure provides a method of lubricating a machine part with a lubricant composition comprising at least one compound of formula (I), wherein the machine part comprises an industrial gear, a windturbine gear, an axle, a differential, an engine, a crankshaft, a transmission, a clutch, a hydraulic apparatus, a slideway apparatus, and/or a turbine.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 represents an average profile deviation (ffm) caused by micropitting in a micropitting test for an embodiment of the invention.
Figure 2 represents percent micropitting area (GF) in a micropitting test for an embodiment of the invention.
Figure 3 represents weight loss (W) in a micropitting test for an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

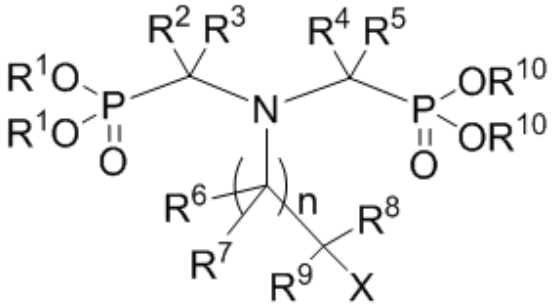
[0014] The invention disclosed herein relates to novel aminobisphosphonate compounds useful as antiwear and/or friction modifier additive components, lubricant additive concentrates and lubricant compositions, each comprising such compounds, and methods for making and using the same.

[0015] Although certain embodiments of the present invention may be described individually herein, it is understood by the skilled artisan that any one embodiment can be combined with any other embodiment or

CLAIMS

What is claimed:

1. A compound of formula (I)



(I)

wherein each of R^1 and R^{10} is the same or different and independently selected from C_1-C_{20} linear alkyl, C_2-C_{20} linear alkenyl, C_3-C_{20} branched alkyl, and C_3-C_{20} branched alkenyl;

n is an integer from 1 to 7;

each of R^2, R^3, R^4, R^5, R^6, R^7, R^8, and R^9 is the same or different and is each independently selected from H, C_1-C_{10} linear alkyl, C_2-C_{10} linear alkenyl, C_3-C_{10} branched alkyl, and C_3-C_{10} branched alkenyl;

X is selected from the group consisting of hydroxy and $N(R^{11})(R^{12})$;

R^{11} and R^{12} are the same or different and are each independently selected from the group consisting of H, hydroxy, alkyl, alkenyl, and alkynyl, and

wherein R^1 and R^{10} are not both ethyl.

2. The compound of claim 1, wherein each of R^1 and R^{10} is C_1-C_{10} linear alkyl.

3. The compound of claim 1 or 2, wherein each of R^2, R^3, R^4, and R^5 are H.

4. The compound of any one of claims 1 to 3, wherein each of R^6, R^7, R^8, and R^9 are H.

5. The compound of any one of claims 1 to 4, wherein n is 1 or 2.

6. The compound of any one of claims 1 to 5, wherein X is hydroxyl.

7. The compound of any one of claims 1 to 5, wherein X is $N(R^{11})(R^{12})$, and R^{11} and R^{12} are C_1-C_4 alkyl.

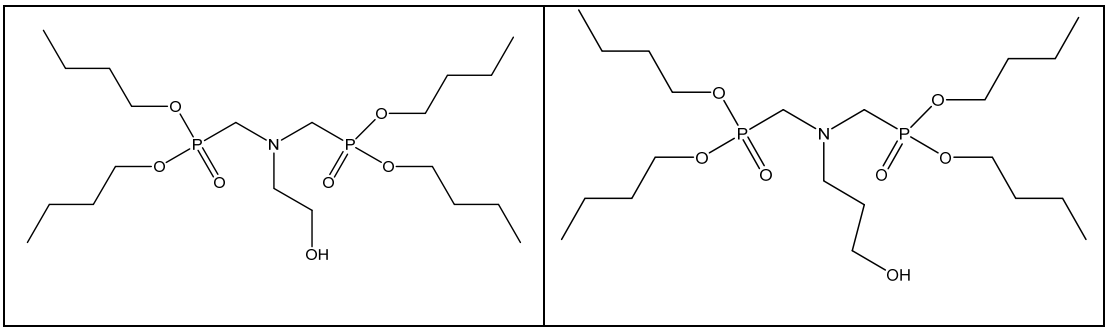
8. The compound of claim 1, wherein

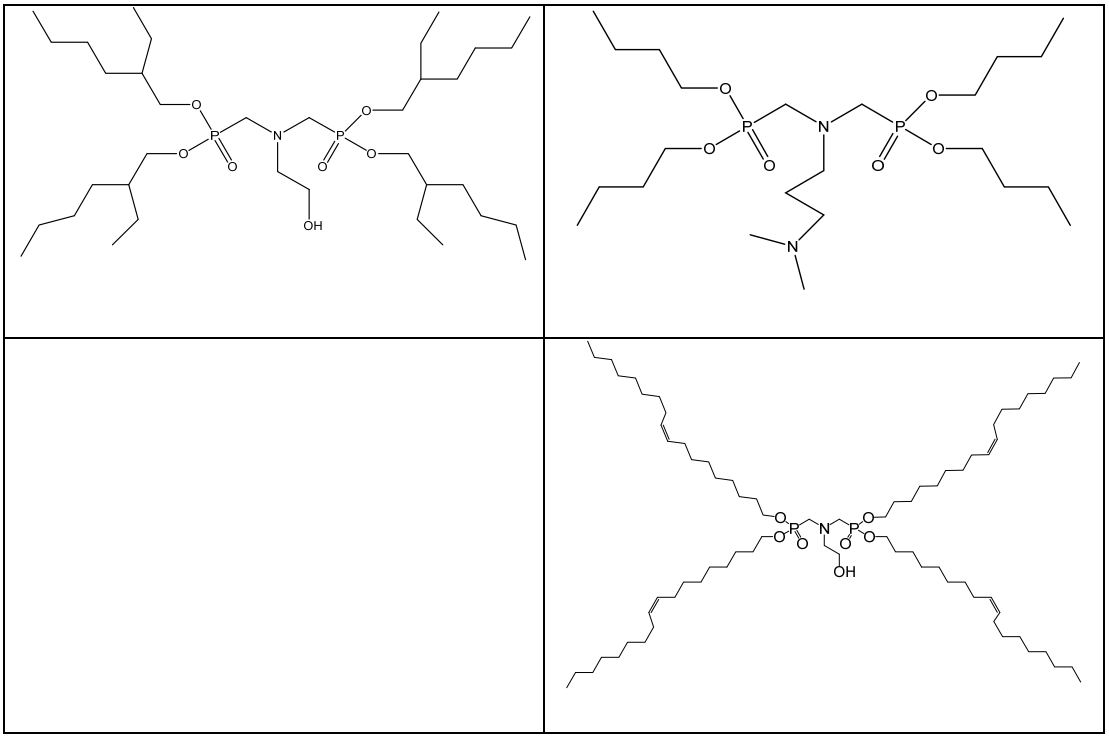
(a) each of R^1 and R^{10} is the same and is C_1-C_{20} linear alkyl;

(b) each of R^2, R^3, R^4, R^5, R^6, R^7, R^8, and R^9 are H; and

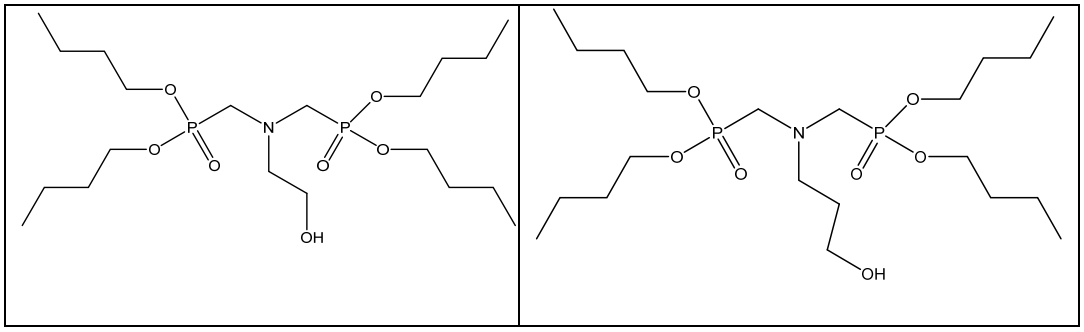
(c) n is 1 or 2.

9. The compound of claim 1, wherein the compound of formula (I) is selected from:





10. The compound of claim 1, wherein the compound of formula (I) is selected from:



11. A lubricant additive concentrate comprising a compound according to any one of claims 1 to 10.

12. The lubricant additive concentrate of claim 11, wherein the lubricant additive concentrate further comprises one or more additive components selected from the group consisting of an antioxidant, an additional antiwear agent, a corrosion inhibitor, a detergent, an extreme pressure agent, a dispersant, a viscosity index improver, and a friction modifier.

13. A lubricant composition comprising:

a) a major amount of base oil; and

b) a compound according to any one of claims 1 to 10.

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