SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, there is provided lubricating oil compositions which protect silver bearings and reduce friction in medium speed diesel engines. Also provided, is a method for reducing silver bearing wear and friction in medium speed diesel engines.

Also provided is a medium speed diesel engine crankcase lubricating oil composition comprising:

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

(b) 0.1 to 5.0 weight percent of a silver lubricity additive, wherein the silver lubricity additive is diethoxylated oleylammonium bis(2-ethylhexyl) phosphate.

Also provided is a method for reducing silver bearing wear and friction in a medium speed diesel engine comprising lubricating said engine with a lubricating oil composition comprising:

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

(b) 0.1 to 5.0 weight percent of a silver lubricity additive which is:

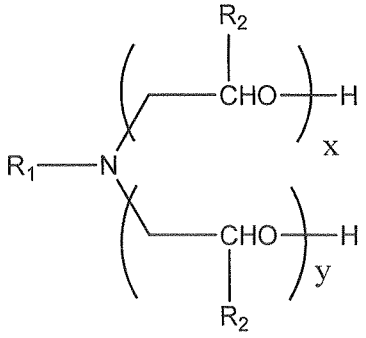
(i) an alkoxylated fatty amine or salt thereof;

(ii) an alkoxylated fatty diamine or salt thereof; or

(iii) mixtures of (i) and (ii) above;

wherein the alkoxylated fatty amine is of Formula 1:

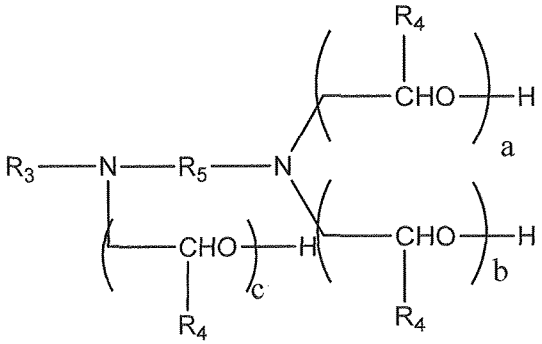
Formula 1



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; and wherein x and y independently are each at least 1 and $x + y \leq 50$; and

wherein the alkoxylated fatty diamine is of Formula 2:

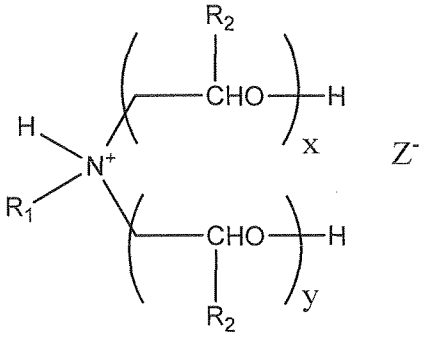
Formula 2



wherein R3 is an aliphatic fatty acid chain ranging from C8 to C24; each R4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein a + b + c independently are each at least 1 and $a + b + c \leq 50$;

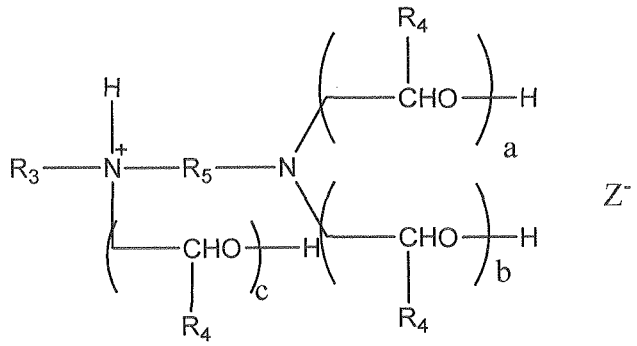
wherein the alkoxylated fatty amine salt is of Formula 3:

Formula 3



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; wherein x and y independently are each at least 1 and $x + y \leq 50$; and wherein Z is an anion of an organic or an inorganic acid; and wherein the alkoxylated fatty diamine salt is of Formula 4:

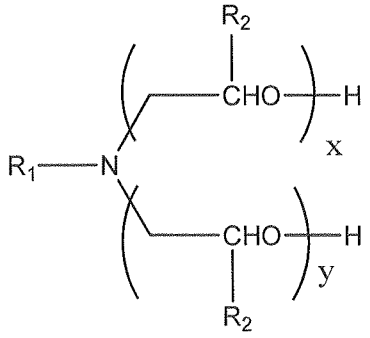
Formula 4



wherein R_3 is an aliphatic fatty acid chain ranging from C8 to C24; each R_4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein a + b + c independently are each at least 1 and $a + b + c \leq 50$; and wherein Z is an anion of an organic or an inorganic acid.

Also provided is the use of 0.1 to 5.0 weight percent of (i) an alkoxylated fatty amine or salt thereof, (ii) an alkoxylated fatty diamine or salt thereof; or mixtures of (i) and (ii) above, as a silver lubricity additive in a medium speed diesel engine lubricating oil composition, wherein the alkoxylated fatty amine is of Formula 1:

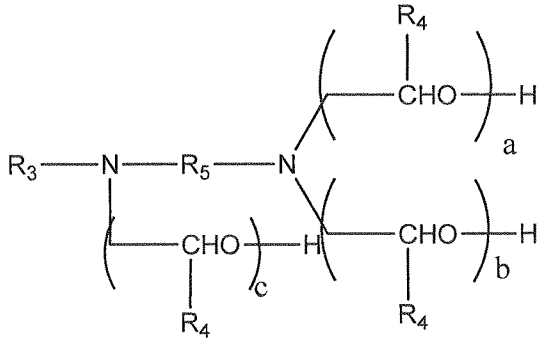
Formula 1



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; and wherein x and y independently are each at least 1 and $x + y \leq 50$; and

wherein the alkoxylated fatty diamine is of Formula 2:

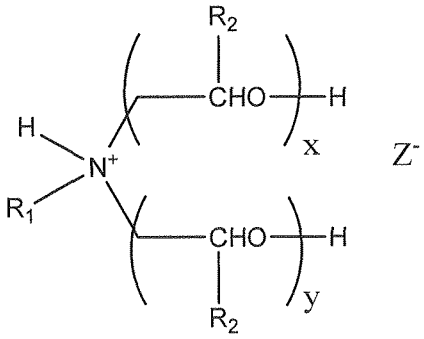
Formula 2



wherein R3 is an aliphatic fatty acid chain ranging from C8 to C24; each R4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein a + b + c independently are each at least 1 and $a + b + c \leq 50$;

wherein the alkoxylated fatty amine salt is of Formula 3:

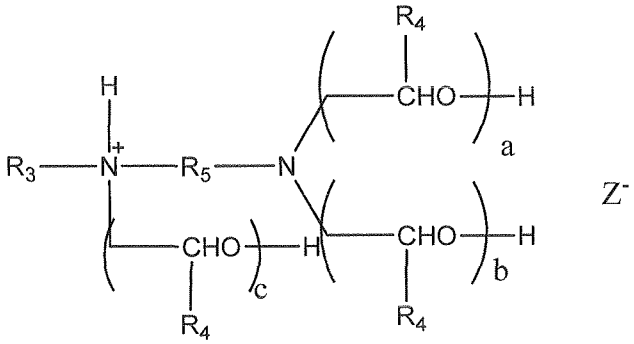
Formula 3



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; wherein x and y independently are each at least 1 and $x + y \leq 50$; and wherein Z is an anion of an organic or an inorganic acid; and

wherein the alkoxylated fatty diamine salt is of Formula 4:

Formula 4



wherein R_3 is an aliphatic fatty acid chain ranging from C8 to C24; each R_4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein $a + b + c$ independently are each at least 1 and $a + b + c \leq 50$; and wherein Z is an anion of an organic or an inorganic acid.

Among other factors, the present invention is based on the surprising discovery of lubricating oil compositions which reduce silver bearing wear and friction in medium speed diesel engines.

Definitions:

The following terms will be used throughout the specification and will have the following meanings unless otherwise indicated.

The term "medium speed diesel engine crankcase lubricating oil composition" as used herein refers to a lubricating oil additive composition for engine oils used in medium speed diesel engines as commonly found in railroad locomotives, marine tugboats, and stationary power applications.

The term "silver protection" as used herein refers to the ability of the medium speed crankcase lubricating oil composition of the present invention to protect silver and silver-plated bearings against wear in medium speed diesel engine crankcase.

The term "a major amount" of a base oil refers to where the amount of the base oil is at least 40 wt. % of the lubricating oil composition. In some embodiments, "a major amount" of a base oil refers to an amount of the base oil more than 50 wt.%, more than 60 wt.%, more than 70 wt.%, more than 80 wt.%, or more than 90 wt.% of the lubricating oil composition.

In the following description, all numbers disclosed herein are approximate values, regardless whether the word "about" or "approximate" is used in connection therewith. They may vary by 1 percent, 2 percent, 5 percent, or, sometimes, 10 to 20 percent.

DETAILED DESCRIPTION OF THE INVENTION

In general, provided herein is a medium speed diesel engine crankcase lubricating oil composition comprising:

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

(b) 0.1 to 5.0 weight percent of a silver lubricity additive comprising:

(i) an alkoxylated fatty amine or salt thereof;

WHAT IS CLAIMED IS:

1. A medium speed diesel engine crankcase lubricating oil composition comprising:

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

(b) 0.1 to 5.0 weight percent of a silver lubricity additive, wherein the silver lubricity additive is diethoxylated oleylammonium bis(2-ethylhexyl) phosphate.

2. The lubricating oil composition of Claim 1, wherein the silver lubricity additive is present at 0.20 to 4 weight percent.

3. A method for reducing silver bearing wear and friction in a medium speed diesel engine comprising lubricating said engine with a lubricating oil composition comprising:

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

(b) 0.1 to 5.0 weight percent of a silver lubricity additive which is:

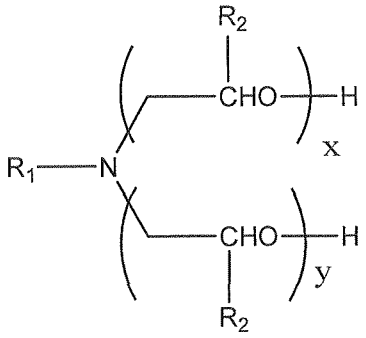
(i) an alkoxylated fatty amine or salt thereof;

(ii) an alkoxylated fatty diamine or salt thereof; or

(iii) mixtures of (i) and (ii) above;

wherein the alkoxylated fatty amine is of Formula 1:

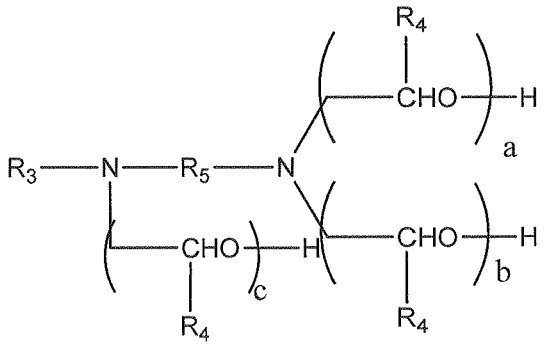
Formula 1



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; and wherein x and y independently are each at least 1 and $x + y \leq 50$; and

wherein the alkoxylated fatty diamine is of Formula 2:

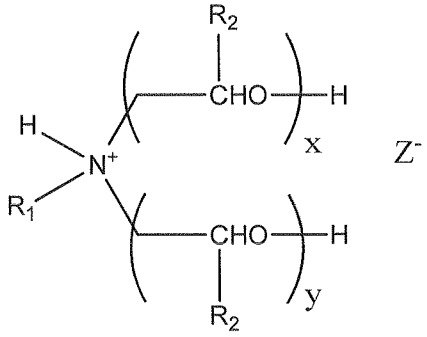
Formula 2



wherein R3 is an aliphatic fatty acid chain ranging from C8 to C24; each R4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein a + b + c independently are each at least 1 and $a + b + c \leq 50$;

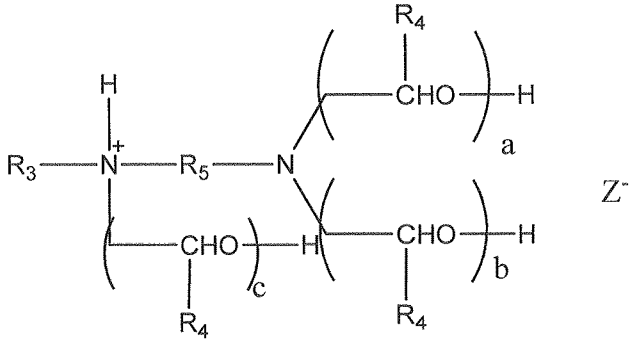
wherein the alkoxylated fatty amine salt is of Formula 3:

Formula 3



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; wherein x and y independently are each at least 1 and $x + y \leq 50$; and wherein Z is an anion of an organic or an inorganic acid; and wherein the alkoxylated fatty diamine salt is of Formula 4:

Formula 4



wherein R_3 is an aliphatic fatty acid chain ranging from C8 to C24; each R_4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein a + b + c independently are each at least 1 and $a + b + c \leq 50$; and wherein Z is an anion of an organic or an inorganic acid.

4. The method of Claim 3, wherein Z is selected from the group comprising: phosphate, phosphite, dithiophosphate, sulfate, sulfonate, carbonate, and anions from carboxylic acid and fatty acid.

5. The method of Claim 3, wherein the alkoxylated fatty amine is selected from the group comprising: propoxylated monoamine, butoxylated monoamine, alkoxylated alkyl diisopropanolamine, ethoxylated monoamines such as ethoxylated octadecylamine, ethoxylated cocoalkylamines, ethoxylated oleylamines, diethoxylated oleylamine, ethoxylated soyaalkylamines, and ethoxylated tallowalkylamines;
wherein the alkoxylated fatty diamine is selected from the group comprising, tris(2-hydroxyethyl)-N-tallowalkyl-1,3-diamine propane commonly known as Ethoduomeen T/13, Ethoduomeen T/20 and Ethoduomeen T/25; and
wherein the alkoxylated fatty salt is diethoxylated oleylammonium bis(2-ethylhexyl) phosphate.

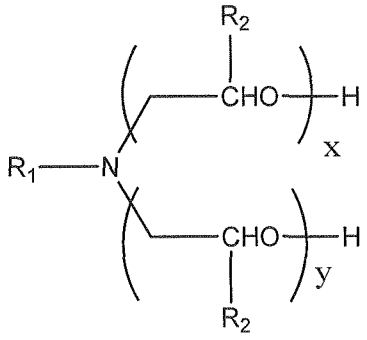
6. The method of Claim 3, wherein the alkoxylated fatty amine or alkoxylated fatty diamine contain a saturated or unsaturated C_{12}-C_{24} alkyl radical which is branched or straight chain.

7. The method of Claim 3, wherein the silver lubricity additive is present at 0.20 to 4 weight percent.

8. The method of Claim 3, wherein the medium speed diesel engine is selected from the group comprising railroad locomotive, marine tugboat and stationary power engines.

9. Use of 0.1 to 5.0 weight percent of (i) an alkoxylated fatty amine or salt thereof, (ii) an alkoxylated fatty diamine or salt thereof; or mixtures of (i) and (ii) above, as a silver lubricity additive in a medium speed diesel engine lubricating oil composition, wherein the alkoxylated fatty amine is of Formula 1:

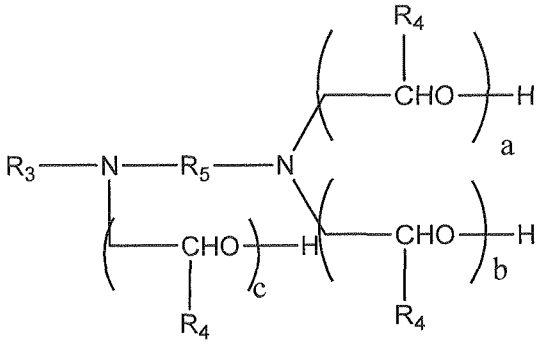
Formula 1



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; and wherein x and y independently are each at least 1 and $x + y \leq 50$; and

wherein the alkoxylated fatty diamine is of Formula 2:

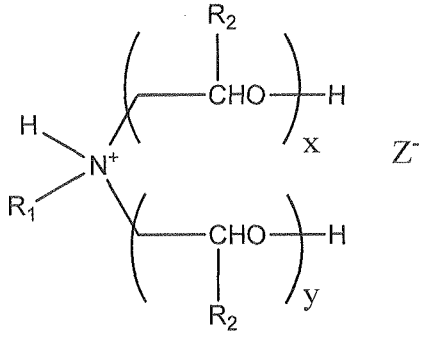
Formula 2



wherein R3 is an aliphatic fatty acid chain ranging from C8 to C24; each R4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein $a + b + c$ independently are each at least 1 and $a + b + c \leq 50$;

wherein the alkoxylated fatty amine salt is of Formula 3:

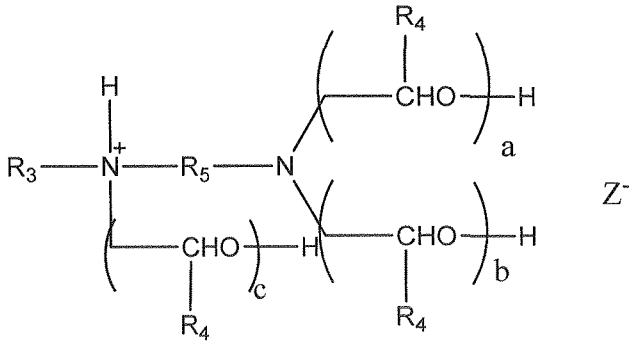
Formula 3



wherein R_1 is an aliphatic fatty acid chain ranging from C8 to C24; R_2 is independently hydrogen or alkyl of C1 to C8; wherein x and y independently are each at least 1 and $x + y \leq 50$; and wherein Z is an anion of an organic or an inorganic acid; and

wherein the alkoxylated fatty diamine salt is of Formula 4:

Formula 4



wherein R_3 is an aliphatic fatty acid chain ranging from C8 to C24; each R_4 is independently hydrogen or alkyl of C1 to C8; and R_5 is a divalent alkylene of C1 to C8; wherein a + b + c independently are each at least 1 and $a + b + c \leq 50$; and wherein Z is an anion of an organic or an inorganic acid.

10. The use according to Claim 9, wherein Z is selected from the group comprising: phosphate, phosphite, dithiophosphate, sulfate, sulfonate, carbonate, and anions from carboxylic acid and fatty acid.

11. The use according to Claim 9, wherein the alkoxylated fatty amine is selected from the group comprising: propoxylated monoamine, butoxylated monoamine, alkoxylated alkyl diisopropanolamine, ethoxylated monoamines such as ethoxylated octadecylamine, ethoxylated cocoalkylamines, ethoxylated oleylamines, diethoxylated oleylamine, ethoxylated soyaalkylamines, and ethoxylated tallowalkylamines;
wherein the alkoxylated fatty diamine is selected from the group comprising, tris(2-hydroxyethyl)-N-tallowalkyl-1,3-diamine propane commonly known as Ethoduomeen T/13, Ethoduomeen T/20 and Ethoduomeen T/25; and
wherein the alkoxylated fatty salt is diethoxylated oleylammonium bis(2-ethylhexyl) phosphate.

12. The use according to Claim 9, wherein the alkoxylated fatty amine or alkoxylated fatty diamine contain a saturated or unsaturated C_{12}-C_{24} alkyl radical which is branched or straight chain.

13. The use according to Claim 9, wherein the silver lubricity additive is present at 0.20 to 4 weight percent.

14. The use according to Claim 9, wherein the medium speed diesel engine is selected from the group comprising railroad locomotive, marine tugboat and stationary power engines.