oil solubility. These friction modifiers generally operate at boundary layer conditions by forming thin mono-molecular layers of physically adsorbed polar oil-soluble products or reaction layers which can be readily sheared off and which exhibit a significantly lower friction coefficients compared to typical anti-wear or extreme pressure agents. The most commonly used organic friction modifiers are fatty acid amides, such as oleylamide, fatty amines, such as oleylamine, and fatty acid esters, such as glycerol monooleate.

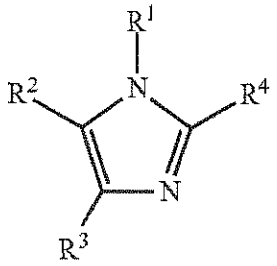
To improve fuel efficiency, there has been a drive to develop new components which improve the frictional properties of the lubricating oil composition.

BACKGROUND ART

Elliott et al., GB 1,061,904 discloses and exemplifies aminomethyl derivatives of benzimidazoles and aminomethyl derivatives of benzotriazole; and their use as metal deactivators in lubricating compositions or functional fluids. Phillips et al., GB 1,511,593 discloses substituted aminomethyl hydrogenated benzimidazoles and benzotriazoles indicating their use as metal passivators in functional fluids.

SUMMARY OF THE INVENTION

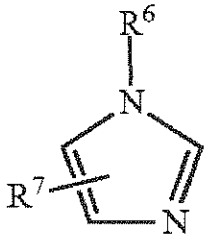
According to a first aspect, there is provided a compound of formula I:



formula I

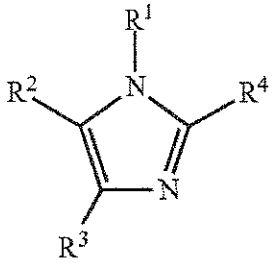
wherein R^1, R^2 and R^4 are hydrogen; and R^3 is a moiety of formula $—CH_2NHR^5$ wherein R^5 is a C_{10} to C_{28} aliphatic group.

According to a second aspect, there is provided a compound having the formula:



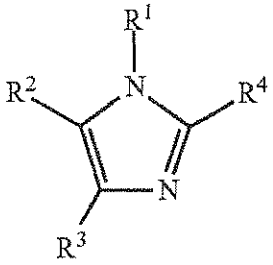
wherein R^6 and is a moiety of formula —CH_2NHR^8 wherein R^8 is a C_8 to C_{28} aliphatic group and R^7 is hydrogen.

According to a third aspect, there is provided a lubricating oil composition comprising a major amount of an oil of lubricating viscosity and from 0.01 to 5 weight percent of one or more compounds having the formula



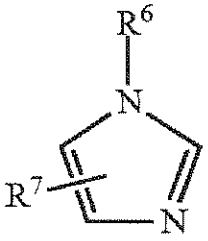
wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula —CH_2NHR^5 provided that at least one R^1, R^2, R^3 and R^4 is a moiety of formula —CH_2NHR^5 wherein R^5 is a C_8 to C_{28} aliphatic group.

According to a fourth aspect, there is provided a lubricating oil additive concentrate comprising from 90 to 10 weight percent of a liquid organic diluent and from about 10 to 90 weight percent of one or more compounds having the formula



wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula $—CH_2NHR^5$ provided that at least one R^1, R^2, R^3 and R^4 is a moiety of formula $—CH_2NHR^5$ wherein R^5 is a C_8 to C_{28} aliphatic group.

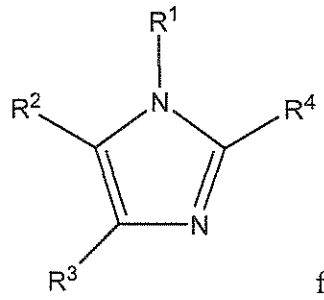
According to a fifth aspect, there is provided a compound having the formula:



wherein: R^6 is a C_1 to C_4 alkyl group; and R^7 is a moiety of formula $—CH_2NHR^8$ wherein R^8 is a C_8 to C_{28} aliphatic group.

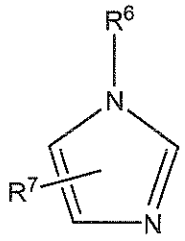
Embodiments of t~~T~~he present invention are~~is~~ directed to aminomethyl-substituted imidazole compounds and their use as friction modifiers in lubricating oils. Thus, oil soluble aminomethyl-substituted imidazole compounds may be added to an oil of lubricating viscosity to form a lubricating oil composition having improved frictional properties. Also disclosed is a process for preparing the aminomethyl-substituted imidazole compounds through a Mannich reaction of imidazole, formaldehyde and a C_8 to C_{28} aliphatic mono amine. A further embodiment~~aspect~~ is directed to a lubricating oil additive concentrate containing a liquid organic diluents and the aminomethyl-substituted imidazole compounds as per embodiments of the present invention.

Accordingly, one embodiment is directed to aminomethyl-substituted imidazole compounds which can be represented by the formula I:



formula I

wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula $-CH_2NHR^5$ provided that at least one R^1, R^2, R^3 and R^4 is a moiety of formula $-CH_2NHR^5$ wherein R^5 is a C_8 to C_{28} aliphatic group. In this regard, the substituents are selected such that the overall compound is oil soluble; typically this is by selecting the degree of substitution, suitable chain length or chain branching in the aliphatic group. In a further embodimentaspect, R^1, R^2 and R^4 are hydrogen and R^3 is of formula $-CH_2NHR^5$ wherein R^5 is a C_{10} to C_{28} aliphatic group. Preferred aliphatic groups are C_8 to C_{28} alkyl and alkenyl groups either branched or straight chain groups. Thus in one embodimentaspect the aliphatic groups are alkenyl groups. More particularly the aliphatic groups saturated aliphatic groups. Particularly preferred are mono and di-substituted aminomethyl groups and accordingly another embodimentaspect is directed to compound of the formula II:



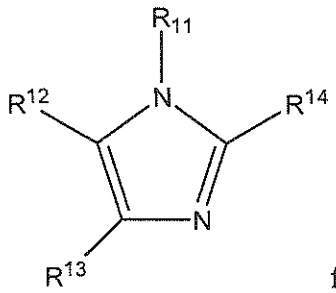
formula II

wherein R^6 and R^7 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula $-CH_2NHR^8$ provided that at least one R^6 and R^7 is a moiety of formula $-CH_2NHR^8$ wherein R^8 is a C_8 to C_{28} aliphatic group. In another embodimentaspect R^8 is a C_{10} to C_{18} aliphatic group. Preferred aliphatic groups are alkyl and alkenyl groups, either straight or branched chain; more preferred are saturated aliphatic groups. In one embodimentaspect the aliphatic group is a linear saturated aliphatic group. The aliphatic group is selected so that the overall compound is rendered oil soluble. Mono aminomethyl substituents are directed to when R^6 is hydrogen or when R^7 is hydrogen. Typically the compound of formula II will exist as mixtures due to the method for

preparation of the compounds; and mixtures are typically employed in the lubricating compositions. Carbon attachment of $-CH_2NHR^8$ group on the imidazole can be directed where R^6 is selected to from C_1 to C_4 alkyl group. In this embodiment~~aspect~~, for carbon attachment of $-CH_2NHR^8$ group the 4 and 5 position of the imidazole are preferred.

A further embodiment of the present invention is directed to processes for preparing aminomethyl-substituted imidazoles which comprises reacting

(a) an imidazole compound having the formula III



formula III

wherein R^{11}, R^{12}, R^{13} and R^{14} are independently selected from the group consisting of hydrogen and a C_1 to C_4 alkyl group wherein at least one of R^{11}, R^{12}, R^{13} and R^{14} is hydrogen;

(b) formaldehyde or a formaldehyde-producing reagent; and

(c) an amine of having the formula

$$H_2N\text{-}R^{15}$$

wherein R^{15} is a C_8 to C_{28} aliphatic group. Particularly suited aliphatic groups are C_{10} to C_{28} aliphatic group and more preferably a C_{10} to C_{18} aliphatic group. In one embodiment~~aspect~~ the aliphatic group is a saturated aliphatic group. Preferred amines include decylamine, dodecylamine, hexadecylamine, oleylamine, and octadecylamine.

A further embodiment of the present invention is directed to a lubricating oil composition comprising a major amount of an oil of lubricating viscosity and from 0.01 to 5 weight percent of one or more of the above described aminomethyl-substituted imidazoles as per embodiments of the present invention.

A further embodiment of the present invention is directed to a lubricating oil additive concentrate comprising 10 percent to 90 weight percent of a liquid organic diluent and from about 90 to 10 weight percent of one or more of the above described

aminomethyl-substituted imidazoles as per embodiments of the present invention. Both the lubricating oil composition and the lubricating oil additive concentrate may contain other additives designed to improve the properties of the lubricating oil.

DETAILED DESCRIPTION OF THE INVENTION

As used herein, the following terms have the following meaning unless expressly stated to the contrary:

The term "aliphatic" as used herein refers to both branched and straight chain hydrocarbon groups, which are saturated or unsaturated. In other words, the aliphatic group may be alkyl, alkenyl or alkynyl.

The term "alkyl" as used herein refers to both branched and straight chain saturated aliphatic hydrocarbon groups, and where specified, having the specified number of carbon atoms. Thus, the term "C_1 to C_4 alkyl," as used herein, indicates an alkyl group having from 1 to 4 carbon atoms such as methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl and tert-butyl.

The term "alkenyl" as used herein refers to branched or straight hydrocarbon chains comprising one or more unsaturated carbon-carbon bonds.

The term "alkynyl" as used herein refers to branched or straight hydrocarbon chains comprising one or more triple carbon-carbon bonds.

Processes for Preparing Aminomethyl-Substituted Imidazole Compounds

Aminomethyl-substituted imidazole compounds of the present invention may be prepared by numerous reaction mechanisms; employing either a multi-step process or a single step process.

Thus, one process for preparing the aminomethyl-substituted imidazole compounds comprises:

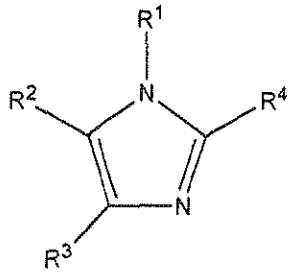
(a) reacting

(i) at least one imidazole carboxaldehyde of formula IV

CLAIMS

What is claimed is:

1. A compound of formula I:



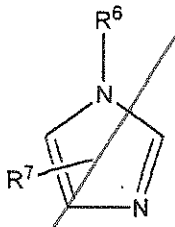
formula I

wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula $-CH_2NHR^5$ provided that at least one R^1, R^2, R^3 and R^4 is a moiety of formula $-CH_2NHR^5$ wherein R^5 is a C_8 to C_{28} aliphatic group.

2. The compound of claim 1 wherein R^1, R^2 and R^4 are hydrogen and R^3 is a moiety of formula $-CH_2NHR^5$ wherein R^5 is a C_{10} to C_{28} aliphatic group.

3. The compound of claim 2 wherein R^5 is C_{10} to C_{18} aliphatic group.

4. The compound of claim 1 having the formula II:



formula II

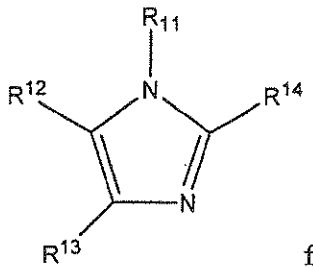
wherein R^6 and R^7 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula $-CH_2NHR^8$ provided that at least one R^6 and R^7 is a moiety of formula $-CH_2NHR^8$ wherein R^8 is a C_8 to C_{28} aliphatic group.

5. The compound of claim 4 wherein R^6 is hydrogen.

6. The compound of claim 4, wherein R^7 is hydrogen.

7 A process for preparing an aminomethyl-substituted imidazole compound comprising, reacting

(a) an imidazole compound having the formula III



formula III

wherein R^{11}, R^{12}, R^{13} and R^{14} are independently selected from the group consisting of hydrogen and a C_1 to C_4 alkyl group wherein at least one of R^{11}, R^{12}, R^{13} and R^{14} is hydrogen;

(b) formaldehyde or a formaldehyde-producing reagent; and

(c) an amine of having the formula

$$H_2N\text{-}R^{15}$$

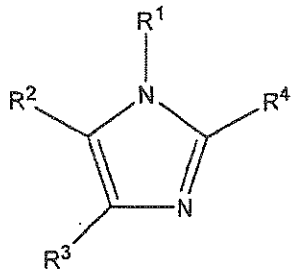
wherein R^{15} is a C_8 to C_{28} aliphatic group.

8. The process of claim 7 wherein R^{15} is C_{10} to C_{18} aliphatic group.

9. The process of claim 7 wherein R^{11}, R^{12}, R^{13} and R^{14} are hydrogen.

10. A product produced according to the process of claim 7.

11. A lubricating oil composition comprising a major amount of an oil of lubricating viscosity and from 0.01 to 5 weight percent of one or more compounds having the formula



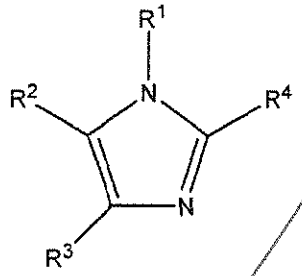
wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula $-CH_2NHR^5$ provided that at

least one R^1, R^2, R^3 and R^4 is a moiety of formula $-CH_2NHR^5$ wherein R^5 is a C_8 to C_{28} aliphatic group.

12. The lubricating oil composition of claim **11** wherein R^1, R^2 and R^4 are hydrogen and R^3 is a moiety of formula $-CH_2NHR^5$ wherein R^5 is a C_{10} to C_{28} aliphatic group.

13. The lubricating oil composition of claim **11** wherein R^5 is a C_{10} to C_{18} aliphatic group.

14. A lubricating oil additive concentrate comprising from 90 to 10 weight percent of a liquid organic diluent and from about 10 to 90 weight percent of one or more compounds having the formula

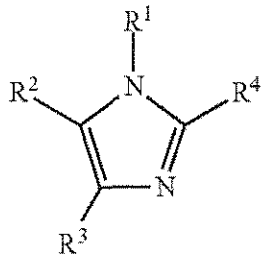


wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula $-CH_2NHR^5$ provided that at least one R^1, R^2, R^3 and R^4 is a moiety of formula $-CH_2NHR^5$ wherein R^5 is a C_8 to C_{28} aliphatic group.

15. The lubricating oil additive concentrate of claim **14** wherein R^1, R^2 and R^4 are hydrogen and R^3 is a moiety of formula $-CH_2NHR^5$ wherein R^5 is a C_{10} to C_{28} aliphatic group.

CLAIMS:

1. A compound of formula I:

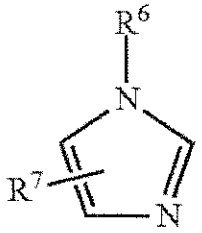


formula I

wherein R^1, R^2 and R^4 are hydrogen; and R^3 is a moiety of formula —CH_2NHR^5 wherein R^5 is a C_{10} to C_{28} aliphatic group.

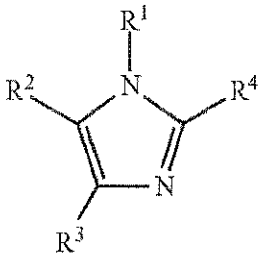
2. The compound of claim 1 wherein R^5 is C_{10} to C_{18} aliphatic group.

3. A compound having the formula:



wherein R^6 and is a moiety of formula —CH_2NHR^8 wherein R^8 is a C_8 to C_{28} aliphatic group and R^7 is hydrogen.

4. A lubricating oil composition comprising a major amount of an oil of lubricating viscosity and from 0.01 to 5 weight percent of one or more compounds having the formula

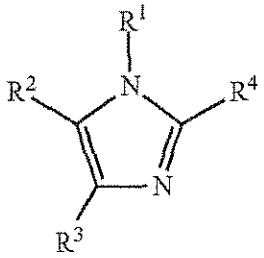


wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula —CH_2NHR^5 provided that at least one R^1, R^2, R^3 and R^4 is a moiety of formula —CH_2NHR^5 wherein R^5 is a C_8 to C_{28} aliphatic group.

5. The lubricating oil composition of claim 4 wherein R^1, R^2 and R^4 are hydrogen and R^3 is a moiety of formula —CH_2NHR^5 wherein R^5 is a C_{10} to C_{28} aliphatic group.

6. The lubricating oil composition of claim 4 wherein R^5 is a C_{10} to C_{18} aliphatic group.

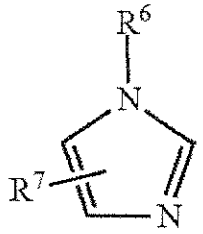
7. A lubricating oil additive concentrate comprising from 90 to 10 weight percent of a liquid organic diluent and from about 10 to 90 weight percent of one or more compounds having the formula



wherein R^1, R^2, R^3 and R^4 are independently selected from the group consisting of hydrogen, a C_1 to C_4 alkyl group and a moiety of formula —CH_2NHR^5 provided that at least one R^1, R^2, R^3 and R^4 is a moiety of formula —CH_2NHR^5 wherein R^5 is a C_8 to C_{28} aliphatic group.

8. The lubricating oil additive concentrate of claim 7 wherein R^1, R^2 and R^4 are hydrogen and R^3 is a moiety of formula —CH_2NHR^5 wherein R^5 is a C_{10} to C_{28} aliphatic group.

9. A compound having the formula:



wherein: R^6 is a C_1 to C_4 alkyl group; and R^7 is a moiety of formula —CH_2NHR^8 wherein R^8 is a C_8 to C_{28} aliphatic group.

10. The compound of claim 9 wherein R^7 is substituted in the 4 or 5 position of the imidazole ring.