Metal contamination of diesel fuel and the resultant formation of carboxylate salts is believed to be a significant cause of injector sticking. The formation of lacquers is yet another major cause of injector sticking.

One approach to combatting IDIDs and injector sticking resulting from carboxylate salts is to try to eliminate the source of metal contamination and/or carboxylic acids or to try to ensure that particularly problematic carboxylic acids are eliminated. This has not been entirely successful and there is a need for additives to provide control of IDIDs.

Deposit control additives are often included in fuel to combat deposits in the injector nozzle or at the injector tip. These may be referred to herein as “external injector deposits”. Additives are also used to control deposits on vehicle fuel filters. However additives which have been found to be useful to control “external deposits” and fuel filter deposits are not always effective at controlling IDIDs. A challenge for the additive formulator is to provide more effective detergents.

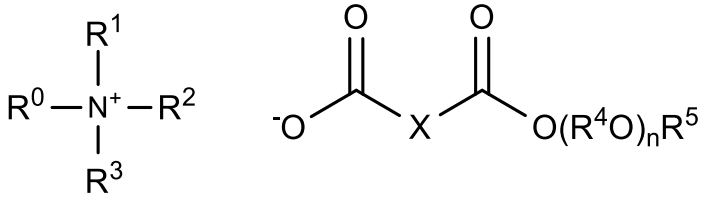
It is an aim of the present invention to provide methods and uses which improve the performance of a diesel engine, especially a diesel engine having a high pressure fuel system. This may be achieved for example by preventing or reducing the formation of IDIDs and/or by reducing or removing existing IDIDs. The invention provides methods and uses which control “external injector deposits” and/or fuel filter deposits.

Reducing or preventing the formation of deposits may be regarded as providing “keep clean” performance. Reducing or removing existing deposits may be regarded as providing “clean up” performance. It is an aim of the present invention to provide “keep clean” and/or “clean up” performance.

Many different types of compounds are known in the art for use as detergent additives in fuel oil compositions, for the control of deposits in engines.

SUMMARY

In one aspect, there is provided a fuel or lubricating composition comprising a quaternary ammonium compound of formula (I):

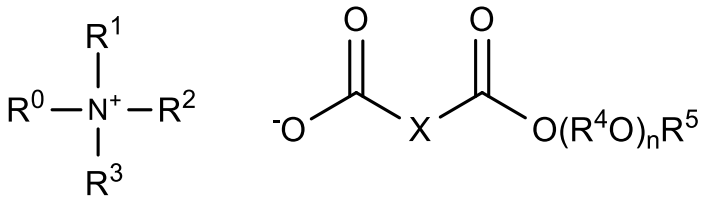


(I)

wherein R^0, R^1, R^2 and R^3 is each independently an optionally substituted hydrocarbyl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen; wherein X is CH_2CHR or $CHRCH_2$ wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

In another aspect, there is provided a method of preparing fuel composition, the method comprising preparing a quaternary ammonium salt by reacting (a) a tertiary amine of formula $R^1R^2R^3N$, wherein each of R^1, R^2 and R^3 is independently an optionally substituted alkyl, alkenyl or aryl group with (b) an acid-derived alkylating agent in the presence of (c) a compound of formula $HOOCXCOO\text{-}(R^4O)_n\text{-}R^5$, wherein R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen; and mixing the quaternary ammonium salt into the fuel; wherein n is a positive integer and/or X is CH_2CHR or $CHRCH_2$, wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

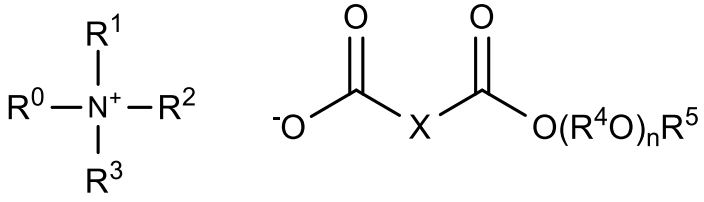
In another aspect, there is provided a use of a ammonium compound of formula (I):



(I)

wherein R^0, R^1, R^2 and R^3 is each individually an optionally substituted alkyl, alkenyl or aryl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen as an additive in a fuel or lubricant composition; wherein X is CH_2CHR or $CHRCH_2$ wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

In a further aspect, there is provided a method of improving the performance of an engine, the method comprising combusting in the engine a fuel composition comprising as an additive a quaternary ammonium compound of formula (I):



(I)

wherein R^0, R^1, R^2 and R^3 is each independently an optionally substituted hydrocarbyl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen; wherein X is CH_2CHR or $CHRCH_2$ wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

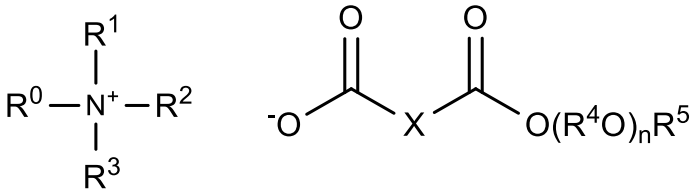
DETAILED DESCRIPTION

The present invention relates to novel quaternary ammonium compounds having an ester counterion that is the partial ester of a polycarboxylic acid that are useful as detergents.

According to a first aspect of the present invention there is provided a quaternary ammonium compound of formula (I):

Claims

1. A fuel or lubricating composition comprising a quaternary ammonium compound of formula (I):



(I)

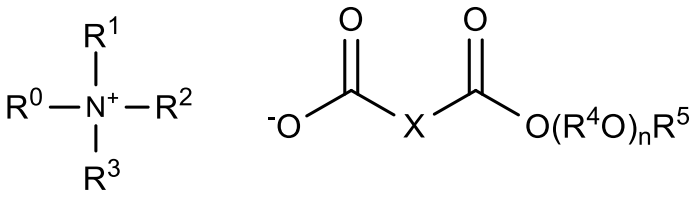
wherein R^0, R^1, R^2 and R^3 is each independently an optionally substituted hydrocarbyl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen, wherein X is CH_2CHR or $CHRCH_2$ wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

2. A method of preparing a fuel composition, the method comprising preparing a quaternary ammonium salt by reacting (a) a tertiary amine of formula $R^1R^2R^3N$ wherein each of R^1, R^2 and R^3 is independently an optionally substituted alkyl, alkenyl or aryl group with (b) an acid-activated alkylating agent in the presence of (c) a compound of formula $HOOCXCOO\text{-}(R^4O)_n\text{-}R^5$, wherein R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen; and mixing the quaternary ammonium salt into the fuel; wherein n is a positive integer and/or X is CH_2CHR or $CHRCH_2$, wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

3. A method according to claim 2 wherein component (b) is an epoxide.

4. A composition according to claim 1 wherein the composition is a fuel composition, preferably a diesel fuel composition.

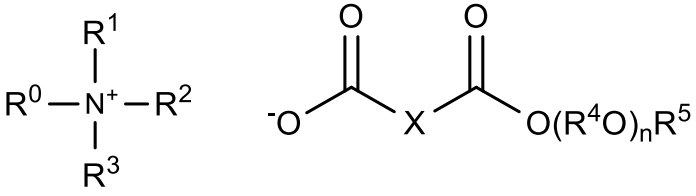
5. Use of a quaternary ammonium compound of formula (I):



(I)

wherein R^0, R^1, R^2 and R^3 is each individually an optionally substituted alkyl, alkenyl or aryl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen as an additive in a fuel or lubricant composition; wherein X is CH_2CHR or $CHRCH_2$ wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

6. A method of improving the performance of an engine, the method comprising combusting in the engine a fuel composition comprising as an additive a quaternary ammonium compound of formula (I):



(I)

wherein R^0, R^1, R^2 and R^3 is each independently an optionally substituted hydrocarbyl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen wherein X is CH_2CHR or $CHRCH_2$ wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms.

7. A composition, method or use according to any preceding claim wherein HOOCXCOO-$(R^4O)_n$-R^5 is derived from a hydrocarbyl substituted succinic acid or a hydrocarbyl substituted succinic anhydride.

8. A composition, method or use according to any preceding claim wherein each R^4 is ethylene or propylene, preferably $-CH_2CH_2-$ or $-CH(CH_3)CH_2-$, more preferably $-CH(CH_3)CH_2-$.

9. A composition, method or use according to any preceding claim wherein R^5 is hydrogen and n is at least 1.

10. A composition, method or use according to any of claims 1 to 8 wherein R^5 is an optionally substituted alkyl group having 4 to 40 carbon atoms and n is from 0 to 40.

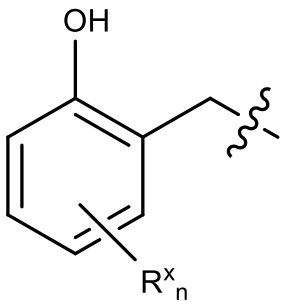
11. A composition, method or use according to any preceding claim wherein each of R^1 and R^2 is independently an optionally substituted alkyl group having from 1 to 12 carbon atoms.

12. A composition, method or use according to any preceding claim wherein R^3 is an alkyl or hydroxyalkyl group having 1 to 10 carbon atoms.

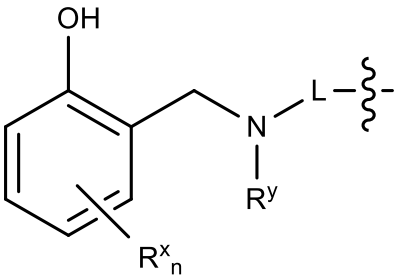
13. A composition, method or use according to any of claims 1 to 11 wherein R^3 is selected from:

(1) a polyisobutenyl group having a molecular weight of from 100 to 5000, preferably from 450 to 2500;

(2) an optionally substituted alkylene phenol moiety of formula (A) or (B)



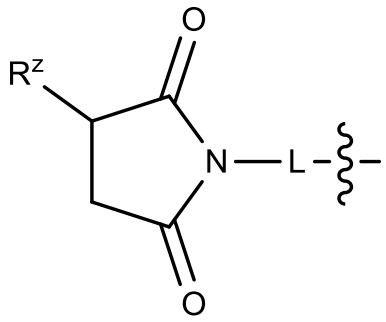
(A)



(B)

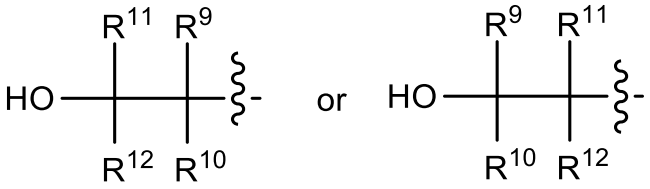
wherein n is 0 to 4, preferably 1, R^x is an optionally substituted hydrocarbyl group, R^y is an optionally substituted alkyl, alkenyl or aryl group; and L is a linking group; and

(3) a succinimide moiety of formula:



wherein R^z is an optionally substituted hydrocarbyl group and L is a linking group.

14. A composition, method or use according to any preceding claim wherein R^0 as is a group of formula:



wherein each of R^9, R^{10}, R^{11}, R^{12} is independently selected from hydrogen or an optionally substituted alkyl, alkenyl or aryl group.

15. A method according to claim 2 wherein n is a positive integer and X is an optionally substituted alkylene or arylene group.

16. A composition, method or use according to any of claims 1 to 12, 14 or 15 the quaternary ammonium compound is the reaction product of:

(a) a tertiary amine of formula $R^1R^2R^3N$ wherein each of, R^1, R^2 and R^3 is independently an optionally substituted alkyl group having 1 to 12 carbon atoms ;

(b) an epoxide selected from styrene oxide, ethylene oxide, propylene oxide, butylene oxide, epoxyhexane, octene oxide, stilbene oxide, 2-ethylhexyl glycidyl ether, 1,2-epoxydodecane and other alkyl and alkenyl epoxides having 2 to 50 carbon atoms; and

(c) a compound of formula $HOOCXCOO\text{-}(R^4O)_n\text{-}R^5$ wherein X is CH_2CHR or $CHRCH_2$ wherein R is an alkyl or alkenyl group having 20 to 24 carbon atoms; and
n is more than 1, R^4 is an ethylene or propylene group and R^5 is hydrogen; or
n is 0 or and R^5 is a C1 to C20 alkyl group.

17. A composition, method or use according to any of claims 1 to 12 or 14 to 16 wherein the quaternary ammonium compound is the reaction product of:

(a) a tertiary amine of formula $R^1R^2R^3N$ wherein each of, R^1, R^2 and R^3 is independently an alkyl or hydroxyalkyl group having 1 to 6 carbon atoms ;

(b) an epoxide selected from propylene oxide, butylene oxide and 2-ethylhexyl glycidyl ether; and

(c) a compound of formula $HOOCXCOO\text{-}(R^4O)_n\text{-}R^5$ which is the reaction product of a succinic acid or anhydride having a C_{20} to C_{24} alkyl or alkenyl substituent and an alcohol selected from polypropylene glycol having a number average molecular weight of 300 to 800, 2-ethylhexanol and butanol.

18. A composition, method or use according to any preceding claim wherein the composition is a diesel fuel composition.

19. A composition, method or use according to claim 18 wherein the diesel fuel composition comprises one or more further detergents selected from:

(i) a quaternary ammonium salt additive;

(ii) the product of a Mannich reaction between an aldehyde, an amine and an optionally substituted phenol;

(iii) the reaction product of a carboxylic acid-derived acylating agent and an amine;

(iv) the reaction product of a carboxylic acid-derived acylating agent and hydrazine;

(v) a salt formed by the reaction of a carboxylic acid with di-n-butylamine or tri-n-butylamine;

(vi) the reaction product of a hydrocarbyl-substituted dicarboxylic acid or anhydride and an amine compound or salt which product comprises at least one amino triazole group; and

(vii) a substituted polyaromatic detergent additive.

20. A composition, method or use according to any preceding claim wherein the composition is a diesel fuel composition comprising a mixture of two or more quaternary ammonium salt additives.

21. A method or use as defined in any of claims 5 to 20 wherein the additive is used as a detergent to combat deposits in a diesel fuel composition in a diesel engine.

22. A method or use according to any of claims 5 to 21 which is carried out in a modern diesel engine having a high pressure fuel system.

23. A method or use according to any of claims 5 to 22 which achieves “keep clean” performance.

24. A method or use according to any of claims 5 to 23 which achieves “clean up” performance.

25. A method or use according to any of claims 17 to 24 wherein the deposits are injector deposits.

26. A method or use according to claim 25 wherein the deposits are internal diesel injector deposits.

27. A method or use according to any of claims 5 to 26 which achieves an improvement in performance selected from one or more of:

- a reduction in power loss of the engine;
- a reduction in external diesel injector deposits;
- a reduction in internal diesel injector deposits;

- an improvement in fuel economy;
- a reduction in fuel filter deposits;
- a reduction in emissions; and
- an increase in maintenance intervals.

28. A method or use according to claim 27 which provides an improvement in performance in modern diesel engines having a high pressure fuel system and provides an improvement in performance in traditional diesel engines.

29. Use according to any of claims 5 to 28 which provides one or more further benefits selected from lubricity benefits, corrosion inhibition and cold flow improvement.

30. A composition according to any of claims 1, 4 or 7 to 20 which further comprises one or more further additives selected from lubricity improvers, corrosion inhibitors and cold flow improvers.