

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.

- 5 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.
- 10 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
- 15 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

20 reducing or removing existing IDIDs. The invention also 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"

25 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.

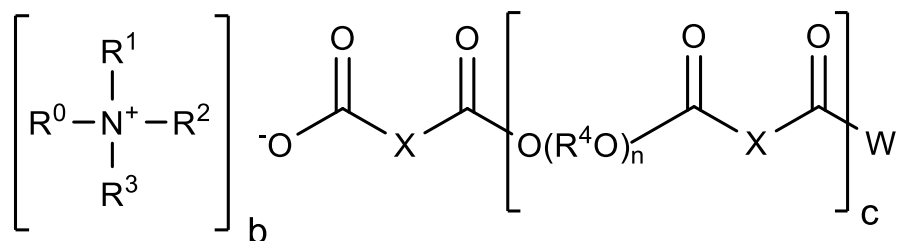
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SUMMARY

In one aspect of the present disclosure, there is provided an additive composition for a fuel or lubricating oil comprising a quaternary ammonium compound of formula (I):

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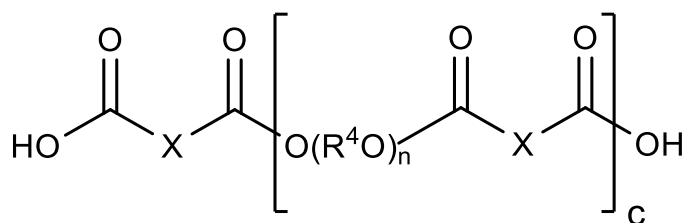
4a



(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; n is a positive integer; c is at least 1 W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

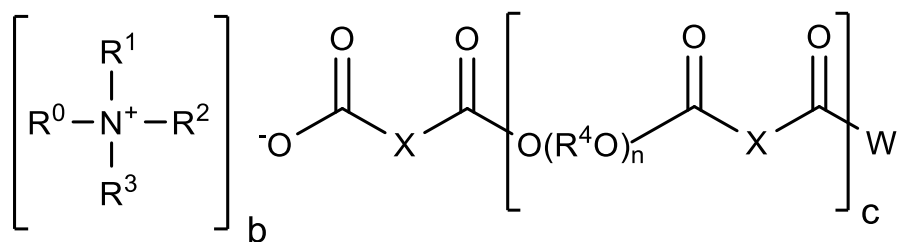
In another aspect, the present disclosure provides a method of preparing a quaternary ammonium compound, the method comprising reacting (a) a tertiary amine of formula $R^1R^2R^3N$ with (b) an epoxide; in the presence of (c) a compound of formula (IIB):



(IIB)

wherein R^4 is an optionally substituted alkylene group; n is 0 or a positive integer; C is at least 1; W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

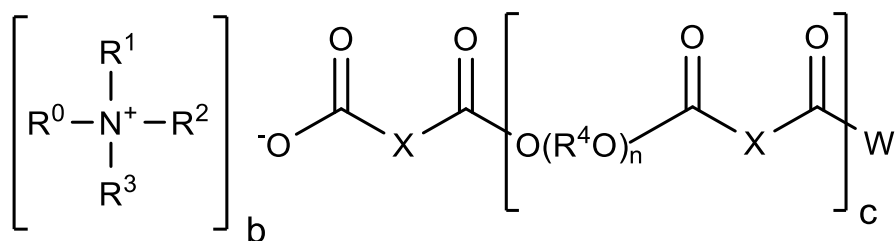
In yet another aspect, there is provided a fuel composition comprising a quaternary ammonium compound of formula (I):



(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; n is a positive integer; c is at least 1; W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

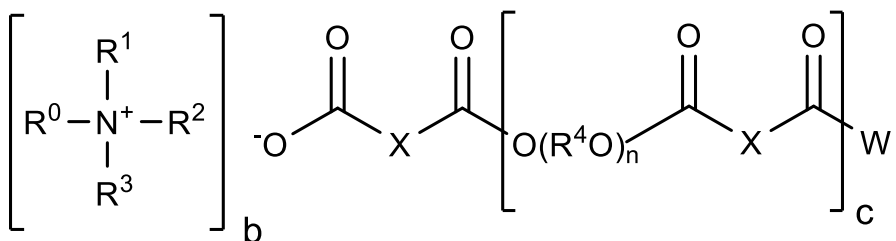
- 5 In yet another aspect, the present disclosure provides a use of a quaternary ammonium compound of formula (I):



(I)

- 10 as an additive 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; n is a positive integer; c is at least 1; W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

- 15 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)

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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; n is a positive integer; c is at least 1; W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

- 25 In yet another aspect of the present disclosure, there is provided a use of an ester as defined herein to reduce the treat rate of one or more further additives selected from lubricity improvers, corrosion inhibitors and cold flow improvers whilst maintaining performance.

DETAILED DESCRIPTION

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

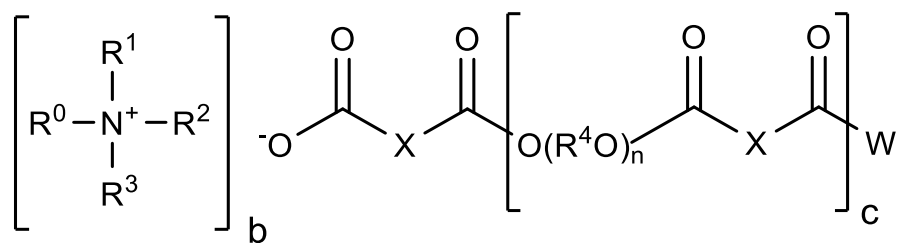
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According to a first aspect of the present invention there is provided a quaternary ammonium compound of formula (I):

Claims

1. An additive composition for a fuel or lubricating oil comprising a quaternary ammonium compound of formula (I):

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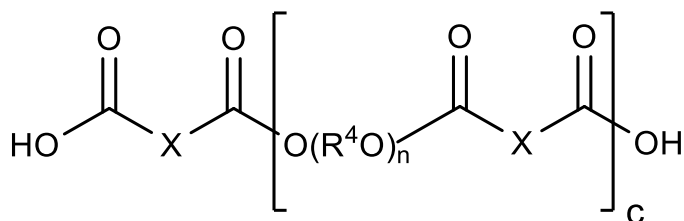
(I)

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; n is a positive integer; c is at least 1, W is O^- or OH ; b is 1 when W is OH , and b is 2 when W is O^- .

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2. A method of preparing a quaternary ammonium compound, the method comprising reacting (a) a tertiary amine of formula $R^1R^2R^3N$ with (b) an epoxide; in the presence of (c) a compound of formula (IIB):

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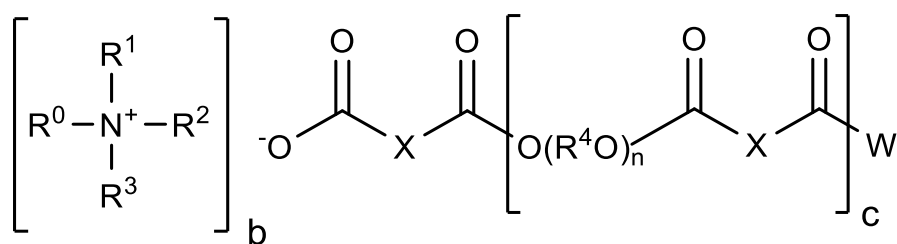


(IIB)

wherein R^4 is an optionally substituted alkylene group; n is 0 or a positive integer; C is at least 1; W is O^- or OH ; b is 1 when W is OH , and b is 2 when W is O^- .

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3. A fuel composition comprising a quaternary ammonium compound of formula (I):



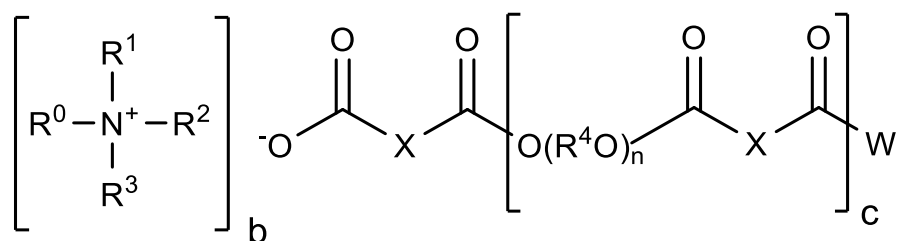
(I)

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; n is a positive integer; c is at least 1; W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

~~4. A composition according to claim 3 wherein the composition is an additive composition for a fuel or lubricating oil.~~

~~5.4. A fuel composition according to claim 3 wherein the composition is a fuel composition, preferably which is a diesel fuel composition.~~

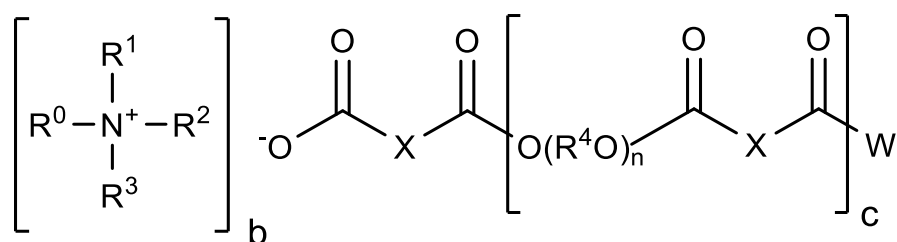
~~6.5. Use of a quaternary ammonium compound of formula (I):~~



(I)

as an additive 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; n is a positive integer; c is at least 1; W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

~~7.6. 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; n is a positive integer; c is at least 1; W is O^- or OH; b is 1 when W is OH, and b is 2 when W is O^- .

~~8.7.~~ A ~~compound, composition, method or use~~ according to ~~any preceding claim~~ claim 2 wherein the anion precursor of formula (IIB) is derived from a hydrocarbyl substituted succinic acid or a hydrocarbyl substituted succinic anhydride.

~~9.8.~~ A compound, composition method or use according to any preceding claim wherein each X is a moiety CH_2CHR or $CRHCH_2$ in which R is an alkyl or alkenyl group having 6 to 36 carbon atoms.

~~10.9.~~ A compound, 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 $-CH(CH_3)CH_2-$.

~~11.10.~~ A compound, composition method or use according to any preceding claim wherein n is from 1 to 20.

~~12.11.~~ A compound, 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.

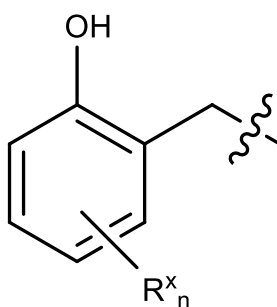
~~13.12.~~ A compound, composition, method or use according to any preceding claim wherein R^3 is an alkyl group having 1 to 24 carbon atoms.

~~14.13.~~ A compound, composition, method or use according to any of claims 1 to 13 wherein R^3 is selected from benzyl, or a hydroxyalkyl or hydroxyalkoxyalkyl group having 2 to 20 carbon atoms.

~~15.14.~~ A compound, composition, method or use according to any of claims 1 to 13 wherein R^3 is selected from:

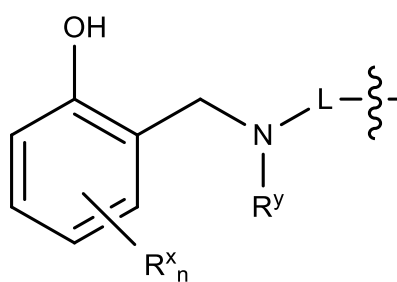
(1) a polyisobutenyl group having a number average molecular weight of from 100 to 5000, preferably from 450 to 2500;

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



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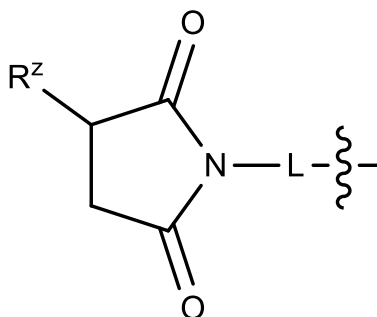
(A)



(B)

15 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

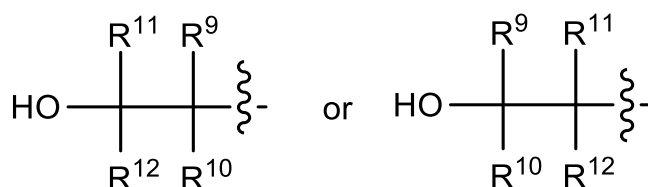
(3) a succinimide moiety of formula:



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wherein R^2 is an optionally substituted hydrocarbyl group and L is a linking group.

~~16.15.~~ A compound, 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.

~~17.16.~~ A composition, method or use according to any of claims 3 to ~~16-15~~ wherein the composition is a diesel fuel composition.

~~18.17.~~ A composition, method or use according to claim ~~17-16~~ 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.

- 5 19-18. A composition, method or use according to any of claims 3 to 18-17 wherein the diesel fuel composition comprises a mixture of two or more quarternary ammonium compounds.
- 10 20-19. A method or use as defined in any of claims 3-5 to 19-18 wherein the additive is used as a detergent to combat deposits in a diesel fuel composition in a diesel engine.
- 15 21-20. A method or use according to any of claims 6-5 to 20-19 wherein which is carried out in a modern diesel engine having a high pressure fuel system.
- 20 22-21. A method or use according to any of claims 6-5 to 21-20 which achieves "keep clean" performance.
- 25 23-22. A method or use according to any of claims 6-5 to 22-21 which achieves "clean up" performance.
- 30 24-23. A method or use according to any of claims 18-19 to 23-22 wherein the deposits are injector deposits.
- 35 25-24. A method or use according to claim 24-23 wherein the deposits are internal diesel injector deposits.
- 40 26-25. A method or use according to any of claims 6-5 to 24 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.
- 45 27-26. A method or use according to claim 26-25 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.

- | 28.27. Use according to any of claims ~~2 to 27~~ 5 or 7 to 26 which provides one or more further benefits selected from lubricity benefits, corrosion inhibition and cold flow improvement.
- | 5 29.28. A composition according to any of claims ~~1 or 3 to 19~~ 1, 3, 4 or 7 to 18 which further comprises one or more further additives selected from lubricity improvers, corrosion inhibitors and cold flow improvers.
- | 10 30.29. Use of an ~~ester~~ additive as defined in any preceding claim to reduce the treat rate of one or more further additives selected from lubricity improvers, corrosion inhibitors and cold flow improvers whilst maintaining performance.