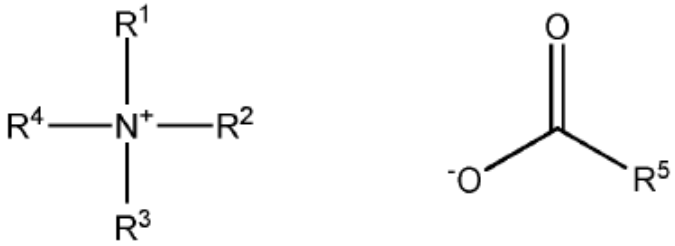
Claims

1. A fuel composition comprising as an additive one or more quaternary ammonium salts of formula:



wherein each of R^1, R^2, R^3 and R^4 is independently selected from an optionally substituted alkyl, alkenyl or aryl group having less than 8 carbon atoms and R^5 is hydrogen or an optionally substituted hydrocarbyl group.

2. A fuel composition according to claim 1 which is the reaction product of a tertiary amine of formula $R^1R^2R^3N$ with a quaternising agent selected from:

(i) an ester of formula R^5COOR^4;

(ii) a carbonate compound of formula R^0OCOOR^4 and then a carboxylic acid of formula R^5COOH; and

(iii) an epoxide having less than 8 carbon atoms and a carboxylic acid of formula R^5COOH;

wherein R^0 is an optionally substituted hydrocarbyl group.

3. A fuel composition according to claim 1 or claim 2 wherein the quaternary ammonium salt is the reaction product of:

(a) a tertiary amine of formula $R^1R^2R^3N$;

(b) an epoxide having less than 8 carbon atoms; and

(c) a carboxylic acid of formula R^5COOH.

4. A fuel composition according to any preceding claim wherein R^1 is an optionally substituted alkyl or alkenyl group having 1 to 6 carbon atoms, R^2 is an optionally substituted alkyl or alkenyl group having 1 to 6 carbon atoms and R^3 is an optionally substituted alkyl or alkenyl group having 1 to 6 carbon atoms.

5. A fuel composition according to any preceding claim wherein R^1 is an unsubstituted alkyl group or a hydroxyalkyl group, R^2 is an unsubstituted alkyl group or a hydroxyalkyl group and R^3 is an unsubstituted alkyl group or a hydroxyl alkyl group.

6. A fuel composition according to any preceding claims wherein R^4 is a hydroxy substituted alkyl group.

7. A fuel composition according to claim 6 wherein the fuel is diesel fuel, and which optionally comprises one or more further detergents selected from:

(i) an additional quaternary ammonium salt additive which is not a quaternary ammonium compound of claim 1;

(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.

8. A fuel composition according to claim 6 wherein the fuel is gasoline fuel, and which optionally comprises one or more gasoline detergents selected from:

(p) hydrocarbyl-substituted polyoxyalkylene amines or polyetheramines;

(q) acylated nitrogen compounds which are the reaction product of a carboxylic acid-derived acylating agent and an amine;

(r) hydrocarbyl-substituted amines wherein the hydrocarbyl substituent is substantially aliphatic and contains at least 8 carbon atoms;

(s) Mannich base additives comprising nitrogen-containing condensates of a phenol, aldehyde and primary or secondary amine;

(t) aromatic esters of a polyalkylphenoxyalkanol;

(u) an additional quaternary ammonium salt additive which is not a quaternary ammonium compound of claim 1; and

(v) tertiary hydrocarbyl amines having a maximum of 30 carbon atoms.

9. A method of improving the performance of an engine, the method comprising combusting in said engine a fuel composition as claimed in any preceding claim.

10. A method according to claim 9 wherein the engine is a gasoline engine and the fuel is a gasoline fuel.

11. A method according to claim 9 wherein the engine is a diesel engine having a fuel injection system which comprises a high pressure fuel injection (HPFI) system with fuel pressures greater than 1350 bar.

12. A method according to claim 9 or claim 11 wherein improvement in performance is achieved by combating deposits in the engine.

13. A method according to claim 12 which combats internal diesel injector deposits; and/or which combats external diesel injector deposits, including injector nozzle deposits and injector tip deposits; and/or which combats fuel filter deposits.

14. A method according to claim 9 or claim 11 wherein the improvement in performance is a power gain compared to when combusting an unadditised base fuel and with clean injectors.

15. The use of an additive in a fuel composition to improve the performance of an engine combusting said fuel composition wherein the additive is a quaternary ammonium salt as defined in any of claims 1 to 6.

16. The use according to claim 15 to achieve "keep clean" performance or to achieve "clean up" performance.

17. A method of preparing a fuel composition as claimed in any of claims 1 to 6, the method comprising adding the quaternary ammonium salt additive to the fuel after the fuel has left the distribution terminal.