In another aspect of the disclosure, there is provided a method of preparing a fuel or lubricating composition, the method comprising preparing a quaternary ammonium salt by reacting:

i) a cyclic tertiary amine having less than 19 carbon atoms, which is an N-alkyl heterocycle selected from pyrrolidine, piperidine, morpholine, piperazine, pyrrole, imidazole and dihydropyrrole; with

ii) an epoxide having less than 8 carbon atoms; in the presence of

iii) a carboxylic acid of formula R^5COOH, wherein R^5 is $CHR^{11}CHR^{12}COOR^{13}$, wherein one of R^{11} and R^{12} is hydrogen and the other is a polyisobutenyl group or an optionally substituted alkyl or alkenyl group having 6 to 50 carbon atoms and R^{13} is hydrogen or an optionally substituted alkyl group;

and mixing the quaternary ammonium salt into the fuel or an oil of lubricating viscosity.

In yet another aspect, there is provided a method of improving the performance of an engine, the method comprising; preparing a fuel composition as described herein; and combusting the fuel composition in said engine.

The quaternary ammonium salts of the present invention include cations of formula $R{=}{=}N^+R^1R^2$, wherein each of R^1 and R^2 is independently an optionally substituted alkyl, alkenyl or aryl group having less than 8 carbon atoms, and R together with N forms a heterocycle having less than 12 carbon atoms.

For the avoidance of doubt, the structure $R{=}{=}N^+R^1R^2$ is used to indicate that the group R forms 2 bonds to N, not that it forms a double bond.

In this specification, unless otherwise stated references to optionally substituted alkyl groups may include aryl-substituted alkyl groups and references to optionally-substituted aryl groups may include alkyl-substituted or alkenyl-substituted aryl groups.

R^1 and R^2 may be the same or different. In some embodiments they are the same. In some embodiments they are different.

Preferably R^1 is an optionally substituted alkyl, alkenyl or aryl group having from 1 to 7 carbon atoms, preferably from 1 to 5 carbon atoms, more preferably from 1 to 4 carbon atoms.

R^1 may be optionally substituted with one or more groups selected from halo (especially chloro and fluoro), hydroxy, alkoxy, keto, acyl, cyano, mercapto, alkylmercapto, dialkylamino, nitro, nitroso, and sulphoxy. The alkyl groups of these substituents may be further substituted.

Preferably R^1 is an optionally substituted alkyl or alkenyl group. Preferably R^1 is an optionally substituted alkyl group. Preferably R^1 is an optionally substituted alkyl or alkenyl group having from 1 to 7 carbon atoms, preferably from 1 to 6 carbon atoms, more preferably from 1 to 5 carbon atoms, suitably from 1 to 4 carbon atoms, preferably from 1 to 3 carbon atoms, more preferably from 1 to 2 carbon atoms.

Preferably R^1 is an optionally substituted alkyl or alkenyl group, preferably having from 1 to 6, preferably from 1 to 4 carbon atoms. Preferably R^1 is an alkyl group. It may be a substituted alkyl group, for example a hydroxy substituted alkyl group. Preferably R^1 is an unsubstituted alkyl group or a hydroxy alkyl group. More Preferably R^1 is an unsubstituted alkyl group. The alkyl chain may be straight-chained or branched. Preferably R^1 is selected from methyl, ethyl, propyl and butyl, including isomers thereof. Most preferably R^1 is methyl.

In some embodiments R^1, R and N together form an aromatic ring and the quaternary ammonium salt may have the structure:

Claims:

1. A method of preparing a fuel or lubricating composition, the method comprising preparing a quaternary ammonium salt by reacting:
   a) a cyclic tertiary amine having less than 19 carbon atoms, which is an N-alkyl heterocycle selected from pyrrolidine, piperidine, morpholine, piperazine, pyrrole, imidazole and dihydropyrrole; with
   b) an epoxide having less than 8 carbon atoms; in the presence of
   c) a carboxylic acid of formula R^5COOH; wherein R^5 is $CHR^{11}CHR^{12}COOR^{13}$, wherein one of R^{11} and R^{12} is hydrogen and the other is a polyisobutenyl group or an optionally substituted alkyl or alkenyl group having 6 to 50 carbon atoms and R^{13} is hydrogen or an optionally substituted alkyl group;
   and mixing the quaternary ammonium salt into the fuel or an oil of lubricating viscosity.

2. A method according to claim 1, wherein the N-alkyl heterocycle is an N-methyl heterocycle.

3. A method according to any preceding claim for preparing a lubricating composition.

4. A method according to any of claims 1 to 2 for preparing a fuel composition.

5. A method according to claim 4, wherein the fuel composition is diesel fuel

6. A method according to claim 5 wherein the diesel fuel composition comprises one or more further detergents selected from:
   i) an additional quaternary ammonium salt additive which is not a quaternary ammonium compound prepared in 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.

7. A method according to claim 4 wherein the fuel composition is gasoline fuel.

8. A method according to claim 7 wherein the gasoline fuel composition 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 preparing a fuel composition as claimed in any of claims 4 to 8; the method comprising adding the quaternary ammonium salt additive to the fuel after the fuel has left the distribution terminal.

10. A method of improving the performance of an engine, the method comprising; preparing a fuel composition according to the method of claim 1 or claim 2; and combusting the fuel composition in said engine.

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

12. A method according to claim 10 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.

13. A method according to claim 10 or claim 12 wherein improvement in performance is achieved by combating deposits in the engine.

14. A method according to claim 13 which combats internal diesel injector deposits.

15. A method according to claim 13 or claim 14 which combats external diesel injector deposits, including injector nozzle deposits and injector tip deposits.

16. A method according to any of claims 12 to 15 which combats fuel filter deposits.

17. A method according to claim 10 or claim 12 wherein the improvement in performance is a power gain compared to when combusting an unadditised base fuel and with clean injectors.

18. A method according to any of claims 10 to 17 which achieves “keep clean” performance.

19. A method according to any of claims 10 to 18 which achieves “clean up” performance.