performance in relation to IDIDs. It is a further aim to also provide "keep clean" and/or "clean up" performance in relation to external injector deposits and/or fuel filter deposits.

According to a first aspect of the present invention there is provided a method of combating internal diesel injector deposits caused by carboxylate residues and/or lacquers in the injectors of a diesel engine, the method comprising combusting in the engine a diesel fuel composition comprising (a) the reaction product of a carboxylic acid-derived acylating agent and an amine and (b) a quaternary ammonium salt additive; wherein the quaternising agent used to prepare the quaternary ammonium salt addive (b) is selected from the group consisting of dialkyl sulphates; an ester of a carboxylic acid; alkyl halides; benzyl halides; hydrocarbyl substituted carbonates; and hydrocarbyl epoxides in combination with an acid or mixtures thereof.

According to a second aspect of the present invention there is provided the use of a combination of (a) the reaction product of a carboxylic acid-derived acylating agent and an amine and (b) a quaternary ammonium salt additive to combat internal diesel injector deposits caused by carboxylate residues and/or lacquers in the injectors of a diesel engine; wherein the quaternising agent used to prepare the quaternary ammonium salt addive (b) is selected from the group consisting of dialkyl sulphates; an ester of a carboxylic acid; alkyl halides; benzyl halides; hydrocarbyl substituted carbonates; and hydrocarbyl epoxides in combination with an acid or mixtures thereof.

Preferred features of the first and second aspects of the present invention will now be described.

The present invention relates to combating internal diesel injector deposits caused by carboxylate residues and/or lacquers. By combating internal diesel injector deposits we mean to include the prevention of deposit formation, the reduction of deposit formation and/or the removal of existing deposits. Thus combatting IDIDs may refer to providing "keep clean" and/or "clean up" performance.

The present invention relates to combatting internal diesel injector deposits or IDIDs in the injectors of a diesel engine. This problem typically occurs in modern diesel engines having a high pressure fuel system. Preferably the diesel engine has a fuel injection system which comprises a high pressure fuel injection (HPFI) system. The fuel pressure may be greater than 1350 bar, for example greater than 1500 bar or greater than 2000 bar. Preferably, the diesel engine has fuel injection system which comprises a common rail injection system or a unit injection system for example a piezoelectric injector. The skilled person will have a good knowledge of such engines. In the common rail injection system fuel is compressed utilizing a high-pressure pump that supplies it to the fuel injection valves through a common rail. In the

unit injection system the high-pressure pump and fuel injection valve are integrated in one assembly. Preferably, the diesel engine has a fuel injection system which comprises a common rail injection system.

By carboxylate residues we mean to refer to salts of carboxylic acids. These may be salts of monocarboxylic acids, dicarboxylic acids or polycarboxylic acids. Mixtures of two or more different compounds may be present. The acids may be short-chain carboxylic acids, for

Claims

1. A method of combating internal diesel injector deposits caused by carboxylate residues and/or lacquers in the injectors of a diesel engine, the method comprising combusting in the engine a diesel fuel composition comprising (a) the reaction product of a carboxylic acid-derived acylating agent and an amine and (b) a quaternary ammonium salt additive; wherein the quaternising agent used to prepare the quaternary ammonium salt addive (b) is selected from the group consisting of dialkyl sulphates; an ester of a carboxylic acid; alkyl halides; benzyl halides; hydrocarbyl substituted carbonates; and hydrocarbyl epoxides in combination with an acid or mixtures thereof.

2. The use of a combination of (a) the reaction product of a carboxylic acid-derived acylating agent and an amine and (b) a quaternary ammonium salt additive to combat internal diesel injector deposits caused by carboxylate residues and/or lacquers in the injectors of a diesel engine; wherein the quaternising agent used to prepare the quaternary ammonium salt addive (b) is selected from the group consisting of dialkyl sulphates; an ester of a carboxylic acid; alkyl halides; benzyl halides; hydrocarbyl substituted carbonates; and hydrocarbyl epoxides in combination with an acid or mixtures thereof.

3. A method or use according to claim 1 or claim 2 wherein the acylated nitrogen-containing additive (a) comprises the reaction product of a polyisobutene-substituted succinic acid or succinic anhydride and a polyethylene polyamine.

4. A method or use according to claim 3 wherein the polyisobutene substituent of the polyisobutene-substituted succinic acid or succinic anhydride has a number average molecular weight of between 250 and 2300.

5. A method or use according to claim 4 wherein the polyisobutene substituent of the polyisobutene-substituted succinic acid or succinic anhydride has a number average molecular weight of between 450 and 1500.

6. A method or use according to any one of claims 3 to 5 wherein at least 90% of the succinimide molecules have a molecular weight of more than 400.

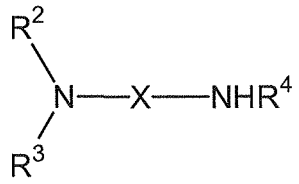
7. A method or use according to any preceding claim wherein the quaternary ammonium salt additive (b) for use herein is the reaction product of a quaternising agent and a nitrogen-containing species having at least one tertiary amine group selected from:

(i) the reaction product of a hydrocarbyl-substituted acylating agent and a compound comprising at least one tertiary amine group and a primary amine, secondary amine or alcohol group;

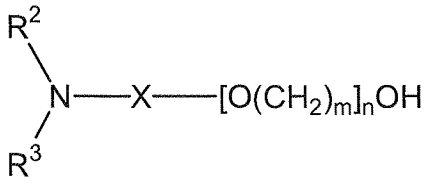
(ii) a Mannich reaction product comprising a tertiary amine group; and

(iii) a polyalkylene substituted amine having at least one tertiary amine group.

8. A method or use according to claim 7 wherein component (i) comprises one or more compounds formed by the reaction of a hydrocarbyl-substituted acylating agent and an amine of formula (I) or (II):



(I)

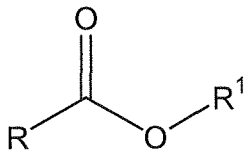


(II)

wherein R^2 and R^3 are the same or different alkyl groups having from 1 to 22 carbon atoms; X is an alkylene group having from 1 to 20 carbon atoms; n is from 0 to 20; m is from 1 to 5; and R^4 is hydrogen or a C_1 to C_{22} alkyl group.

9. A method or use according to claim 8 wherein X is a propylene group.

10. A method or use according to any preceding claim wherein the quaternising agent used to prepare the quaternary ammonium salt addive (b) is a compound of formula (III):



(III)

wherein R is an optionally substituted alkyl, alkenyl, aryl or alkylaryl group and R^1 is a C_1 to C_{22} alkyl, aryl or alkylaryl group.

11. A method or use according to claim 10 wherein the quaternizing agent is selected from dimethyl oxalate, methyl 2-nitrobenzoate and methyl salicylate.

12. A method or use according to any preceding claim wherein the diesel engine has a fuel injection system which comprises a high pressure fuel injection (HPFI) system with fuel pressures greater than 1350 bar.