[0005] Also, low sulfur diesel fuels and ultra low sulfur diesel fuels are now common in the marketplace for such engines. A "low sulfur" diesel fuel means a fuel having a sulfur content of 50 ppm by weight or less based on a total weight of the fuel. An "ultra low sulfur" diesel fuel (ULSD) means a fuel having a sulfur content of 15 ppm by weight or less based on a total weight of the fuel. Low sulfur diesel fuels tend to form more deposits in diesel engines than conventional fuels, for example, because of the need for additional friction modifiers and/or corrosion inhibitors in the low sulfur diesel fuels.

[0006] In accordance with the disclosure, exemplary embodiments provide a diesel fuel composition for an internal combustion engine comprising, a method for improving performance of fuel injectors, and a method for cleaning fuel injectors for an internal combustion engine. The fuel composition includes a major amount of fuel and a minor effective amount of a reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group and (ii) at least on halogen substituted C_2-C_8 carboxylic acid, ester, amide, or salt thereof, wherein the reaction product as made is substantially devoid of free anion species.

[0006a] In one aspect, there is provided a fuel composition for a fuel injected diesel engine comprising: greater than 50 wt. % of fuel, a cetane improver, a first reaction product of a hydrocarbyl substituted dicarboxylic acid, or anhydride and an aminoguanidine, wherein the first reaction product has less than one equivalent of amino triazole group per molecule, and from more than 5 ppm to 200 ppm based on a total weight of the fuel of a second reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group wherein the hydrocarbyl substituted compound is selected from the group consisting of C_{10}-C_{30}-alkyl or alkenyl-substituted amidopropyldimethylamines and C_{12}-C_{200}-alkyl or alkenyl-substituted succiniccarbonyldimethylamines and (ii) a halogen substituted C_2-C_8 carboxylic acid salt, wherein the second reaction product as made is free of non-covalently bonded anion species, and wherein the first and second reaction product amounts are sufficient to improve engine performance, wherein said improved engine performance comprises engine power restoration by at least 80% when measured according to a CEC F98-08 DW10 test.

[0007] Another embodiment of the disclosure provides a method of improving the injector performance of a fuel injected diesel engine. The method includes operating the engine on a fuel composition comprising a major amount of fuel and from about 5 to about 200 ppm by weight based on a total weight of the fuel of a reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group and (ii) at least one halogen substituted C_2-C_8 carboxylic acid, ester, amide, or salt thereof, wherein the reaction product as made is substantially devoid of free anion species. The reaction product present in the fuel is effective to improve the injector performance of the engine by at least about 80 % when measured according to a CEC F98-08 DW10 test.

[0007a] In another aspect, there is provided a method of improving the injector performance of a fuel injected diesel engine comprising operating the engine on a fuel composition comprising greater than 50 wt. % of fuel containing bio-diesel components, a first reaction product of a hydrocarbyl substituted dicarboxylic acid, or anhydride and an aminoguanidine, wherein the first reaction product has less than one equivalent of amino triazole group per molecule, and from more than 5 ppm to 200 ppm by weight based on a total weight of the fuel of a second reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group wherein the hydrocarbyl substituted compound is selected from the group consisting of C_{10}-C_{30}-alkyl or alkenyl-substituted amidopropyldimethylamines and C_{12}-C_{200}-alkyl or alkenyl-substituted succiniccarbonyldimethylamines and (ii) a halogen substituted C_2-C_8 carboxylic acid salt, wherein the second reaction product as made is free of non-covalently bonded anion species, and, wherein the first and second reaction products present in the fuel improve the injector performance of the engine by at least 80 % when measured according to a CEC F98-08 DW10 test.

[0008] A further embodiment of the disclosure provides a method of operating a fuel injected diesel engine. The method includes combusting in the engine a fuel composition comprising a major amount of fuel and from about 5 to about 500 ppm by weight based on a total weight of the fuel of a reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group and (ii) at least one halogen substituted C_2-C_8 carboxylic acid, ester, amide, or salt thereof, wherein the reaction product as made is substantially devoid of free anion species.

[0008a] In another aspect, there is provided a method of operating a fuel injected diesel engine comprising combusting in the engine a fuel composition comprising greater than 50 wt. % of fuel, a cetane improver, a first reaction product of a hydrocarbyl substituted dicarboxylic acid, or anhydride and an aminoguanidine, wherein the first reaction product has less than one equivalent of amino triazole group per molecule, and from more than 5 ppm to 200 ppm by weight based on a total weight of the fuel of a second reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group wherein the hydrocarbyl substituted compound is selected from the group consisting of C_{10}-C_{30}-alkyl or alkenyl-substituted amidopropyldimethylamines and C_{12}-C_{200}-alkyl or alkenyl-substituted succiniccarbonyldimethylamines and (ii) a halogen substituted C_2-C_8 carboxylic acid salt, wherein the second reaction product as made is free of non-covlently bonded anion species.

[0009] Another embodiment of the disclosure provides an additive concentrate for a fuel for use in an injected diesel fuel engine. The additive concentrate includes a reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group and (ii) at least one halogen substituted C_2-C_8 carboxylic acid, ester, amide, or salt thereof, wherein the reaction product as made is substantially devoid of free anion species; and at least one component selected from the group consisting of diluents, compatibilizers, corrosion inhibitors, cold flow improvers (CFPP additive), pour point depressants, solvents, demulsifiers, lubricity additives, friction modifiers, amine stabilizers, combustion improvers, dispersants, antioxidants, heat stabilizers, conductivity improvers, metal deactivators, marker dyes, organic nitrate ignition accelerators, and cyclomatic manganese tricarbonyl compounds.

[00010] An advantage of the fuel additive described herein is that the additive may not only reduce the amount of deposits forming on fuel injectors, but the additive may also be effective to clean up dirty fuel injectors sufficient to provide improved power recovery to the engine.

[00010a] In another aspect, there is provided an additive concentrate for a fuel for use in a injected fuel diesel engine comprising a cetane improver, a first reaction product of a hydrocarbyl substituted dicarboxylic acid, or anhydride and an aminoguanidine, wherein the first reaction product has less than one equivalent of amino triazole group per molecule, and a second reaction product of (i) a hydrocarbyl substituted compound containing at least one tertiary amino group wherein the hydrocarbyl substituted compound is selected from the group consisting of C_{10}-C_{30}-alkyl or alkenyl-substituted amidopropyldimethylamines and C_{12}-C_{200}-alkyl or alkenyl-substituted succiniccarbonyldimethylamines and (ii) a halogen substituted C_2-C_8 carboxylic acid salt, wherein the second reaction product as made is free of non-convalently bonded anion species and wherein an amount of additive concentrate in the fuel provides from more than 5 ppm to 200 ppm of the reaction product based on a total weight of the fuel; and at least one component selected from the group consisting of diluents, carrier fluids, compatibilizers, corrosion inhibitors, cold flow improvers (CFPP additive), pour point depressants, solvents, demulsifiers, lubricity additives, friction modifiers, amine stabilizers, combustion improvers, dispersants, antioxidants, heat stabilizers, conductivity improvers, metal deactivators, marker dyes, organic nitrate ignition accelerators, and cyclomatic manganese tricarbonyl compounds.

[00011] Additional embodiments and advantages of the disclosure will be set forth in part in the detailed description which follows, and/or can be learned by practice of the disclosure. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure, as claimed.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[00012] The fuel additive component of the present application may be used in a minor amount in a major amount of fuel and may be added to the fuel directly or added as a component of an additive concentrate to the fuel. A particularly suitable fuel additive component for improving the operation of internal combustion engines may be made by a wide variety of well known reaction techniques with amines or polyamines. For example, such additive component may be made by reacting a tertiary amine of the formula

