performance. It is an aim of the present invention to provide “keep clean” and/or “clean up” performance.

SUMMARY

In one aspect, there is provided a diesel fuel composition comprising as an additive the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms; wherein the polycarboxylic acid or anhydride thereof is selected from citric acid, itaconic acid, citraconic acid, 2-methylene glutaric acid, 2-methylene adipic acid, isocitric acid, 2-hydroxycitric acid, malic acid, tartaric acid, 2-hydroxyadipic acid, 2-hydroxyglutaric acid, aconitic acid, and anhydrides and/or isomers thereof.

In another aspect, the present disclosure provides a method of improving the performance of an engine, the method comprising combusting in the engine a fuel composition comprising as an additive the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms; wherein the engine is a diesel engine or direct injection spark ignition engine; and wherein the polycarboxylic acid or anhydride thereof is selected from citric acid, itaconic acid, citraconic acid, 2-methylene glutaric acid, 2-methylene adipic acid, isocitric acid, 2-hydroxycitric acid, malic acid, tartaric acid, 2-hydroxyadipic acid, 2-hydroxyglutaric acid, aconitic acid, and anhydrides and/or isomers thereof.

In yet another aspect, there is provided the use of the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms as an additive for a fuel composition to improve the performance of an engine combusting said fuel composition; wherein the engine is a diesel engine or direct injection spark ignition engine; and wherein the polycarboxylic acid or anhydride thereof is selected from citric acid, itaconic acid, citraconic acid, 2-methylene glutaric acid, 2-methylene adipic acid, isocitric acid, 2-hydroxycitric acid, malic acid, tartaric acid, 2-hydroxyadipic acid, 2-hydroxyglutaric acid, aconitic acid, and anhydrides and/or isomers thereof.

DETAILED DESCRIPTION

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. Examples of common detergents include hydrocarbyl-substituted amines; hydrocarbyl substituted succinimides; Mannich reaction products and quaternary ammonium salts. All of these known detergents are nitrogen-containing compounds.

The present invention relates in particular to detergent compounds for diesel or gasoline fuel that do not contain nitrogen. Such compounds are much less commonly used as detergents.

The use of succinic acid compounds as fuel additives is however generally known. For example polyisobutenyl substituted succinic acid compounds (PIBSAs) have long been known as additives for improving the lubricity or corrosion resistance of fuels. Existing fuel additives based on carboxylic acid compounds typically include a long hydrocarbyl chain on the acid portion of the molecule to provide fuel solubility.

The present inventors have surprisingly found a class of additives based on polycarboxylic acids which do not include such a hydrocarbyl chain.

According to a first aspect of the present invention there is provided a fuel composition comprising as an additive the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms.

According to a second aspect of the present invention 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 the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms.

According to a third aspect of the present invention there is provided the use of the reaction product of polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms as an additive for a fuel composition to improve the performance of an engine combusting said fuel composition.

The method of the second aspect preferably involves combusting in the engine a composition of the first aspect.

Claims

1. A diesel fuel composition comprising as an additive the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms;
wherein the polycarboxylic acid or anhydride thereof is selected from citric acid, itaconic acid, citraconic acid, 2-methylene glutaric acid, 2-methylene adipic acid, isocitric acid, 2-hydroxycitric acid, malic acid, tartaric acid, 2-hydroxyadipic acid, 2-hydroxyglutaric acid, aconitic acid, and anhydrides and/or isomers thereof.

2. A method of improving the performance of an engine, the method comprising combusting in the engine a fuel composition comprising as an additive the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms; wherein the engine is a diesel engine or direct injection spark ignition engine; and wherein the polycarboxylic acid or anhydride thereof is selected from citric acid, itaconic acid, citraconic acid, 2-methylene glutaric acid, 2-methylene adipic acid, isocitric acid, 2-hydroxycitric acid, malic acid, tartaric acid, 2-hydroxyadipic acid, 2-hydroxyglutaric acid, aconitic acid, and anhydrides and/or isomers thereof.

3. The use of the reaction product of a polycarboxylic acid having no more than 5 carbon atoms per carboxylic acid group, or an anhydride thereof and an alcohol having at least 5 carbon atoms as an additive for a fuel composition to improve the performance of an engine combusting said fuel composition; wherein the engine is a diesel engine or direct injection spark ignition engine; and wherein the polycarboxylic acid or anhydride thereof is selected from citric acid, itaconic acid, citraconic acid, 2-methylene glutaric acid, 2-methylene adipic acid, isocitric acid, 2-hydroxycitric acid, malic acid, tartaric acid, 2-hydroxyadipic acid, 2-hydroxyglutaric acid, aconitic acid, and anhydrides and/or isomers thereof.

4. A composition, method or use according to any preceding claim wherein the polycarboxylic acid or anhydride thereof is selected from citric acid, itaconic acid or itaconic anhydride.

5. A composition, method or use according to any preceding claim wherein the alcohol is a compound of formula $H\text{-}(OR)_n\text{-}OR^1$, wherein R is an optionally substituted alkylene group; R^1 is an optionally substituted hydrocarbyl group; and n is 0 or a positive integer.

6. A composition, method or use according to claim 5 wherein the alcohol is selected from:
   - alkanols of formula $CH_3(CH_2)_xOH$ wherein x is from 4 to 23, preferably from 9 to 19;

- branched or cyclic alkyl alcohols in which n is 0;
- alkenyl alcohols in which n is 0;
- glycol ethers in which n is not 0.

7. A composition, method or use according to claim 5 or claim 6 wherein the alcohol is selected from an

- an alcohol of formula R^1OH wherein R^1 is a (preferably branched) alkyl group having 8 to 30 carbon atoms;
- an alcohol of formula R^1OH wherein R^1 is an alkenyl group having 8 to 30 carbon atoms; and
- an alcohol of formula $H-(OR)_n-OR^1$ wherein n is from 1 to 24, R is ethylene, propylene or isopropylene, and R^1 is an unsubstituted alkyl group having 8 to 30, preferably 12 to 24, carbon atoms.

8. A composition, method or use according to any preceding claim wherein the alcohol is selected from hexanol, octanol, nonanol, decanol, dodecanol, tetradecanol, cetyl alcohol, stearyl alcohol, 2-ethyl-1-butanol, 2-ethyl-1-hexanol, 2-ethyl-1-heptanol, 2-propylheptanol, 2-ethyl-1-decanol, 2-hexyl-1-decanol, 2-octyl-1-decanol, 2-hexyl-1-dodecanol, 2-octyl-1-dodecanol, 2-decyl-1-tetradecanol, isotridecanol, cyclohexanol, cyclooctanol, benzyl alcohol, citronellol, oleyl alcohol, 9-decen-1-ol, cis-3-hexen-1-ol, trans-2-hexen-1-ol, 5-hexen-1-ol, 6-methyl-5-hepten-2-ol, 1-octen-3-ol, trans-2-octen-1-ol, 10-undecen-1-ol and compounds of formula $CH_3(CH_2)_xO(CH_2CH(CH_3)O)_yH$ or an isomer thereof wherein x is from 10 to 15, and y is from 10 to 20.

9. A composition, method or use according to any preceding claim wherein the polycarboxylic acid or anhydride thereof and the alcohol are reacted in a molar ratio of from 2:1 to 1:2.

10. A composition, method or use according to any preceding claim wherein the additive has an acid value of from 0.6 to 9.7 mmol H^+/g, preferably from 1.3 to 7.1 mmol H^+/g, more preferably from 1.6 to 6.2 mmol H^+/g.

11. A composition, method or use according to any preceding claim wherein the fuel composition is a diesel fuel composition, which optionally comprises one or more further additives 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;

(vii) a substituted polyaromatic detergent additive;

(viii) partial esters of substituted succinic acids.

12. A composition, method or use according to claim 11 wherein the diesel fuel composition further comprises a quaternary ammonium salt additive; preferably wherein the quaternary ammonium salt additive is the reaction product of a nitrogen-containing species having at least one tertiary amine group and a quaternising agent wherein the nitrogen containing species is 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; preferably wherein the quaternising agent is an ester quaternising agent.

13. A composition, method or use according to any preceding claim wherein the fuel composition optionally comprises one or more further additives 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; and

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

14. A method or use according to any of claims 2 to 13 which combats deposits in the engine.

15. A method or use according to any of claims 2 to 14 wherein the engine is a diesel engine, preferably a modern diesel engine having a high pressure fuel system.

16. A method or use according to claim 15 wherein the improvement in performance is 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.

17. A method or use according to any of claims 2 to 16 which combats internal diesel injector deposits.

18. A method or use according to any of claims 2 to 17 which achieves a maximum exhaust temperature deviation of less than 30ºC in the DW10C test.

19. A method or use according to any of claims 2 to 14 wherein the engine is a gasoline engine, preferably a direct injection spark ignition engine.

20. A method or use according to claim 19 wherein the improvement in performance is selected from one or more of:

- improved fuel economy
- reduced maintenance
- less frequent overhaul or replacement of injectors
- improved driveability
- improved power
- improved acceleration

21. A method or use according to any of claims 2 to 20 which achieves “keep clean” performance.

22. A method or use according to any of claims 2 to 21 which achieves “clean up” performance.