molecular weight of 1000 and a dicarboxylic acid. However, the inventors have surprisingly found that certain esters of polycarboxylic acids and polyhydric alcohols are particularly effective as detergents, especially in modern diesel engines having a high pressure fuel system.

SUMMARY

In one aspect, there is provided a method of combatting deposits in a modern diesel engine having a high pressure fuel system, the method comprising combusting in the engine a diesel fuel composition comprising as an additive the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula $H-(OR)_n-OH$, wherein R is an optionally substituted alkylene group and n is at least 1.

In another aspect, there is provided a use of an ester compound as a detergent additive in a diesel fuel composition in a modern diesel engine having a high pressure fuel system; wherein the ester compound is the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula $H-(OR)_n-OH$, wherein R is an optionally substituted alkylene group and n is at least 1.

In yet another aspect, there is provided a diesel fuel composition comprising as an additive an ester compound which is the reaction product of a succinic acid or anhydride having a C_{20} to C_{24} alkyl or alkenyl substituent and a polyhydric alcohol of formula $H-(OR)_n-OH$, wherein R is an optionally substituted alkylene group and n is at least 1

DETAILED DESCRIPTION

According to a first aspect of the present invention there is provided a diesel fuel composition comprising as an additive an ester compound which is the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula $H-(OR)_n-OH$, wherein R is an optionally substituted alkylene group and n is at least 1.

According to a second aspect of the present invention there is provided a method of combatting deposits in a diesel engine, the method comprising combusting in the engine a diesel fuel composition comprising as an additive an ester compound which is the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula $H-(OR)_n-OH$, wherein R is an optionally substituted alkylene group and n is at least 1.

According to a third aspect of the present invention there is provided the use of an ester compound as a detergent additive in a diesel fuel composition in a diesel engine; wherein the ester compound is the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula $H-(OR)_n-OH$, wherein R is an optionally substituted alkylene group and n is at least 1.

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

Preferred features of the first, second and third aspects of the invention will now be described. Any feature of any aspect may be combined with any feature of any other aspect as appropriate.

The present invention relates to a composition, a method and a use involving a fuel additive. This additive is the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula $H-(OR)_n-OH$. The additive may be referred to herein as “the additive of the present invention” or as “the ester additive”.

Compounds of this type are known in the art and are described, for example in US2993773. However, they have not previously been used as detergents in diesel fuels.

Claims

1. A method of combatting deposits in a modern diesel engine having a high pressure fuel system, the method comprising combusting in the engine a diesel fuel composition comprising as an additive the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula H-$(OR)_n$-OH, wherein R is an optionally substituted alkylene group and n is at least 1.

2. Use of an ester compound as a detergent additive in a diesel fuel composition in a modern diesel engine having a high pressure fuel system; wherein the ester compound is the reaction product of an optionally substituted polycarboxylic acid or an anhydride thereof and a polyhydric alcohol of formula H-$(OR)_n$-OH, wherein R is an optionally substituted alkylene group and n is at least 1.

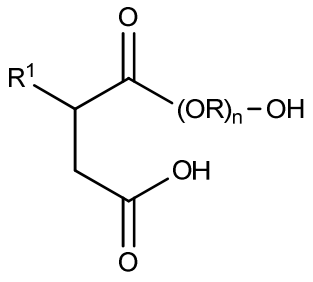
3. A method or use according to claim 1 or 2 wherein the optionally substituted polycarboxylic acid or anhydride thereof is a hydrocarbyl substituted succinic acid or a hydrocarbyl substituted succinic anhydride.

4. A method or use according to any preceding claim wherein each R is ethylene or propylene, preferably -CH_2CH_2- or -$CH(CH_3)CH_2$-, more preferably -$CH(CH_3)CH_2$-; and n is from 1 to 20.

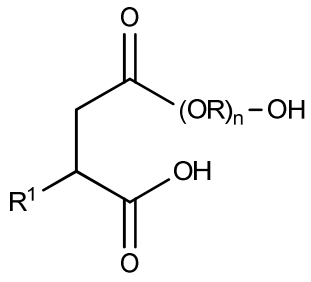
5. A method or use according to any preceding claim wherein the polycarboxylic acid or anhydride thereof includes an optionally substituted alkyl or alkenyl group having 6 to 100 carbon atoms, preferably 6 to 50 carbon atoms.

6. A method or use according to any preceding claim wherein the optionally substituted polycarboxylic acid or hydrocarbyl substituted anhydride and alcohol of formula H-(OR)n-OH are reacted in a molar ratio of from 1.5:1 to 1:1.5.

7. A method or use according to any preceding claim wherein the additive includes compounds having the formula (C1) or (C2):



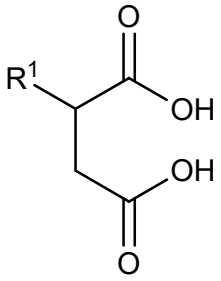
(C1)



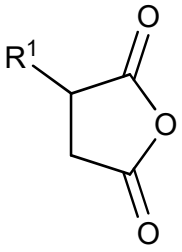
(C2)

wherein R^1 is hydrogen or an optionally substituted hydrocarbyl group.

8. A method or use according to any preceding claim wherein the additive comprises the reaction product of a succinic acid or anhydride of formula (A3) or (A4):



(A3)

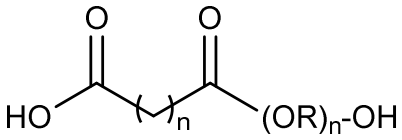


(A4)

and an alcohol of formula H-$(OR)_n$-OH; wherein R^1 is an alkyl or alkenyl group having 6 to 36 carbon atoms or a polyisobutenyl group having a number average molecular weight of from 200 to 1300; wherein the alcohol of formula H-$(OR)_n$-OH is selected from ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol, tetrapropylene glycol, trehalose, sorbitol, glycerol, pentaerythritol, trimethylolpropane, 1,3-propanediol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 1,6-hexanediol, neopentyl glycol and a polyethylene or polypropylene glycol having a number average molecular weight of 300 to 1200.

9. A method or use according to any preceding claim wherein the additive comprises the reaction product of a succinic acid or anhydride having a C_{20} to C_{24} alkyl or alkenyl substituent and an alcohol selected from 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, tripropylene glycol and polypropylene glycols having a number average molecular weight of from 300 to 600.

10. A method or use according to any preceding claim wherein the additive includes compounds having the formula (E):



(E)

11. A diesel fuel composition comprising as an additive an ester compound which is the reaction product of a succinic acid or anhydride having a C_{20} to C_{24} alkyl or alkenyl substituent and a polyhydric alcohol of formula H-$(OR)_n$-OH, wherein R is an optionally substituted alkylene group and n is at least 1.

12. A composition, method or use according to any preceding claim wherein the polyhydric alcohol is selected from ethylene glycol, propylene glycol, 1,3-propanediol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 1,6-hexanediol and neopentyl glycol.

13. A composition, method or use according to any preceding claim wherein the polyhydric alcohol is selected from ethylene glycol, propylene glycol and oligomers and polymers thereof.

14. A method or use according to any of claims 1 to 10, 12 and 13 which achieves “keep clean” performance.

15. A method or use according to any of claims 1 to 10 and 12 to 14 which achieves “clean up” performance.

16. A method according to any of claims 1 to 10 and 12 to 15 wherein the deposits are injector deposits.

17. A method according to claim 16 wherein the deposits are internal diesel injector deposits.

18. A composition, method or use according to any preceding claim wherein the diesel fuel composition comprises less than 50 ppm sulphur by weight.

19. A composition, method or use according to any preceding claim wherein the diesel fuel composition comprises biodiesel.

20. A composition, method or use according to any preceding claim wherein the diesel fuel composition comprises one or more further detergents 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; and

(vii) a substituted polyaromatic detergent additive.

21. A composition, method or use according to any preceding claim wherein the diesel fuel composition comprises a mixture of two or more ester additives.

22. A method or use according to any of claims 1 to 10 and 12 to 21 which achieves an improvement in performance 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.

23. A method or use according to claim 22 which provides an improvement in performance in modern diesel engines having a high pressure fuel system and provides an improvement in performance in traditional diesel engines.

24. Use according to any of claims 2 to 10, 12 to 15 and 18 to 23 which provides one or more further benefits selected from lubricity benefits, corrosion inhibition and cold flow improvement.

25. A composition according to any of claims 11 to 13 and 18 to 21 which further comprises one or more further additives selected from lubricity improvers, corrosion inhibitors and cold flow improvers.