

## FUEL ADDITIVE

### Field of the Invention

- 5 This invention relates to fuel additives and their use in fuel compositions, especially fuel compositions comprising diesel and ethanol.

### Background to the Invention

- 10 Ethanol is added to diesel and other fuels to improve the exhaust emissions arising from combustion. However, some ethanol-diesel mixtures can separate into two or more distinct phases, especially when water is present, and are therefore undesirable for use as a combustible fuel per se. For this reason, surfactant/co-solvent blends are used which improve the miscibility of ethanol and diesel.

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WO 02/088280 discloses a fuel additive comprising an oleic alkanolamide and an alkoxyated oleic acid.

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WO 02/090469 discloses a fuel additive for improving water tolerance, the additive comprising:

- (i) greater than about 60 % w/w of one or more alkyl esters of fatty acids and/or 2-ethylhexanol;
- (ii) from 10 to 40% w/w of one or more fatty alkanolamides; and
- (iii) up to about 10% w/w of one or more fatty acids.

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### Summary of the Invention

- 30 The present invention provides novel fuel additives comprising an alcohol having at least 6 carbon atoms, e.g. 2-ethylhexanol, and a fatty acid alkanolamide, e.g. oleic alkanolamide. Fuel compositions comprising the additives have been found to be stable at lower temperatures and capable of tolerating substantial quantities of water.

In a first aspect, the present invention provides a fuel additive comprising:

- 35 (i) one or more alcohols having at least 6 carbon atoms; and  
(ii) one or more fatty acid alkanolamides;  
wherein the composition is substantially free of fatty acids.

In another aspect, the present invention provides a fuel composition comprising a hydrocarbon fuel and a fuel additive of the invention.

- 5 The fuel additives of the invention may be used to produce a stable, clear and homogeneous solution with a hydrocarbon fuel, e.g. diesel/ethanol, even in the presence of significant quantities of water. Thus, ethanol may be blended satisfactorily with conventional diesel fuel without undergoing phase separation. The present additives are also advantageous in that only small quantities of additive, e.g.  
10 less than 1% by volume, may be needed to achieve a satisfactory blend.

#### Description of Various Embodiments

- A fuel additive of the invention comprises at least one alcohol having at least 6 carbon  
15 atoms and one or more fatty acid alkanolamides, wherein the composition is substantially free of fatty acids. In one embodiment, the fuel additive comprises less than 0.1%, e.g. less than 0.05%, by volume of fatty acids. In a particular embodiment, the fuel additive is free of fatty acids. For the avoidance of doubt, the term "fatty acids" as used herein should not be construed to cover alkoxylated fatty acids, which are an  
20 optional component of an additive of the invention. In a further embodiment, the fuel additive is substantially free of alkyl esters of fatty acids.

- The additive comprises one or more alcohols comprising at least 6 carbon atoms. The or each of said one or more alcohols may comprise a linear or branched alkyl group. In  
25 one embodiment, the one or more alcohols comprise an alcohol having from 6 to 9 carbon atoms. In a particular embodiment, said alcohol comprises 7 or 8 carbon atoms. Preferably, the one or more alcohols comprise 2-ethylhexanol. The additive may comprise 2-ethylhexanol as the sole alcohol.

- 30 The one or more fatty acid alkanolamides may comprise, for example, an oleic alkanolamide. The oleic alkanolamide is preferably an oleic ethanolamide and more preferably oleic diethanolamide. Oleic alkanolamides and processes for their production are described in WO 02/088280 and WO 02/38707, the contents of which are incorporated herein by reference. In a particular embodiment, the additive comprises an  
35 oleic alkanolamide in combination with an alkanolamide of one or both of linoleic acid (e.g. from 5 to 15% v/v) and linolenic (e.g. from 5 to 15% v/v) acid, optionally in

combination with one or more alkanolamides of erucic, stearic, palmitic and myristic acids. Such alkanolamide mixtures may be obtained from vegetable oils, e.g. soy oil, and the like.

5 In one embodiment, the fuel additive comprises:

- (i) from 20 to 80% by weight of the one or more alcohols, e.g. 2-ethylhexanol; and
- (ii) from 20 to 80% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide.

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In another embodiment, the fuel additive comprises:

- (i) from 40 to 60% by weight of the one or more alcohols, e.g. 2-ethylhexanol; and
- (ii) from 40 to 60% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide.

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In a further embodiment, the fuel additive comprises:

- (i) from 45 to 55% by weight of the one or more alcohols, e.g. 2-ethylhexanol; and
- (ii) from 45 to 55% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide.

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In a particular embodiment, the fuel additive comprises:

- (i) about 50% by weight of the one or more alcohols, e.g. 2-ethylhexanol; and
- (ii) about 50% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide.

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The performance of the additives has been found to be especially desirable when the alcohol, e.g. 2-ethylhexanol, and fatty acid alkanolamide, e.g. oleic dialkanolamide, components are used in substantially similar proportions.

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An optional component of the fuel additive is an alkoxylated fatty acid such as an alkoxylated oleic acid.

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Included in the invention is a fuel additive comprising:

- (i) from 20 to 80% by weight of the one or more alcohols, e.g. 2-ethylhexanol;
- (ii) from 10 to 80% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide; and
- 5 (iii) from 0 to 70% by weight of one or more alkoxyated fatty acids, e.g. an alkoxyated oleic acid.

In a particular embodiment, the additive comprises:

- 10 (i) from 40 to 60% by weight of the one or more alcohols, e.g. 2-ethylhexanol;
- (ii) from 10 to 60% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide; and
- (iii) from 0 to 50% by weight of one or more alkoxyated fatty acids, e.g. an alkoxyated oleic acid.

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The one or more alkoxyated fatty acids preferably contain an alkoxyated oleic acid. The alkoxyate may be an ethoxyate or a propyloxyate or a mixture thereof. Of mention are ethoxyated fatty acids, in particular ethoxyated oleic acids. Ethoxyated oleic acids may be produced by ethoxylation or esterification of acids derived from animal fats, e.g. 20 beef tallow, or vegetable oils, such as soya. The alkoxyated oleic acid may be obtained from a precursor comprising, e.g. from 65 to 70% v/v, oleic acid, but may also contain linoleic acid, e.g. from 5 to 15% v/v, linolenic acid from 5 to 15% v/v and may also include small amounts of one or more of erucic, stearic, palmitic and myristic acids.

- 25 The degree of ethoxylation may range, for example, from 0.5 to 20, e.g. from 0.5 to 10, in particular from 1 to 3. In a particular embodiment, the alkoxyated fatty acid comprises monoethoxyated oleic acid.

In one embodiment, the additive comprises:

- 30 (i) from 20 to 80% by weight of the one or more alcohols, e.g. 2-ethylhexanol;
- (ii) from 10 to 40% by weight of the one or more fatty acid alkanolamides, an oleic alkanolamide; and
- (iii) from 10 to 50% by weight of the one or more alkoxyated fatty acids, e.g. 35 an alkoxyated oleic acid.

In another embodiment, the additive comprises:

- (i) from 40 to 60% by weight of the one or more alcohols, e.g. 2-ethylhexanol;
- (ii) from 10 to 40% by weight of the one or more fatty acid alkanolamides, an oleic alkanolamide; and
- (iii) from 10 to 50% by weight of the one or more alkoxylated fatty acids, e.g. an alkoxylated oleic acid.

In a further embodiment, the additive comprises:

- (i) from 45 to 55% by weight of the one or more alcohols, e.g. 2-ethylhexanol;
- (ii) from 20 to 30% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide; and
- (iii) from 20 to 30 % by weight of one or more alkoxylated fatty acids, e.g. an alkoxylated oleic acid.

In a particular embodiment, the additive comprises:

- (i) about 50% by weight of the one or more alcohols, e.g. 2-ethylhexanol;
- (ii) about 25% by weight of the one or more fatty acid alkanolamides, e.g. an oleic alkanolamide; and
- (iii) about 25% by weight of the one or more alkoxylated fatty acids, e.g. an alkoxylated oleic acid.

The performance of the additives has been found to be especially desirable when the ratio of the alcohol, e.g. 2-ethylhexanol, to the fatty acid alkanolamide, e.g. oleic alkanolamide, and alkoxylated fatty acid, e.g. alkoxylated oleic acid, components is approximately 2:1:1 respectively.

The additive may be added to any known hydrocarbon fuel. The concentration of the additive in the fuel composition may vary depending on, for example, the nature of the fuel, however, the concentration can be very low, typically of the order of from 0.05 to 1.5% v/v, e.g. from 0.1 to 1.0% v/v, and in particular from 0.5 to 1.0% v/v.

The hydrocarbon fuel may comprise any known hydrocarbon fuel or mixtures thereof. Such fuels include, without limitation, diesel fuels, e.g. petroleum diesel or biodiesel, gasoline, aviation fuel, kerosene and alcohols such as ethanol. The additive is seen to

particularly good effect when added to fuels based on low fraction oils.

5 In one embodiment, the hydrocarbon fuel comprises a petroleum diesel. Such fuels may generally be obtained from the distillation of petroleum and its efficiency can be measured by the cetane number. Suitable diesel fuels for use in accordance with the invention generally have a cetane number of from 35 to 60, preferably from 40 to 55. The amount of diesel fuel blended to form the fuel composition of the invention may be from 60 % v/v to 95 % v/v, based on the total volume of the fuel consumption.

10 In another embodiment, the hydrocarbon fuel comprises biodiesel.

In a further embodiment, the fuel composition comprises a blend of biodiesel and a petroleum diesel. In one embodiment, the fuel composition comprises up to 50% v/v biodiesel, for example from 1 to 50% v/v, e.g. from 5 to 30% v/v, in particular from 10 to 15 20% v/v biodiesel.

The fuel composition may further comprise an oxygenator. The oxygenator may be an alcohol, such as ethanol. When an oxygenator such as ethanol is present, the amount of ethanol in the fuel may vary and may be from 1 to 50% v/v ethanol, e.g. from 1 to 20% 20 v/v, in particular from 1 to 10% v/v ethanol. A suitable fuel grade ethanol for use in accordance with the invention may contain none or only contaminant levels of water, e.g. less than 0.5% by volume of water. Alternatively, a suitable fuel grade ethanol for use in accordance with the invention may contain higher amounts of water, e.g. up to 1% v/v water.

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In a particular embodiment, the fuel composition comprises from 89 to 98.5% by volume of one or more diesel fuels, from 1 to 10% by volume of an alcohol (e.g. ethanol) and 0.5 to 1% by volume of an additive of the invention.

30 The fuel composition may be substantially free of water, save for trace water contamination. In one embodiment, the fuel composition comprises less than 0.1 % w/w water.

35 The fuel composition may further comprise a cetane booster, e.g. in an amount of from 0.1 to 0.5% v/v. Suitable cetane boosters include 2-ethylhexyl nitrate, tertiary butyl peroxide, diethylene glycol methyl ether, cyclohexanol, and mixtures thereof. The

cetane booster may form part of the fuel additive or may be added separately to the fuel.

The fuel composition may also include a demulsifier, e.g. in an amount of less than 5 % v/v, in particular less than 1 % v/v. The demulsifier may form part of the fuel additive or  
5 may be added separately to the fuel.

The fuel composition may further comprise one or more additives selected from cold flow improvers, detergent additives and lubricity additives.

10 The present additives may advantageously be used to solubilise nitrogen compounds. Thus, the additive or fuel composition may further comprise a nitrogen compound. The nitrogen compound may be selected from the group consisting of ammonia, hydrazine, alkyl hydrazine, dialkyl hydrazine, urea, ethanolamine, monoalkyl ethanolamine, and  
15 dialkyl ethanolamine wherein alkyl is independently selected from methyl, ethyl, n-propyl or isopropyl. Of particular mention is urea. The nitrogen compound may be an anhydrous compound or a hydrous compound, e.g. in the form of an aqueous solution.

The following Example illustrates the invention.

#### 20 Example

An additive comprising a 1:1 weight ratio of 2-ethylhexanol to oleic diethanolamide was added to low sulphur, ASTM D975-compliant diesel in an amount of 0.5% by volume. The fuel composition further comprised 7.7% by volume of fuel grade (ASTM D4806-  
25 compliant) ethanol and 0.12% of a cetane improver. The cloud point of the fuel composition was compared to that of a composition comprising 0.5% by volume oleic diethanolamide over a range of water contents. At certain water contents, the additive of the invention was found to lower the cloud point by at least 5 °C.

CLAIMS

1. A fuel additive comprising:
  - (i) one or more alcohols having at least 6 carbon atoms; and
  - (ii) one or more fatty acid alkanolamides;wherein the composition is substantially free of fatty acids.
2. An additive according to claim 1, further comprising one or more alkoxylated fatty acids.
3. An additive according to claim 1 or claim 2, which comprises:
  - (i) from 40 to 60% by weight of the one or more alcohols;
  - (ii) from 10 to 60% by weight of the one or more fatty acid alkanolamides; and
  - (iii) from 0 to 50% by weight of one or more alkoxylated fatty acids.
4. An additive according to claim 3, which comprises:
  - (i) from 40 to 60% by weight of the one or more alcohols; and
  - (ii) from 40 to 60% by weight of the one or more fatty acid alkanolamides.
5. An additive according to claim 4, which comprises:
  - (i) from 45 to 55% by weight of the one or more alcohols; and
  - (ii) from 45 to 55% by weight of the one or more fatty acid alkanolamides.
6. An additive according to claim 5, which comprises:
  - (i) about 50% by weight of the one or more alcohols; and
  - (ii) about 50% by weight of the one or more fatty acid alkanolamides.
7. An additive according to claim 3, which comprises:
  - (i) from 40 to 60% by weight of the one or more alcohols;
  - (ii) from 10 to 60% by weight of the one or more fatty acid alkanolamides; and
  - (iii) from 10 to 50% by weight of the one or more alkoxylated fatty acids.

8. An additive according to claim 7, which comprises:
- (i) from 45 to 55% by weight of the one or more alcohols;
  - (ii) from 20 to 30% by weight of the one or more fatty acid alkanolamides; and
  - 5 (iii) from 20 to 30 % by weight of the one or more alkoxylated fatty acids.
9. An additive according to claim 8, which comprises:
- (i) about 50% by weight of the one or more alcohols;
  - (ii) about 25% by weight of the one or more fatty acid alkanolamides; and
  - 10 (iii) about 25% by weight of the one or more alkoxylated fatty acids.
10. An additive according to any preceding claim, wherein the one or more alcohols comprise one or more alcohols having from 6 to 9 carbon atoms.
- 15 11. An additive according to any preceding claim, wherein the one or more alcohols comprise 2-ethylhexanol.
12. An additive according to any preceding claim, wherein the one or more fatty acid alkanolamides comprise an oleic alkanolamide, e.g. an oleic ethanolamide.
- 20 13. An additive according to claim 12, wherein the one or more fatty acid alkanolamides comprise oleic diethanolamide.
14. An additive according to any of claims 2 to 13, wherein the one or more
- 25 alkoxylated fatty acids comprise an alkoxylated oleic acid, e.g. an ethoxylated oleic acid.
15. An additive according claim 14, wherein the alkoxylated oleic acid is monoethoxylated oleic acid.
- 30 16. A fuel composition comprising a hydrocarbon fuel and a fuel additive of any preceding claim.
17. A composition according to claim 16, wherein the fuel comprises gasoline.
- 35 18. A composition according to claim 16, wherein the hydrocarbon fuel comprises a diesel fuel.

19. A composition according to claim 18, wherein the fuel comprises a petroleum diesel, a biodiesel or a mixture thereof.
- 5 20. A composition according to any of claims 16 to 19, further comprising ethanol.
21. A composition according to any of claims 16 to 19, wherein the additive is present in an amount of from 0.1 to 1% by volume.