US 20120311922A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2012/0311922 A1

Tinetti et al.

(43) Pub. Date: Dec. 13, 2012

(54) CORROSION AND MICROBIAL CONTROL IN HYDROCARBONACEOUS COMPOSITIONS

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(21) Appl. No.: **13/569,448**

(22) Filed: **Aug. 8, 2012**

Related U.S. Application Data

(63) Continuation of application No. 12/744,615, filed on May 25, 2010, filed as application No. PCT/US08/85485 on Dec. 4, 2008.

(60) Provisional application No. 61/015,231, filed on Dec. 20, 2007.

Publication Classification

(51) **Int. Cl.**

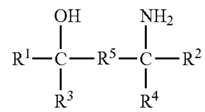
C10L 1/24	(2006.01)
C10G 75/02	(2006.01)
C10L 1/14	(2006.01)
C10L 1/30	(2006.01)
C10L 1/233	(2006.01)

(52) **U.S. Cl.** **44/307**; 44/314; 44/334; 44/341; 585/4

(57) **ABSTRACT**

Provided are additives of formula I for use in hydrocarbonaceous compositions, such as petroleum or liquid fuels:

(I)



wherein R^1, R^2, R^3, R^4, and R^5 are as defined herein. The additives improve the corrosion resistance of the compositions and, when the composition is biodiesel, also improve microbial resistance. The additives further enhance the antimicrobial efficacy of any added biocides contained in such compositions.

Figure 1: Synergistic Effect of 3-amino-4-ocatanol with FUELSAVER (135 ppm)

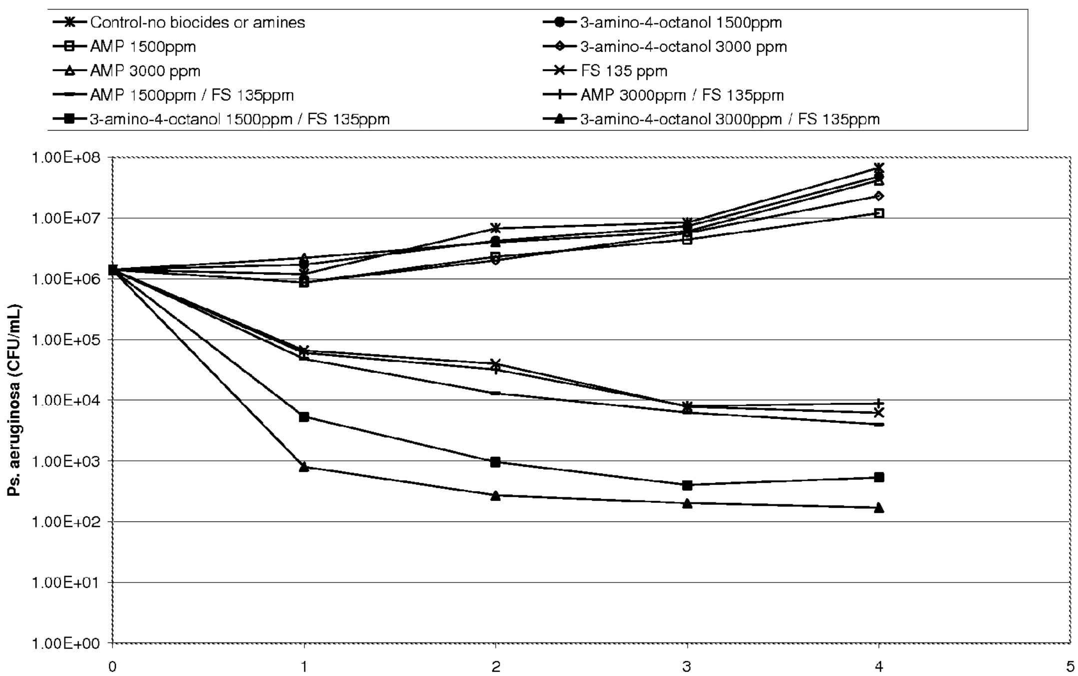


Figure 2: Synergistic Effect of 3-Amino-4-Octanol with 50 ppm Kathon FP

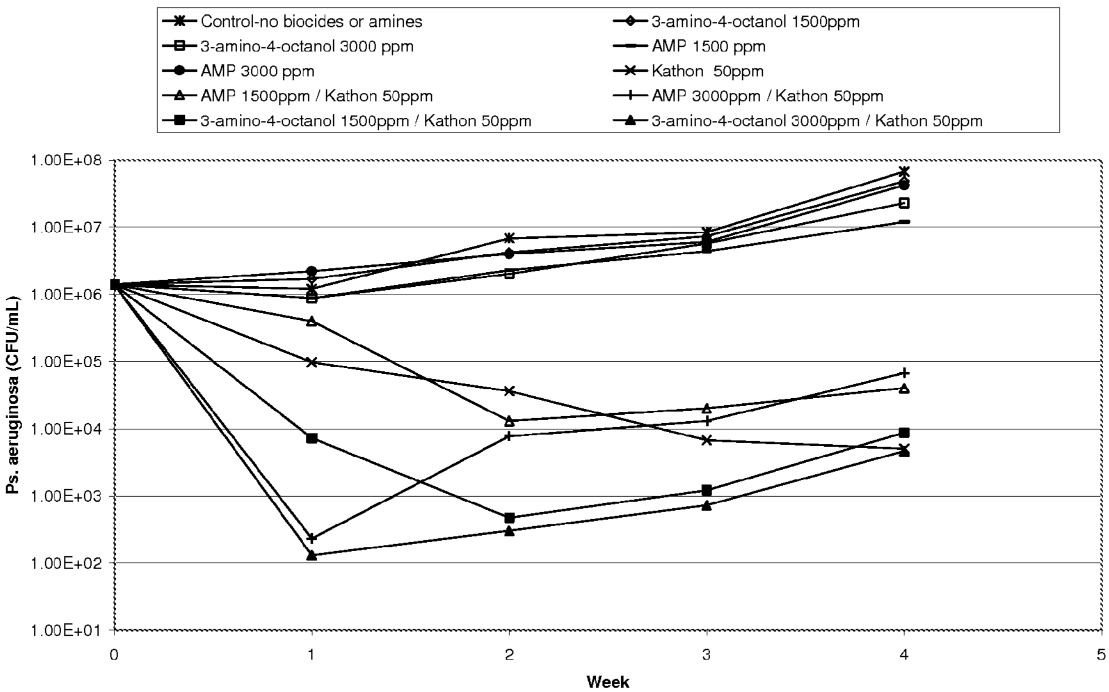
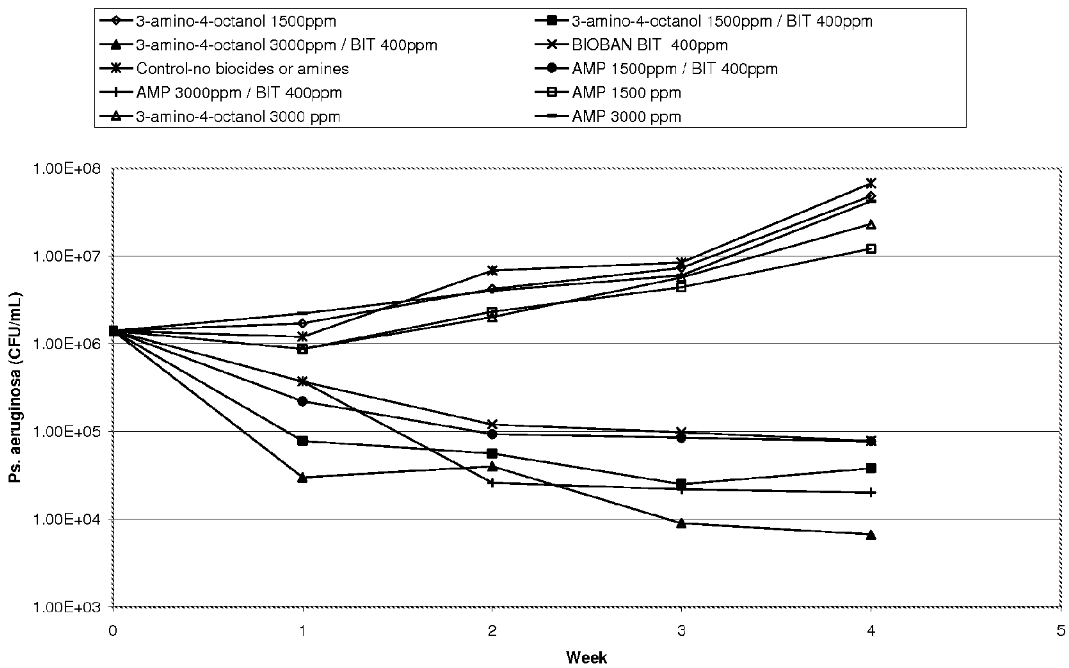


Figure 3: Effect of 3-Amino-4-Octanol with 400 ppm BIOBAN BIT 20 DPG



CORROSION AND MICROBIAL CONTROL IN HYDROCARBONACEOUS COMPOSITIONS

FIELD OF THE INVENTION

[0001] The invention relates to additives for hydrocarbonaceous compositions. More specifically, the invention relates to aminoalcohol additives that improve the corrosion properties and microbial resistance of hydrocarbonaceous compositions, such as petroleum and fuels. The aminoalcohol additives also enhance the efficacy of biocidal agents typically used in such compositions.

BACKGROUND OF THE INVENTION

[0002] Hydrocarbonaceous compositions, such as petroleum (crude oil) and fuels, almost always contain moisture. Additional water can accumulate in tanks as atmospheric moisture condenses. Moisture accumulates in diesel tanks, for example, as condensate droplets on exposed tank surfaces, as dissolved water in the fuel and as water bottoms beneath the fuel. Similarly for petroleum, water can condense and accumulate in pipelines. Alcohol/fuel mixtures, such as "gasohol," tend to absorb and retain higher concentrations of water than does alcohol-free petroleum-based fuel. In addition, more recently, water has begun to be deliberately incorporated into fuel for environmental benefits. It has been found that internal combustion engines, especially diesel engines, that employ water-fuel emulsions can produce lower nitrogen oxides, hydrocarbons and particulate emissions. Reducing emissions from vehicles has been driven by governmental and environmental concerns and so it is expected that the use of aqueous hydrocarbon fuel emulsions will increase.

[0003] The presence of water in hydrocarbonaceous compositions, either through deliberate introduction (e.g. emulsified fuel), or through condensation (e.g. in storage or transportation vessels), can, however, lead to problems. Because microbes depend on water for survival, water in the hydrocarbonaceous compositions can cause microbial contamination. Microbes depend on the organic molecules in these compositions for nutrition and growth. Consequently, some species attack the compositions directly, growing at the expense of hydrocarbon and non-hydrocarbon components.

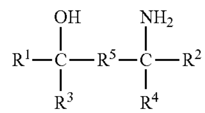
[0004] The biodegradation of fuel, in support of microbial growth, is a direct cause of fuel contamination. Color, heat of combustion, pour point, cloud point, thermal stability, detergent and anti-corrosive properties adversely change as microbes selectively attack fuel components. In addition to loss of additive and fuel performance, as bacteria and fungi reproduce, they form biomass, which accumulates at the fuel: water interface, on tank surfaces and on filters. In the case of crude oil, microbiologically influenced corrosion can occur in pipelines as a result of the activity and growth of sulfate reducing bacteria (SRB).

[0005] Corrosion issues can also be influenced by the presence of water and acids in hydrocarbonaceous compositions. Biodiesel fuel, in particular, contains free fatty acids and petroleum-derived fuels typically contain residual naphthenic acids and sulfur which can react with water vapor during combustion to form sulfuric acid. While removal of sulfur and acids from fuel is possible, this introduces additional process costs for the fuel manufacturer. In addition, lubricants that are based on phosphoric and carboxylic acids are deliberately added to some fuels (e.g. fuel emulsions) to improve performance. In crude oil, in addition to microbiologically influenced corrosion, the presence of dissolved carbon dioxide (carbonic acid) and/or hydrogen sulfide can also lead to corrosion issues.

[0006] In view of the foregoing, a need exists in the art for additives that assist in limiting corrosion and/or microbial growth in hydrocarbonaceous compositions.

BRIEF SUMMARY OF THE INVENTION

[0007] The invention provides a blend comprising: a hydrocarbonaceous composition; and an aminoalcohol of formula (I)



(I)

wherein R^1, R^2, R^3, R^4, and R^5 are as defined below.

[0008] The invention also provides a blend comprising a hydrocarbonaceous composition, an aminoalcohol of formula I, and a biocide.

[0009] The invention further provides a method of providing microbial resistance to a biodiesel fuel, the method comprising including in the biodiesel fuel an effective amount of an aminoalcohol of formula I.

BRIEF DESCRIPTION OF THE FIGURES

[0010] FIG. **1** is a chart depicting the synergistic effect of 3-amino-4-octanol with the biocide FUELSAVER™ in a diesel fuel.

[0011] FIG. **2** is a chart depicting the synergistic effect of 3-amino-4-octanol with the biocide Kathon™ FP in a diesel fuel.

[0012] FIG. **3** is a chart depicting the effect of 3-amino-4-octanol with the biocide BIOBAN™ BIT 20 DPG in a diesel fuel.

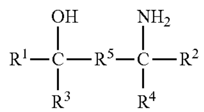
DETAILED DESCRIPTION OF THE INVENTION

[0013] In one aspect, the invention provides aminoalcohol additives for hydrocarbonaceous compositions. By "hydrocarbonaceous composition" is meant petroleum (crude oil), or liquid fuels such as gasoline, diesel, biodiesel, water-fuel emulsions, ethanol-based fuels, and ether-based fuels. Preferred fuels include those that contain a high level of acid content, such as biodiesels.

[0014] The additives inhibit the corrosion of systems in contact with the hydrocarbonaceous compositions, such as storage tanks, pipelines, and engines. The improved corrosion resistance is believed to result, in part, from the ability of the aminoalcohols to control the pH of the compositions.

[0015] In addition to improved corrosion stability, it has also been surprisingly discovered that the aminoalcohols of formula I, when used in a biodiesel fuel, increases the microbial resistance of the biodiesel. This is so even when the biodiesel fuel does not contain added biocide compounds.

[0016] The additives of the invention are aminoalcohol compounds of the formula I:


(I)

wherein:

[0017] R^1 and R^3 are each independently H, linear or branched alkyl, alkenyl, alkynyl, cycloalkyl, or aryl (preferably phenyl), or R^1, R^3 and the carbon to which they are attached form a cycloalkyl ring,

[0018] R^2 and R^4 are each independently H or alkyl, provided that R^2 and R^4 together contain 2 or fewer carbon atoms; and

[0019] R^5 is absent or is a C_1-C_{10} alkylene (bridging alkyl), arylene (preferably phenyl), arylene-alkylene-, or -alkylene-arylene- (e.g., benzyl, phenethyl, and the like);

[0020] wherein the aminoalcohol of formula (I) contains at least 5 carbon atoms, and wherein the alkyl, cycloalkyl, alkylene, aryl, and arylene groups of R^1, R^3, and R^5 are optionally substituted with alkyl or phenyl.

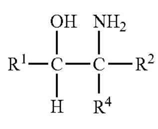
[0021] Preferred aminoalcohols of formula I include compounds of formula I-1, which are compounds of formula I in which R^1 is C_1-C_6 alkyl, more preferably straight chain or branched propyl, butyl, pentyl, or hexyl, and particularly preferably n-butyl.

[0022] Preferred aminoalcohols of formula I and I-1 include compounds of formula I-2, which are compounds of formula I or I-1 in which R^2 is H, methyl, or ethyl.

[0023] Preferred aminoalcohols of formulae I, I-1, and I-2 also include compounds of formula I-3, which are compounds of formula I, I-1, or I-2 in which R^3 is hydrogen and R^4 is hydrogen.

[0024] Preferred aminoalcohols of formulae I, I-1, I-2 and I-3 further include compounds of formula I-4, which are compounds of formula I, I-1, I-2 or I-3 in which R^5 is a bond or is a methylene or ethylene bridge.

[0025] Further preferred aminoalcohols of formula I include compounds of formula II:


(II)

wherein

[0026] R^1 is C_2-C_6 alkyl; and

[0027] R^2 and R^4 are each independently H or C_1-C_2 alkyl, wherein R^2 and R^4 together contain 2 or fewer carbon atoms.

[0028] Particularly preferred primary aminoalcohols for use in the invention include: 2-amino-3-hexanol, 2-amino-2-methyl-3-hexanol, 3-amino-4-octanol, 2-amino-2-methyl-3-heptanol, 2-amino-4-ethyl-3-octanol, 2-amino-3-heptanol, 2-amino-1-phenylbutanol, and mixtures thereof. Especially preferred is 3-amino-4-octanol.

[0029] The aminoalcohol compounds of the invention may be readily prepared by a person of ordinary skill in the art using techniques well known in the art. For example, such compounds may be prepared by the reaction of nitroalkanes with an aldehyde to form a nitroalcohol, followed by catalytic hydrogenation of the nitro group to the amine. More detailed descriptions of exemplary aminoalcohol syntheses are provided in the Examples.

[0030] The aminoalcohols may be used in the form of acid salts. Suitable salts include, but are not limited to, boric acid, lactic acid, pelargonic acid, nonanoic acid, neodecanoic acid, sebacic acid, azelaic acid, citric acid, benzoic acid, undecylenic acid, lauric acid, myristic acid, stearic acid, oleic acid, tall oil fatty acid, ethylenediaminetetraacetic acid and like materials.

[0031] The aminoalcohol is generally used in the hydrocarbonaceous composition at a concentration sufficient to provide corrosion stability and/or to increases microbial resistance (in the latter case, when used with biodiesel). The amount required to provide these beneficial effects can be readily determined by a person of ordinary skill in the art. By way of example, it is generally preferred that between about 0.001 and about 5 weight percent, more preferably between about 0.001 and about 2 weight percent, based on the total weight of the composition, be used.

[0032] The aminoalcohol can also be used in combination with other primary, secondary, and tertiary aminoalcohols, as well as with other corrosion inhibitors. The hydrocarbonaceous composition can contain other optional additives. For instance, where the composition is a fuel, typical additives include, without limitation, lubricants, cetane enhancers, combustion promoters, antioxidants/thermal stabilizers, and/or detergents/deposit control additives.

[0033] In addition to improved corrosion stability and microbial resistance as described above, it has also been found that primary aminoalcohols of formula I synergistically enhance the activity of biocides in hydrocarbonaceous compositions. The combination of the aminoalcohol and the biocide therefore provides more effective and longer-lasting microbial control at reduced biocide concentrations than would be expected if the biocide was used alone.

[0034] Thus, according to a second aspect, the invention provides a blend comprising a hydrocarbonaceous composition, an aminoalcohol of formula I, and a biocide. This aspect of the invention is particularly applicable to compositions that contain water which, as discussed above, is a characteristic of most petroleum and fuels, whether the water is added deliberately (e.g., fuel emulsions) or not. Such compositions typically contain at least 0.01% by weight of water and no more than about 50%.

[0035] Preferred hydrocarbonaceous compositions for this second aspect of the invention include petroleum and liquid fuels. Preferred liquid fuels include gasoline, diesel, biodiesel, water-fuel emulsions, ethanol-based fuels, and ether-based fuels. More preferred liquid fuels include gasoline, diesel, water-fuel emulsions, ethanol-based fuels, and ether-based fuels. A particularly preferred liquid fuel for this aspect is diesel fuel. As demonstrated by the examples, the aminoalcohols of formula I are themselves non-biocidal in diesel fuel, thus the discovery that they are able to synergistically enhance the efficacy of biocide compounds in diesel is surprising.

[0036] Any biocide that is compatible with hydrocarbonaceous compositions may be utilized in the blends of the invention. Preferred biocides include: triazines such as 1,3,5-tris-(2-hydroxyethyl)-s-triazine and trimethyl-1,3,5-triazine-1,3,5-triethanol, an example being GROTAN by Troy Corporation, iodopropynylbutylcarbamate, such as POLYPHASE supplied by Troy Corporation, 1,2-benzisothiazolin-3-one, such as BIOBAN BIT marketed by The Dow Chemical Company, 4,4-dimethyloxazolidine, an example being BIOBAN CS-1135 from The Dow Chemical Company, 7-ethyl bicyclooxazolidine, marketed as BIOBAN CS-1246 by The Dow Chemical Co., a combination of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine, marketed as FUELSAVER by The Dow Chemical Co., 2-methyl-4-isothiazolin-3-one, a combination of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one, such as the KATHON brand supplied by Rohm & Haas Corporation, 2-bromo-2-nitro-1,3-propanediol, octylisothiazolinone, dichloro-octylisothiazolinone, dibromo-octylisothiazolinone, phenolics such as o-phenylphenol and p-chloro-m-cresol and their corresponding sodium and/or potassium salts, sodium pyrithione, zinc pyrithione, n-butyl benzisothiazolinone, 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride, chlorothalonil, carbendazim, diiodomethyltolylsulfone, 2,2-dibromo-3-nitrilopropionamide (DBNPA), glutaraldehyde, N,N'-Methylene-bis-morpholine, ethylenedioxy methanol (e.g. Troyshield B7), phenoxyethanol, (e.g. Comtram 121), tetramethylol acetylenediurea (e.g. Protectol TD), dithiocarbamates, 2,6-Dimethyl-m-dioxan-4-ol acetate (e.g Bioban DXN), dimethylol-dimethyl-hydantoin, tris(hydroxymethyl)nitromethane, bicyclic oxazolidines (e.g. Nuospet 95), (thiocyanomethylthio)-benzothiazole (TCMTB), methylene bis(thiocyanate (MBT), substituted dioxaborinanes such as BIOBOR JF from Hammonds Fuel Additives, tetrakis (hydroxymethyl)phosphonium sulfate (THPS) such as AQUCAR THPS 75 from The Dow Chemical Company, quaternary ammonium compounds such as alkyl dimethyl benzyl ammonium chloride (ADBAC), cocodiamine, dazomet such as Protectol DZ from BASF, and mixtures of two or more thereof.

[0037] Further preferred biocides, particularly where the hydrocarbonaceous composition is a liquid fuel, are a combination of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine (available as FUELSAVER™ from The Dow Chemical Company), a combination of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one (CMIT/MIT), a combination of (thiocyanomethylthio)-benzothiazole (TCMTB) and methylene bis(thiocyanate) (MBT), substituted dioxaborinanes, and mixture of two or more thereof.

[0038] Further preferred biocides, particularly where the hydrocarbonaceous composition is petroleum, include glutaraldehyde, 2-bromo-2-nitro-1,3-propanediol, isothiazolinones such as BIT and CMIT/MIT, 2,2-dibromo-3-nitrilopropionamide (DBNPA), tetrakis(hydroxymethyl)phosphonium sulfate (THPS), oxazolidines such as 4,4-dimethyloxazolidine and 7-ethyl bicyclooxazolidine, quaternary ammonium compounds such as alkyl dimethyl benzyl ammonium chloride (ADBAC), cocodiamine, dazomet, and mixtures of two or more thereof.

[0039] In the invention, the biocide (or combination of biocides) is preferably present in the blend at a concentration of between about 0.001 and 2 weight percent based on the total weight of the blend. However, in order to reduce cost and minimize potential for adverse environmental impact, it is preferred that low concentrations of biocides be used. Indeed, it is one of the advantages of the invention that by enhancing the efficacy of the biocide, the aminoalcohols described herein permit less biocide to be used than could be achieved without the aminoalcohol.

[0040] The concentration of aminoalcohol of formula I relative to biocide in the blend is not critical, but in some preferred embodiments corresponds to a weight ratio of aminoalcohol to biocide between about 5000:1 and about 1:2. In further preferred embodiments, the weight ratio of aminoalcohol to biocide is between about 100:1 and 1:2. In still further preferred embodiments, the weight ratio is between about 60:1 and 1:1.

[0041] A preferred fuel based blend according to the invention comprises:

[0042] (a) a liquid fuel;

[0043] (b) an aminoalcohol of formula (I) as defined above: and

[0044] (c) a biocide selected from the group consisting of:

[0045] (i) a mixture of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine (FUELSAVER™ from The Dow Chemical Company);

[0046] (ii) a mixture of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one;

[0047] (iii) a mixture of (thiocyanomethylthio)-benzothiazole (TCMTB) and methylene bis(thiocyanate) (MBT); and

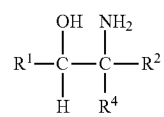
[0048] (iv) substituted dioxaborinanes.

[0049] In this embodiment, the weight ratio of aminoalcohol to biocide (i) is preferably between about 30:1 and 1:1, more preferably between about 25:1 and 1.5:1. Further, the weight ratio of aminoalcohol to biocide (ii) is preferably between about 70:1 and 3:1.

[0050] A more preferred fuel based blend according to the invention comprises:

[0051] (a) a liquid fuel;

[0052] (b) an aminoalcohol of formula II:



(II)

[0053] wherein

[0054] R^1 is C_2-C_6 alkyl; and

[0055] R^2 and R^4 are each independently H or C_1-C_2 alkyl provided that R^2 and R^4 together contain 2 or fewer carbon atoms; and

[0056] (c) a biocide selected from the group consisting of:

[0057] (i) a mixture of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine;

[0058] (ii) a mixture of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one;

[0059] (iii) a mixture of (thiocyanomethylthio)-benzothiazole and methylene bis(thiocyanate); and

[0060] (iv) substituted dioxaborinanes.

[0061] In this embodiment, the weight ratio of aminoalcohol to biocide (i) is preferably between about 30:1 and 1:1, more preferably between about 25:1 and 1.5:1. Further, the weight ratio of aminoalcohol to biocide (ii) is preferably between about 70:1 and 3:1.

[0062] A particularly preferred fuel based blend according to the invention comprises:

[0063] (a) a liquid fuel;

[0064] (b) 3-amino-4-octanol; and

[0065] (c) a biocide selected from the group consisting of:

[0066] (i) a mixture of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine;

[0067] (ii) a mixture of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one;

[0068] (iii) a mixture of (thiocyanomethylthio)-benzothiazole and methylene bis(thiocyanate); and

[0069] (iv) substituted dioxaborinanes.

[0070] In this embodiment, the weight ratio of aminoalcohol to biocide (i) is preferably between about 30:1 and 1:1, more preferably between about 25:1 and 1.5:1. Further, the weight ratio of aminoalcohol to biocide (ii) is preferably between about 70:1 and 3:1.

[0071] A preferred petroleum based blend according to the invention comprises:

[0072] (a) petroleum;

[0073] (b) an aminoalcohol of formula (I) as defined above: and

[0074] (c) a biocide selected from the group consisting of: glutaraldehyde, 2-bromo-2-nitro-1,3-propanediol, tetrakis(hydroxymethyl)phosphonium sulphate (THPS), 2,2-dibromo-3-nitrilopropionamide (DBNPA), an isothiazolinone compound, a quaternary ammonium compound, cocodiamine; and, dazomet.

[0075] A more preferred petroleum blend according to the invention comprises:

[0076] (a) petroleum;

[0077] (b) an aminoalcohol of formula II as defined above; and

[0078] (c) a biocide selected from the group consisting of: glutaraldehyde, 2-bromo-2-nitro-1,3-propanediol, tetrakis(hydroxymethyl)phosphonium sulphate (THPS), 2,2-dibromo-3-nitrilopropionamide (DBNPA), an isothiazolinone compound, quaternary ammonium compounds, cocodiamine, and dazomet.

[0079] A particularly preferred petroleum blend according to the invention comprises:

[0080] (a) petroleum

[0081] (b) 3-amino-4-octanol; and

[0082] (c) a biocide selected from the group consisting of: glutaraldehyde, 2-bromo-2-nitro-1,3-propanediol, tetrakis(hydroxymethyl)phosphonium sulphate (THPS), 2,2-dibromo-3-nitrilopropionamide (DBNPA), an isothiazolinone compound, quaternary ammonium compounds, cocodiamine, and dazomet.

[0083] "Alkyl," as used in this specification, encompasses straight and branched chain aliphatic groups having from 1-8 carbon atoms, more preferably 1-6 carbon atoms. Preferred alkyl groups include, without limitation, methyl, ethyl, propyl, isopropyl, butyl, isobutyl, sec-butyl, tert-butyl, pentyl, and hexyl.

[0084] The term "alkenyl" as used herein means an unsaturated straight or branched chain aliphatic group with one or more carbon-carbon double bonds, having from 2-8 carbon atoms, and preferably 2-6 carbon atoms. Preferred alkenyl groups include, without limitation, ethenyl, propenyl, butenyl, pentenyl, and hexenyl.

[0085] The term "alkynyl" as used herein means an unsaturated straight or branched chain aliphatic group with one or more carbon-carbon triple bonds, having from 2-8 carbon atoms, and preferably 2-6 carbon atoms. Preferred alkynyl groups include, without limitation, ethynyl, propynyl, butynyl, pentynyl, and hexynyl.

[0086] An "alkylene" group is an alkyl as defined hereinabove, that is positioned between and serves to connect two other chemical groups. Preferred alkylene groups include, without limitation, methylene, ethylene, propylene, and butylene.

[0087] The term "cycloalkyl" as employed herein includes saturated and partially unsaturated cyclic hydrocarbon groups having 3 to 12 carbons, preferably 3 to 8 carbons, and more preferably 3 to 7 carbons. Preferred cycloalkyl groups include, without limitation, cyclopropyl, cyclobutyl, cyclopentyl, cyclopentenyl, cyclohexyl, cyclohexenyl, cycloheptyl, and cyclooctyl.

[0088] An "aryl" group is a C6-C12 aromatic moiety comprising one to three aromatic rings. Preferably, the aryl group is a C6-C10 aryl group. Preferred aryl groups include, without limitation, phenyl, naphthyl, anthracenyl, and fluorenyl. More preferred is phenyl.

[0089] Alkyl, cycloalkyl, and aryl (and their bridging derivatives alkylene, cycloalkylene, and arylene) are optionally substituted with one or more other alkyl (e.g., methyl, ethyl, butyl), phenyl, or both. When substituted, the number of carbons in the substituent are counted towards the 6-12 carbons of the compound.

[0090] The following examples are illustrative of the invention but are not intended to limit its scope.

EXAMPLES

Example 1

Preparation of 3-amino-4-octanol

[0091] Preparation of the 3-nitro-4-octanol from 1-nitropropane and valeraldehyde. A sample of 3-nitro-4-octanol is synthesized by the addition of 1-nitropropane (1-NP, 300 g, 3.37 mols) into a 1 liter 3-necked round-bottomed flask (RBF, 24/40, 29/42, 24/40) equipped with a thermocouple, a magnetic stirrer, a 500 ml addition funnel, a nitrogen inlet, and a glass stopper. This light yellow liquid is diluted by the addition of methanol (MeOH, 150 g) that results in an endotherm. The caustic catalyst is added (16 g of a 10% aqueous solution and 0.60 g of a 50% aqueous caustic solution, 1.9 g total, 1.4 mole %). This changes the reaction color to orange and results in a slight exotherm. The valeraldehyde (258 g, 3.00 mols, 0.89 equivalents) is charged to the addition funnel and slowly added to the 1-NP over 3 h. The heat of reaction raises the temperature to 40-45° C. Once the valeraldehyde addition is complete, the contents of the RBF are transferred into a 1 liter glass bottle, purged with nitrogen, and stored at ambient temperature. The reaction progress is monitored by gas chromatography. After 2 weeks the conversion reaches 84 area % and the reaction is stopped by the addition of a 10% aqueous hydrochloric acid solution (19 ml). The resulting pH=1 solution is concentrated in vacuo (50° C./full vacuum/0.5 h) to remove solvent and residual reagents. The resulting olive green solution (491 g, 95 area % corrected purity, 89% yield) is filtered (0.5 micron), purged with nitrogen, and stored in the refrigerator until needed.

[0092] Catalytic hydrogenation of the 3-nitro-4-octanol to the 3-amino-4-octanol alkanolamine. A sample of 3-amino-4-octanol (3A4O) is synthesized by the reduction of the 3-nitro-4-octanol by a Parr Autoclave unit. The stainless steel, 2 liter autoclave is loaded with Grace 3201 Raney Nickel (RaNi, 90 g wet, 45 g dry, 10 wt %) and methanol (MeOH, 300 g). The autoclave is sealed, assembled, purged with nitrogen then hydrogen, pressurized with hydrogen (600 psig), stirred at 600 RPM, and warmed to 40° C. The nitro-alcohol (491 g) is diluted with absolute ethanol (EtOH, 150 g) and pumped into the autoclave (4 ml/min). After 3.5 h the addition is complete and after 4 h the reaction is judged complete as no hydrogen uptake is observed. The autoclave is cooled, stirring stopped, vented, and purged with nitrogen. The autoclave is disassembled and the contents are vacuum filtered to remove the RaNi catalyst. This results in the isolation of a light yellow liquid (92 area %) that is concentrated in vacuo (55° C./full vacuum) before product is taken overhead (57-62° C./full vacuum). This results in the isolation of a clear, colorless, semi-solid (344 g, 95.3 area %, 75% overall yield) that contains some oxazolidine (2.2 area %) and some secondary amines (0.5 area %).

Example 2

Preparation 2-amino-3-heptanol

[0093] Preparation of the 2-nitro-3-heptanol from nitroethane (NE) and valeraldehyde. In a similar fashion as Example 1, a sample of 2-nitro-3-heptanol is synthesized by the addition of nitroethane (NE, 275 g, 3.67 mols) into a 1 liter 3-necked round-bottomed flask (RBF, 24/40, 29/42, 24/40) equipped with a thermocouple, a magnetic stirrer, a 500 ml addition funnel, a nitrogen inlet, and a glass stopper. The clear, colorless liquid is diluted by the addition of 95% ethanol (EtOH, 160 g) that results in an endotherm. The caustic catalyst is added (10 g of a 10% aqueous solution, 0.68 mole %) changing the reaction color to yellow and resulting in a slight exotherm. The valeraldehyde (258 g, 3.00 mols, 0.89 equivalents) is charged to the addition funnel and slowly added to the NE over 4 h. The heat of reaction raises the temperature to 40-45° C. Once the valeraldehyde addition is complete, the contents of the RBF are transferred into a 1 liter glass bottle, purged with nitrogen, and stored at ambient temperature at night and 50° C. during the day. The reaction progress is monitored by gas chromatography. After 6 days the conversion reaches 81 area % and the reaction is stopped by the addition of a 10% aqueous hydrochloric acid solution (9 ml). The resulting pH=1 solution is concentrated in vacuo (50° C./full vacuum/0.5 h) to remove solvent and residual reagents. The resulting green solution (494 g, 90 area % corrected purity, 83% yield) is filtered (0.5 micron), purged with nitrogen, and stored in the refrigerator until needed.

[0094] Catalytic hydrogenation of the 2-nitro-3-heptanol to the 2-amino-3-heptanol alkanolamine. A sample of 2-amino-3-heptanol (2A3H) is synthesized by the reduction of the 2-nitro-3-heptanol by a Parr Autoclave unit. The stainless steel, 2 liter autoclave is loaded with Grace 3201 Raney Nickel (RaNi, 90 g wet, 45 g dry, 9 wt %) and methanol (MeOH, 300 g). The autoclave is sealed, assembled, purged with nitrogen then hydrogen, pressurized with hydrogen (600 psig), stirred at 600 RPM, and warmed to 40° C. The nitro-alcohol (491 g) is diluted with absolute ethanol (EtOH, 150 g) and pumped into the autoclave (4 ml/min). After 3 h the addition is complete and after 3.5 h the reaction is judged complete as no hydrogen uptake is observed. The autoclave is cooled, stirring stopped, vented, and purged with nitrogen. The autoclave is disassembled and the contents are vacuumed filtered to remove the RaNi catalyst. This results in the isolation of a yellow liquid (82 area %) that is concentrated in vacuo (55° C./full vacuum) before product is taken overhead (40-50° C./full vacuum). This results in the isolation of a clear, colorless, solid (302 g, 91.2 area %, 64% overall yield) that contains some oxazolidine (3.4 area %).

Example 3

Preparation of 2-amino-2-methyl-3-heptanol

[0095] Preparation of the 2-methyl-2-nitro-3-heptanol from 2-nitropropane (2-NP) and valeraldehyde. In a similar fashion as example 1, a sample of 2-methyl-2-nitro-3-heptanol is synthesized by the addition of 2-nitropropane (2-NP, 300 g, 3.37 mols) into a 1 liter 3-necked round-bottomed flask (RBF, 24/40, 29/42, 24/40) equipped with a thermocouple, a magnetic stirrer, a 500 ml addition funnel, a nitrogen inlet, and a glass stopper. The clear, colorless liquid is diluted by the addition of absolute ethanol (EtOH, 150 g) that results in an endotherm. The caustic catalyst is added (16 g of a 10% aqueous solution and 0.6 g of a 50% aqueous solution, 1.4 mole %) changing the reaction color to light yellow and resulting in a slight exotherm. The valeraldehyde (258 g, 3.00 mols, 0.89 equivalents) is charged to the addition funnel and slowly added to the 2-NP over 3 h. The heat of reaction raises the temperature to 40-45° C. Once the valeraldehyde addition is complete, the contents of the RBF are transferred into a 1 liter glass bottle, purged with nitrogen, and stored at ambient temperature. The reaction progress is monitored by gas chromatography and reaches 72% completion after 3 weeks and the reaction is stopped by the addition of a 10% aqueous hydrochloric acid solution (16 ml). The resulting royal blue, pH=1 solution is concentrated in vacuo (50° C./full vacuum/0.5 h) to remove solvent and residual reagents. The resulting green solution (422 g, 90 area % corrected purity, 80% yield) is diluted with absolute ethanol (150 g), filtered (0.5 micron), purged with nitrogen, and stored in the refrigerator until needed.

[0096] Catalytic hydrogenation of the 2-methyl-2-nitro-3-heptanol to the 2-amino-2-methyl-3-heptanol. A sample of 2-amino-2-methyl-3-heptanol (2A2M3H) is synthesized by the reduction of the 2-methyl-2-nitro-3-heptanol by a Parr Autoclave unit. The stainless steel, 2 liter autoclave is loaded with Grace 3201 Raney Nickel (RaNi, 90 g wet, 45 g dry, 10 wt %) and methanol (MeOH, 300 g). The autoclave is sealed, assembled, purged with nitrogen then hydrogen, pressurized with hydrogen, stirred at 600 RPM, and warmed to 40° C. The yellow nitro-alcohol (422 g) is diluted with absolute ethanol (EtOH, 150 g) and is pumped into the autoclave (4 ml/min). After 3 h the addition is complete and after 3.5 h the reaction is judged complete as no hydrogen uptake is observed. The autoclave is cooled, stirring stopped, vented, and purged with nitrogen. The autoclave is disassembled and the contents are vacuum filtered to remove the RaNi catalyst. This results in the isolation of a light yellow liquid (80 area %) that is concentrated in vacuo (55° C./full vacuum) before product is taken overhead (50-52° C./full vacuum). This results in the isolation of a clear, colorless, solid (268 g, 91.9 area %, 57% overall yield) that contains some oxazolidine (4.9 area %).

Example 4

Preparation of 2-amino-4-ethyl-3-octanol

[0097] Preparation of the 2-nitro-4-ethyl-3-octanol from nitroethane and 2-ethylhexanal. In a similar fashion as example 1, a sample of 2-nitro-4-ethyl-3-octanol is synthesized by the addition of nitroethane (NE, 200 g, 2.67 mols) into a 1 liter 3-necked round-bottomed flask (RBF, 24/40, 29/42, 24/40) equipped with a thermocouple, a magnetic stirrer, a 500 ml addition funnel, a nitrogen inlet, and a glass stopper. This is diluted by the addition of absolute ethanol (EtOH, 150 g) that results in an endotherm. Deionized water (7.5 g) followed by the caustic catalyst (8.0 ml of a 10% aqueous solution) are added. The reaction color darkens to orange and a slight exotherm is observed. The 2-ethylhexanal (307 g, 2.40 mols, 0.90 equivalents) is charged to the addition funnel and slowly added to the NE over 3.5 h. The heat of reaction raises the temperature to 30'C. Once the valeraldehyde addition is complete, the contents of the RBF are transferred into a 1 liter glass bottle, purged with nitrogen, and stored at ambient temperature. The reaction progress is monitored by gas chromatography. After 2 days the measured conversion is 53.2 area % and 55.8 area % after 2 weeks. The reaction is then stopped by the addition of a 10% aqueous hydrochloric acid solution (8 ml) and the pH=1 solution is concentrated in vacuo (55° C./full vacuum/0.5 h) to remove solvent and residual reagents. The resulting yellow solution (362 g, 72 area % purity, 74.3% yield) is filtered (0.5 micron), purged with nitrogen, and stored in the refrigerator until needed.

[0098] Catalytic hydrogenation of the 2-nitro-4-ethyl-3-octanol to the 2-amino-4-ethyl-3-octanol amino alcohol. A sample of 2-amino-4-ethyl-3-octanol is synthesized by the reduction of the 2-nitro-4-ethyl-3-octanol by a Parr Autoclave unit. The stainless steel, 2 liter autoclave is loaded with Grace 3201 Raney Nickel (RaNi, 70 g wet, 35 g dry, 10 wt %) and methanol (MeOH, 300 g). The autoclave is sealed, assembled, purged with nitrogen then hydrogen, pressurized with hydrogen (750 psig), stirred at 600 RPM, and warmed to 40° C. The nitro-alcohol (362 g) is diluted with methanol MeOH, 380 ml) and pumped into the autoclave (5 ml/min). After 2 h the addition is complete and after another 15 min the reaction is judged complete as no hydrogen uptake is observed. The autoclave is cooled, stirring stopped, vented, and purged with nitrogen. The autoclave is disassembled and the contents are vacuum filtered to remove the RaNi catalyst. This results in the isolation of a light yellow liquid (84 area % pure) that is concentrated in vacuo (55° C./full vacuum) before product is taken overhead (122° C./15 mm) using a vacuum jacketed 18" vigreux column/head assembly. This results in the isolation of product as a clear, colorless, solution (182 g, 96.9 area %, 44% overall yield).

Examples 5-16

Corrosion Testing

[0099] Examples 5-16 illustrate the effect of the aminoalcohols of the invention on the corrosion of metals in contact with fuels.

[0100] Mild carbon steel (MCS), low carbon fine grain steel (LCFGS) and cast iron (CI) coupons from Metaspec Co are used. Each coupon measures 1"×2"×⅛". All coupons are cleaned with acetone prior to total immersion in diesel or biodiesel fuel. Each coupon is weighed before testing and again after testing and cleaning. Fuels and water are placed into 4 oz wide-mouth flint glass jars and one coupon is totally submerged in the fuel in each jar. The test system consists of 80% fuel and 20% deionized water (weight basis). For test samples, the aminoalcohol is added at 0.427% on the total weight of fuel plus water (56 grams of fuel+14 grams of DI water+0.30 grams aminoalcohol). Samples are heated at 50° C. in a mechanical convection oven. The coupons are checked visually each week, and the fuel color is noted. Jars are agitated to disperse the water and rotated to view coupons in the fuel; the weekly agitation simulates agitation due to periodic fuel addition and withdrawal from storage tanks. The jars remain closed during the testing. After the testing, the coupons are re-weighed and visually assessed for corrosion. Results for 3-amino-4-octanol are represented in Table 1.

[0101] As can be seen, 3-amino-4-octanol reduces mass loss for all metals tested in contact with the diesel fuel/water mixtures. In addition, visual corrosion is eliminated with mild carbon steel and low carbon fine grain steel. For biodiesel fuel, a reduction in weight loss is not observed with the presence of 3-amino-4-octanol, however, a visual reduction in corrosion is observed with the low carbon fine grain steel sample.

TABLE 1

Corrosion testing results for 3-amino-4-octanol (3A4O)

Ex. No.	Metal	Fuel	Biocide	Wt Before (g)	Wt After (g)	Wt Loss (g)	Corrosion (visual)
5	MCS	Diesel	3A4O	8.2259	8.2259	0.0000	No
6	MCS	Diesel	None (control)	8.2481	8.2194	−0.0287	Yes
7	MCS	Biodiesel	3A4O	8.2623	8.2510	−0.0113	No
8	MCS	Biodiesel	None (control)	8.3333	8.3320	−0.0013	No
9	LCFGS	Diesel	3A4O	28.9036	28.9012	−0.0024	No
10	LCFGS	Diesel	None (control)	31.1581	31.1291	−0.0290	Yes
11	LCFGS	Biodiesel	3A4O	27.6149	27.5889	−0.0260	No
12	LCFGS	Biodiesel	None (control)	26.4376	26.4346	−0.0030	Yes
13	CI	Diesel	3A4O	26.7304	26.7296	−0.0008	Yes
14	CI	Diesel	None (control)	29.2987	29.2736	−0.0251	Yes
15	CI	Biodiesel	3A4O	27.1794	27.1394	−0.0400	Yes
16	CI	Biodiesel	None (control)	30.4496	30.4392	−0.0104	Yes

MCS = Mild Carbon Steel;
LCFGS = Low Carbon Fine Grain Steel;
CI = cast iron.
3A4O = 3-amino-4-octanol.

Microbial Resistance Examples

[0102] The following examples illustrate the effect of the aminoalcohols on the microbial resistance of fuels with and without biocides.

Materials

[0103] Bacteria.

[0104] *Pseudomonas aeruginosa* ATCC#33988, Yeast: *Yarrowia tropicalis* ATCC#48138, and Mold: *Hormoconis resinae* ATCC#20495, are sub cultured in Bushnell-Haas broth, and used for the mixed inoculum. The organism concentrations in the mixed inoculum are as follows: *Ps. aeruginosa*—4.8×10^8 cfu/mL; *Y. tropicalis*—2.2×10^7 cfu/mL; *H. resinae*—6.3×10^7 cfu/mL

[0105] Diesel Fuel.

[0106] 2007 Certification Diesel, GMPT-5-019-A, is obtained from Haltermann Products (a subsidiary of The Dow Chemical Company), Channelview, Tex. Product Number: HF 582b; Product Code: 20582b.

[0107] Biodiesel Fuel.

[0108] Biodiesel for these examples is obtained from Stepan Company (Northfield, Ill.)

[0109] Biocides.

[0110] The biocides chosen for this evaluation include biocides already registered and frequently used in fuels because of their solubility and effectiveness (e.g. Kathon FP 1.5 and FUELSAVER™). BIOBAN BIT 20 DPG is also tested. Compositional and supplier information are provided below.

[0111] Kathon™ FP 1.5 (Rohm and Haas): 1.15% 5-chloro-2-methyl-4-isothiazolin-3-one and 0.35% 2-methyl-4-isothiazolin-3-one (CMIT/MIT).

[0112] FUELSAVER™ (Dow): 90% Morpholine dimorpholine blend. 4-(2-nitrobutyl)morpholine and 4,4'-(2-ethyl-2-nitrotrimethylene)-dimorpholine (FS).

[0113] BIOBAN™ BIT 20 DPG (Dow): 18% 1,2 benzisothiazolin-3-one.

[0114] Biocide Loadings.

[0115] For the registered biocides, the lower and upper label limits are used—Kathon™ FP: 50 and 400 ppm; FUELSAVER™: 135 and 1000 ppm. BIOBAN™ BIT 20 DPG is currently not registered for use in fuel, therefore, the label limits for "oil in water emulsions" are applied: 400 and 1800 ppm.

[0116] Aminoalcohols.

[0117] 3-Amino-4-ocatanol (3A4O) 97+% (from ANGUS Chemical Co., Buffalo Grove, Ill.).

[0118] 2-Amino-2-methyl-1-propanol (a 95% aqueous solution, obtained as AMP-95 from ANGUS Chemical Company). This aminoalcohol is used for comparison to the aminoalcohols of the invention.

[0119] Aminoalcohol Loadings.

[0120] Both aminoalcohols are evaluated with and without biocides at loadings of 1500 and 3000 ppm.

[0121] Microbial Testing Procedures

[0122] Testing is carried out in glass bottles with bakelite screw tops for four weeks. For each fuel sample, the aminoalcohol and then the biocide when present are added at the desired loadings to 130 mL of either diesel or biodiesel fuel with agitation for 5 min. Bushnell-Haas broth (24 mL) is added as the aqueous phase below the diesel fuel. One mL of the mixed inoculum is added. The samples are mixed weekly by turning the bottle upside down 5 times. The organism count listed for day 0 represents the initial organism populations detected in the water bottom after mixing the water bottom and the fuel.

[0123] Microbial survival is measured using the plate count method. Tryptic soy agar is used for *Pseudomonas aeruginosa*, and Sabouraud dextrose agar with 0.5 ug/ml gentamycin for *Yarrowia tropicalis*, and bacteriological grade agar 1.5%, with 0.01% potassium tellurite for *Hormoconis resinae*. Bacteria are incubated at 37° C. for 48 hours, and fungi at 25° C. for 5-7 days.

[0124] The data collected from the evaluation of the aminoalcohols in diesel fuel is represented by FIGS. **1-3** and Tables 2-4. As can be seen from the data, in diesel fuel, none of the aminoalcohols are able to increase the microbial resistance of the fuel by themselves. Synergy, however, is observed between 3-amino-4-octanol (3A4O) and the three biocides evaluated. The synergy is most apparent at low loadings of biocide, because at the high loadings, the biocides themselves are essentially completely effective over the time period tested. 3-Amino-4-octanol is particularly synergistic with FUELSAVER™ (FIG. **1**). Synergy with Kathon™ (CMIT/MIT) is more evident early on in the testing and then appears to taper off with time (FIG. **2**). Synergy of 3-amino-4-octanol with BIT is not significant against *Ps. Aeruginosa* (FIG. **3**), but is evident with *Y. tropicalis* (Table 4).

[0125] The data collected from the evaluation of the aminoalcohols of the invention in biodiesel fuel is represented by Table 6. As can be seen from the data, the presence of aminoalcohol in biodiesel significantly enhances the microbial resistance of biodiesel, even in the absence of biocide.

TABLE 2

Diesel fuel alone and diesel fuel with aminoalcohol

Bacteria/Time	Fuel only	Fuel + 3A4O 1500 ppm	Fuel + 3A4O 3000 ppm	Fuel + AMP[1] 1500 ppm	Fuel + AMP[1] 3000 ppm
Ps. aeruginosa					
Day 0	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6
Wk 1	1.2E6	1.7E6	8.7E5	8.7E5	2.2E6
Wk 2	6.8E6	4.2E6	2.0E6	2.3E6	4.0E6
Wk 3	8.4E6	7.3E6	5.7E6	4.4E6	6.0E6
Wk 4	6.7E7	4.8E7	2.3E7	1.2E7	4.2E7
Y. tropicalis					
Day 0	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5
Wk 1	5.8E5	1.1E5	2.0E5	1.3E5	9.0E4
Wk 2	2.7E6	8.0E5	6.3E5	7.2E5	2.3E5
Wk 3	6.0E6	2.2E6	3.0E6	1.3E6	5.2E5
Wk 4	2.0E7	8.3E6	1.2E7	7.0E6	4.3E6
H. resinae					
Day 0	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5
Wk 1	3.4E5	2.7E5	3.5E5	3.0E5	1.2E5
Wk 2	8.0E5	3.8E5	6.7E5	6.4E5	4.5E5
Wk 3	7.2E5	7.7E5	8.2E5	7.4E5	5.8E5
Wk 4	4.8E6	4.4E6	6.0E6	1.8E6	3.3E6

[1]Comparative example.

TABLE 3

Diesel fuel plus (a) biocide (FUELSAVER ™) only; and (b) biocide and aminoalcohol.

	Biocide[1]	Biocide (135 ppm) + 3A4O		Biocide (135 ppm) + AMP[1]		Biocide[1]	Biocide (1000 ppm) + 3A4O		Biocide (1000 ppm) + AMP[1]	
Bacteria/Time	135 ppm	1500 ppm	3000 ppm	1500 ppm	3000 ppm	1000 ppm	1500 ppm	3000 ppm	1500 ppm	3000 ppm
Ps. Aeruginosa										
Day 0	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6
Wk 1	6.6E4	5.3E3	8.0E2	4.8E4	6.0E4	7.0E1	<10	<10	<10	<10
Wk 2	4.0E4	9.6E2	2.7E2	1.3E4	3.2E4	2.7E2	<10	<10	<10	<10
Wk 3	7.8E3	4.0E2	2.0E2	6.3E3	8.0E3	<10	<10	<10	<10	<10
Wk 4	6.2E3	5.3E2	1.7E2	4.0E3	8.8E3	<10	<10	<10	<10	<10
Y. tropicalis										
Day 0	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5
Wk 1	8.6E4	5.0E3	4.2E2	4.0E4	2.7E4	3.2E3	2.4E2	<10	1.5E3	3.4E3
Wk 2	2.8E4	4.7E2	9.0E1	2.0E4	6.6E3	<10	8.0E1	<10	<10	<10
Wk 3	5.0E3	2.2E2	<10	4.8E3	6.0E3	<10	<10	<10	<10	<10
Wk 4	4.6E3	1.7E2	<10	6.7E3	2.8E3	<10	<10	<10	<10	<10
H. resinae										
Day 0	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5
Wk 1	6.8E4	8.3E3	5.6E3	3.9E4	1.8E4	7.0E3	1.3E3	2.0E2	3.0E3	4.6E3
Wk 2	3.5E4	6.7E2	1.6E2	9.0E3	5.8E3	3.0E2	2.2E2	4.0E1	8.0E2	4.0E2
Wk 3	1.6E4	4.3E2	6.0E1	7.7E3	4.0E3	5.0E1	<10	<10	<10	<10
Wk 4	9.0E3	4.0E2	1.4E2	7.0E3	7.4E3	9.0E1	<10	<10	<10	<10

[1]Comparative Example

TABLE 4

Diesel fuel plus (a) biocide (KATHON ™ FP) only; and (b) biocide and aminoalcohol.

	Biocide[1]	Biocide (50 ppm) + 3A4O		Biocide (50 ppm) + AMP[1]		Biocide[1]	Biocide (400 ppm) + 3A4O		Biocide (400 ppm) + AMP[1]	
Bacteria/Time	50 ppm	1500 ppm	3000 ppm	1500 ppm	3000 ppm	400 ppm	1500 ppm	3000 ppm	1500 ppm	3000 ppm
Ps. Aeruginosa										
Day 0	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6
Wk 1	9.7E4	7.2E3	1.3E2	4.0E5	2.3E2	1.1E2	<10	<10	3.0E2	<10
Wk 2	3.6E4	4.7E2	3.0E2	1.3E4	7.7E3	<10	<10	<10	9.0E1	<10
Wk 3	6.7E3	1.2E3	7.2E2	2.0E4	1.3E4	<10	<10	<10	<10	<10
Wk 4	5.0E3	8.6E3	4/6E3	4.0E4	6.7E4	<10	<10	<10	<10	<10
Y. tropicalis										
Day 0	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5
Wk 1	2.4E4	3.1E3	2.0E2	4.7E4	3.8E4	<10	<10	<10	<10	<10
Wk 2	9.0E3	1.2E2	6.0E1	3.0E4	1.8E4	8.0E1	<10	<10	<10	<10
Wk 3	1.2E4	8.0E2	<10	5.6E4	3.6E4	<10	<10	<10	<10	<10
Wk 4	3.6E4	4.5E3	<10	8.0E4	6.2E4	<10	<10	<10	<10	<10
H. resinae										
Day 0	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5
Wk 1	3.8E4	1.7E4	1.8E3	2.0E4	3.6E4	1.4E2	3.8E2	6.0E1	2.6E2	1.0E3
Wk 2	1.7E4	4.8E2	7.8E2	7.8E3	4.0E3	5.0E1	7.0E1	1.4E2	1.4E2	3.8E2
Wk 3	8.0E3	6.6E2	2.4E3	8.6E3	6.2E3	<10	<10	8.0E1	3.2E2	4.2E2
Wk 4	6.6E3	2.2E3	7.2E3	2.5E4	5.0E4	<10	<10	<10	4.3E3	8.7E3

[1]Comparative Example

TABLE 5

Diesel fuel plus (a) biocide (BIOBAN ™ BIT 20 DPG) only; and (b) biocide and aminoalcohol.

	Biocide[1]	Biocide (400 ppm) + 3A4O		Biocide (400 ppm) + AMP[1]		Biocide[1]	Biocide (1800 ppm) + 3A4O		Biocide (1800 ppm) + AMP[1]	
Bacteria/Time	400 ppm	1500 ppm	3000 ppm	1500 ppm	3000 ppm	1800 ppm	1500 ppm	3000 ppm	1500 ppm	3000 ppm
Ps. aeruginosa										
Day 0	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6	1.4E6
Wk 1	3.7E5	7.8E4	3.0E4	2.2E5	3.7E5	4.4E4	1.7E4	8.8E3	5.7E4	3.7E4
Wk 2	1.2E5	5.6E4	4.0E4	9.3E4	2.6E4	9.2E3	4.4E3	1.9E3	2.0E4	1.4E4
Wk 3	9.8E4	2.5E4	9.0E3	8.5E4	2.2E4	7.0E3	1.8E3	3.6E3	1.2E4	8.0E3
Wk 4	7.8E4	3.8E4	6.7E3	7.7E4	2.0E4	5.8E3	2.3E3	2.8E3	8.6E3	5.4E3
Y. tropicalis										
Day 0	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5	3.3E5
Wk 1	7.4E4	9.0E3	5.4E3	5.6E4	4.8E4	2.0E4	6.3E3	9.2E3	1.0E4	9.2E3
Wk 2	1.0E4	1.4E3	2.8E3	5.2E4	3.0E4	7.3E3	8.0E2	2.4E2	5.8E3	5.3E3
Wk 3	3.0E4	6.7E2	4.5E2	4.4E4	2.6E4	6.8E3	<10	<10	3.3E3	2.8E3
Wk 4	2.5E4	5.8E2	7.0E2	6.0E4	4.6E4	4.0E3	<10	<10	5.7E3	1.3E3
H. resinae										
Day 0	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5	4.2E5
Wk 1	1.0E5	8.8E4	3.8E4	8.6E4	6.2E4	8.2E4	2.0E4	2.2E3	3.3E4	2.8E4
Wk 2	6.7E4	7.5E3	4.1E3	3.3E4	2.5E4	1.1E4	1.4E3	2.8E3	2.8E4	9.4E3
Wk 3	7.3E4	2.0E3	1.3E3	3.7E4	1.1E4	1.4E4	7.4E2	5.6E2	3.0E4	7.6E3
Wk 4	7.0E4	3.7E3	6.7E3	7.8E4	3.0E4	2.6E4	8.0E2	4.8E2	1.8E4	5.8E3

[1]Comparative Example

TABLE 6

Biodiesel fuel with a) aminoalcohol (3-amino-4-octanol), b) biocide (FUELSAVER ™), and c) aminoalcohol and biocide

3A40 (ppm)	Biocide (ppm)	Week 1 *Ps. Aeruginosa*	Week 1 *Y. tropicalis*	Week 1 *H. resinae*	Week 2 *Ps. Aeruginosa*	Week 2 *Y. tropicalis*	Week 2 *H. resinae*
0	0	3.80E+06	4.40E+05	5.80E+05	1.20E+07	2.70E+06	2.20E+06
0	250	1.80E+05	8.30E+04	1.10E+05	9.40E+04	4.80E+05	3.20E+05
0	500	8.80E+04	6.00E+04	8.40E+04	3.80E+04	1.00E+05	6.70E+04
0	1000	4.80E+04	2.30E+04	5.50E+04	8.60E+03	6.20E+04	1.20E+04
1500	0	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
3000	0	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
1500	250	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
1500	500	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
3000	250	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
3000	500	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2

3A40 (ppm)	Biocide (ppm)	Week 3 *Ps. Aeruginosa*	Week 3 *Y. tropicalis*	Week 3 *H. resinae*	Week 4 *Ps. Aeruginosa*	Week 4 *Y. tropicalis*	Week 4 *H. resinae*
0	0	8.80E+06	1.80E+07	5.20E+06	9.20E+06	7.30E+06	8.50E+05
0	250	5.40E+04	3.80E+05	3.30E+05	9.40E+04	6.40E+04	4.20E+05
0	500	8.20E+03	7.70E+04	7.00E+04	1.60E+04	2.70E+04	6.00E+04
0	1000	6.70E+02	3.40E+04	6.80E+03	8.80E+03	5.70E+03	7.20E+03
1500	0	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
3000	0	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
1500	250	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
1500	500	<1.0E2	<1.0E2	<1.0E2	3.20E+03	<1.0E2	<1.0E2
3000	250	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2
3000	500	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2	<1.0E2

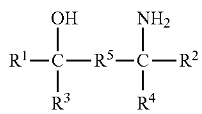
[0126] While the invention has been described above according to its preferred embodiments, it can be modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using the general principles disclosed herein. Further, the application is intended to cover such departures from the present disclosure as come within the known or customary practice in the art to which this invention pertains and which fall within the limits of the following claims.

1. A blend comprising:

a hydrocarbonaceous composition;

an aminoalcohol of formula (I)

(I)



wherein:

R^1 and R^3 are each independently H, linear or branched alkyl, alkenyl, alkynyl, cycloalkyl, or aryl, or R^1, R^3 and the carbon to which they are attached form a cycloalkyl ring,

R^2 and R^4 are each independently H or alkyl, provided that R^2 and R^4 together contain 2 or fewer carbon atoms; and

R^5 is absent or is a C_1-C_{10} alkylene, arylene, arylene-alkylene-, or -alkylene-arylene-,

wherein the aminoalcohol contains at least 5 carbon atoms, and wherein alkyl, cycloalkyl, alkylene, aryl, and arylene are optionally substituted with alkyl or phenyl; and

a biocidally effective amount of a biocide.

2. A blend according to claim **1** wherein R^1 is C_1-C_6 alkyl.

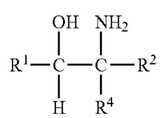
3. A blend according to claim **1** wherein R^2 is H, methyl, or ethyl.

4. A blend according to claim **1** wherein R^3 is hydrogen and R^4 is hydrogen.

5. A blend according to claim **1** wherein R^5 is absent or is a methylene or ethylene bridge.

6. A blend according to claim **1** wherein the aminoalcohol is a compound of formula II:

(II)



wherein

R^1 is C_2-C_6 alkyl; and

R^2 and R^4 are each independently H or C_1-C_2 alkyl provided that R^2 and R^4 together contain 2 or fewer carbon atoms

7. A blend according to claim **1** wherein the aminoalcohol is 2-amino-3-hexanol, 2-amino-2-methyl-3-hexanol, 3-amino-4-octanol, 2-amino-2-methyl-3-heptanol, 2-amino-4-ethyl-3-octanol, 2-amino-3-heptanol, 2-amino-1-phenylbutanol, or mixtures of two or more thereof.

8. A blend according to claim **1** wherein the aminoalcohol is 3-amino-4-octanol.

9. (canceled)

10. A blend according to claim **1** wherein the biocide is a triazine, an iodopropynylbutylcarbamate, 1,2-benzisothiazolin-3-one, 4,4-dimethyloxazolidine, 7-ethyl bicyclooxazolidine, a combination of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine, 2-methyl-4-isothiazolin-3-one, a combination of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one, 2-bromo-2-nitro-1,3-propanediol, octylisothiazolinone, dichloro-octylisothiazolinone, dibromo-octylisothiazolinone, a phenolic or corresponding sodium or potassium salt thereof, sodium pyrithione, zinc pyrithione, n-butyl benzisothiazolinone, 1-(3-chloroallyl)-3,5,7-triaza-1-azoniaadamantane chloride, chlorothalonil, carbendazim, diiodomethyltolylsulfone, 2,2-dibromo-3-nitrilopropionamide, glutaraldehyde, N,N'-Methylene-bis-morpholine, ethylenedioxy methanol, phenoxyethanol, tetramethylol acetylenediurea, dithiocarbamates, 2,6-Dimethyl-m-dioxan-4-ol acetate, dimethylol-dimethyl-hydantoin, tris(hydroxymethyl)nitromethane, a bicyclic oxazolidine, (thiocyanomethylthio)-benzothiazole, methylene bis(thiocyanate), a substituted dioxaborinane, tetrakis (hydroxymethyl)phosphonium sulfate, a quaternary ammonium compound, cocodiamine, dazomet, or mixtures thereof.

11. A blend according to claim **1** wherein the hydrocarbonaceous composition is a liquid fuel and the biocide is a combination of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine, a combination of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one, a combination of (thiocyanomethylthio)-benzothiazole with methylene bis(thiocyanate (MBT), a substituted dioxaborinane, or mixtures thereof.

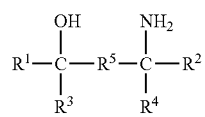
12. A blend according to claim **1** wherein the hydrocarbonaceous composition is petroleum and the biocide is glutaraldehyde, 2-bromo-2-nitro-1,3-propanediol, an isothiazolinone compound, 2,2-dibromo-3-nitrilopropionamide, tetrakis(hydroxymethyl)phosphonium sulfate, an oxazolidine compound, a quaternary ammonium, cocodiamine, dazomet, or mixtures thereof.

13. A fuel blend comprising:

a liquid fuel;

a corrosion inhibitory amount of an aminoalcohol of formula (I)

(I)



wherein:

R^1 and R^3 are each independently H, linear or branched alkyl, alkenyl, alkynyl, cycloalkyl, or aryl, or R^1, R^3 and the carbon to which they are attached form a cycloalkyl ring,

R^2 and R^4 are each independently H or alkyl, provided that R^2 and R^4 together contain 2 or fewer carbon atoms; and

R^5 is absent or is a C_1-C_{10} alkylene, arylene, arylene-alkylene-, or -alkylene-arylene-,

wherein the aminoalcohol contains at least 5 carbon atoms, and wherein alkyl, cycloalkyl, alkylene, aryl, and arylene are optionally substituted with alkyl or phenyl; and a biocide selected from the group consisting of:

(i) a blend of 4-(2-nitrobutyl)-morpholine with 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine;

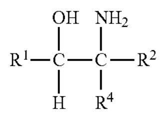
(ii) a blend of 5-chloro-2-methyl-4-isothiazolin-3-one with 2-methyl-4-isothiazolin-3-one;

(iii) a blend of (thiocyanomethylthio)-benzothiazole (TCMTB) and methylene bis(thiocyanate (MBT); and

(iv) a substituted dioxaborinane.

14. A fuel blend according to claim **13** wherein the aminoalcohol is of formula (II):

(II)



wherein

R^1 is C_2-C_6 alkyl; and

R^2 and R^4 are each independently H or C_1-C_2 alkyl provided that R^2 and R^4 together contain 2 or fewer carbon atoms.

15. A fuel blend according to claim **13** wherein the aminoalcohol is 3-amino-4-octanol.

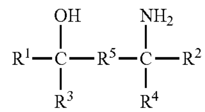
16. A fuel blend according to claim **13** wherein the weight ratio of aminoalcohol to biocide (i) is between about 30:1 and 1:1.

17. A fuel blend according to claim **13** wherein the weight ratio of aminoalcohol to biocide (ii) is preferably between about 70:1 and 3:1.

18. (canceled)

19. A method for providing microbial resistance to a biodiesel fuel, the method comprising including in the biodiesel fuel an effective amount of an aminoalcohol of formula (I):

(I)



wherein:

R^1 and R^3 are each independently H, linear or branched alkyl, alkenyl, alkynyl, cycloalkyl, or aryl, or R^1, R^3 and the carbon to which they are attached form a cycloalkyl ring,

R^2 and R^4 are each independently H or alkyl, provided that R^2 and R^4 together contain 2 or fewer carbon atoms; and

R^5 is absent or is a C_1-C_{10} alkylene, arylene, arylene-alkylene-, or -alkylene-arylene-,

wherein the aminoalcohol contains at least 5 carbon atoms, and wherein alkyl, cycloalkyl, alkylene, aryl, and arylene are optionally substituted with alkyl or phenyl.

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