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(54) **METHOD AND COMPOSITIONS FOR REDUCING DEPOSITS IN ENGINES COMBUSTING ETHANOL-CONTAINING FUELS AND A CORROSION INHIBITOR**

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(57) **ABSTRACT**

The present disclosure provides compositions and methods for reducing deposit formation in engines combusting a fuel containing ethanol and a corrosion inhibitor. In particular, E85 fuels with a corrosion inhibitor are provided containing polyetheramine additives able to reduce, eliminate and/or prevent deposits on engine combustion surfaces and surfaces of engine components exposed to the fuel containing ethanol and a corrosion inhibitor

# METHOD AND COMPOSITIONS FOR REDUCING DEPOSITS IN ENGINES COMBUSTING ETHANOL-CONTAINING FUELS AND A CORROSION INHIBITOR

## FIELD

**[0001]** The present disclosure relates to the use of polyetheramine fuel additive in fuels containing an alcohol and a corrosion inhibitor. The polyetheramine fuel additives improve the properties of the resulting fuel and also enhance the benefits to the consumer and to the environment of utilizing varying amounts of ethanol as a fuel in combustion engines. In particular, the present disclosure provides compositions and methods for reducing the formation of deposits in engine combusting a fuel containing an alcohol, such as ethanol, and a corrosion inhibitor.

## BACKGROUND

**[0002]** The use of ethanol alone or in gasoline blends can create new problems for fuel equipment designed to handle the more non-polar hydrocarbonaceous petroleum fractions commonly known as gasolines. The polarity, corrosivity, adhesiveness, friction properties, and perhaps conductivity of ethanol or ethanol-containing fuel can create new problems and new needs in the fuel industry.

**[0003]** A common blend of gasoline and ethanol being discussed is 15% gasoline and 85% ethanol, often commonly referred to as "E85" fuel (hereinafter "E85"). Other ethanol fuels can comprise, for example 10% ethanol (E10) and 100% ethanol (E100).

**[0004]** Commercial ethanol is widely treated with additives designed to prevent human consumption. Such treated ethanol is called denatured alcohol, or denatured ethanol and common denaturants include gasoline, gasoline components, and kerosene. Other denaturants for rendering fuel alcohol unfit for beverage use are defined in 27 CFR 21.24.

**[0005]** The use of varying degrees of ethanol in gasoline fuels can create problems with, for example, increased engine deposits, fuel stability, corrosion, fuel economy, fuel driveability, luminosity, fuel economy, demulse, ignition, driveability, antioxidancy, oil drain interval, achieving CARB standards, achieving Top-Tier auto-maker standards, achieving US EPA standards, solubility, component compatibility, fuel line plugging, engine durability, engine wear, injector fouling, which will benefit from the inclusion in the fuel of certain fuel additives.

**[0006]** Work by the auto manufacturers and others has indicated that low pHe ethanol (in both E-85 and E-10 blends) can contribute to accelerated corrosion of certain fuel system parts. While the ASTM Standards limit total acidity, as acetic acid, to 0.007 mass percent (56 mg/L), this standard is not always sufficient to limit more aggressive sulfuric based acids. Ethanol meeting the ASTM acidity standard may still be of low pHe. This accelerated corrosion has prompted the use of corrosion inhibitors to buffer the ethanol and protect metal components of the fuel distribution system; however, these can cause the formation of undesirable engine deposits. Therefore, a buffer is often desired.

**[0007]** DCI-11 is a commercially available corrosion inhibitor and buffer sold by Innospec (formerly Associated Octel) and used in fuels. However, engine deposit problems arise from the combustion of ethanol-containing fuels containing this and other corrosion inhibitors. These deposits differ significantly from conventional deposits that result from fuel and lubricant degradation and/or combustion.

**[0008]** A need therefore exists for a solution to the problem of these new and unexpected engine deposits formed in engines combusting ethanol-containing fuels having corrosion inhibitors or gasoline-ethanol-corrosion inhibitor mixtures. A need also exists to retain DCI-11 to buffer the acidic species such as acetic acid and/or sulfuric based acids, among others, present in ethanol-containing fuels, but overcome the new and unexpected deposit formations.

## SUMMARY OF THE EMBODIMENTS

**[0009]** An embodiment presented herein provides fuel additive agents for use in reducing or inhibiting corrosion inhibitor-derived deposits in engines (or engine components) combusting ethanol-containing fuels, including but not limited to E100, E85, E50, and the like down to E10 and trace blends of ethanol in gasoline.

**[0010]** Another embodiment presented herein provides polyetheramine (PEA) fuel additive agents for use in reducing or inhibiting deposits in engines (or engine components) combusting a corrosion inhibitor and ethanol-containing fuels, including but not limited to E100, E85, E50, and the like down to E10 and trace blends in gasoline.

**[0011]** In another embodiment, the corrosion inhibitor is the result of combining an organic acid and an amine. It has been observed that the PEA is very effective in reducing or preventing the formation of engine deposits formed in an engine combusting an ethanol-containing fuel that further contains combinations of at least one organic acid and at least one amine or their salts useful as corrosion inhibitors.

**[0012]** In one embodiment herein, the ethanol content of the fuel composition is from about 74 to about 85%. In another embodiment, the fuel is 100% ethanol and in yet another embodiment the ethanol content of the fuel composition is about 50%, or is from about 50% to about 74%.

**[0013]** Another embodiment provides a method to improve corrosion inhibition and/or to reduce the formation of engine deposits in an internal combustion engine, said method comprising combusting in said engine a fuel composition comprising gasoline, ethanol and at least one fuel additive. The fuel additives used herein are effective in preventing or minimizing corrosion of and/or deposits on metal surfaces and certain plastic or synthetic parts or surfaces in combustion engines that come in contact with fuel containing ethanol and a corrosion inhibitor. Parts such as fuel pumps, valves, gaskets, float devices, relay or signaling devices, gauges, screens, filters, intake valves, pistons, and others can all experience some degree of corrosion and/or deposits. The corrosion and/or deposits can vary depending on the type and duration of exposure, the chemical nature of the exposed surface, and the concentration of ethanol and corrosion inhibitor in the fuel. By the present disclosure, a fuel additive package or concentrate for ethanol-containing fuel can be designed to reduce corrosion and deposit formation in these engines. The fuel additive concentrate herein can contain one or more corrosion inhibitors, polyetheramine and a diluent which can be an oil, a fuel, gasoline, ethanol, solvent, carrier fluid, or other material combustible in a gasoline engine.

**[0014]** There is provided herein a fuel additive package or concentrate for ethanol-containing fuel, said concentrate comprising one or more corrosion inhibitors set forth herein and a diluent which can be an oil, a fuel, gasoline, ethanol, solvent, carrier fluid, or other liquid material combustible in a gasoline engine.

**[0015]** Thus, in one embodiment herein is provided a fuel additive concentrate comprising ethanol and polyetheramine, for use in a gasoline containing a corrosion inhibitor or defined herein, including but not limited to those materials having a product resulting from combining an organic acid or diacid and an amine, diamine or polyamine.

**[0016]** Accordingly, in another example herein is provided a composition to reduce corrosion and/or corrosion inhibitor-induced deposits in an internal combustion engine combusting an ethanol-containing fuel, said composition comprising gasoline, ethanol, and one or more materials selected from the group consisting of succinimide dispersants, succinamide dispersants, amides, Mannich base dispersants, polyetheramine dispersants, phenolics, hindered phenolics, polyolefin amines, aryl amines, diphenyl amines, monocarboxylic acids, dicarboxylic acids, polycarboxylic acids, an oxylated alkylphenolic resin, and formaldehyde polymer with 4-(1,1-dimethylethyl)phenol, methyloxirane and oxirane, octane enhancer materials (such as tetraethyl lead, methylcyclopentadienyl manganese tricarbonyl, azides, peroxides, and alkyl nitrates), monoesters, diesters, ethers, ketones, diethers, polyethers, glymes, glycols, oxiranes, C1—C8 aliphatic hydrocarbons, butylene oxide, propylene oxide, ethylene oxide, epoxides, butane, pentane, xylene, nitrous oxide, nitromethane, phenates, salicylates, sulfonates, nonylphenol ethoxylates, and fuel-soluble alkali detergents and alkaline earth metal-containing detergents.

**[0017]** It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are intended to provide further explanation of the present disclosure, as claimed.

## DETAILED DESCRIPTION OF EMBODIMENTS

**[0018]** By "corrosion" herein is meant any degradation, rusting, weakening, deterioration, softening, and the like of an engine surface or a part or component of an engine or engine component or part due to exposure to an ethanol-containing fuel.

**[0019]** By "PEA" and "polyetheramine" herein is meant organic compounds having one or more aminic nitrogen atoms, and one or more oxygen-containing ether bonds. Thus, the prefix "poly," is not a limitation here requiring two or more but rather is the common term of art and can, in one embodiment, encompass an organic compound having one aminic nitrogen, and one oxygen-containing ether bond if the molecular weight and volubility prevent deposit formation. The ether portions can be derived form, for example, ethylene oxide, propylene oxide, butylene oxide and mixtures thereof. In a particular embodiment, the PEA can be a diamine, and/or can have a molecular weight of greater than 700. In another embodiment, the molecular weight of the polyetheramine can be 700 to 3000 and particularly 900 to 1500. More specifically, PEA's useful in the present disclosure can also include carbamates, amino carbamates, mono- and di-thiocarbamates, amino alkyls, and amido alkanolamines, all of which are known to those skilled in the art. A key to the performance in the present disclosure is the need for solubility of the detergent in the ethanol-containing fuel requires more polarity than present with conventional (non-polar) polyisobutylene detergents.

**[0020]** By "corrosion inhibition" or "reducing corrosion" herein is meant any improvement in minimizing reducing, eliminating or preventing corrosion.

**[0021]** By "deposits" or "engine deposits" herein is meant build up of solid material within an engine, where the deposits can originate from the fuel before combustion, uncombusted fuel, and combination by-products, or from corrosion inhibitors added to ethanol or to ethanol-gasoline blends. The deposits can also include material on the intake valves (known as Intake Valve Deposits or IVD) or combustion chamber deposits (known as CCD), or fuel injector deposits. The "deposits" herein can appear in or on metal surfaces and certain plastic or synthetic parts or surfaces in combustion engines that come in contact with fuel containing ethanol and a corrosion inhibitor. Parts such as fuel pumps, valves, gaskets, float devices, relay or signaling devices, gauges, screens, filters, intake valves, combustion chambers, port injectors, pistons, and others experience some degree of deposits from the corrosion inhibitors described in ethanol fuels.

**[0022]** By "ethanol" herein is meant ethyl alcohol, the chemical compound $C_2H_5OH$. This can arise in or be provided in many qualities or grades, such as commercial or fuel grade, as well as pure or reagent grade ethanol, and can be derived from any source such as but not limited to petroleum refinery streams, distillation cuts, and bio-derived (e.g. bio-ethanol from corn or other crops).

**[0023]** By "New Energy ethanol" herein is meant ethanol produced by or for a company known as New Energy and which ethanol is known to have about 0.9 PTB or less of Innospec DCI-11 corrosion inhibitor.

**[0024]** By "ADM ethanol" herein is meant ethanol produced by or for Archer Daniels Midland corporation and which is known to have about 32 PTB of Innospec DCI-11 corrosion inhibitor.

**[0025]** By "corrosion inhibitor" herein is meant at least the following: low molecular weight (i.e., <700) amines (mono-, di-, tri, and poly), amines, etheramines, imines, imidazolines, thiadiazoles, monocarboxylic acids, dicarboxylic acids, p-phenylenediamine and dicyclohexylamine, alkyl substituted succinic anhydrides and acids and mixtures thereof and salts thereof. Corrosion inhibitors useful herein can also include or comprise tetrapropenylsuccinic acid or anhydride and polymers thereof. These can include the commercial products, for example, those known as Petrolite Tolad 3222 and Petrolite Tolad 3224 which are believed to be generally of a structure $NH_2(CH_2)_n$—NH—$(CH_2)_mO$—$C_{8-10}$ where n and m are independently 1 to about 10. Also included herein as "corrosion inhibitor" is the Innospec (formerly Associated Octel) product DCI-11™, which is believed to contain the reaction product of an organic acid and an amine or a diamine, such as Duomine™ having the structure $NH_2(CH_2)_n$—NH—$C_{8-10}$ were n is 1 to about 10. The DCI-11 product is believed to be the low molecular weight (<500) amine salt of a carboxylic acid.

**[0026]** Petrolite Tolad 357 is a corrosion inhibitor useful herein and believed to be a composition having a molecular weight of about 700 or less comprising (1) an alkenyl succinic acid or anhydride (ASAA), and (2) the reaction produce of ASAA and a trialkanol amine such as triethanolamine (TEA) where ASAA (3 moles) is reacted with TEA (1 mole) to yield an amide and/or amine salt.

**[0027]** In another embodiment the corrosion inhibitor is the product of combining an organic acid or diacid and an amine, diamine or polyamine in a ratio of about 5:1

[0028] In another embodiment herein is provided a fuel composition that can be, or can comprise, 1.0 to 100 volume percent of one or more alcohols, and 0 to 99% gasoline, and a corrosion inhibitor, said inhibitor comprising, by weight, (a) about 35% to 70% of at least one mono- or di-alkenyl succinic acid in which the alkenyl group has 8 to 18 carbons; and (b) about 30% to 65% of an aliphatic or cycloaliphatic amine, diamine or polyamine containing 2 to 12 carbon atoms. In one embodiment, the corrosion inhibitor can be dissolved in a hydrocarbon solvent consisting of an aromatic hydrocarbon, an alcohol containing 1 to 4 carbon atoms, or mixture thereof, the ratio of the hydrocarbon solvent to the total of (a) and (b) being about 15:85 to 50:50, wherein the corrosion inhibitor is present in the fuel composition at less than about 1000 ppm.

[0029] In another embodiment herein the corrosion inhibitor can be or comprise a composition having by weight (a) about 75% to 95% of at least one polymerized unsaturated aliphatic monocarboxylic acid, said unsaturated acid having 16 to 18 carbons per molecule, and (b) about 5% to 25% of at least one monoalkenylsuccinic acid in which the alkenyl group has 8 to 18 carbons.

[0030] The corrosion inhibitor can be blended into or with the ethanol, or the gasoline, or the ethanol/gasoline blend.

[0031] In one embodiment of an ethanol-containing fuel composition, the corrosion inhibitor comprises a nitrogen-containing material having a molecular weight of less than about 700 and the PEA has at least one aminic nitrogen atom and a molecular weight greater than about 700.

[0032] Corrosion inhibitors herein can include, but are not limited to, the following commercial products and their derivatives and chemically equivalent products:

[0033] Octel DCI-11 often used in fuel ethanol at, for example, about 20 PTB

[0034] Petrolite Tolad 3222 often used in fuel ethanol at, for example, about 20 PTB

[0035] Petrolite Tolad 3224 often used in fuel ethanol at, for example, about 13 PTB

[0036] Petrolite Tolad 357 often used in fuel ethanol at, for example, about 15 PTB

[0037] Nalco 5403 often used in fuel ethanol at, for example, about 30 PTB

[0038] ENDCOR FE-9730 (formerly Betz® ACN 13) often used in fuel ethanol at, for example, about 20 PTB

[0039] MidContinental MCC5011E often used in fuel ethanol at, for example, about 20 PTB

[0040] MidContinental MCC5011EW often used in fuel ethanol at, for example, about 27 PTB

[0041] CorrPro 654 often used in fuel ethanol at, for example, about 13 PTB

[0042] By "PTB" herein is meant "pounds per thousand barrels" a common term of art in the fuel additive industry.

[0043] Thus, there is provided herein in one embodiment a method to reduce deposits formed in an internal combustion engine, said method comprising combusting in said engine a fuel composition comprising gasoline, alcohol, a corrosion inhibitor and at least one polyetheramine fuel additive, whereby deposits in the engine are prevented or reduced relative to the deposits produced in the engine when combusting an alcohol-containing fuel composition containing a corrosion inhibitor but without at least one polyetheramine fuel additive. In one embodiment herein the alcohol is ethanol and in another it is methanol, propanol, butanol, and/or mixtures comprising any combination thereof.

[0044] It has been discovered that excess acidic components, such as acetic acid and sulfuric acid species, contribute to wear and deposit accumulation in the engines and/or on the valves or other engine parts. The use herein of PEA helps to raise the pH slightly by buffering the acetic and/or sulfuric acid components, thereby reducing or preventing the formation of deposit-contributing reaction products. The use of PEA herein is also useful in buffering the acid corrosion inhibitor. Thus, the present disclosure provides a corrosion inhibitor buffer in the form of a PEA and in ethanol-containing fuels.

[0045] Also provided herein is a fuel comprising (a) an alcohol selected from the group consisting of methanol, ethanol, propanol, and butanol, and mixtures thereof (b) gasoline, (c) the products of combining an organic carboxylic acid or diacid and an amine, diamine, or polymine and (d) a polyetheramine.

[0046] The following examples further illustrate aspects of the present disclosure but do not limit the present disclosure.

## EXAMPLES

[0047] Test Method—Chevrolet Impala FFV test—5000 miles intake valve deposit run on a 2006 3.5 liter 6-cylinder Flexible Fuel Vehicle (FFV) Chevrolet Impala. FFV refers to vehicles capable of operating on blends of up to 85% ethanol and 15% hydrocarbon such as unleaded gasoline. The test consisted of multistage 100 minute cycles made up of a mix of accelerations and steady driving at 25 MPH, 40 MPH and 65 MPH. The engine's six intake valves are weighed before the start of mileage accumulation and at the end of the 5000 test miles. The average of the difference in intake valve deposits is reported as the average intake valve deposit weight.

TABLE I

5,000 Mile Chevrolet Impala FFV Deposit Test

| Example | Denatured Ethanol % | Ethanol Source | Conventional RUL gasoline, % | H-6400 PEA PTB | DCI-11 PTB | Average IVD mg/valve |
|---|---|---|---|---|---|---|
| 1 | 0 | none | 100 | 0 | 0 | 429 |
| 2 | 84 | A | 16 | 0 | 32 | 227 |
| 3 | 84 | B | 16 | 0 | 0 | 99 |
| 4 | 84 | B | 16 | 0 | 32 | 230 |
| 5 | 84 | A | 16 | 500 | 32 | 4 |
| 6 | 84 | A | 16 | 85 | 32 | 11 |

Source A - Denatured Ethanol containing 32 PTB Innospec DCI-11
Source B - Denatured Ethanol with no corrosion inhibitor

### Example 1

[0048] Additive-free conventional regular unleaded gasoline run to 5,000 miles in a 2006 3.5 L Flexible Fuel (FFV) Chevrolet Impala running a modified Quad 4 cycle. The 429 mg/valve deposit level is typical of what would be expected from this type of fuel and test cycle.

Example 2

**[0049]** Fuel prepared by blending 84% ADM ethanol with 15% conventional regular unleaded gasoline. The ethanol was known to contain 32 PTB of Innospec DC-11 corrosion inhibitor as supplied. This fuel when tested in the Chevrolet Impala FFV test generated a surprisingly high level of intake system deposits. Pure ethanol burns cleanly and generates very few deposits, so one would have expected to generate less than 100 mg/valve or only 15-20% of the deposit observed with 100% gasoline since only 15%-20% of the E-85 fuel was made up of the unleaded gasoline. Instead the E-85 gave a surprisingly high level of 227 mg/valve, which is more than double what would have been predicted.

Example 3

**[0050]** Fuel prepared from 85% New Energy ethanol which contained less than 1 PTB of corrosion inhibitor. When this fuel was tested in the Chevrolet Impala FFV test, it generated an average intake valve deposits of 99 mg/valve. This is more of what one would expect from running the test on a blend of 84% clean burning ethanol and 16% regular unleaded gasoline.

Example 4

**[0051]** This fuel was prepared by blending 84% New Energy ethanol which does not contain any corrosion inhibitor with 16% regular unleaded gasoline and additizing that fuel with 32 PTB of Innospec DCI-11 corrosion inhibitor. When this fuel was tested in the Chevrolet Impala FFV test, it generated essentially the same deposit level, 230 mg/valve, as the fuel tested in Example 2. These results suggest that the Innospec corrosion inhibitor is surprisingly contributing to the mass of the intake valve deposits.

Example 5

**[0052]** This E-84 fuel is the same as used in Example 2, but this time the fuel was treated with 500 PTB of Afton Chemical's PEA, HiTEC 6400. When this fuel was tested in the Chevrolet Impala FFV test, it generated average of only 4 mg/valve of intake valve deposit, even though it contained 32 PTB of Innospec DC-11 corrosion inhibitor as supplied.

Example 6

**[0053]** This was the same E-84 fuel as used in Example 2, but this time treated with only 85 PTB of HiTEC 6400. When this fuel was tested in the Chevrolet Impala FFV test, it generated an average of 11 mg/valve, even though it contained 32 PTB of Innospec DC-11 corrosion inhibitor.

**[0054]** Normally the majority of intake valve deposits are formed from decomposition of fuel components on the intake valves and additives are designed to remove those types of deposits. These examples show that the majority of deposits formed from ethanol-gasoline fuel blends can come from the use of a corrosion inhibitor that would generate a different type of intake valve deposits. It has been discovered that PEA additives can effectively remove conventional deposits formed from the fuel, but also deposits caused by the use of corrosion inhibitors in ethanol-gasoline fuel blends.

**[0055]** Table II below provides illustrations of some desired additive combinations for various ethanol-containing fuels whereby corrosion might be controlled or reduced in an engine combusting the ethanol-containing fuel.

TABLE II

| Fuel | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| E85 | 40–200 | 120 | | | | | | | | |
| E85 | 40–200 | | 80 | | | | | | | |
| E85 | 40–200 | | | 100 | | | | | | |
| E85 | 40–200 | | | | 120 | | | | | |
| E85 | 40–200 | | | | | 140 | | | | |
| E85 | 40–200 | | | | | | 160 | | | |
| E85 | 40–200 | | | | | | | 100 | | |
| E85 | 40–200 | | | | | | | | 120 | |
| E85 | 40–200 | | | | | | | | | 100 |

Where amounts are in ppm of the finished fuel:
A = HiTEC 6400 PEA
B = DCI-11 corrosion inhibitor
C = Petrolite Tolad 3222 corrosion inhibitor
D = Petrolite Tolad 3224 corrosion inhibitor
E = Petrolite Tolad 357 corrosion inhibitor
F = MidContinental MCC5011E corrosion inhibitor
G = MidContinental MCC5011EW corrosion inhibitor
H = CorrPro 654 corrosion inhibitor
I = Nalco 5403 corrosion inhibitor
J = ENDCOR FE 9730 corrosion inhibitor

Table II illustrates examples of how the corrosion inhibitors can be combined with a PEA, whereby the result will be reduction in or prevention of intake deposits in an engine combusting the E85 fuel.

**[0056]** Thus, in one embodiment herein is provided a fuel comprising ethanol, gasoline, a polyetheramine fuel additive, and a corrosion inhibitor selected from the group consisting of Octel DCI-11 corrosion inhibitor, Petrolite Tolad 3222 corrosion inhibitor, Petrolite Tolad 3224 corrosion inhibitor, Nalco 5403 corrosion inhibitor, ENDCOR FE-9730 corrosion inhibitor, MidContinental MCC5011E corrosion inhibitor, MidContinental MCC5011EW corrosion inhibitor, CorrPro 654 corrosion inhibitor, NALCO 5403 corrosion inhibitor, ENDCOR FE 9730 corrosion inhibitor, and Betz® ACN 13 corrosion inhibitor, or chemical equivalents thereof. In one embodiment, the fuel is an E-85 gasoline-ethanol blend.

**[0057]** In one embodiment herein the ratio of corrosion inhibitor to PEA can be from about 1:20 to about 20:1. In another embodiment, the radio of corrosion inhibitor to PEA can be from about 1:10 to about 10:1. In yet another embodiment the ratio of corrosion inhibitor to PEA can be from about 1:5 to about 5:1.

**[0058]** In yet another embodiment herein the minimum amount of corrosion inhibitor, such as DCI-11, is about 5 PTB and in another the amount is from about 10 PTB to about 30 PTB in the finished fuel. In addition, the fuel in one embodiment contain from 30-60 PTB of the PEA, such as HiTEC® 6400 PEA.

**[0059]** Other embodiments of the present disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the disclosure disclosed herein. As used throughout the specification and claims, "a" and/or "an" may refer to one or more than one. Unless otherwise indicated, all numbers expressing quantities of ingredients, properties such as molecular weight, percent, ratio, reaction conditions, and so forth used in the specification and claims are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the specification and claims are approximations that may vary depending upon the desired properties sought to be obtained by the present disclosure. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques. Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the disclosure are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contains certain errors necessarily resulting from the standard deviation found in their respective testing measurements. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the disclosure being indicated by the following claims.

What is claimed is:

**1**. A method to reduce deposit formation in an internal combustion engine combusting an alcohol-containing fuel composition comprising a corrosion inhibitor, said method comprising (a) combining the fuel with at least one polyetheramine fuel additive, and (b) combusting the fuel and polyetheramine fuel additive in the engine, whereby deposit formation is reduced relative to the deposit formation occurring when combusting the alcohol-containing fuel with a corrosion inhibitor but without a polyetheramine fuel additive.

**2**. The method of claim **1**, wherein the polyetheramine fuel additive is selected from the group consisting of organic compounds having one or more aminic nitrogen atoms, and one or more oxygen-containing ether bonds, wherein said organic compound has a molecular weight of 700 to 3000.

**3**. The method of claim **1**, wherein the fuel further comprises gasoline.

**4**. The method of claim **1**, wherein the alcohol is selected from the group consisting of methanol, ethanol, propanol, butanol, and mixtures of any combinations thereof.

**5**. The method of claim **1**, wherein the corrosion inhibitor is selected from the group consisting of those materials having a structure $NH_2(CH_2)_n$—NH—$(CH_2)_m$O—$C_{8-10}$ where n and m are independently 1 to about 10.

**6**. The method of claim **1**, wherein the corrosion inhibitor is selected from the group consisting of those materials having a structure $NH_2(CH_2)_n$—NH—$C_{8-10}$ where n is 1 to about 10.

**7**. The method of claim **1**, wherein the corrosion inhibitor comprises the result of combining a carboxylic acid or diacid and an amine, diamine or polyamine.

**8**. The method of claim **1**, wherein the corrosion inhibitor has a molecular weight of less an 700 and is selected from the group consisting of monoamines, diamines, triamines, polyamines, etheramines, imines, imidazolines, thiadiazoles, monocarboxylic acids, dicarboxylic acids, p-phenylenediamine, dicyclohexylamine, alkyl substituted succinic anhydrides and acids, mixtures and reaction products thereof and salts thereof.

**9**. A composition to reduce deposit formation in an internal combustion engine combusting an alcohol-containing fuel, said composition comprising a corrosion inhibitor, alcohol, and one or more materials selected from the group consisting of polyetheramine dispersants.

**10**. The composition of claim **9**, wherein the alcohol is selected from the group consisting of methanol, ethanol, propanol, butanol, and mixtures of any combination thereof.

**11**. The composition of claim **9**, wherein the alcohol is ethanol.

**12**. The composition of claim **9**, wherein the fuel further comprises gasoline.

**13**. The composition of claim **11**, wherein the ethanol content of the fuel composition is from about 74% to about 85% and wherein the corrosion inhibitor comprises the result of combining a carboxylic acid and an amine.

**14**. A fuel additive concentrate for gasoline engines combusting an alcohol-containing fuel containing a corrosion inhibitor, said concentrate comprising one or more corrosion inhibitors, a polyetheramine additive and a diluent selected from the group consisting of an oil, a fuel, gasoline, an alcohol, solvent, carrier fluid, and other liquid materials combustible in a gasoline engine.

**15**. A fuel additive concentrate comprising an alcohol and polyetheramine.

**16**. The fuel additive of claim **15**, wherein the alcohol is ethanol.

**17**. A fuel additive concentrate comprising alcohol and a corrosion inhibitor.

**18**. The fuel additive of claim **17**, wherein the alcohol is ethanol.

**19**. A fuel comprising alcohol, gasoline, a polyetheramine fuel additive and a corrosion inhibitor selected form the group consisting of Octel DCI-11 corrosion inhibitor, Petrolite Tolad 3222 corrosion inhibitor, Petrolite Tolad 3224 corrosion inhibitor, Nalco 5403 corrosion inhibitor, ENDCOR FE-9730 corrosion inhibitor, MidContinental MCC5011E corrosion inhibitor, MidContinental MCC5011EW corrosion inhibitor, CorrPro 654 corrosion inhibitor, NALCO 5403 corrosion inhibitor, ENDCOR FE 9730 corrosion inhibitor, and Betz® ACN 13 corrosion inhibitor.

**20**. The fuel composition of claim **19**, wherein the alcohol is ethanol.

**21**. A method to reduce the formation of deposits in an internal combustion engine, said method comprising combusting in said engine a fuel composition comprising gasoline, alcohol, a corrosion inhibitor and at least one polyetheramine fuel additive, whereby deposits in the engine are prevented or reduced relative to the deposits produced in the engine when combusting an alcohol-containing fuel composition containing a corrosion inhibitor but without at least one polyetheramine fuel additive.

**22**. The method of claim **21**, wherein the alcohol is ethanol.

**23**. A fuel composition that is, or can comprise, 1.0 to 100 volume percent of one or more alcohols, and 0 to 99% gasoline, and a corrosion-inhibiting amount of a corrosion inhibitor, said inhibitor derived form, by weight, (a) about 35% to 70% of at least one mono- or di-alkenyl succinic acid in which the alkenyl group has 8 to 18 carbons; and (b) about 30% to 65% of an aliphatic or cycloaliphatic amine containing 2 to 12 carbon atoms, wherein the corrosion inhibitor is present in the fuel composition at less than about 1000 ppm.

**24**. A fuel comprising:

(a) one or more alcohols,

(b) gasoline,

(c) the product of combining an organic carboxylic acid or diacid and an amine, diamine, or polyamine, and

(d) a polyetheramine.

**25**. The fuel of claim **24**, wherein the one or more alcohols comprise(s) ethanol.

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