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(54) **Method and compositions for reducing corrosion in engines combusting ethanol-containing fuels**

(57) The present disclosure provides compositions and methods for improving corrosion inhibition in engines combusting a fuel containing ethanol. In particular, E85 fuels are provided containing additives able to reduce,

eliminate and/or prevent corrosion of engine combustion surfaces and surfaces of engine components exposed to the fuel containing ethanol.

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Description**FIELD**

[0001] The present disclosure relates to the use of fuel additives in fuels containing ethanol. The 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 improving corrosion inhibition in engines combusting a fuel containing ethanol.

BACKGROUND

[0002] Much has been said about the use of ethanol as a fuel by itself, and also as a blend component for use with gasoline, and even with diesel fuels. Ethanol can be produced from land crops and aquatic vegetation and thus provides a viable renewable fuel source.

[0003] 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.

[0004] 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).

[0005] E85, gasoline, and diesel are seasonally adjusted to ensure proper starting and performance in different geographic locations. For example, E85 sold during colder months often contain only 70% ethanol and then 30% petroleum additives to produce the necessary vapour pressure for starting in cold temperatures. During warmer months the petroleum additive content for E85 can often be, for example, 17% to about 20%. However, as the interest increases to other fuel blends and to possibly wider use of E100, the need for better cold start performance and reliability will increase.

[0006] So-called "driveability" of a vehicle is a function of the fuel combustion performance and poor driveability is manifested as slow or erratic starting, ignition failure, unsteady combustion and rough riding. Various techniques and fuel additives have been employed in the past to address this problem with gasoline fuels. Ethanol-containing fuels, from E100 to E5, and other gasoline-ethanol blends will produce additional problems with achieving improved driveability. A need exists to improve the driveability of vehicles combusting such gasoline-ethanol blends.

[0007] Similarly, engine wear can be a problem in engines combusting ethanol or ethanol-containing gasoline fuels, particularly in older engines designed and built before the introduction of ethanol-containing fuels. This engine wear can appear as corrosion or increased deposits. This will often result in decreased driveability, reduced fuel economy, or even catastrophic engine failure. A need exists for a method and fuel compositions to reduce the engine wear in engines combusting ethanol-containing fuels, such as gasoline.

[0008] 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.

[0009] Fuel delivery systems in vehicles combusting gasoline fuels have increasingly complicated componentry, some of which is, can be or will be highly sensitive to variations in certain fuel parameters. Physical and chemical properties of the fuel can negatively impact the performance or life of these fuel delivery systems. Thus, certain components designed for use in traditional gasolines might be susceptible to fatigue, and/or corrosion that can reduce performance or cause complete engine or component failure upon prolonged exposure to fuels containing ethanol, particularly fuels containing high percentages of ethanol, like E85 and E100. Therefore, a need exists to protect such older engines and well as improve the reliability of newer engines when all are exposed to prolonged combustion of ethanol-containing fuels.

[0010] 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, and injector fouling, which will benefit from the inclusion in the fuel of certain fuel additives.

[0011] As currently offered to consumers by several automakers, flexible fuel vehicles (FFVs) are designed to operate on any mixture of gasoline and ethanol - with ethanol concentrations of up to 85% by volume (E85). There is one major difference between an FFV and a conventional gasoline-fueled vehicle - the FFV detects the ethanol/gasoline ratio and makes appropriate adjustments to the engine's ignition timing and air/fuel mixture ratios to account for the ethanol and optimize performance and maintain emissions control. The vehicle must be equipped with an air/fuel ratio map capable of handling the adjustments necessary for optimized performance on both gasoline and E85. Components of the fuel delivery systems on FFVs are also modified and upgraded to be resistant to the corrosive effects of alcohol in the fuel.

[0012] The properties of E85 are governed by ASTM specifications which were issued in 1999 and may be considered somewhat dated. For instance, they clearly do not reflect the EPA Tier 2/Gasoline Sulfur regulations which require refiners to meet a 30 ppm average gasoline sulfur limit starting in 2006. The ASTM specification for E85 allows for up to 300 ppm sulfur in the mixture. This high level could degrade the performance of catalytic converters that must be on the FFV to meet emission standards.

[0013] Pure ethanol differs from conventional gasoline in that it has a constant boiling point temperature, higher octane, lower energy density, and requires more heat for vaporization. Blends containing 85% ethanol by volume have a higher octane value than regular gasoline, but because of the lower energy density of ethanol, an E85 blend contains only about 69 - 74% of the energy of regular gasoline on a Btu/gallon basis. This means that a 35% increase in the capacity of the fuel handling infrastructure (delivery tanks and carriers) would be needed for E85 systems to enable the same level of mobility (total vehicle miles of travel) as that provided by the current gasoline distribution system.

[0014] Neither the ASTM standards nor EPA regulations currently require deposit control additives to protect the intake valves and fuel injectors of vehicles operated on E85. The engines on FFVs operate like those on gasoline vehicles, but there is little published information available on their deposit formation tendencies. Evaluations of the need for deposit control additives in E85 (and their effectiveness) have not been completed.

[0015] Much like gasoline, the volatility of E85 must be adjusted seasonally and by geographic region to assure adequate cold start and drive away performance. This is done by increasing the amount of gasoline (typically from 15% to 30% by volume) in blends sold during colder months.

[0016] Pure ethanol has broader flammability limits than gasoline and burns with lower flame luminosity. When blended with hydrocarbon fuels, the vapor space flammability limits of ethanol approach those of gasoline and luminosity is increased.

[0017] With a stoichiometric air-to-fuel ratio of 10 (compared to 14.7 for regular gasoline), E85 needs more fuel per pound of air for optimum combustion; therefore E85 can not be used in conventional vehicles which are designed for no more than E10.

[0018] E85 contains about 69 - 74% of the energy of gasoline on a gallon basis. Therefore fuel economy (miles/gallon) on FFVs is substantially reduced when operated on E85. The extent of the decrease depends upon the reduction of heating value due to the presence of the ethanol in fuel, and the vehicle response. Analysis of the gasoline and E85 city/highway fuel economy ratings for the 33 model year 2006 FFVs indicates that the fuel economy penalty for E85 averages about 26% with a range between 24% and 34%.

[0019] Given the above cited average fuel economy penalty of 26% for a model year 2006 FFV operated on E85, this means that on a cents/mile basis, the retail price of a gallon of E85 would have to be at least 60 cents less than the current average retail price of gasoline in order for the fuel operating costs on E85 to be comparable with those on gasoline.

[0020] OGA-480, a polyetheramine available from Chevron Oronite, has been used in E100 fuel but has not been used in E85, nor have other amines been used in ethanol/gasoline blends, to the knowledge of the present inventors.

SUMMARY OF THE EMBODIMENTS

[0021] An embodiment presented herein provides fuel additive agents for use in reducing or inhibiting corrosion 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. 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%.

[0022] Another embodiment provides a method to improve corrosion inhibition 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 here are effective in preventing or minimizing corrosion of metal surfaces and certain plastic or synthetic parts or surfaces in combustion engines that come in contact with fuel containing ethanol. 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, also sometimes regarded as wear problems. The corrosion can vary depending on the type and duration of exposure, the chemical nature of the exposed surface, and the concentration of ethanol in the fuel. By the present disclosure, a fuel additive package or concentrate for ethanol-containing fuel can be designed to reduce corrosion in these engines. The fuel additive concentrate herein can contain one or more corrosion inhibitors and a diluent which can be an oil, a fuel, gasoline, ethanol, solvent, carrier fluid, or other material combustible in a gasoline engine.

[0023] There is provided herein 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.

[0024] Accordingly, in another example herein is provided a composition to reduce corrosion 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, and polyetheramine dispersants, phenolics, hindered phenolics, 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.

[0025] 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

[0026] By "gasoline performance additive" herein is meant any one or more chemicals useful in the present disclosure for dissolving or dispersing in a gasoline fuel.

[0027] 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 an engine component or part due to exposure to an ethanol-containing fuel.

[0028] By "corrosion inhibition" or "reducing corrosion" herein is meant any improvement in minimizing, reducing, eliminating or preventing corrosion.

[0029] 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 a commercial of 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. bioethanol from corn).

[0030] By "corrosion inhibitor" herein is meant at least the following: succinimide dispersants, succinamide dispersants, amides, Mannich base dispersants, and polyetheramine dispersants, phenolics, hindered phenolics, aryl amines, diphenyl amines, monocarboxylic acids, dicarboxylic acids, p-phenylenediamine and dicyclohexylamine, oxyated alkylphenolic resins, formaldehyde polymer with 4-(1,1-dimethylethyl)phenol, methyloxirane and oxirane, octane enhancer materials, monoesters, diesters, ketones, ethers, diethers, polyethers, glycols, glymes, 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,

[0031] Thus, there is provided herein in one embodiment a method to reduce corrosion in an internal combustion engine, said method comprising combusting in said engine a fuel composition comprising gasoline, ethanol and at least one fuel additive, said additive being selected from the group consisting succinimide dispersants, succinamide dispersants, amides, Mannich base dispersants, and polyetheramine dispersants, whereby corrosion is reduced relative to the corrosion when combusting a fuel composition without ethanol.

[0032] In another embodiment, the fuel additive useful to reduce corrosion can be selected from phenolics, hindered phenolics, aryl amines, diphenyl amines, monocarboxylic acids, dicarboxylic acids, polycarboxylic acids, an oxyated alkylphenolic resin, and formaldehyde polymer with 4-(1,1-dimethylethyl)phenol, methyloxirane and oxirane, octane enhancer materials, monoesters, diesters, ethers, ketones, diethers, polyethers, glymes, glycols, corrosion inhibitor materials, 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.

[0033] In another embodiment herein, heterocyclic aromatics for nonferrous metal corrosion protection are useful herein for use with ethanol-containing fuels. These can include, for example and without limitation, p-phenylenediamine and dicyclohexylamine. These are particularly effective in reducing corrosion by neutralizing acidic components that can get into the fuel from the ethanol or bioethanol sources.

[0034] Similarly, acidic additives are useful in reducing corrosion by neutralizing basic materials and contaminants that can enter the fuel blend from the ethanol or bioethanol. In this regard, monocarboxylic acids, dicarboxylic acids, and polycarboxylic acids are particularly effective.

[0035] Rust inhibitors have been used in gasoline fuels not containing ethanol. However, the introduction of E100 fuels and blends such as E85 has created additional problems of rust problems in engines and equipment and components contacting the ethanol fuel. Rust inhibitors useful here in preventing corrosion of surfaces exposed to ethanol-containing fuels can include, for example tall oil fatty acids, dodecenyl succinic acid (DDSA) and mono carboxylic acids, such as oleic acid. Thus, there is provided herein a composition to reduce corrosion 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 tall oil fatty acids, dodecenyl succinic acid, and oleic acid plus N,N dimethylcyclohexylamine.

[0036] Copper and lead bearing corrosion inhibitors may be used, but are typically not required with the formulation of the present invention. Typically such compounds are the thiadiazole polysulfides containing from 5 to 50 carbon atoms, their derivatives and polymers thereof. Derivatives of 1,3,4 thiadiazoles such as those described in U.S. Pat. Nos. 2,719,125; 2,719,126; and 3,087,932; are typical. Other similar materials are described in U.S. Pat. Nos. 3,821,236; 3,904,537; 4,097,387; 4,107,059; 4,136,043; 4,188,299; and 4,193,882. Other additives are the thio and polythio sulfenamides of thiadiazoles such as those described in UK Patent Specification No. 1,560,830. Benzotriazoles derivatives also fall within this class of additives. When these compounds are included in the fuel composition, they are typically present in an amount not exceeding 0.2 wt. % active ingredient.

[0037] Some engines have copper-containing or silver-containing components or devices that can contact the fuel supply. Such components can experience corrosion, particularly when the fuel contains, or is, ethanol. In certain instances, the ethanol can carry significant dissolved water which can exacerbate the corrosion problem posed by the ethanol alone. To address corrosion reduction on such components, the present disclosure provides a method to reduce corrosion of copper and/or silver in an engine having copper or silver components and combusting an ethanol-containing fuel by adding to the ethanol or to the fuel at least one additive selected from succinimide dispersants, succinamide dispersants, amides, Mannich base dispersants, and polyetheramine dispersants, phenolics, hindered phenolics, aryl amines, diphenyl amines, monocarboxylic acids, dicarboxylic acids, polycarboxylic acids, p-phenylenediamine and dicyclohexylamine, an oxylated alkylphenolic resin, formaldehyde polymer with 4-(1,1-dimethylethyl)phenol, methyloxirane and oxirane, octane enhancer materials, monoesters, diesters, ethers, diethers, polyethers, glycols, glymes, 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, whereby the copper and/or silver component(s) have/has reduced corrosion relative to the corrosion observed when the copper and/or silver component(s) are/is exposed to a fuel without ethanol.

Ethanol Blend	Vapor Pressure at 77F mmHg
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E100	59.02
E75	250.60
+4% pentane	256.60
+8% pentane	262.60
+10% pentane	265.60
E85	188.14
+0.1% Pentane	188.25
+0.5% Pentane	188.68
+1% Pentane	189.23
+4% Pentane	192.47
+8% Pentane	196.77
+10% Pentane	198.90
+0.1% Butane	188.87
+0.5% Butane	191.77
+1% Butane	195.38
+4% Butane	217.00
+8% Butane	245.70
+10% Butane	260.00
+4% diethyl ether	188.05
+8% diethyl ether	187.95
+10% diethyl ether	187.89
+0.1% dimethyl ether	189.13
+0.5% dimethyl ether	193.07

(continued)

Ethanol Blend	Vapor Pressure at 77F mmHg
+1% dimethyl ether	197.99
+4% dimethyl ether	227.40
+8% dimethyl ether	266.30
+10% dimethyl ether	285.70

[0038] The following examples further illustrate aspects of the present disclosure but do not limit the present disclosure.

EXAMPLES:

Example 1

[0039] To an E85 fuel can be added 1.0 percent by weight of dodecenyl succinic acid (DDSA) and the fuel formulation can be supplied to and combusted in an internal combustion spark ignited engine. The corrosion exhibited on the engine surfaces exposed to the fuel blend plus DDSA will display less corrosion after 5,000 miles than the corrosion exhibited on the engine surfaces after 5,000 miles of exposure to the same fuel blend without the DDSA.

Example 2

[0040] To an E85 fuel can be added 2.0 percent by weight of oleic acid and the fuel formulation can be supplied to and combusted in an internal combustion spark ignited engine. The corrosion exhibited on the engine surfaces exposed to the fuel blend plus oleic acid will display less corrosion after 5,000 miles than the corrosion exhibited on the engine surfaces after 5,000 miles of exposure to the same fuel blend without the oleic acid.

Example 3

[0041] To an E85 fuel can be added 2.0 percent by weight of a condensation product of alpha halogenated mono-carboxylic acid with 2,5-dimercapto-1,3,4-thiadiazole and the fuel formulation can be supplied to and combusted in an internal combustion spark ignited engine. The corrosion exhibited on the engine surfaces exposed to the fuel blend plus the thiadiazole derivative will display less corrosion after 5,000 miles than the corrosion exhibited on the engine surfaces after 5,000 miles of exposure to the same fuel blend without the thiadiazole derivative.

Example 4

[0042] To an E85 fuel can be added 1.0 percent by weight of the reaction product of oleic acid and 2,5-dimercapto-1,3,4-thiadiazole and the fuel formulation can be supplied to and combusted in an internal combustion spark ignited engine. The corrosion exhibited on the engine surfaces exposed to the fuel blend plus the thiadiazole derivative will display less corrosion after 3,000 miles than the corrosion exhibited on the engine surfaces after 3,000 miles of exposure to the same fuel blend without the thiadiazole derivative.

[0043] In addition to Examples 1-4 above, the benefits and advantages of the present invention will be observed by testing the compositions disclosed herein in ASTM D665A corrosion test. Further confirmation of the present invention is provided by performing the test NACE TM 0172 on the compositions disclosed herein and comparing the results to fuel compositions not containing alcohol or not containing the presently disclosed additives.

[0044] The table below provide illustration 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.

Fuel	A	B	C	D	E	F	G	H	I
E100	50	5	5		10				5
E85	30	5				10		15	
E50	25			10		20	10		

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(continued)

Fuel	A	B	C	D	E	F	G	H	I
E10	20	5	10			30			

Where amount are in ppm of the finished fuel:

A = alkylated succinimide dispersant from 950 MW PIB and tetraethylenpentamine

B = Mannich base dispersant from 1250 MW PIB and a polyamine

C = Polyetheramine dispersant

D = 2,6 di-t-butyl phenolic antioxidant

E = aromatic amine antioxidant

F = octane improver selected from MMT, tetraethyl lead, azides, peroxides, alkyl nitrates

G = esters, diesters, ethers, diethers, polyethers, and glycols

H = monocarboxylic acids, dicarboxylic acids, polycarboxylic acids

I = alkaline earth metal phenates, salicylates, sulfonates, nonylphenol ethoxylates, fuel-soluble alkali detergents or alkaline earth metal-containing detergents

5,000 Mile Keep Clean Test Summary

Test No.	Ethanol, %	H-6560, PTB	IVD, mg	CCD, mg
2	0	0	429	1232
3	0	85	5	1438
4	84 (2)	30/5 (1)	191	299
5	74 (2)	85/22 (1)	134	265
6	84 (2)	0	227	184
7	84 (3)	0	99	176
8	84 (2)	500 (4)	4	277

Footnotes:

1 First number is treat rate in gasoline. Second number is treat rate in blend.

2 ADM Ethanol (4 ppm sulfates, 32 PTB Octel DCI-11 corrosion inhibitor)

3 New Energy Ethanol (<1 ppm sulfates, 0.9 PTB corrosion inhibitor)

4 H-6400 polyetheramine, not H-6560

[0045] Another test to demonstrate the benefit of the present disclosure involved waer scar measurements, shown in Table 4.

Table 4

Run	BLEND	Treat Rate, PTB	MWSD
1	E85	--	605
2	E85 + H4142	50	445
3	E85 + 50% DDSA	25	540
4	E85 with ADM Ethanol	--	495

H-6560 is a Mannich dispersant containing a PIB carrier and a polyol carrier

E85 with ADM Ethanol has the DCI-11 (@32PTB) corrosion ethanol MWSD is measured in microns.

[0046] Table 4 shows the results of wear scar testing in which a median wear scar diameter MWSD) is reported. Run 1 was E85 using New Energy Ethanol and this baseline MWSD was 605. When HiTEC® 4142 (oleic acid plus N,N

dimethylcyclohexylamine) was added as a corrosion inhibitor, the MWSD was reduced to 445. Changing the corrosion inhibitor in the E85 fuel to DDSA (50% in A150 solvent) gave a slightly higher value of 540 but still improved over the baseline for E85. Using ADM Ethanol in the E85 produced even further reduction in the wear scar, probably due to the corrosion inhibitor (DCI-11) in the ethanol. This Table shows the benefit in wear scar reduction and hence in reducing wear in an engine achieved by incorporation of dodecenyl succinic acid and/or oleic acid plus N,N dimethylcyclohexylamine into an ethanol-containing gasoline fuel blend.

[0047] 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.

Claims

1. A method to reduce corrosion in an internal combustion engine having fuel injectors, said method comprising combusting in said engine a fuel composition comprising gasoline, ethanol and at least one fuel additive, said additive being selected from the group consisting of succinimide dispersants, succinamide dispersants, amides, Mannich base dispersants, and polyetheramine dispersants, whereby corrosion is reduced relative to the corrosion when combusting a fuel composition without ethanol.
2. The method of claim 1, wherein the composition comprises a second fuel additive, said additive being selected from the group consisting of phenolics, hindered phenolics, aryl amines, and diphenyl amines.
3. The method of claim 1 or 2, wherein the composition comprises a second fuel additive, said additive being selected from the group consisting of p-phenylenediamine and dicyclohexylamine.
4. The method of any one of the preceding claims, wherein the composition comprises a second fuel additive, said additive being selected from the group consisting of oxylated alkylphenolic resins, and formaldehyde polymer with 4-(1,1-dimethylethyl)phenol, methyloxirane and oxirane.
5. The method of any one of the preceding claims, wherein the composition comprises a second fuel additive, said additive being selected from the group of methyl cyclopentadienyl manganese tricarbonyl, cyclopentadienyl manganese tricarbonyl, azides, tetraethyl lead, peroxides and alkyl nitrates.
6. The method of any one of the preceding claims, wherein the composition comprises a second fuel additive, said additive being selected from the group of monoesters, diesters, ethers, ketones, diethers, polyethers, and glycols.
7. The method of any one of the preceding claims, wherein the composition comprises a second fuel additive, said additive being selected from the group consisting of monocarboxylic acids, dicarboxylic acids and polycarboxylic acids.
8. The method of any one of the preceding claims, wherein the composition comprises a second fuel additive, said additive being selected from the group consisting of phenates, salicylates, sulfonates, nonylphenol ethoxylates, fuel-soluble alkali detergents and alkaline earth metal-containing detergents.
9. The method of any one of the preceding claims, wherein the composition comprises a second fuel additive, said additive being selected from the group consisting of oxiranes, C1-C8 aliphatic hydrocarbons, butylene oxide, propylene oxide, ethylene oxide, epoxides, butane, pentane, xylene, nitrous oxide, and nitromethane.

10. A composition to reduce corrosion 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, aryl amines, diphenyl amines, monocarboxylic acids, dicarboxylic acids, polycarboxylic acids, p-phenylenediamine and dicyclohexylamine, oxylated alkylphenolic resins, formaldehyde polymer with 4-(1,1-dimethylethyl) phenol, methyloxirane and oxirane, methyl cyclopentadienyl manganese tricarbonyl, cyclopentadienyl manganese tricarbonyl, azides, tetraethyl lead, peroxides, alkyl nitrates, monoesters, diesters, ethers, ketones, diethers, polyethers, glycols, glymes, oxiranes, C1-C8 aliphatic hydrocarbons, butylene oxide, propylene oxide, ethylene oxide, epoxides, butane, pentane, xylene, nitrous oxide, nitromethane, phenates, salicylates, sulfonates, nonylphenol ethoxylates, fuel-soluble alkali detergents and alkaline earth metal-containing detergents.

11. The composition of claim 10, wherein the ethanol content of the fuel composition is from about 74% to about 85%.

12. The composition of claim 10, wherein the ethanol content of the fuel composition is from about 50% to about 74%.

13. A method to reduce corrosion of copper and/or silver in an engine having copper or silver components and combusting an ethanol-containing fuel by adding to the ethanol or to the fuel at least one additive selected from succinimide dispersants, succinamide dispersants, amides, Mannich base dispersants, polyetheramine dispersants, phenolics, hindered phenolics, aryl amines, diphenyl amines, monocarboxylic acids, dicarboxylic acids, polycarboxylic acids, p-phenylenediamine and dicyclohexylamine, oxylated alkylphenolic resins, formaldehyde polymer with 4-(1,1-dimethylethyl) phenol, methyloxirane and oxirane, octane enhancer materials, monoesters, diesters, ketones, ethers, diethers, polyethers, glycols, glymes, oxiranes, C1-C8 aliphatic hydrocarbons, butylene oxide, propylene oxide, ethylene oxide, epoxides, butane, pentane, xylene, nitrous oxide, nitromethane, phenates, salicylates, sulfonates, nonylphenol ethoxylates, fuel-soluble alkali detergents and alkaline earth metal-containing detergents, whereby the copper and/or silver components(s) have/has reduced corrosion relative to the corrosion observed when the copper and/or silver components(s) are/is exposed to a fuel without ethanol.

14. The method of claim 13, wherein the ethanol content of the fuel composition is from about 74% to about 85%.

15. The method of any of claim 13, wherein the ethanol content of the fuel composition is from about 50% to about 74%.

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

17. A composition to reduce corrosion 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 2,5-dimercapto-1,3,4-thiadiazole, dodecenyl succinic acid, oleic acid, a condensation product of alpha halogenated mono-carboxylic acid with 2,5-dimercapto-1,3,4-thiadiazole, and the reaction product of oleic acid and 2,5-dimercapto-1,3,4-thiadiazole.

18. A composition to reduce corrosion 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 tall oil fatty acids, dodecenyl succinic acid, and oleic acid plus N,N dimethylcyclohexylamine.



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