

FUEL ADDITIVE COMPOSITIONS AND METHODS FOR CONTROLLING DEPOSITS

CROSS REFERENCE TO RELATED APPLICATIONS

[001] This application claims the priority benefit of U.S. Provisional Application No. 63/455,289, filed March 29, 2023, the disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[002] This disclosure relates to fuel additives. More specifically, this disclosure describes compositions and methods that promote deposit cleaning performance.

BACKGROUND

[003] Traditional fuel additives developed for port fuel injection (PFI) gasoline engines are generally not optimized for controlling formation of deposits in direct injection spark ignition (DISI) engines, sometimes referred to as direct injection gasoline (DIG) or gasoline direct injection (GDI) engines. Unlike PFI engines, DISI engines deliver fuel directly into the combustion chamber. When fuel is directly injected, it is immediately exposed to high temperatures and pressures. In this environment, combustion products can accumulate on the external and/or internal surfaces of the injector and nozzle (known as injector fouling).

[004] The formation of deposits, both around the injector nozzle and inside the combustion chamber, can have significant negative impact on one or more of fuel flow rate, injection duration, and spray pattern. Moreover, injector deposit formation is not just limited gasoline engines but can also impact diesel engines. This, in turn, can lead to increased emission, increased particulate matter (PM) formation, reduced fuel economy, loss of power/performance, increased wear, and/or reduced equipment life.

BRIEF DESCRIPTION OF DRAWINGS

[005] FIGS. 1A-1C show photographs of deposit control as described in the Example section.

SUMMARY

[006] In one aspect, there is provided a fuel composition comprising:
i) a hydrocarbon-based fuel comprising gasoline, or diesel; and ii) one or more guanidine or amidine-based detergents.

[007] In another aspect, there is provided a method for controlling carbon deposits in an internal combustion engine comprising: providing a fuel in the internal combustion engine, wherein the fuel comprises: i) a hydrocarbon-based fuel comprising gasoline, or diesel; and ii) one or more guanidine or amidine-based detergents.

[008] In another aspect, there is provided a concentrate composition comprising: about 30 to 90 wt % of an organic solvent boiling in a range of from 65°C to 205°C; and about 10 to 70 wt % of a detergent mixture comprising: ii) one or more nitrogen-containing detergents as described herein.

DETAILED DESCRIPTION

[009] This disclosure provides compositions and methods for improving engine performance, specifically improving deposit cleaning performance and/or lowering particulate emissions. The present invention may be effective at controlling carbon deposits in an internal combustion engine. In particular, the significant improvements in deposit control may be achieved through the use of compositions comprising at least the one or more nitrogen-containing detergents disclosed herein.

Fuel Compositions

[010] In general, the fuel composition of the present invention comprises (i) a hydrocarbon-based fuel and one or more nitrogen-containing detergents.

Hydrocarbon-based Fuel

[011] The hydrocarbon-based fuel includes gasoline, or diesel. Gasoline fuel refers to a composition containing at least predominantly C₄-C₁₂ hydrocarbons. In one embodiment, gasoline or gasoline boiling range components is further defined to refer to a composition containing at least predominantly C₄-C₁₂ hydrocarbons and further having a boiling range of from about 37.8°C (100°F) to about 204°C (400°F). In an alternative embodiment, gasoline is defined to refer to a composition containing at least predominantly C₄-C₁₂ hydrocarbons, having a boiling range of from about 37.8°C (100°F) to about 204°C (400°F), and further defined to meet ASTM D4814.

[012] In certain embodiments, the hydrocarbon-based fuel comprises gasoline and ethanol. Blends of gasoline and ethanol suitable for use in the compositions and methods comprise between about 5 and about 35 vol% ethanol, or about 15 to about 25 vol% ethanol. In certain embodiments, the hydrocarbon-based fuel is an E20 base fuel or a gasoline fuel comprising 20 vol% ethanol.

[013] Diesel fuel refers to middle distillate fuels containing at least predominantly C₁₀-C₂₅ hydrocarbons. In one embodiment, diesel is further defined to refer to a composition containing at least predominantly C₁₀-C₂₅ hydrocarbons, and further having a boiling range of from about 165.6°C (330°F) to about 371.1°C (700°F). In an alternative embodiment, diesel is as defined above to refer to a composition containing at least predominantly C₁₀-C₂₅ hydrocarbons, having a boiling range of from about 165.6°C (330°F) to about 371.1°C (700°F), and further defined to meet ASTM D975.

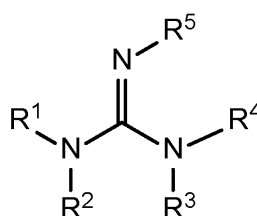
[014] The hydrocarbon-based fuel is present in a major amount by weight % of the total fuel composition. In some embodiments, the hydrocarbon-based fuel is present in about 50 wt% or greater, 55 wt% or greater, 60 wt% or greater, 65 wt% or greater, 70 wt% or greater, 75 wt% or greater, 80 wt% or greater, 85 wt% or greater, 90 wt% or greater, 95 wt% or greater or between any range from about 50 wt% to up to below 100 wt%.

[015] The gasoline employed in the present invention may be clean burning gasoline (CBG). CBG refers to gasoline formulations that contain reduced levels of sulfur, aromatics and olefins. The exact formulation may vary depending on local regulatory definitions.

[016] The fuel composition of the present disclosure comprises one or more guanidine or amidine-based detergents.

Guanidine-based Detergents

[017] Guanidine-based detergents can be represented by the following generalized structure:



Formula 1

wherein R¹, R², R³, R⁴ and R⁵ are each independently hydrogen, monovalent organic groups (e.g., aromatic or aliphatic groups), or monovalent heterorganic groups (e.g., aromatic or aliphatic groups which comprise one or more N, O, S or P) in the form of groups or moieties that are bonded through a carbon atom.

[018] In some embodiments, the guanidine-based detergent includes a cyclic moiety, wherein any two or more of R¹, R², R³, R⁴ and R⁵ optionally can be bonded together to form a cyclic structure (e.g., a five-, six, or seven-membered ring). The cyclic structures may be aromatic or non-aromatic, as well as vary from being fully saturated to fully unsaturated. The organic and heterorganic groups may have from 1 to 10 carbon atoms (e.g., 1 to 6 carbon atoms).

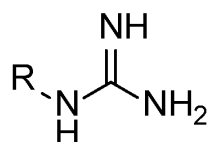
[019] In some embodiments, one or more of R¹, R², R³, R⁴ and R⁵ is an aromatic group, for example phenyl, substituted phenyl, heteroaryl, or substituted heteroaryl. In

certain embodiments, two or more of R^1 , R^2 , R^3 , R^4 and R^5 is an aromatic group. In certain embodiments, three or more of R^1 , R^2 , R^3 , R^4 and R^5 is an aromatic group.

[020] Suitable examples of the guanidine-based detergents include mono-substituted guanidine, multi-substituted guanidine, cyclic guanidine, imidazole (including benzimidazole), and N-guanidinosuccinimide. In some cases, a guanidine-based detergent could be categorized under more than one guanidine grouping.

Mono-substituted Guanidines

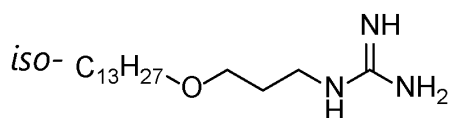
[021] The fuel composition of the present disclosure may include one or more mono-substituted guanidines. In some embodiments, the mono-substituted guanidine may have the following generalized structure:



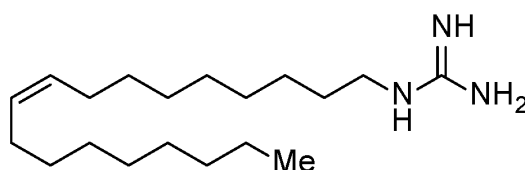
Formula 2

where R is alkyl ($\text{C}_n\text{H}_{2n+1}$, $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), unsaturated hydrocarbyl ($\text{C}_n\text{H}_{2m+1}$, where $m < n$, $n \geq 2$), alkoxyalkyl ($\text{C}_n\text{H}_{2n+1}\text{OC}_m\text{H}_{2m}$, $n \geq 1$, $m \geq 2$), polyalkoxyalkyl ($\text{C}_n\text{H}_{2n+1}(\text{OC}_m\text{H}_{2m})_q$, $n \geq 1$, $m \geq 2$, $q \geq 2$) or aryloxyalkyl ($\text{C}_n\text{H}_{2n+1}\text{C}_6\text{H}_4\text{OC}_m\text{H}_{2m}$, $n \geq 1$, $m \geq 2$) group.

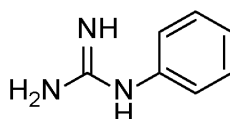
[022] Non-limiting examples of mono-substituted guanidine include the following:



Formula 3A



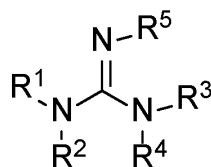
Formula 3B



Formula 3C

Multi-substituted Guanidines

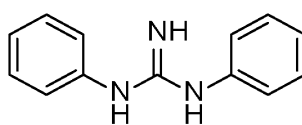
[023] The fuel composition of the present disclosure may include one or more multi-substituted guanidines. In some embodiments, the multi-substituted guanidine may have the following generalized structure:



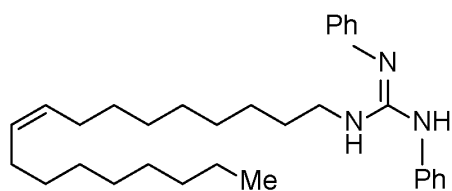
Formula 4

wherein R^1 , R^2 , R^3 , R^4 , and R^5 are independently a hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), unsaturated hydrocarbyl (C_nH_{2m+1} , $n \geq 2$, $m < n$) or aryl group (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group); wherein at least 2 of R^1 , R^2 , R^3 , R^4 , and R^5 are not hydrogen.

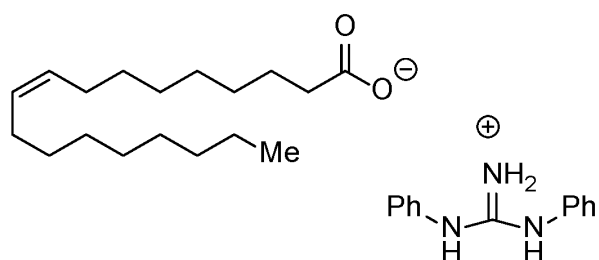
[024] Non-limiting examples of multi-substituted guanidine include the following:



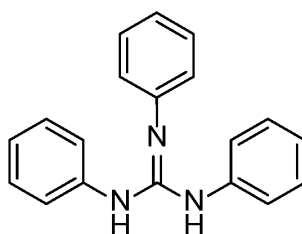
Formula 5A



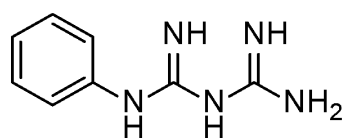
Formula 5B



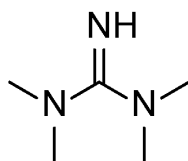
Formula 5C



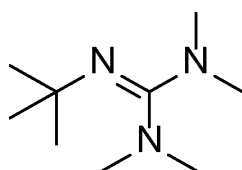
Formula 5D



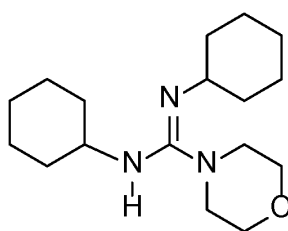
Formula 5E



Formula 5F



Formula 5G



Formula 5H

Cyclic Guanidines

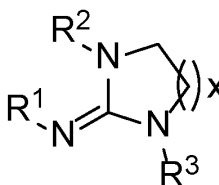
[025] The fuel composition of the present disclosure may include one or more cyclic guanidines. Cyclic structures may be aromatic or non-aromatic, as well as vary from being fully saturated to fully unsaturated, including partially saturated or partially unsaturated.

[026] In some embodiments, the cyclic guanidine may have one of the following generalized structures:



Formula 6

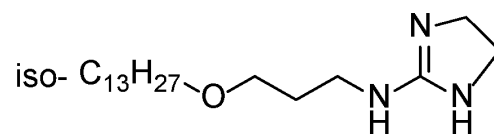
wherein R^1 and R^2 are independently hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), unsaturated hydrocarbyl (C_nH_{2m+1} , where $m < n$, $n \geq 2$), alkoxyalkyl ($C_nH_{2n+1}OC_mH_{2m}$, $n \geq 1$, $m \geq 2$), polyalkoxyalkyl ($C_nH_{2n+1}(OC_mH_{2m})_q$, $n \geq 1$, $m \geq 2$, $q \geq 2$) or aryloxyalkyl ($C_nH_{2n+1}C_6H_4OC_mH_{2m}$, $n \geq 1$, $m \geq 2$) group; and R^3 is hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), hydroxyalkyl ($C_nH_{2n}OH$, $n \geq 1$), aminoalkyl ($C_nH_{2n}NH_2$, $n \geq 1$) group. In some embodiments, n is from 2 to 6 such as from 3 to 6 or from 3 to 6. Alternatively, the cyclic guanidine may have the following generalized structure:



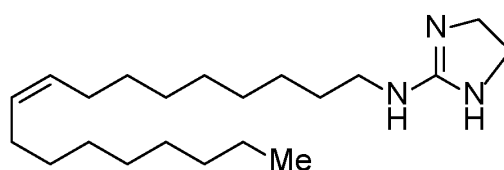
Formula 7

wherein R^1 is hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), unsaturated hydrocarbyl (C_nH_{2m+1} , where $m < n$, $n \geq 2$), alkoxyalkyl ($C_nH_{2n+1}OC_mH_{2m}$, $n \geq 1$, $m \geq 2$), polyalkoxyalkyl ($C_nH_{2n+1}(OC_mH_{2m})_q$, $n \geq 1$, $m \geq 2$, $q \geq 2$) or aryloxyalkyl ($C_nH_{2n+1}C_6H_4OC_mH_{2m}$, $n \geq 1$, $m \geq 2$) group; and R^2 and R^3 are independently hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), hydroxyalkyl ($C_nH_{2n}OH$, $1 \leq n \leq 6$), or aminoalkyl ($C_nH_{2n}NH_2$, $1 \leq n \leq 6$) group. In some embodiments, n is from 2 to 6, such as from 2 to 5, or from 3 to 6.

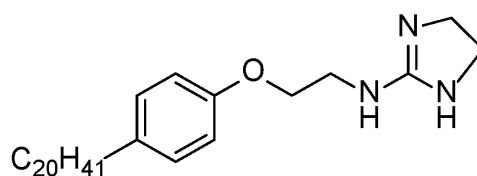
[027] Non-limiting examples of cyclic guanidine include the following:



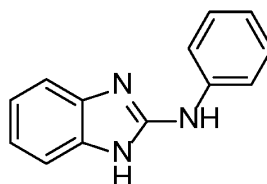
Formula 8A



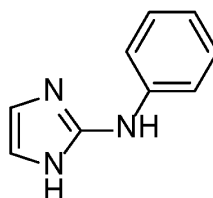
Formula 8B



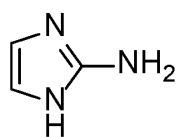
Formula 8C



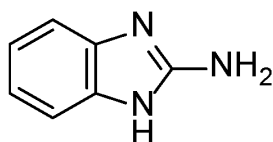
Formula 8D



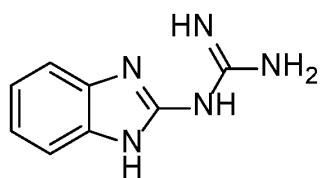
Formula 8E



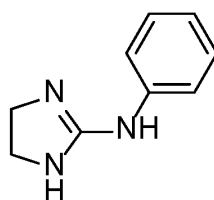
Formula 8F



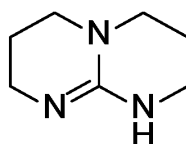
Formula 8G



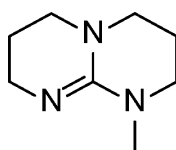
Formula 8H



Formula 8I



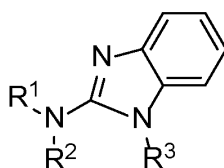
Formula 8J



Formula 8K

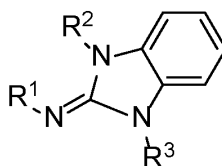
Imidazoles

[028] The fuel composition of the present disclosure may include one or more imidazoles. In some embodiments, the imidazole may have one of the following generalized structures:



Formula 9A

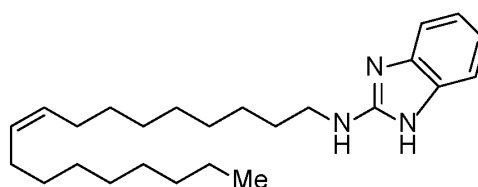
wherein R^1 and R^2 are independently hydrogen, alkyl, aryl, unsaturated hydrocarbyl, alkoxyalkyl, or aryloxyalkyl group; and R^3 is hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), hydroxyalkyl ($C_nH_{2n}OH$, $1 \leq n \leq 6$), or aminoalkyl ($C_nH_{2n}NH_2$, $1 \leq n \leq 6$) group; or



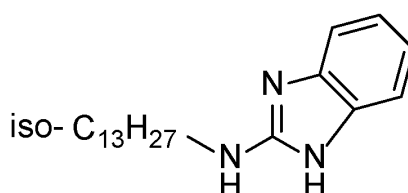
Formula 9B

wherein R^1 is hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), unsaturated hydrocarbyl (C_nH_{2m+1} , where $m < n$, $n \geq 2$), alkoxyalkyl ($C_nH_{2n+1}OC_mH_{2m}$, $n \geq 1$, $m \geq 2$), polyalkoxyalkyl ($C_nH_{2n+1}(OC_mH_{2m})_q$, $n \geq 1$, $m \geq 2$, $q \geq 2$) or aryloxyalkyl ($C_nH_{2n+1}C_6H_4OC_mH_{2m}$, $n \geq 1$, $m \geq 2$) group; and R^2 and R^3 are independently hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), hydroxyalkyl ($C_nH_{2n}OH$, $1 \leq n \leq 6$), or aminoalkyl ($C_nH_{2n}NH_2$, $1 \leq n \leq 6$) group.

[029] Non-limiting examples of imidazoles include the following:



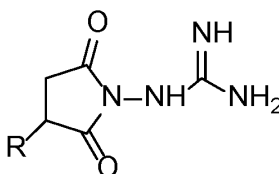
Formula 10A



Formula 10B

N-guanidinosuccinimides

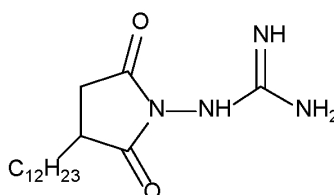
[030] The fuel composition of the present disclosure may include one or more *N*-guanidinosuccinimides. In some embodiments, the *N*-guanidinosuccinimide may have the following generalized structure:



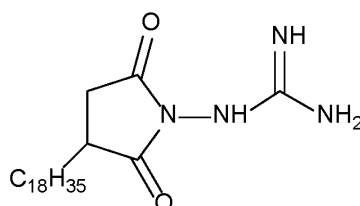
Formula 11

wherein R is hydrogen, an alkyl group (C_nH_{2n+1} , $n \geq 1$) or an unsaturated hydrocarbyl group (C_nH_{2m+1} , where $m < n$, $n \geq 2$).

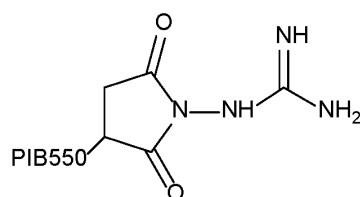
[031] Non-limiting examples of *N*-guanidinosuccinimides include the following:



Formula 12A



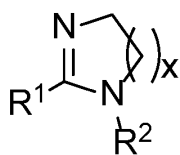
Formula 12B



Formula 12C

Amidine-based Detergents

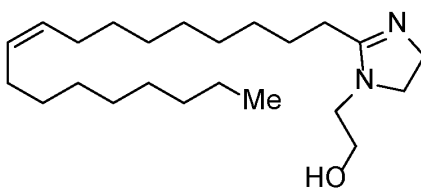
[032] The fuel composition of the present disclosure may include one or more amidines. In some embodiments, the amidine may have the following generalized structure:



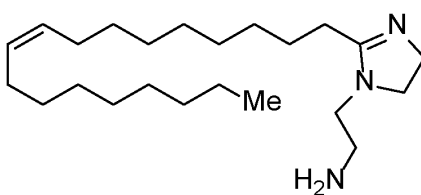
Formula 13

wherein R^1 is hydrogen, alkyl (C_nH_{2n+1} , $n \geq 1$), aryl (a substituted or unsubstituted carbocyclic or heterocyclic aromatic group), unsaturated hydrocarbyl (C_nH_{2m+1} , where $m < n$, $n \geq 2$), alkoxyalkyl ($C_nH_{2n+1}OC_mH_{2m}$, $n \geq 1$, $m \geq 2$), polyalkoxyalkyl ($C_nH_{2n+1}(OC_mH_{2m})_q$, $n \geq 1$, $m \geq 2$, $q \geq 2$) or aryloxyalkyl ($C_nH_{2n+1}C_6H_4OC_mH_{2m}$, $n \geq 1$, $m \geq 2$), hydroxyalkyl ($C_nH_{2n}OH$, $1 \leq n \leq 6$), or aminoalkyl ($C_nH_{2n}NH_2$, $1 \leq n \leq 6$) group.

[033] Non-limiting examples of amidines include the following:

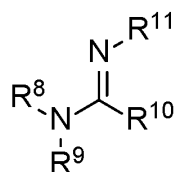


Formula 14A



Formula 14B

[034] Amidine-based detergents can be represented by the following generalized Formula 15:



Formula 15

wherein R^8 , R^9 , R^{10} and R^{11} are each independently selected from hydrogen, monovalent organic groups, monovalent heterorganic groups (e.g., comprising nitrogen, oxygen, sulfur or phosphorus, in the form of groups or moieties that are bonded through a carbon atom and that do not contain acid functionality such as carboxylic or sulfonic), and combinations thereof; and wherein any two or more of R^8 , R^9 , R^{10} and R^{11} optionally can be bonded together to form a cyclic structure (e.g., a five-, six, or seven-membered ring). The cyclic structures may be aromatic or non-aromatic, as well as vary from being fully saturated to fully unsaturated. The organic and heterorganic groups may have from 1 to 10 carbon atoms (e.g., 1 to 6 carbon atoms).

[035] In certain embodiments, one or more of wherein R^8 , R^9 , R^{10} and R^{11} is an aromatic group, for example phenyl or substituted phenyl. In certain embodiments, two or more of wherein R^8 , R^9 , R^{10} and R^{11} is an aromatic group. In certain embodiments, three or more of wherein R^8 , R^9 , R^{10} and R^{11} is an aromatic group.

[036] Each amine-based detergent can be present in the exemplary compositions in an amount of about 10 ppm to about 3000 ppm, such as about 1000 to about 2500, about 1250 to about 2250, 1500 to about 2000, 10 ppm to about 750 ppm (such as 20 to 700, 30 to 650, 50 to 600, 100 to 500, 200 to 400, 250 to 350, and so forth) based on the total fuel composition.

Other Additives

[037] The fuel composition may comprise other generally known fuel additives. Suitable examples include, but are not limited to, antioxidants, metal deactivators, demulsifiers, oxygenates, antiknock agents, dispersants, carrier fluids, and other

detergents. In diesel fuel, other well-known additives can be employed such as pour point depressants, flow improvers, and the like.

[038] Each of the foregoing additives, when used, is used at a functionally effective amount to impart the desired properties to the fuel composition. Generally, the concentration of each of these additives, when used, may range, unless otherwise specified, from about 0.001 to about 20 wt. %, such as about 0.01 to about 10 wt. %.

Concentrate

[039] The compounds of the present disclosure may be formulated as a concentrate using an inert stable oleophilic (i.e., soluble in hydrocarbon fuel) organic solvent boiling in a range of 65°C to 205°C. An aliphatic or an aromatic hydrocarbon solvent may be used, such as benzene, toluene, xylene, or higher-boiling aromatics or aromatic thinners. Aliphatic alcohols containing 2 to 8 carbon atoms, such as ethanol, isopropanol, methyl isobutyl carbinol, *n*-butanol and the like, in combination with the hydrocarbon solvents are also suitable for use with the present additives. In the concentrate, the amount of the additive may range from 10 to 70 wt % (e.g., 20 to 40 wt %).

[040] In one embodiment, a concentrate composition comprises: about 30 to 90 wt % of an organic solvent boiling in a range of from 65°C to 205°C and; about 10 to 70 wt % of a detergent mixture comprising: one or more guanidine-based or amidine-based detergents described herein.

Methods of Use

[041] The nitrogen-containing detergents can be used advantageously in compositions and methods for improving engine performance, specifically improving deposit cleaning performance and/or lowering particulate emissions. In certain embodiments, the exemplary nitrogen-containing detergents, alone or in the form of fuel compositions or concentrate compositions, can be applied by any suitable means to an internal combustion engine for the purpose of controlling, preventing or reducing carbon deposits. In particular, the significant improvements in deposit

control may be achieved through the use of compositions comprising at least the (iii) one or more nitrogen-containing detergents disclosed herein.

[042] In one embodiment, the method is for controlling carbon deposits in an internal combustion engine.

[043] In one embodiment, the method comprises: providing a fuel in the internal combustion engine, wherein the fuel comprises: i) a hydrocarbon-based fuel comprising gasoline, diesel or a blend of gasoline and ethanol; and ii) one or more guanidine-based or amidine-based detergent s as disclosed herein.

[044] The following examples are intended to be non-limiting.

EXAMPLES

Deposit Control for Direct Injection Spark Ignition (DISI) Engine

[045] Diphenyl guanidinium oleate was blended in Premium Unleaded Fuel (PUL) and tested for deposit control (Table 1). Each example also includes same amounts of commonly used fuel additives such as a detergent.

Table 2

Table for Injector flow restriction

Example	Composition	% Injector Flow Restriction Improvement over PUL baseline
1	172.5 ppmw diphenyl guanidinium oleate	1.8%
2	172.5 ppmw Fatty Acid Imidazoline	3.4%

3	436.3 ppmw Aminoguanidine	2.4%
4	172.5 ppmw Tomaguanidine	1.6%
5	150.4 ppmw (oleyl)imidazolidine-2-imine	1.8%A

* as compared to a cleaned injector at start of test

[046] FIGS. 1A-1C show injector deposit removing capabilities of a cyclic guanidine (Formula 8A). More specifically, FIG. 1A shows pictures of injector nozzles after running it with baseline fuel for 50 hours. FIG. 1B shows pictures of injector nozzles after running it with the cyclic guanidine. FIG. 1C shows pictures of clean injector nozzles.

[047] All documents described herein are incorporated by reference herein, including any priority documents and/or testing procedures to the extent they are not inconsistent with this text. As is apparent from the foregoing general description and the specific embodiments, while forms of the present disclosure have been illustrated and described, various modifications can be made without departing from the spirit and scope of the present disclosure. Accordingly, it is not intended that the present disclosure be limited thereby.

[048] For the sake of brevity, only certain ranges are explicitly disclosed herein. However, ranges from any lower limit may be combined with any upper limit to recite a range not explicitly recited, as well as, ranges from any lower limit may be combined with any other lower limit to recite a range not explicitly recited, in the same way, ranges from any upper limit may be combined with any other upper limit to recite a range not explicitly recited. Additionally, within a range includes every point or

individual value between its end points even though not explicitly recited. Thus, every point or individual value may serve as its own lower or upper limit combined with any other point or individual value or any other lower or upper limit, to recite a range not explicitly recited.

[049] Likewise, the term "comprising" is considered synonymous with the term "including." Likewise whenever a composition, an element or a group of elements is preceded with the transitional phrase "comprising," it is understood that we also contemplate the same composition or group of elements with transitional phrases "consisting essentially of," "consisting of," "selected from the group of consisting of," or "is" preceding the recitation of the composition, element, or elements and vice versa.

[050] The terms "a" and "the" as used herein are understood to encompass the plural as well as the singular.

[051] Various terms have been defined above. To the extent a term used in a claim is not defined above, it should be given the broadest definition persons in the pertinent art have given that term as reflected in at least one printed publication or issued patent. Furthermore, all patents, test procedures, and other documents cited in this application are fully incorporated by reference to the extent such disclosure is not inconsistent with this application and for all jurisdictions in which such incorporation is permitted.

[052] The foregoing description of the disclosure illustrates and describes the present disclosure. Additionally, the disclosure shows and describes only the preferred embodiments but, as mentioned above, it is to be understood that the disclosure is capable of use in various other combinations, modifications, and environments and is capable of changes or modifications within the scope of the concept as expressed herein, commensurate with the above teachings and/or the skill or knowledge of the relevant art. While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing

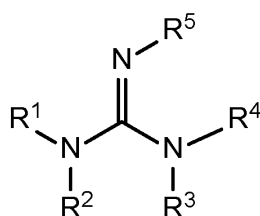
from the basic scope thereof, and the scope thereof is determined by the claims that follow.

[053] It is understood that when combinations, subsets, groups, etc. of elements are disclosed (e.g., combinations of components in a composition, or combinations of steps in a method), that while specific reference of each of the various individual and collective combinations and permutations of these elements may not be explicitly disclosed, each is specifically contemplated and described herein.

[054] The embodiments described hereinabove are further intended to explain best modes known of practicing it and to enable others skilled in the art to utilize the disclosure in such, or other, embodiments and with the various modifications required by the particular applications or uses. Accordingly, the description is not intended to limit it to the form disclosed herein. Also, it is intended that the appended claims be construed to include alternative embodiments.

CLAIMS

1. A fuel composition comprising:
 - i) a hydrocarbon-based fuel comprising gasoline or diesel;
 - ii) one or more guanidine-based or amidine-based detergents, or an acceptable salt thereof.
2. The fuel composition of claim 1, wherein the guanidine-based detergent or an acceptable salt thereof, is based on the following structure:

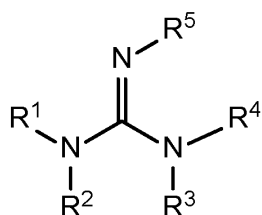


wherein R¹, R², R³, R⁴ and R⁵ are each independently selected from hydrogen, monovalent organic groups and monovalent heterorganic groups in the form of groups or moieties that are bonded through a carbon atom and that do not contain acid functionality such as carboxylic or sulfonic; and

wherein any two or more of R¹, R², R³, R⁴ and R⁵ optionally can be bonded together to form a cyclic structure.

3. The fuel composition of claim 1, wherein the guanidine-based detergent is mono-substituted guanidine, multi-substituted guanidine, cyclic guanidine, benzimidazole, or N-guanidinosuccinimide.
4. The fuel composition of claim 3, wherein the benzimidazole is aminobenzimidazole or iminobenzimidazole.

5. The fuel composition of claim 1, wherein the guanidine-based detergent is guanidium oleate or guanidium palmitate.
6. The fuel composition of claim 1, wherein the fuel composition comprises about 35 ppmw to about 5000 ppmw of the carrier fluids and about 500 ppmw to about 3000 ppmw of the guanidine-based detergents.
7. The fuel composition of claim 1, wherein the fuel composition comprises about 35 ppmw to about 5000 ppmw of the carrier fluids and about 500 ppmw to about 3000 ppmw of the amidine-based detergents.
8. A method for controlling carbon deposits in an internal combustion engine comprising:
providing a fuel in the internal combustion engine, wherein the fuel comprises:
i) a hydrocarbon-based fuel comprising gasoline or diesel;
and
ii) one or more guanidine-based or amidine-based detergents, or an acceptable salt thereof.
9. The method of claim 8, wherein the guanidine-based detergent or an acceptable salt thereof, is based on the following structure:



wherein R¹, R², R³, R⁴ and R⁵ are each independently selected from hydrogen, monovalent organic groups and monovalent heterorganic groups in the form of

groups or moieties that are bonded through a carbon atom and that do not contain acid functionality such as carboxylic or sulfonic; and

wherein any two or more of R¹, R², R³, R⁴ and R⁵ optionally can be bonded together to form a cyclic structure.

10. The method of claim 8, wherein the guanidine-based detergent is mono-substituted guanidine, multi-substituted guanidine, cyclic guanidine, benzimidazole, or N-guanidinosuccinimide.

11. The method of claim 10, wherein the benzimidazole is aminobenzimidazole or iminobenzimidazole.

12. The method of claim 8, wherein the guanidine-based detergent is guanidium oleate or guanidium palmitate.

13. The method of claim 8, wherein the fuel composition comprises about 35 ppmw to about 5000 ppmw of the carrier fluids and about 500 ppmw to about 3000 ppmw of the guanidine-based detergents.

14. The method of claim 8, wherein the fuel composition comprises about 35 ppmw to about 5000 ppmw of the carrier fluids and about 500 ppmw to about 3000 ppmw of the amidine-based detergents.