fluorescence that can overwhelm any usual fluorescence from such markers. Moreover, fluorescent markers are also often unstable in hydrocarbon fuels and/or either react with fuel additives or simply lose their fluorescence over time.

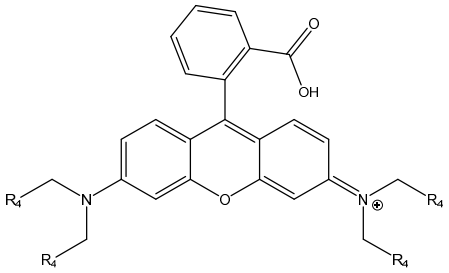
BRIEF DESCRIPTION OF THE FIGURES

[0005] FIGS. 1 to 5 are plots of additive treat rate versus fluorescence intensity of a marker compound in water phase.

SUMMARY

[0006] In one approach or example, a method for identifying a hydrocarbon fuel is provided herein. The method includes obtaining a sample of a hydrocarbon fuel containing a measureable amount of a marker compound, the marker compound having a fluorescence intensity and at least partially soluble in water; combining the hydrocarbon fuel with water, and mixing the fuel and water mixture; after the mixing, allowing the fuel and water mixture to separate into a water phase and a fuel phase to at least partially extract the marker compound into the water phase; and subjecting the water phase to light having a wavelength of 250 nm to 800 nm and observing the fluorescence emitted from the marker compound in the water phase. In some approaches, the observing includes measuring a fluorescence intensity of the water phase and determining a concentration of the marker compound in the fuel based on the fluorescence intensity of the water phase with the at least partially extracted maker compound therein relative to a baseline fluorescence intensity of the water phase without the marker compound.

[0007] In other approaches or examples, the method of the previous paragraph may be combined with optional features and optional method steps in any combination thereof. These optional features, steps, or examples may include: wherein the fuel is selected from gasoline or diesel; and/or wherein the fuel is gasoline containing low alcohol (e.g., methanol, ethanol, or propanol); and/or wherein the gasoline contains at least about 2 volume percent ethanol; and/or wherein the fuel includes a fuel performance additive selected from the group consisting of detergents, antioxidants, carrier fluids, metal deactivators, corrosion inhibitors, biocides, antistatic additives, drag reducing agents, demulsifiers, emulsifiers, dehazers, anti-icing additives, antiknock additives, anti-valve-seat recession additives, lubricity additives, surfactants, combustion improvers, or combinations thereof; and/or wherein the detergent is selected from



(Formula III) and wherein each R_4 is independently a C1 to C10 alkyl group; and/or wherein the marker compound is first added to the fuel performance additive; and/or wherein the water includes a pH 4 to 10 buffer solution; and/or wherein the buffer solution includes dihydrogen potassium phosphate and dibasic sodium phosphate.

[0007a] In one aspect of the present disclosure, there is provided a method for identifying a hydrocarbon fuel, the method comprising:

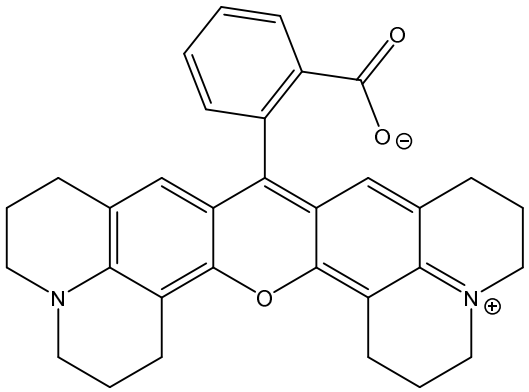
obtaining a sample of a hydrocarbon fuel containing a measureable amount of a marker compound, the marker compound having a fluorescence intensity and at least partially soluble in water;

combining the hydrocarbon fuel with water to form a fuel and water mixture and mixing the fuel and water mixture;

after the mixing, allowing the fuel and water mixture to separate into a water phase and a fuel phase to at least partially extract the marker compound into the water phase; and

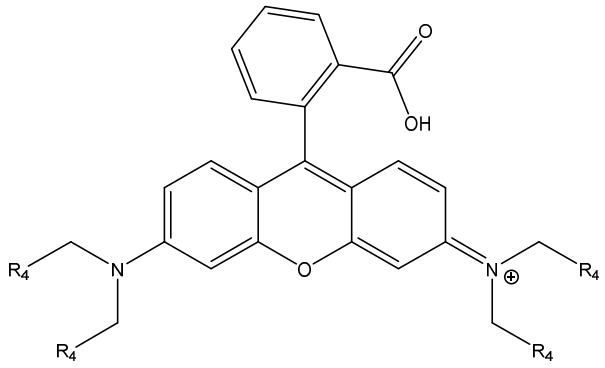
subjecting the water phase to light having a wavelength of 250 nm to 800 nm and observing the fluorescence emitted from the marker compound in the water phase,

wherein the marker compound having a fluorescence intensity has a structure of Formula II:



(Formula II); or

wherein the marker compound having a fluorescence intensity has a structure of Formula III:

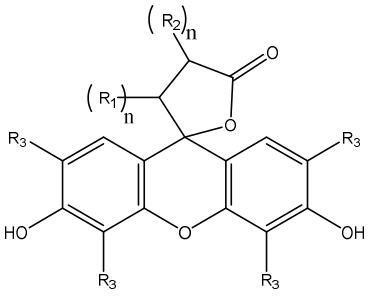


(Formula III)

wherein each R_4 is independently a C1 to C10 alkyl group.

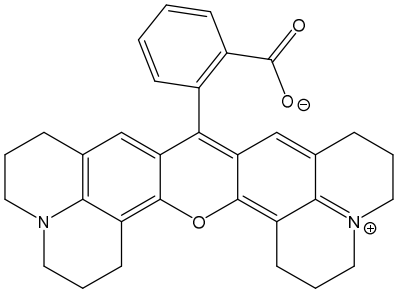
[0008] In other approaches or examples, a gasoline composition is also provided by the present disclosure. In examples thereof, the gasoline composition includes a major amount of gasoline including at least about 2 volume percent ethanol; a gasoline performance additive including an additive selected from the group comprising detergents, antioxidants, carrier fluids, metal deactivators, corrosion inhibitors, biocides, antistatic additives, drag reducing agents, demulsifiers, emulsifiers, dehazers, anti-icing additives, antiknock additives, anti-valve-seat recession additives, lubricity additives, surfactants, combustion improvers, or combinations thereof; about 0.01 to about 100 parts per billion of a marker compound having a fluorescence intensity; and a partition ratio of the marker compound between water and gasoline of at least about 0.1.

[0009] In other examples or approaches, the gasoline composition of the previous paragraph may be combined with optional features and examples in any combination thereof. These optional features or examples may include: wherein the gasoline includes about 25 to about 1000 ptb (pounds per thousand barrels) of the fuel performance additive in the gasoline; and/or wherein the marker compound having a fluorescence intensity has a structure of Formula I:



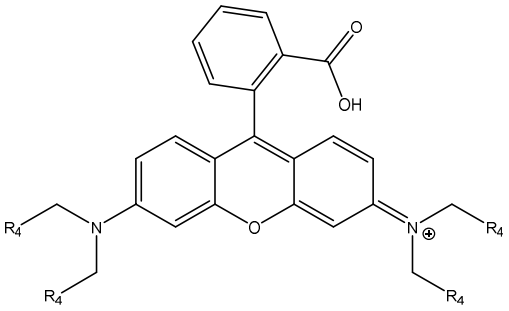
(Formula I)

wherein R_1 and R_2 are independently hydrogen, a linear or branched alkyl group, or R_1 and R_2 may join to form a cyclic group or an aromatic group; n is an integer of 1 or 2; and each R_3 is hydrogen, a halogen atom, or a linear or branched C1 to C12 alkyl group; and/or wherein the marker compound having a fluorescence intensity has a structure of Formula II:



(Formula II); and/or

wherein the marker compound having a fluorescence intensity has a structure of Formula III:



(Formula III) and wherein each R_4 is independently a C1 to C10 alkyl group.

[0009a] In another aspect of the present disclosure, there is provided a gasoline composition comprising:

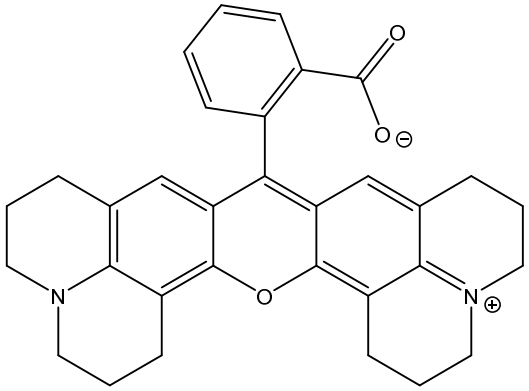
a major amount of gasoline containing at least 2 volume percent ethanol;

a gasoline performance additive including an additive selected from the group comprising detergents, antioxidants, carrier fluids, metal deactivators, corrosion inhibitors, biocides, antistatic additives, drag reducing agents, demulsifiers, emulsifiers, dehazers, anti-icing additives, antiknock additives, anti-valve-seat recession additives, lubricity additives, surfactants, combustion improvers, or combinations thereof;

0.1 to 100 parts per billion of a marker compound having a fluorescence intensity; and

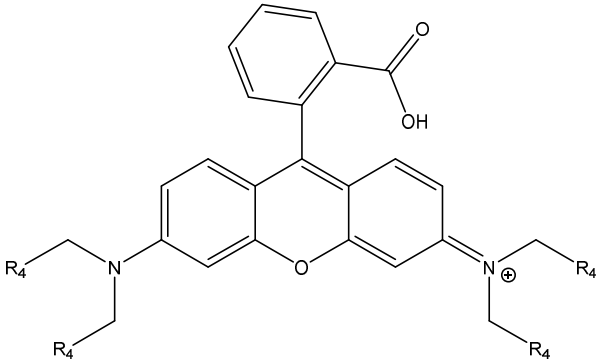
a partition ratio of the marker compound between water and gasoline of at least 0.1;

wherein the marker compound having a fluorescence intensity has a structure of Formula II:



(Formula II); or

wherein the marker compound having a fluorescence intensity has a structure of Formula III:



(Formula III)

wherein each R_4 is independently a C1 to C10 alkyl group.

DETAILED DESCRIPTION

[00010] In one aspect, the present disclosure provides methods for identifying a hydrocarbon fuel, such as the presence and/or amounts of marker compounds having a fluorescence intensity and, through correlation, also identify the presence and/or amounts of additive package(s) within the hydrocarbon fuel. In one approach or embodiment, the methods herein include first obtaining a sample of a hydrocarbon fuel containing a measureable amount of a marker compound. Preferably, the marker compound has a fluorescence intensity and is at least partially soluble in water. Next, the hydrocarbon fuel with the marker compound therein is combined with water to form a fuel and water mixture. The mixture is agitated to facilitate contact between the water and fuel. After the agitation, the fuel and water are allowed to separate into a water phase and a fuel phase to at least partially extract the marker compound into the water phase. Then, a fluorescence intensity of the water phase is measured and a concentration of the marker

CLAIMS

WHAT IS CLAIMED IS

1. A method for identifying a hydrocarbon fuel, the method comprising:

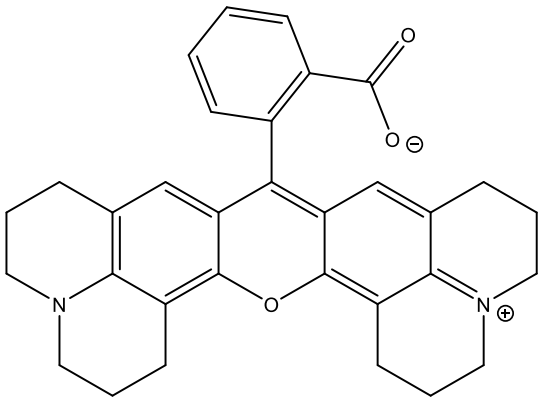
obtaining a sample of a hydrocarbon fuel containing a measureable amount of a marker compound, the marker compound having a fluorescence intensity and at least partially soluble in water;

combining the hydrocarbon fuel with water to form a fuel and water mixture and mixing the fuel and water mixture;

after the mixing, allowing the fuel and water mixture to separate into a water phase and a fuel phase to at least partially extract the marker compound into the water phase; and

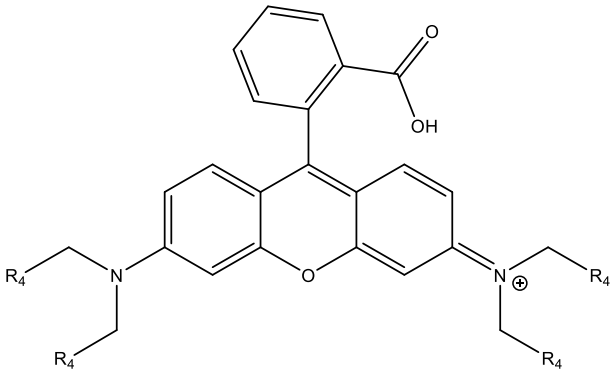
subjecting the water phase to light having a wavelength of 250 nm to 800 nm and observing the fluorescence emitted from the marker compound in the water phase,

wherein the marker compound having a fluorescence intensity has a structure of Formula II:



(Formula II); or

wherein the marker compound having a fluorescence intensity has a structure of Formula III:



(Formula III)

wherein each R_4 is independently a C1 to C10 alkyl group.

2. The method of claim 1, wherein the observing step comprises measuring a fluorescence intensity of the water phase and determining the concentration of the marker compound in the fuel based on the fluorescence intensity of the water phase with the at least partially extracted maker compound therein relative to a baseline fluorescence intensity of the water phase without the marker compound.

3. The method of claim 1, wherein the fuel is selected from gasoline or diesel; and/or wherein the fuel is gasoline containing ethanol; and/or wherein the gasoline contains at least 2 volume percent ethanol.

4. The method of any preceding claim, wherein the fuel includes a fuel performance additive selected from the group consisting of detergents, antioxidants, carrier fluids, metal deactivators, corrosion inhibitors, biocides, antistatic additives, drag reducing agents, demulsifiers, emulsifiers, dehazers, anti-icing additives, antiknock additives, anti-valve-seat recession additives, lubricity additives, surfactants, combustion improvers, or combinations thereof.

5. The method of claim 4, wherein the detergent is selected from the group consisting of Mannich reaction products formed by condensing a long-chain aliphatic hydrocarbon-substituted phenol or cresol with an aldehyde and an amine; long chain aliphatic hydrocarbons having an amine or a polyamine attached thereto; fuel-soluble nitrogen containing salts, amides, imides, succinimides, imidazolines, esters, and long chain aliphatic hydrocarbon-substituted dicarboxylic acids or their anhydrides or mixtures thereof; polyetheramines; and combinations thereof.

6. The method of any preceding claim, wherein a relationship between the fluorescence intensity and the concentration of marker compound in the fuel is linear within a concentration range of the marker compound of interest in the fuel; and/or wherein the fuel includes 0.1 to 100 parts per billion of the marker compound; and/or wherein a partition ratio of the marker compound between the water phase and fuel phase is at least 0.1.

7. The method of any preceding claim, wherein the marker compound is first added to the fuel performance additive; and/or wherein the water includes a pH 4 to 10 buffer solution; and/or wherein the buffer solution includes dihydrogen potassium phosphate and dibasic sodium phosphate.

8. A gasoline composition comprising:

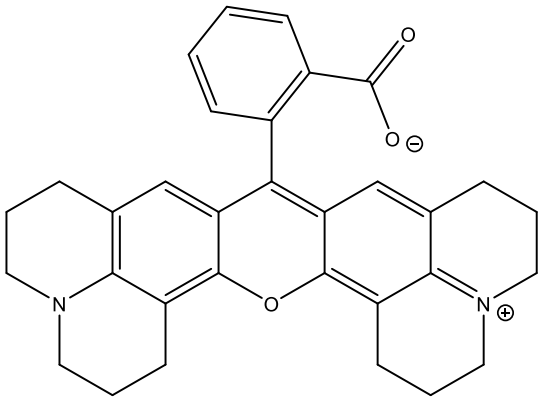
a major amount of gasoline containing at least 2 volume percent ethanol;

a gasoline performance additive including an additive selected from the group comprising detergents, antioxidants, carrier fluids, metal deactivators, corrosion inhibitors, biocides, antistatic additives, drag reducing agents, demulsifiers, emulsifiers, dehazers, anti-icing additives, antiknock additives, anti-valve-seat recession additives, lubricity additives, surfactants, combustion improvers, or combinations thereof;

0.1 to 100 parts per billion of a marker compound having a fluorescence intensity; and

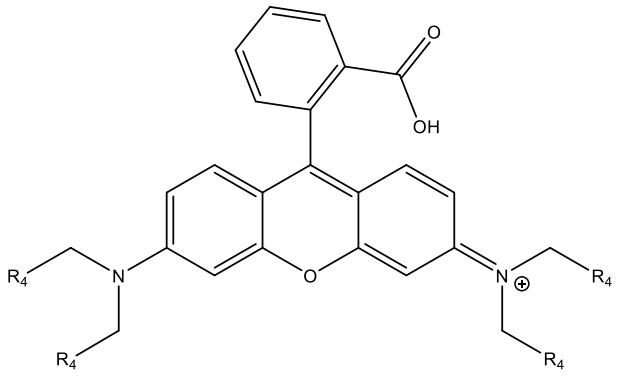
a partition ratio of the marker compound between water and gasoline of at least 0.1;

wherein the marker compound having a fluorescence intensity has a structure of Formula II:



(Formula II); or

wherein the marker compound having a fluorescence intensity has a structure of Formula III:



(Formula III)

wherein each R_4 is independently a C1 to C10 alkyl group.

9. The gasoline of claim 8, wherein the gasoline includes 25 to 300 ptb of the fuel performance additive in the gasoline.