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(54) Titre : UN ADDITIF DIESEL NON VOLATILE NOVATEUR PRESENTE UNE MICRO-EMULSIFICATION ET INDUIT UNE MICRO-EXPLOSION, CONVENANT AUX MOTEURS A COMBUSTION INTERNE PAR COMPRESSION, AUX DISPOSITIFS A COMBUSTION DIRECTE ET AUX MOTEURS A PROPULSION A REACTIO
(54) Title: A NOVEL NON-VOLATILE DIESEL ADDITIVE EXHIBITS MICRO-EMULSIFICATION AND INDUCES MICRO-EXPLOSION, SUITABLE FOR COMPRESSION INTERNAL COMBUSTION ENGINES, DIRECT COMBUSTION DEVICES ANDJET PROPULSION ENGINES

(57) **Abrégé/Abstract:**

The fuel additives of the present invention comprise essentially of about 3-15 weight % of Fatty Acid, about 30-40 weight % of Alkylene Glycol, about 0-1 weight % of Quaternary Ammonium Bromide, about 0-1 weight % of Siloxane Solution, about 5- 15 weight % of De-ionized Water, and about 45-55 weight % of Hydroscopic Liquid. These highly effective fuel additives are non-volatile, and can eliminate the formation of deposits and form air-borne micro-emulsion molecules, and induce micro- explosion in any internal compression combustion engines, particularly, in the fuel injection system and any direct combustion diesel burners.

Abstract

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A Novel Non-Volatile Diesel Additive Exhibits Micro-Emulsification and Induces Micro-Explosion, Suitable for Compression Internal Combustion Engines, Direct Combustion Devices and Jet Propulsion Engines

5 Background of the Invention

1. Field of the Invention

The present invention is related to novel fuel additives which are non-volatile and more effective and environmentally safer than the relatively flammable naphtha and/or naphthalene containing engine fuel additive products. The inventive fuel compositions are
10 suitable for compression combustion of diesel engines, direct combustion devices, as well as jet propulsion engines.

2. Description of the Prior Art

The performance of the compression combustion engine may be adversely affected by
15 the formation of deposits in or around the fuel dispensing system and in the combustion chamber. Even when present in minor amounts, these deposits, would cause incomplete combustion, as a result a noticeable reduction in the performance of the engine, thus increase in fuel consumption, and the production of exhaust pollutants.

It is generally accepted that deposit formation is largely dependent on the fuel
20 composition, and to a lesser extent, on the engine design and on the operating conditions of the engine. In an effort to control deposit formation, considerable efforts have been directed toward developing fuel additives that could facilitate the complete combustion of fuel, thereby reduced the tendency to cause the formation of deposits. In particular, the majority of the

researches have been directed toward developing fuel additives that either prevent or reduce the formation of such deposits.

For example, it has been proposed to employ various alkyl ethers, as fuel additive, for the purpose of dissolving deposits generated by diesel fuel. Such attempts are described in
5 U.S. Pat. Nos. 2089580, 2104021, 2221839, 2563101, 2786745, 2930681, 3032971, 3103101, 3270497, and 5425790. As described in those patents, it is frequently the practice to employ such ethers either alone or in combination with alcohol to provide improved performance characteristics in a variety of liquid hydrocarbon fuels.

U.S. Pat. No. 5912189 discloses compositions that are useful as fuel additives for
10 reducing intake valve deposits. Such compositions comprise the reaction product of: (a) a cyclic compound containing at least one nitrogen and at least one carbonyl group; (b) an aldehyde or ketone; and (c) an ether amine.

U.S. Pat. No. 5873917 discloses compositions that are useful in reducing intake valve deposits. Such compositions contain: (a) a polyether alcohol; (b) a hydrocarbon phenol; and (c)
15 optionally, a nitrogen-containing dispersant.

U.S. Pat. No. 4818250 further discloses other alternatives to conventional fuels, including U.S. Pat. No. 4131434 to Gonzalez, which is directed to a fuel additive for diesel oil, to improve fuel efficiency and reduce resulting air pollutants. Exemplary Gonzalez additives are aromatic and aliphatic hydrocarbon solvents with and without oxygenated functional
20 groups, terpene, and aromatic nitrogen containing compounds.

US Pat. No. 7828862 to Leung et al. discloses a type of fuel additive compositions that can eliminate the formation of deposits and form air-borne micro-cluster molecules in internal

combustion engines, particularly, in the fuel injection system and combustion chamber of such engines.

Q.H. Zho (<http://www.docin.com/p-273607035.html>) studied and reported the thermodynamic properties of methanol induced micro-emulsion in bio-diesel. The mathematical models and numerical methods of diesel engine combustion were systematically studied. The model of turbulence and droplet with spraying, the model of kinetic and equilibrium chemical reaction were analyzed, as well.

Despite such efforts, further improvements in the art are needed. Specifically, what are needed are fuel additive that is non-volatile, containing a more powerful, micro-emulsion that functions as fuel surface tension softener that lubricates the parts, as well as inducing micro-explosion within the fuel droplet in the combustion chamber of the compression combustion engines. Fuel compositions also include traces amount of silicones, as hydrocarbon accelerant, to facilitate a full combustion within the combustion cycle, therefore reduces toxic emissions, such as carbon monoxide and nitrogen oxides.

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Summary of the Invention

The present invention provides a fuel additive composition for use in compression combustion engines comprising:

- (a) about 3 to 15 Wt % of Fatty Acid
- (b) about 30 to 40 Wt % of Alkylene Glycol
- (c) about 0 to 1 Wt % of Quaternary Ammonium Bromide
- (d) about 0 to 1 Wt % of Solution of Siloxane
- (e) about 5 to 15 Wt % of De-ionized Water

(f) about 45 to 55 Wt % of the Hydroscopic Liquid

The present invention provides a fuel composition comprising the additives above. The additives can be used for kerosene and diesel fuels. Such fuel additive compositions are particularly suited for controlling fuel deposits in engines, and are expected to reduce combustion chamber deposits in such engines. The present invention additionally provides micro-emulsion for controlling the formation of spray droplet, thus, reducing toxic incomplete gas emissions, such as: carbon monoxide and / or nitrogen oxides, and particularly, in the fuel compression system and combustion chamber of such engines. The method involves fueling and operating such engines with this fuel additive invention comprising alkylene glycol, oleic acid and hydroscopic solution as the main ingredients.

Description of the preferred Embodiment

The present invention is directed to fuel additives for diesel compression engines, as well as jet propulsion engines. The characteristics of the inventive fuel additive include its non-volatility, greater efficiency in terms of km per hour (km/h), improved safety due to a lower vapor pressure, cleaner burning resulting in fewer emissions and particulates being released into the atmosphere, and cooler burning engines.

The preferred Fatty Acid is Oleic Acid, which occurs naturally in various animal and vegetable fats and oils. It is an odorless, colorless oil and has the chemical formula of $\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$.

Depending upon the particular components present and the type of engine for which it is formulated, the inventive fuels preferably comprise from about 30 wt % to about 40 wt % Alkylene Glycol, more preferably from about 35 wt % to about 40 wt % of Propylene Glycol.

Propylene Glycol is an oxygen rich molecule, with 44% of oxygen in the molecule. It is an efficient fuel for complete combustion in the internal combustion engine chamber. However, due to its relatively high polarity (dipole moment of 2.25D & 2.55D), it is immiscible with the non-polar diesel fuel. With reference to Q.H. Zho (<http://www.docin.com/p-273607035.html>), a medium chain fatty acid was used, as an emulsifier to interconnect the Propylene Glycol molecules into the diesel. The preferred medium chain fatty acid is preferred to be Oleic Acid from about 3 wt % to 15 wt %, more preferably from about 5 wt % to about 10 wt %.

The additive of the present invention also comprises traces amount, 0 wt % to 1 wt % of Quaternary Ammonium Bromide as surface active agent, is more preferably Cetyl Trimethyl Ammonium Bromide, which is a cationic surfactant with anti-bacteria function.

The additive of the present invention also comprises a solution of Siloxane and or its derivatives, as a hydrocarbon accelerant, is more preferably Polydimethylsiloxane, which is a viscous liquid of 50 cSt or more. The preferred Solution of Siloxane and or its derivatives is Siloxane Solution. Comprising about 0 wt % to 90 wt % of Polydimethylsiloxane, more preferably from 30 wt % to 70 wt %, is homogenized in Pine Oil. Quoting from *the Lubricants and Fuel Additives Manual*, editors W.X. Huang et al., published from China Petroleum Press 1994, the present of Silica, in Siloxane Derivative, would facilitate combustion by elevating the burning temperature inside the combustion chamber, thus furnishing complete combustion. However, Siloxane is an inert compound, rendering its

relatively high chemical resistance characteristic. The present invention discloses Polydimethylsiloxane, from about 0 wt % to 90 wt %, be readily dissolved in Pine Oil to form a homogeneous liquid, more preferably from about 0 wt % to about 1 wt %.

The additive of the present invention also comprises 5 wt % to 15 wt % of De-ionized Water as aqueous media, which forms super micro-emulsified molecules with the organic substrates, more preferably from 10 wt % to 15 wt %.

The additive of the present invention also comprises 45 wt % to 55 wt % of Hydroscopic Liquid, which has a strong hydrophilic (water-liking) tendency with De-ionized Water, more preferably from 50 wt % to 55 wt % of 2-(2-Butoxy-Ethoxy) Ethanol.

All of the above inventive fuel additives are suitable for diesel and kerosene fuels preferably, diesel having a cetane number of at least 45. A preferred diesel additive formulation comprises from about 3 to about 15 wt % Fatty Acid, more preferably about 5 to 8 wt % of Oleic Acid. The preferred fuel additive invention also comprises from about 30 to 40 wt % of Alkylene Glycol, more preferably about 35 to 40 wt % Propylene Glycol. The preferred fuel additive invention further comprises trace amount about 0 to 1 wt % of Quaternary Ammonium Surfactant, more preferably about 0.01 to 0.1 wt % of Cetyl Trimethyl Ammonium Bromide. The preferred fuel additive invention further comprises trace amount about 0 to 1 wt % of Siloxane Solution, more preferably about 0.01 to 0.1 wt %. The preferred fuel additive invention comprises from most preferably about 5 to 15 wt % of De-ionized Water more preferably about 10 to 15 wt %. The preferred fuel additive invention further comprises about 45 to 55 wt % of Hydroscopic Liquid, more preferably about 50 to 55 wt % of 2-(2-Butoxy-Ethoxy) Ethanol.

The fuel additives of the present invention can be blended with either kerosene or diesel fuel as needed for different types of engines. The said fuel additive is added in an amount sufficient to produce a fuel additive : fuel (kerosene or diesel fuel) volume ratio of 1:1000.

5 The concepts of the present invention reside in a novel fuel additive, which are not only non-volatile and inexpensive to manufacture, but also have the capability of enhancing the performance characteristics of kerosene and diesel fuels, such that the treated kerosene/diesel fuels, when consumed in an internal combustion or direct combustion engine, burn far more efficiently with substantially less emissions. It has been found that the treated
10 fuel according to the present invention provides not only greater fuel mileage but also provides increase horsepower realization. In accordance with the concepts of the invention, the fuel additives are formulated with a novel combination of components, which function together to significantly reduce hydrocarbon emissions in the burning of kerosene/diesel fuel to which the additive has been combined in internal combustion or direct combustion engines.

15 Accordingly, the present invention includes novel fuel additives that control the formation of deposits in engines. Such fuel additive compositions are particularly suited for controlling fuel injection system deposits in engines, and are expected to reduce combustion chamber deposits in such engines. The fuel additives of the present invention also function as fuel surface tension reducing agent to reduce the surface tension of the fuel.

20 The fuel additives of the present invention comprise Oleic Acid, Propylene Glycol, Cetyl Trimethyl Ammonium Bromide, Siloxane Solution, De-ionized Water and 2-(2-Butoxy-Ethoxy) Ethanol. The presence of Oleic Acid appears to enhance the formation of, Propylene Glycol / De-ionized Water / Cetyl Trimethyl Ammonium Bromide / 2-(2-Butoxy-Ethoxy)

Ethanol, micro-emulsion in the diesel fuel. The Siloxane Solution acts as the hydrocarbon accelerant within the fuel system containing the additive so as to facilitate the complete combustion of the treated fuel.

The fuel additives of the present invention can be blended with kerosene or diesel fuel as needed for different types of engines. The said inventive fuel additives can also be mixed with kerosene or diesel fuel, in the respective ratios from 1:1000.

According to the present invention, the characteristics of the inventive fuel additive include greater efficiency in terms of km per hour (km/h), improved safety due to a lower vapor pressure, cleaner burning resulting in fewer emissions and particulates being released into the atmosphere, and cooler burning engines.

The following formulations are not intended to limit the scope of the invention, but are intended to illustrate the various aspects of the invention.

Formulation 1:

1.	Oleic Acid	5 Wt %
2.	Propylene Glycol	35 Wt %
3.	2,2-Butoxy-Ethoxy Ethanol	50 Wt %
4.	De-ionized Water	10 Wt %
5.	Cetyl Trimethyl Ammonium Bromide	Trace 0.01 Wt %
6.	Siloxane Solution	Trace 0.01 Wt %

Formulation 2:

1.	Oleic Acid	4 Wt %
2.	Propylene Glycol	35 Wt %
3.	2,2-Butoxy-Ethoxy Ethanol	50 Wt %

- | | |
|-------------------------------------|-----------------|
| 4. De-ionized Water | 11 Wt % |
| 5. Cetyl Trimethyl Ammonium Bromide | Trace 0.01 Wt % |
| 6. Siloxane Solution | Trace 0.01 Wt % |

5 Source of Chemical Supplier:

- | | |
|--|---|
| Propylene Glycol | Goldward Fine Chemicals Ltd., Hong Kong |
| Oleic Acid [Oleic Acid] | Goldward Fine Chemicals Ltd., Hong Kong |
| 2-(2-Butoxy-Ethoxy) Ethanol | Goldward Fine Chemicals Ltd., Hong Kong |
| Pine Oil [65 Pine Oil or 85 Pine Oil] | Goldward Fine Chemicals Ltd., Hong Kong |
| 10 Polydimethylsiloxane [DC 200 Fluid] | Dow Corning Corporation, United States |

Preparation of Solution of Siloxane and its Derivatives:

50 Wt % Polydimethylsiloxane, and 50 Wt % of Pine Oil were respectively added to form the homogeneous Siloxane Solution.

15

Preparation of Formula 1:

5 Wt % Oleic Acid, 35 Wt % of Propylene Glycol, 50 Wt % 2-(2-Butoxy-Ethoxy) Ethanol, 0.01 Wt % of Cetyl Trimethyl Ammonium Bromide, and 10 Wt % of De-ionized Water were respectively added to form the homogeneous Formula 1.

20 Preparation of Formula 2:

4 Wt % Oleic Acid, 35 Wt % of Propylene Glycol, 50 Wt % 2-(2-Butoxy-Ethoxy) Ethanol, 0.01 Wt % of Cetyl Trimethyl Ammonium Bromide, and 11 Wt % of De-ionized Water were respectively added to form the homogeneous Formula 2.

Experiment (I): Fuel Efficiency for Direct Combustion Diesel Engine

Formula 1 of this Invention was chosen to compare with the Ultra-Low-Sulfur-Diesel (ULSD) Fuel. Objective of the Experiment was to assess and measure the Fuel Efficiency of the Invention. Studies were conducted with the HURST Brand Diesel Boiler made in 2016 (Max W. PSI: 150, Steam lbs/hour: 6900, MGT Serial No.: ES702150164). A ratio of 1/1000, fuel additive / ULSD Fuel (v/v), was employed to be tested at the mentioned direct combustion diesel burner, which proportion was considered to be the most effective dose.

The direct combustion diesel burner was run for a period of 60 minutes, at 15 minutes intervals, with (A). Neat Diesel; and (B). Diesel + 0.1% Formula 1. Results of the comparison were recorded in Table 1.

Table 1 indicates that, addition of Formula 1 of the Invention to ULSD Fuel in a ratio of (1:1000), a significant increase in fuel efficiency were recorded, as early as the first 15 minutes. Data from "Temperature of Exhaust Chimney" also showed a lower exhaust temperature was observed with Formula 1 added. It was also recorded that there was a drop in the "Fuel Reflow Pressure" detected by the Boiler's build-in temperature sensor.

Table 1

Time	Diesel Used	Fuel Intake Pressure	Fuel Reflow Pressure	Boiler Steam Pressure	Power	Temp. of Exhaust Chimney
(A) Neat Diesel						
0 Minute	0 L	292 PSI	103 PSI	70 PSI	High	200°C
15	24.17 L	292 PSI	103 PSI	70 PSI	High	200°C
30	50.93 L	290 PSI	85 PSI	72 PSI	High	200°C
45	72.75 L	290 PSI	73 PSI	72 PSI	High	200°C
60	97.39 L	290 PSI	73 PSI	72 PSI	High	200°C
(B) Diesel + 0.1% Formula 1						
0 Minute	0 L	290 PSI	90 PSI	72 PSI	High	196°C
15	23.94 L	292 PSI	89 PSI	72 PSI	High	195°C
30	48.11 L	290 PSI	76 PSI	72 PSI	High	187°C
45	69.23 L	290 PSI	62 PSI	73 PSI	High	179°C
60	83.08 L	290 PSI	63 PSI	73 PSI	High	179°C

Experiment (II): Fuel Efficiency for Diesel Fueled Generator

5 A China made Diesel Fueled Generator was used to measure the fuel performance of (i). SinoPetro Diesel; (ii). Formula 1 in SinoPetro Diesel at a ratio of (1:1000, v/v); and (iii). Formula 2 in SinoPetro Diesel at a ratio of (1:1000, v/v). Experiments were conducted by the KDE 2200X Diesel Engine Generator, 50Hz. A ratio of (1:1000, v/v), fuel additive : diesel, was employed to be tested at the mentioned Diesel Fueled Generator, which proportion was considered to be amongst the most effective doses.

10

The Generator was allowed to run on SinoPetro Diesel for 30 minutes or more, until the reading of the Voltage Meter of the Generator became steady at 220V. The energy generated by the Generator was loaded to a 230W Ventilator with frequency of 50Hz. Then, an accurately measured 200.00g of (1). SinoPetro Diesel; (2). 0.1% Formula 1 in SinoPetro

Diesel; and (3). 0.1% Formula 2 in SinoPetro Diesel, was respectively tested for their performances. Data were recorded in Table 2, for analysis.

Table 2

Amount of Fuel	SinoPetro Diesel	0.1% Formula 1 in SinoPetro Diesel	0.1% Formula 2 in SinoPetro Diesel
250g	45 minutes 16 seconds	48 minutes 12 seconds	47 minutes 50 seconds

5 From the results in Table 2, both (0.1% Formula 1 in SinoPetro Diesel) and (0.1% Formula 2 in SinoPetro Diesel) outperformed SinoPetro Diesel by 6.48% and 5.67%, respectively.

Experiment (III): Heat of Combustion in Diesel

10 In this Experiment, (1). SinoPetro Diesel; and (2). 0.1% Formula 1 in SinoPetro Diesel, was respectively used as fuel to heat a container of water. The Heat of Combustion of each fuel was determined by the following equations:

$$Q = \text{Weight of Water (g)} \times \text{Specific Heat Capacity of Water (kJ/g}^\circ\text{C)} \times \text{Change of Temperature (}^\circ\text{C)}$$

$$H = -Q / \text{Mass of Fuel burned}$$

Remarks:

1. Q is Heat Transferred to the water, with unit in kilojoules, (kJ)
2. H is Heat of Combustion, with unit in kilojoules per g, (kJ/g)

20 The corresponding fuel was filled into a burner with a wick contacting the fuel. The weight of the fuel was recorded by a 3 decimal electronic balance. 50 Grams of water was

accurately measured in a beaker. Temperature of Water before heating was recorded as initial temperature. The beaker containing water was then placed on the burner, about 3 cm above wick. The wick was lit and the temperature of the water was monitored, until it reached 45°C. The light was then extinguished and the highest temperature of the water was recorded as final temperature.

Table 3, below, showed the results of “Heat of Combustion” of both the SinoPetro Diesel and (0.1% Formula 1 in SinoPetro Diesel).

	SinoPetro Diesel	0.1% Formula 1 in SinoPetro Diesel
Initial Wt. of Diesel	314.611g	314.944g
Final Wt. of Diesel	314.305g	314.655g
Wt. of Water	50.000g	50.002g
Initial Temp. of Water	21.111°C	21.111 °C
Final Temp. of Water	46.111 °C	46.667 °C
Amount of Heat Transferred to Water	5.225kJ/g	5.341kJ/g
Heat of Combustion	17.07516 kJ/g °C	18.48097 kJ/g °C

From the results of Experiment (III), the “Heat of Combustion” of the fuel with, 0.1% Formula 1 in SinoPetro Diesel (18.48097kJ/g°C), is 8.233% more than pure SinoPetro Diesel (17.07516kJ/g°C).

According to the present invention, the characteristics of the inventive fuel additive include Fuel Efficiency and Heat of Combustion, have demonstrated in all of the Experiments (I), (II), and (III). The fuel additives of the present invention can be blended with either kerosene or diesel fuel as needed for different types of engines or burners. The said inventive
5 fuel additives can also be mixed with kerosene or diesel fuel, in the respective ratios from 1:800 to 1:1200.

It is to be understood that the invention is not limited in its application to the details of the fuel additive. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood, that the phraseology and terminology
10 employed herein are for the purpose of description and should not be regarded as limiting.

As such, those skilled in the art will appreciate that the conception, upon which this disclose is based, may readily be utilized as a basis for designing other chemical compositions, formulae and fuels for carrying out the several purposes of the present invention. And the abstract of the present invention is just an abstract, not intended to be limiting as to the scope
15 of the invention in any way.

Claims:

1. A fuel additive composition for use in internal combustion engines comprising:
 - (a) about 3 to 15 Wt % of Fatty Acid
 - (b) about 30 to 40 Wt % of Alkylene Glycol
 - (c) about 0 to 1 Wt % of Quaternary Ammonium Bromide
 - (d) about 0 to 1 Wt % of Siloxane Solution
 - (e) about 5 to 15 Wt % of De-ionized Water
 - (f) about 45 to 55 Wt % of Hydroscopic Liquid
2. The fuel additive compositions according to claim 1 wherein said fuel additive is added in an amount sufficient to produce a fuel additive : fuel volume ratio of between about 1:800 to 1:1200.
3. The composition according to claim 1(a), wherein, which said Fatty Acid is selected from the group consisting of Stearic Acid, Palmitic Acid, Oleic Acid, and Ricinoleic Acid or a mixture thereof.
4. The composition according to claim 1(b), wherein, said Alkylene Glycol is selected from the group consisting of Ethylene Glycol, and or Propylene Glycol.
5. The composition according to claim 1(c), wherein, said Quaternary Ammonium Bromide is consisted of Cetyl Trimethyl Ammonium Bromide.
6. The composition according to claim 1(d), wherein, said Siloxane Solution is prepared by dissolving from 0 to 90%, v/v, Siloxane and or its derivatives, of any viscosity, in Pine Oil and or Glycol Ether and or R-amine in any ratio.
7. The composition according to claim 1(e), wherein, said De-ionized Water is prepared by ion exchange column, or if such device is not available, any natural source of water or tap water will also do, nonetheless.
8. The composition according to claim 1(f), wherein, said Hydroscopic Liquid is selected from the group consisting of 2-(2-Butoxy-Ethoxy) Ethanol, Diethylene Glycol Monoethyl Ether, Ethylene Glycol Butyl Ether, Propylene Glycol Methyl Ether, Propylene Glycol Ethyl Ether, and Propylene Glycol Tertiary Butyl Ether.