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(54) **Title:** Fuel For Advance Vapour Phase Combustion

(57) **Abstract:**

Cold high energy fuel compositions for jet, turbine, diesel and gasoline combustion engines. The fuel comprises EHS (Enhanced Combustion Structure) compounds and a combustion-improving amount of fuel soluble metallic compounds of high heating value. The EHS compounds have a latent heat of evaporation of at least 21 kJ/mol at boiling point and a laminar Bunsen flame velocity of at least 40 cm/sec. The combustion-improving fuel of soluble metallic compounds has a heating value of at least 5000 Kcal/kg

(56) **Documents Cited:** US- 3030195 A; US- 3224848 A; US- 3346648 A

UNLEADED MMT FUEL COMPOSITIONS

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to fuel compositions for jet, turbine, diesel, and other combustion systems. More particularly, it relates to organomanganese fuel combinations, mechanical and/or chemical means capable of improving combustion, and/or reducing combustion temperatures, whereby thermal efficiency and hazardous emissions are improved.

Description of the Prior Art

The incorporation of various organo-manganese compounds as anti-knock agents (e.g. methylcyclopendienyl manganese tricarbonyl -MMT, et al.) in hydrocarbon fuels is known. See U.S. Patents 2,818,417; 2,839,552; and 3,127,351 (incorporated herein by reference). Organo-manganese's use in heavier fuels such as coal, diesel and jet aviation fuels is also known and believed to help reduce smoke and solid particulate emissions. See U.S. Patents # 3,927,992; 4,240,802; 4,207,078; 4,240,801.

Despite organo-manganese's anti-knock and other benefits, its use in hydrocarbon fuels produces another set of environmental and practical problems. Namely, organo-manganese compounds when combusted in hydrocarbon fuels generate harmful heavy manganese oxides (Mn_3O_4 and Mn_2O_3), which in turn coat engine parts, combustion systems, turbines, exhaust surfaces, emission/exhaust catalysts, etc., causing for example, early fatigue, failure, excessive wear, particulate emissions of metals, long term hydrocarbon emission degradation, and the like. See U.S. Patents 3,585,012; 3,442,631; 3,718,444; and my EPO Patent # 0235280.

For example, deposition of manganese oxide on jet engines, turbines, and the like, has long been a major obstacle to manganese's use. Due to the severity of these deposits, various methods were developed just to remove the oxides from jet engines. See U.S. Patent 3,556,846; 3,442,631; 3,526,545; 3,506,488. Unfortunately, due to the magnitude of this disability, manganese usage has been virtually halted in such applications.

It is also known that such deposits create a diffusional barrier on catalyst surfaces, which degrades catalytic efficiency. See Williamson, Gandhi, Weaver, "Effects of Fuel Additive MMT on Contaminant Retention and Catalyst Performance," SAE Paper 821193, 1982.

Thus, there was an extensive effort by Ethyl Corporation throughout the 1970's and 1980's to find a solution to this problem. Their effort included employing various oxygenated compounds in combination with organomanganese. See for example U.S. Patents Re. 29,488; 3,950,145; 3,948,618; 4,028,065; 4,052,171; 4,141,693; 4,191,536; 4,317,657; 4,175,927; 4,082,517; 3,958,955; 3,926,581; and 3,926,580. However, there has was no successful commercialization of any technology solving this fundamental problem, despite overwhelming need.

Thus, those skilled in the art have known for some time that organo-manganese, even at very low levels, causes the failure of U.S. regulated exhaust emission control systems, and that its use at any level is legally prohibited in unleaded gasolines within the U.S..

Even so, Ethyl Corporation's last failed effort to obtain an E.P.A. Waiver for MMT under § 211 (f) of the Clean Air Act was for a very modest manganese concentration of 1/32 gr (denied January 8, 1992).

All its prior efforts, including at manganese concentrations ranging from 1/64 to 1/8 gr, have resulted in failure. See generally Environmental Protection Agency RE Denial of Applications for MMT Waiver, Federal Register, Vol 43, No. 181, Monday September 18, 1978, and Ethyl Corporation; Denial of Application for Fuel Waiver; Summary of Decision, Federal Register, Vol. 46, No. 230, Tuesday, Dec. 1, 1981.

Recently, automotive manufacturers have raised renewed concerns regarding manganese's propensity to form deleterious oxides, that even at very low concentrations of 1/32 gram manganese, new onboard catalyst diagnostic systems known as "OBD-11 catalyst efficiency monitors" are impaired due oxide deposition on catalyst wash coat surfaces. See Hurley, Hansen, Guttridge, Gandhi, Hammerle, and Matso, "The Effect on Emissions and Emission Component Durability by the Fuel Additive Methylcyclopentadienyl Manganese Tricarbonyl (MMT)," SAE Paper 912437, 1991; Hurley et al, "Characterization of Automotive Catalysts

Exposed to the Fuel Additive MMT," SAE Paper 890582, 1989; Hubbard el al, "Effect of MMT on the OBD-II Catalyst Monitor," SAE Paper 932855, 1993.

Thus, those skilled in the art, continuing to recognize MMT's long legal and environmental prohibitions, have generally abandoned the notion that manganese will ever be included in regulated unleaded gasolines and emission systems.

Even Ethyl Corporation (the sole manufacturer of MMT) for want of a real solution to abate or control adverse oxides, appears resigned to accept if an approval is ever to be granted, it will be for only very modest concentrations (e.g. up to 1/32 gr mn), and that catalyst coating even in these "small concentrations" is still a given. See Ethyl's last § 211 (f) Waiver Application and her EPO Applications 92302679.3; 91306359.0; 91306360.8; and 92307609.5. (filed concurrently with the Waiver effort).

The use of a broad class of fuel soluble carbonates is disclosed in the art. See U.S. Patent 2,331,386 (issued in 1939 prior to the present manganese oxide concern). This patent discloses a wide range of alkyl, homologous alkyl, aryl, and amide carbonated esters for use in oil furnaces and internal combustion engines.

Subsequent carbonate disclosure is found in the art and generally in the context of fuels or compositions that are metal/manganese free. For example, U.S. Patents # 4,891,049, 4,904,279 and 5,004,480 disclose metal free alkyl carbonates in middle distillate fuels for compression ignition, diesel, and jet engines.

U.S. Patent 4,600,408 (issued in 1986) discloses an alkyl phenyl carbonate as an anti-knock agent. This reference, noting the aforementioned organo-manganese oxide problem, likewise discloses the composition must be organo-manganese free.

Since those skilled in the art have long since abandoned hopes of solving organo-manganese's fundamental oxide disability, and given that manganese is only legal in U.S. leaded gasolines, practitioners have been disinclined to separate MMT from lead additive usage. See for example, European Patent Application 91306278.2 related to "Unsymmetrical dialkyl carbonate fuel additives," which apparently recognizes this reality by disclosing tetraethyl lead, tetramethyl lead and cyclopentadienyl tricarbonyl manganese together in the same context, absent suggestion of employing them independently of each other.

Summary of Invention

Applicant has discovered a new class of high energy cool combustion compositions and processes.

The essence of Applicant's invention resides in the discovery of the source of heavy metal oxidation problem, namely the means to prevent heavy oxide generation during metallic combustion.

Applicant has discovered the operating mechanism causing fuels containing metallics, including organomanganese compounds to generate adverse heavy particulate/coating Mn oxides during combustion, which is namely caused by a less than ideal combustion process wherein combustion burning velocities and temperatures are not optimum.

By effectively increasing the burning velocity of the fuel, while ideally reducing combustion temperatures, Applicant not only controls or avoids the generation of adverse metallic oxides, but liberates the capacity of non-lead metallics to become principles in a new clean "high energy source" class of propellants/fuels and combustion process.

In essence Applicant has discovered a combustion process that comprises certain chemical structure/sub-structure and/or mechanical structure/sub-structure that simultaneously 1) increases burning velocity, 2) sustains a high release rate of what might be known as free energy, at 3) reduced combustion temperatures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1. **Combustion Temperature Differences,** compares differences in combustion temperatures of differing fuel compositions measured via exhaust gas temperatures at different engine loads.

Figure 2. **Combustion Temperatures and Hydrocarbon Emissions,** compares combustion temperature differences and their relationship to the generation of hydrocarbons emissions.

Figure 3. **Combustion Temperatures and NOx Emissions,** compares combustion temperature differences and their relationship to the generation of NOx emissions.

Figure 4. **Indicated Burning Velocity,** compares the burning velocity of different fuels under differing loads.

Figure 5. **Burning Velocity and HC Emissions,** compares burning velocity to the generation of HC emissions.

Figure 6. **Burning Velocity and NOx Emissions,** compares burning velocity to the generation of NOx emissions.

Figure 7. **Technical Enleanment,** shows warm driveability and combustion improvements of gasoline due to maintaining minimum distillation temperatures for fuel containing oxygenated compounds.

DETAILED DESCRIPTION OF INVENTION

Applicant's discovery is discovery of the source of the heavy metallic oxide problem and its attendant solution, e.g increased burning velocity and/or reducing combustion temperatures, which is in essence the invention.

Applicant has discovered methods and compositions that accelerate and improve combustion to a more optimum state, while simultaneously reducing combustion temperatures and extending combustion interval.

Applicant has further discovered, under these improved combustion conditions, the metallic, itself, most unexpectedly becomes an integral and powerful agent in the combustion process, unexpectedly improving combustion thermal efficiencies, fuel economy, net available work, power generation, thrust, and the like, while simultaneously reducing hazardous pollutants.

In the context of this invention, Applicant generally refers to thermal efficiency, hereinafter, in both its chemical and mechanical context, e.g. the efficiency of the chemical reaction and the amount of useful work generated in the system, e.g. free energy.

Applicant has found in virtually every case, thermal efficiency, particularly as measured as a function of net useful work generated by the system is increased. Often very substantially. Simultaneously, due to the cool nature of the combustion temperatures, combustion systems will enjoy extended useful life, and ease of operation, as heavy oxides are not formed.

For example, Applicant's has unexpectedly discovered thermal efficiency over existing fuels and combustion systems to be on the order of 2.0% to 20%. And, depending upon the circumstances (e.g. combustion systems, fuel configurations) average improvements can range from 2.0% to 5.0%, 5.0% to 10.0% or higher, with modest improvements ranging from 0.05% to 1.0% to 2.0%. Exceptional improvements will range from 10%, 25% to 40%, 30% to 80%, or more.

Additionally, Applicant ultimately expects additional improvements on the order of 5% to 25%, or more, due to modifications of combustion and fuel injection systems designed to optimize the unique combustion features of Applicant's invention.

Applicant expects significant combustion and energy conversion improvements at altitude in the case of aviation jet systems, aviation gasoline engines. Similar improvements are contemplated for a wide range of applications, e.g. diesel, gasoline, fuel oils, gas oil turbines, etc.

Applicant's combustion methods, fuel chemistry, combustors, fuel injection system, air breathing and emission system are critical structure to the practice of this invention.

Applicant has found unexpected synergism and multiple advantage that will become evident in employing this invention, as will become more fully described below.

Thus, novel design, method, and/or operation of an engine, a combustor, combustion system, injection, air-breathing and/or emission systems, enhancing the combustion object of Applicant's invention are express embodiments.

The simultaneous operation of one or more said systems, or the independent employment of a single system, or component or sub-component of said system, is contemplated in the practice of this invention. Further, it is an embodiment such structure may be employed independently of Applicant's enhanced combustion fuels, which are independently capable of achieving enhanced burning velocity and/or reduced combustion temperatures.

However, the coupling of the systems achieves synergism, which could not otherwise be achieved.

The invention fundamentally resides in increasing 1) burning velocity by a) increasing laminar burning velocity (ECS chemical and/or distillation modification means), b) increasing turbulent velocity (chemical and/or mechanical means), 2) reducing combustion temperature (chemical or mechanical means), in combination with a metallic component based fuel.

Thus, applicant's invention incorporates multiple interrelating chemical and mechanical elements, all vital to the practice of the invention.

It is an embodiment of this invention to employ any number of non-lead metallics (cyclomatic manganese compounds however are initially preferred), as a component of Applicant's fuel composition.

However, metallic use is not required, as will become evident below. Thus, in the disclosure below it is expressly contemplated disclosure of a metal may be read in the alternative.

It is contemplated that compounds/components and/or chemical and/or mechanical, processes, methods and means, including combinations and subcombinations thereof, which increase combustion burning velocity be employed. It is preferred that, while not required, that combustion temperatures be simultaneously reduced.

In the practice of the invention, should an oxygenated compound be employed, maximizing oxygen is a desire. Oxygen contents may range from 0.0001 to 80.0% by weight. Individual fuel composition and combustion systems dictate. However, beneficial results do not tend to occur until 1.0%, 1.5%, 2.0% or more oxygen is included. More preferred concentrations are 2.0% or more. However, smaller concentrations are acceptable in co-fuel applications. A desirable range is from 0.001 to 30.0% oxygen by weight. Additional weight concentrations of oxygen include 0.001 to 15.0%., 0.5% to 1.5%, 0.3% to 2.7%, 2.0% to 3.7%, 0.2% to 0.9%, 1.0% to 4%, 2.0% to 8.0%, 1.8% to 12%, 2.0% to 10.0%, 3.0%, 5.0% to 40%, 2.0% to 53%

It is anticipated in neat fuel and rocket applications, oxygen concentrations will be significant. In initial co-fuel applications (see below) concentrations will be more modest. However, it is an object to include significant concentrations of oxygen in Applicant's fuels, especially reactive oxygen, which can quickly and aggressively react with the metallic.

In the practice of this invention, acceptable increases in the rate of the fuel's burning velocity over an unadjusted fuel or combustion system will range from 1.0% to approximately 800%, or more. Velocity increases of 0.2%, 0.5%, 1.0%, 2.0%, 3.5%, 5% to 10.0%, 7.0% to 15.%, 9.0% to 25%, 5.0% to 20%, 12% to 30%, 15% to 40%, 20% to 50% are desirable. More desireable increases range from 5% to 60%, 10% to 80%, 20% to 100%, 30% to 150%. Other increases are from about 100% to 200%, 100% to 300%. Increases of 200% to 400%, 300% to 600%, 400% to 800%, 500%

to 900% are also contemplated and desireable. Increases of 300%, or more, are highly desireable, especially in Applicant's advance fuel and combustion systems. Increases outside these ranges are contemplated and desireable.

Differing chemical means will also influence differing burning velocity increases, and fuel application. It is an express object of this invention to optimize burning velocities in light of the fuel chemistry, combustion systems, fuel injection and air breathing systems, operating conditions, desired thermal efficiency, and cost.

Burning velocity increases and/or combustion temperatures reductions will vary depending upon the modifications to fuel compositions, combustion and mechanical systems.

It is expressly contemplated that compression ratios, compression pressures, combustion pressures, combustion chamber design, temperature of unburned gas compositions, equivalence ratios, ignition timing, residual gas fractions, fuel injection pressures and timing, air breathing systems, air input temperatures, exhaust systems, exhaust catalysts, heat exchange method/systems, lubrication systems, coolant systems, and/or related methods and/or devices, including combinations and/or subcombinations thereof, will be modified to beneficially take advantage of, enhance, or otherwise make possible the improvements in burning velocities and/or reduction in combustion temperatures.

It is anticipated that knock sensor technology may be employed in higher compression spark ignited engines, operating on gasoline, as necessary to control spark timing to avoid knock. Thus, it is contemplated that Applicant's preferred higher compression ratio engines will simultaneous employ knock sensor technology.

It is contemplated that many applications of the invention will not be fully appreciated until certain thresholds of operation are achieved. For example, and as will be set forth in more detail below, the benefits of improved fuel economies may not fully appear until the engine is operated under moderate to moderately heavy load conditions. Furthermore, absent other adjustments mechanical modification, e.g. reductions in MBT spark advances for gasolines, etc., the full benefit of the invention can not be enjoyed.

Increases in the pre-ignition or post-ignition partial pressure of the vaporized fraction is particularly effective in influencing improvements in burning velocity. Thus, the character of the pre-ignition/post-ignition vaporized fraction and those features related to the diffusion of heat and active reaction centers in unburned gases, and the like, are determinative and are intended to be optimized as an object of this invention.

It is an object of Applicant's invention that the diffusion of pre/post ignition pre-combustion gases operate to increase the momentum/viscosity of the unburned gas to as close as possible to the viscosity of the burned gas, in order to reduce the viscous drag between the burned and the unburned gases. It is in the elimination of this drag, which the principal object of increases in burning velocity are achieved.

Thus, evaporation or injection or compression of the unburned fuel vapor fraction, in a such a manner, to increase its partial (vapor) pressure as gaseous mixture, prior to its combustion is desireable and contemplated.

Further, compounds/components and/or mechanical and/or other means that increase the temperature, velocity of the gaseous mixture within the combustion chamber post ignition/pre-combustion are preferred.

In the vapor state, fuel density differences of a given fuel do not necessarily directly influence improvements of burning velocity. In other words, burning velocity improvements of Applicant's invention do not appear necessarily sensitive to fuel type, once vaporized and/or once injected into the chamber/combustor in the manner and in the desired particle sizes contemplated by this invention.

Thus, compositional changes in the vapor fraction, due to changes in partial vaporization does not, in itself, necessarily produce measurable effect.

The rate of flame propagation relative to unburned gas, in practical fuel-air-residual gas mixtures is a fundamental parameter that directly influences the invention's beneficial objects. Thus, maximizing the elementary reactions that take place in the flame and adapting the mass and thermal diffusivity of the various gaseous species comprising the composition of enhanced combustion (see below), to yield increased combustion burning velocity, is an express embodiment of this invention.

As noted, it is an object to increase turbulent burning velocity, which is both a function of thermodynamic and turbulent parameters. Turbulence is related to engine design, combustion chamber design, fuel injection operation and engine operating parameters, such as equivalence ratio and spark timing.

It is an express embodiment of this invention to increase turbulent burning velocity by increasing laminar burning velocity, as increases in laminar are compounded in turbulent velocities.

It is an embodiment to increase laminar burning velocity by modifying thermodynamic factors, including but not limited to improving the thermal, diffusion, fuel chain branch characteristics of the fuel's composition enhancement chemistry, modifying distillation temperature, modifying ECS chemistry (see below), modifying fuel equivalency ratios, modifying spark advance, reducing injected fuel particle sizing, modifying injection angles, pressures, compression pressures, and improving air-breathing capability, and the like.

It is an embodiment to increase turbulence by modifications in shape and design of combustion system, combustor, combustion chamber and/or also from the velocity and/or direction of the gases flowing into the combustion chamber, before, during, and after combustion, e.g. pre-combustion chambers.

Those means that operate to increase combustion pressures and/or compression pressure are also desireable.

In the case of a spark ignited internal combustion engine, flame velocity is also proportional to intake velocity. However excessive intake velocities can materially reduce the weight of the fuel and air charge taken into the cylinder. To obtain high turbulence without high intake velocities, combustion chamber designs, which produce turbulence near the end of the compression stroke are desirable. Turbulent pre-combustion chambers, advanced fuel-air mixing systems and other means are preferred.

However, it is an embodiment of this invention to employ high intake velocities to increase turbulence, because ECS chemistry is able to materially offset reductions in charge weight. Thus, turbo-charging and super-charging are express embodiments and are preferred.

It is expressly contemplated that combustion systems, which have a lower relative octane number requirements (ONR), or which require lower compression ratio's, or which permit the use of a higher compression ratio on fuels of a given octane number, be employed.

Chemical and/or mechanical means, including for example, exhaust oxygen sensing systems (including EGO sensors) that adjust fuel-air equivalency ratios, which enhance the burning velocity object of this invention, are desirable and contemplated.

As will be evident that many chemical and mechanical means, and variations exist, which when combined and utilized in accord with Applicant invention, accomplish the objects of this invention.

BOILING TEMPERATURE REDUCTION AND MODIFICATION PRACTICE

Additional means of reducing combustion temperatures and improving burning velocities are contemplated. One such means is by reducing the end boiling point of the composition. Applicant has discovered that by reducing or eliminating higher boiling point hydrocarbons from the fuel, the fuel's average latent heat of vaporization is increased absent loss of work potential. Applicant has unexpectedly discovered that fuel economy improvements.

It is Applicant's intent that reduction and/or modification of hydrocarbon co-fuel's T-90, T-50, or T-10 distillation be modifying underlying hydrocarbons streams, or tailoring.

Thus, by reducing boiling temperatures, e.g. end boiling and T-90 temperatures, in combination with Applicant's invention, combustion temperatures and/or burning velocity is improved.

Wide boiling fuels benefit from end boiling, T-90 boiling and T-50 reductions including gasolines, gas oil turbine fuels, fuel oils, diesel fuels, and automotive gasolines. Limited application applies to narrower boiling fuels.

For example, in wide boiling petroleum fractions, e.g. diesel, heavy diesel, gas oil turbine fuels, wide cut jet fuels (Jet B, JP 4), fuel oils, gasolines, etc., reducing the fuel's distillation boiling temperatures, especially end point and/or T 90 temperature by 5^0F to 20^0F, 10^0F to 30^0F, 20^0F to 50^0F, 25^0F to 60^0F, 40^0F to 70^0F, 50^0F to 80^0F, 60^0F to 90^0F, 70^0F to 100^0F, 80^0F to 120^0F, 40^0F to 150^0F, 75^0F to 175^0F, 60^0F to 200^0F, 70^0F to 225^0F, 80^0F to 250^0F, 90^0F to 275^0F, 100^0F to 280^0F, 110^0F to 300^0F, 120^0F to 320^0F, 140^0F to 350^0F, or more, is particularly effective in increasing the fuel's inherent latent heat of vaporization, reducing combustion temperatures, and increasing combustion burning velocities, etc.

Thus, it is a specific embodiment of this invention to reduce end point and T-90 boiling temperatures of co-fuels, which are used together with ECS fuels and or as stand alone fuels.

It is also an embodiment to reduce T-50, T-10 temperature in such a manner to improve combustion.

In the practice of this invention end point/T-90 reduction is contemplated with metallic use, absent ECS compound; whereby reductions in the formation of free carbon in primary combustor zones, reductions in hazardous exhaust emissions, reductions or control of manganese oxides on exhaust catalyst beds, and the like, occur. In the case of automotive fuels, this T-90 reduction tends to reduce VOC, hydrocarbon and/or NOx emissions.

Quite unexpectedly, Applicant has discovered that when reducing gasoline t-90 temperatures to less than 270^{0}F, a material combustion advantage occurs in combination with minor amounts of Mn. Applicant has discovered that fuel economy and/or mileage unexpectedly improved, even though higher heating value components had been eliminated in the T-90 reduction.

Obviously, this effect is sensitive to the fuel and the components that are eliminated and those that remain after T-90 reduction.

Example 1

A method of increasing the fuel economy of a vehicle operating on convention or reformulated gasoline comprising: Reducing the boiling temperature of gasoline such that its boiling temperature at T-90 fraction is no greater than 270°F; mixing MMT into the composition up to 1/32 gr mn/gal; combusting said composition in a gasoline powered vehicle; whereby fuel economy is improved by 0.5% or more.

Example 2

The method of example 1, wherein fuel economy is improved over the clear fuel not having reduced T-90 temperatures and same fuel containing MMT.

Preferred boiling point practice reduction includes the elimination of higher boiling point alkanes, aromatic hydrocarbons, cyclanes, alkenes are preferred.

Similar reductions and/or control of T 50 temperatures are also desireable, so long as technical enleanment or warm driveability is not impaired.

Applicant notes, mid range boiling point control is particularly important in fuel application where oxygenates are employed, especially in carburetor systems.

In the practice of this invention, said boiling point modification/control, enhances combustion and/or the burning velocity features of the fuel.

When an oxygenated compound is employed in excess of 0.5% by weight oxygen content in the fuel, especially for operation in current engines, mid-range temperatures should be from about 160°F/170°F/180°F to about 205°F. Mid range temperatures outside these ranges appear to be less effective.

Importantly, Applicant has discovered when employing both T-90 temperature reduction and mid-range temperature control, the Mn fuel (absent the inclusion of an oxygenate) achieves maximum combustion advantage, e.g. improved fuel economy, reduced manganese oxide formation, and/or improved warm driveability.

Furthermore, the inclusion of an oxygenate enhances this beneficial effect. The better the ECS oxygenated compound the better the beneficial result.

Applicant appreciates that automotive engines and fuels will be modified in the future to achieve even better performance and emission results, accordingly, Applicant contemplates even lower T-90 and mid-range boiling temperatures in future applications.

Example 3

A fuel composition wherein the reduction of end boiling point and/or T-90 temperatures operates to increase average latent heat of vaporization.

Example 4

The example of 3, wherein combustion emissions or fuel economy of a manganese fuel having reduced T-90 temperatures of 270°F, or less, are improved compared same fuel unadjusted for T-90 temperatures.

Example 5

The example of 4, wherein fuel T-90 temperature is less than 280°F, more preferably less than 270°F, and MMT is included in the amount of 1/32 gr. Mn/gal, wherein fuel economy over same unadjusted fuel is greater than 0.2%.

Example 6

The composition of example 5, wherein reduced emissions include toxic and/or NOx emissions.

Example 7

The example of 5, wherein MMT is contained in a quality of 1/32 gram mn or less, per gallon, and wherein fuel economy is improved by 0.2% (1.0%, 1.5% or more preferred).

Example 8

The example of 7, where an oxygenated ECS compound is employed in excess of 0.5% by weight for operation in current automotive engine, and wherein the gasoline's mid-range temperature is from 170°F to approximately 205°F.

Example 9

The example of 8, wherein the composition comprises an ECS compound in a sufficient concentration to increase average burning velocity of composition by an additional 5.0%, or more, over clear composition as measured by laminar bunsen burner.

Example 10

The example of 9, wherein the addition of the ECS compound is sufficient to reduce average combustion temperatures by 25°F, as measured under load of at least 20 indicated horse power (ihp).

Applicant notes this aspect of his invention (e.g. addition of ECS compound with/or without metallic) as applied to gasoline is especially beneficial when T-90 temperatures are equal to or below approximately 300°F, 280°F, 270°F, 260°F, and optionally when T-50 temperatures are in the range of approximately 160°F to 205°F or 170°F to 205, 180°F to 205°F; or alternative 160°F to 190°F or 160°F to 180°F (particularly in later date applications).

The application of mid-range temperature control is generally applicable to all wide boiling fuels.

COMBUSTION TEMPERATURE MODIFICATION

In the practice of this invention, preferred reductions in combustion temperatures range from 10°F to 500°F. Reductions of 25°F to 50°F, or more, are desireable. Reductions of 100°F, or more, are desireable. Reductions of 5°F to 15°F, 10°F to 25°F, 15°F to 30°F, 20°F to 40°F, 25°F to 45°F, 30°F to 50°F, 35°F to 60°F, 40°F to 55°F, 45°F to 60°F, 50°F to 65°F, 55°F to 75°F, 65°F to 75°F, 70°F to 95°F, 85°F to 105°F, 100°F to 120°F, 110°F to 140°F, 100°F to 130°F, 110°F to 150°F, 120°F to 160°F, 150°F to 250°F, 250°F to 450°F, 200°F to 500°F, 300°F to 600°F, 200°F to 800°F, 400°F to 1000°F, 300°F to 900°F, 500°F to 2000°F, 600°F to 2500°F, or more, are preferred, especially with simultaneous increases in burning velocity. Reductions outside above ranges are fully expected, especially as the concentration of the Applicant's enhancement combustion compounds (see below) increase as a percent volume of the fuel composition.

In the case of gasoline, reduced exhaust temperature translates into increased power and/or reductions of exhaust catalyst inlet temperatures. It is an express embodiment of this invention that exhaust catalyst inlet