An unleaded gasoline fuel of about 87 octane suitable for use in automobile spark-ignition (internal combustion) engines, the gasoline having a low sulfur content (below 100 ppmw) and a relatively high olefin content (between 15 and 25 vol. %). Gasoline fuels meeting these requirements generally have emissions characteristics satisfying the requirements of RFG under EPA regulations.
UNLEADED GASOLINE COMPOSITIONS

FIELD OF THE INVENTION

[0001] The present invention relates to fuels, particularly unleaded gasoline fuels for use in automobile spark-ignition (internal combustion) engines, to a method for making the fuels and to related combustion methods. The gasoline fuels of the present invention, when used to power automobile internal combustion engines, generally exhibit atmospheric emissions of carbon monoxide (CO), oxides of nitrogen (NOx) and hydrocarbons (HC) sufficiently low to satisfy the requirements of Reformulated Gasoline (RFG) under Environmental Protection Agency (EPA) regulations. The present invention is specifically directed to a clean burning gasoline fuel of about an 87 octane and having a low sulfur content and a relatively high olefin content. For the most part, gasoline fuels of this invention have been shown to meet or exceed emission requirements of RFG under the EPA regulations.

BACKGROUND OF THE MENTION

[0002] In an attempt to reduce pollution from the combustion of gasoline fuels, federal and state regulatory agencies, as well as the U.S. Congress have developed certain specifications for reformulated gasolines. For example, one such regulatory agency is the California Air Resources Board (CARB), which in 1991 developed specifications for California gasolines, which based upon testing, were intended to provide good engine performance and low emissions.

[0003] The pollutants addressed by the myriad regulatory specifications include CO, NOx, and/or hydrocarbons, which are generally measured in units of gm/mile; and potency-weighted toxics (PWT), which are generally measured in units of mg/mile. Such toxic air contaminants include benzene, 1,3-butadiene, formaldehyde, and acetaldehyde. The specifications have been designed to achieve large reductions in emissions and toxic air contaminants from gasoline-fueled vehicles. Gasolines that do not meet the specifications are believed to be inferior with regard to the emissions, which result from their use in vehicles.

[0004] The regulatory specifications also often address the following gasoline properties: Reid vapor pressure (RVP), Sulfur content, Oxygen content, Aromatic hydrocarbon content, Benzene content, Olefin content, Temperature at which 90 percent of the fuel has been distilled (T-90) and Temperature at which 50 percent of the fuel has been distilled (T-50).

[0005] One regulatory framework has been enacted by Congress and implemented by the EPA. The requirements of the U.S. Clean Air Act and the physical and compositional limitations imposed by the Reformulated Gasoline program and EPA Complex Model regulations (see 40 C.F.R. Part 80) require not only a decrease of permissible sulfur levels but also more restrictive limitations on boiling range, typically defined by Reid vapor pressure (RVP) and T-90 specifications. Limitations on aromatic content may also be necessary under the Complex Model regulations.

[0006] More recent federal emission standards, Tier 2/Gasoline Sulfur standards, further reduce new vehicle NOx levels to an average of 0.07 gm/mile and reduce the permissible level of sulfur in gasoline ultimately to an average gasoline sulfur content of 30 parts per million by weight (ppmw).

[0007] U.S. Pat. No. 5,288,393 (the ‘393 patent) describes regulating the properties and compositions of gasoline fuels by appropriate blending to minimize the release of CO, NOx and/or hydrocarbons. In particular, the patent suggests that by adjusting one or more of the following eight chemical or physical properties in the manner as indicated below, then one can reduce these emissions from automobile engines:

- [0008] (1) decrease the 50% D-86 Distillation Point (T-50);
- [0009] (2) decrease the olefin content;
- [0010] (3) increase the paraffin content;
- [0011] (4) decrease the Reid vapor pressure (RVP);
- [0012] (5) increase the Research Octane Number;
- [0013] (6) decrease the 10% D-86 Distillation Point (T-10);
- [0014] (7) decrease the 90% D-86 Distillation Point (T-90); and
- [0015] (8) increase the aromatic content.

[0016] According to the ‘393 patent, these properties can be adjusted in the indicated manner merely by judicious blending of a plurality of hydrocarbon streams boiling in the gasoline range of 77°F (25°C) to about 437°F (225°C).

[0017] The ‘393 patent specifically teaches that the olefin content is maintained at a value of less than 15 volume percent and that decreasing the olefin content to a value of essentially zero provides the best emission reduction results.

[0018] The ‘393 patent does not mention the importance of sulfur content on the properties of gasoline fuels. Nevertheless, the requirements of the U.S. Clean Air Act and property restrictions imposed by RFG and the EPA Complex Model, impose limits on the permissible sulfur levels in gasoline.

[0019] The present invention is based, in part, on a discovery that gasoline fuels, which generally are able to satisfy stringent emission requirements imposed by RFG and EPA regulations, as well as requirements imposed by other governmental regulatory authorities, can be prepared by blending gasoline feedstocks in a way that results in a gasoline having an olefin content of at least 15% by volume, typically at least 16% by volume and up to about 25% by volume.

[0020] Thus, contrary, for example, to CARB, which has established an olefin (maximum) limit of 10 vol. % and contrary to the teachings of the ‘393 patent, the present invention provides a gasoline composition exhibiting favorable emission characteristics even though it has a relatively high level of olefins. The present invention, therefore, provides refiners with additional flexibility in blending gasoline, particularly gasoline prepared to satisfy strict regulations, in addition to other known ways to satisfy the regulatory guidelines, such as that embodied in the ‘393 patent.
**DETAILED DESCRIPTION OF THE INVENTION**

**[0021]** Definitions:

**[0022]** Aromatic hydrocarbon content means the amount of aromatic hydrocarbons in the fuel expressed to the nearest tenth of a percent by volume (see ASTM D 6293).

**[0023]** Olefin content means the amount of olefins in the fuel expressed to the nearest tenth of a percent by volume (see ASTM D 6293).

**[0024]** Reid vapor pressure (RVP) means the vapor pressure of the fuel expressed to the nearest hundredth of a pound per square inch (psi). RVP is determined in accordance with ASTM standard method D 5191.

**[0025]** Sulfur content means the amount by weight of sulfur contained in the fuel expressed to the nearest part per million (See ASTM D 2622-98 and D 5453-93).

**[0026]** 10% distillation temperature (T-10) means the temperature at which 10% of the fuel has been distilled, expressed to the nearest degree Fahrenheit (see ASTM standard method D 86 for distillation of petroleum products at atmospheric pressure).

**[0027]** 50% distillation temperature (T-50) means the temperature at which 50% of the fuel has been distilled, expressed to the nearest degree Fahrenheit (see ASTM standard method D 86 for distillation of petroleum products at atmospheric pressure).

**[0028]** 90% distillation temperature (T-90) means the temperature at which 90% of the fuel has been distilled, expressed to the nearest degree Fahrenheit (see ASTM standard method D 86 for distillation of petroleum products at atmospheric pressure).

**[0029]** Octane is the average of the Research Octane Number (RON) (see ASTM D 2699) and the Motor Octane Number (MON) (see ASTM D 2700), (RON+MON)/2.

**[0030]** ASTM is the American Society for Testing and Materials.

**[0031]** As noted above, the present invention is directed to an unleaded gasoline fuel having an octave value of about 87, e.g., from 85 to 91. The gasoline fuel is suitable for burning in a spark induced internal combustion automotive engine. The gasoline fuel of this invention is characterized by an olefin content of 15% by volume and higher, typically 16% by volume and higher and by a sulfur content of below about 100 ppm by weight (ppmw), preferably below about 75 ppmw, more preferably below about 50 ppmw and most preferably below about 30 ppmw. Preferably, the gasoline fuel of this invention also has a Reid vapor pressure of less than 9.0 psi, more usually less than 8.0 psi and often less than 7.5 psi, an aromatic hydrocarbon content of greater than about 15 vol. %, a 10% D-86 Distillation Point (T-10) usually less than 150°F, a 50% D-86 Distillation Point (T-50) usually less than 230°F and a 90% D-86 Distillation Point (T-90) usually greater than 300°F. It has been discovered that this gasoline fuel offers acceptable engine performance; at same time, the NOx, CO and hydrocarbon emissions, produced by combusting gasoline fuels meeting these requirements, very often satisfy the restrictions imposed by RFG and EPA regulations.

**[0032]** Surprisingly, the gasoline fuel of the present invention generally is able to meet current regulatory standards for emissions even though the olefin content of the gasoline exceeds the maximum (cap) limit established by CARB and even though the analogous prior art, such as the ‘393 patent, teaches that lower olefin contents are necessary. In particular, it has been determined that by reducing the amount of sulfur in those gasoline blending stocks commonly rich in olefins, such that the level of sulfur in the fully formulated gasoline prepared using these blend stocks is maintained below 100 ppmw, preferably below 75 ppmw, more preferably below 50 ppmw and most preferably below 30 ppmw, one can beneficially use these olefin-containing streams as blend stocks and can retain flexibility with respect to other regulated fuel characteristics while producing a gasoline exhibiting acceptable engine performance and acceptably low emissions.

**[0033]** In another embodiment of the present invention, there is provided a method for operating an automobile having a spark-ignited, internal combustion engine. The method comprises introducing into the engine an unleaded gasoline fuel formulated in accordance with the present invention. The unleaded gasoline fuel is then combusted in the engine. In a preferred embodiment, the automobile also has a catalytic converter into which at least some of the engine exhaust emissions created by combusting the unleaded gasoline fuel are introduced, with the resulting emissions then being discharged from the catalytic converter and subsequently to the atmosphere. Good performance and desired low emissions are realized upon using the unleaded gasoline fuel of the present invention in the operation of an automobile.

**[0034]** Gasoline fuels of the present invention are substantially free of lead, i.e., are unleaded and contain a mixture of aromatic, olefinic, and paraffinic hydrocarbon components, which components generally boil at atmospheric pressure over a temperature range of about 10°F (21°C) to about 450°F (232°C), more usually over a temperature range of about 86°F (30°C) to about 428°F (220°C) and most often over a temperature range of about 100°F (38°C) to about 410°F (210°C). As used herein, an unleaded gasoline fuel is a gasoline containing a concentration of lead no greater than 0.05 gram of lead per gallon (0.013 gram of lead per liter).

**[0035]** The boiling properties of gasoline fuels of the present invention are determined using ASTM standard method D 86 for distillation of petroleum products at atmospheric pressure. Gasoline fuels of this invention preferably have a 10% D-86 Distillation Point (T-10) of less than 150°F, usually falling between 110°F and 145°F; a 50% D-86 Distillation Point (T-50) of less than 230°F, usually falling between 190°F and 210°F and a 90% D-86 Distillation Point (T-90) of greater than 300°F, usually falling between 345°F and 370°F.

**[0036]** The unleaded gasoline fuel of the present invention may also contain, as desired, one or more types of known gasoline additives, so long as the additive does not significantly interfere with the emission reduction goals of the present invention. These additives include an octane enhancing agent, such as methylcyclopentadienyl manganese tri-carbonyl (MMT), detergents, demulsifiers, deposit modifiers, surface ignition inhibitors, e.g., tricresylphosphate.
(TCP) and trimethyl phosphate; metal deactivators represented by salicylidene derivatives, e.g., N,N-salicylidene diamino propane; anti-icing agents, e.g., alcohols and imide succinate; corrosion inhibitors, e.g., aliphatic amine salts, sulfonates and phosphates of alkyl amines; anti-static agents, e.g., anionic, cationic and amphoteric surfactants; coloring agents, e.g., azo dyes; and antioxidant represented by phenols, e.g., 2,6-di-tertiary-butyl-p-cresol and aromatic amines, e.g., phenyl-t-naphthylamine. These additives may be used either individually or in combination. They are used individually normally at 0.5 wt % or less, based on the total weight of the gasoline composition, and usually in the aggregate they are present at less than 10%, although in some circumstances such additives could be used at a higher level.

[0037] The unleaded gasoline fuel of the present invention may also contain and often does contain an oxygenate additive. Such additives include alcohols, e.g., methanol and ethanol, and other oxygenates, e.g., methyl tertiary butyl ether (MTBE) and ethyl tertiary butyl ether (ETBE). When present, an oxygenate is normally used in an amount of up to about 20% by volume.

[0038] Gasoline fuels of the present invention can be prepared by blending gasoline feedstocks readily available in most petroleum refineries. Such feedstocks include, among other streams, an alkylate stream generally obtained by polymerization of isobutane and lower olefin compounds, e.g., butene and propylene, over an acidic catalyst, e.g., sulfuric acid, hydrofluoric acid, or aluminum chloride; a catalytically cracked gas stream (e.g., cracked naphtha), generally from a fluid catalytic cracker (FCC gasoline) or thermal catalytic cracker (TCC); a heavy straight run gas stream, generally obtained by atmospheric distillation of a crude; a dehexanizer bottoms stream, a dehexanizer overheads stream, an aromatic saturated gasoline stream, a light straight run gasoline stream, hydrocracker top product naphtha, and a butane stream.

[0039] Historically, the catalytically cracked gasoline stream has a relatively high octane value as a result of the presence of olefinic components and constituted a main source of olefins in a gasoline fuel. This stream often contains from 30 to 50 vol. % olefins and may contain as high as 40 to 70 vol. % olefins. In some cases, this blend stock contributed as much as half of the gasoline in the refinery pool, and also provided a significant contribution to product octane.

[0040] This catalytically cracked gasoline stream, thus, is a key component of the gasoline fuel of the present invention. This stream also is usually a main source of sulfur in the gasoline, often containing (before desulfurization treatment) up to 5,000 ppm by weight sulfur and sometimes higher. Before being used as a feedstock in making a blended gasoline, particularly in the present invention, the catalytically cracked gasoline stream is generally processed to remove sulfur (i.e., the stream is hydrotreated). Unfortunately, desulfurization causes a reduction in olefin content and subsequently a reduction in octane value. Thus, as the degree of desulfurization increases, the octane value of this gasoline blend stock generally decreases. Depending on the conditions of the hydrotreating operation, however, some of the hydrogen used for desulfurization can also cause some hydrocracking in addition to olefin saturation.

[0041] More recently, a number of processes have been developed for desulfurizing cracked gasoline while maintaining, or upgrading its octane value, often referred to as hydrodesulfurization and catalytic treatment. A variety of technologies are available for suitably treating the catalytically cracked gasoline stream to remove sulfur before using the stream to blend an unleaded gasoline fuel. Suitable processes for removing sulfur, while maintaining/restoring octane, are thus well known in the art. In this regard the following U.S. patents can be cited as describing available technologies, U.S. Pat. Nos. 5,340,466; 5,346,609; 5,409,596; 5,411,658; 5,482,617; 5,500,108; 5,510,016; 5,510,568; 5,525,210; 5,595,634; 5,597,476; 5,770,466; 5,807,477; 5,906,730; 6,042,719; 6,103,105; 6,120,679; 6,153,089 and 6,162,352, all of which are incorporated herein in their entirety by reference.

[0042] By using this desulfurization technology and by blending the various feedstocks so as to maintain the sulfur content of the fully formulated gasoline below 100 ppmw, preferably below 75 ppmw, more preferably below 50 ppmw, and most preferably below 30 ppmw, it has been found that more flexibility is available to blend gasoline fuels in terms of other gasoline properties such as olefin content, in particular, and also aromatic content, T-10, T-50 and T-90 distillation specifications. Generally, the sulfur content of the gasoline fuels of this invention will be below about 50 ppmw.

[0043] The sulfur content of gasoline fuels can be determined using ASTM standard method D 2622-98, which uses X-ray fluorescence spectroscopy. Alternatively, ASTM D 5453-93, which uses Ultraviolet fluorescence, can be used.

[0044] With respect to the olefin content of the gasoline in particular, the present invention contemplates maintaining the olefin content of the gasoline of this invention between 15 and 25 volume percent, more usually between 16 and 25 volume percent. Gasoline fuels of the present invention will often have an olefin content of 17 volume percent or greater.

[0045] For the most part, the Reid vapor pressure (RVP) of the gasoline fuel of the present invention is less than 9.0 psi. In preferred embodiments of the present invention, the Reid vapor pressure (RVP) of the gasoline fuel is less than 8.0 psi, and most often is no greater than 7.5 psi. Normally, the aromatic content of the gasoline can be above about 15 vol. % and for the most part is maintained between 15 and 35 vol. %.

[0046] Generally, as the sulfur content of the gasoline fuel is lowered, the beneficial effects on other gasoline properties become more magnified. Thus, in order to obtain the most flexibility with respect to adjusting the content of aromatics and the T-10, T-50 and T-90 distillation characteristics of the gasoline, lower sulfur contents are preferred.

[0047] The unleaded gasoline fuel of this invention can be advantageously used in all gasoline-fueled cars, particularly those equipped with a catalytic converter. The unleaded gasoline fuel of the present invention is useful throughout the year, with perhaps some modification in the RVP of any particular formulation for seasonal requirements.

[0048] Fuels of the present invention are useful in operating automotive vehicles having a spark-ignited internal combustion engine. These fuels perform particularly well in...
vehicles designed for low exhaust emissions. The fuels are introduced into the engine and then combusted in the engine. In a preferred embodiment, the automotive vehicle also has a catalytic converter into which at least some of the engine exhaust emissions created by combusting the unleaded gasoline are introduced. The resulting emissions are then discharged from the vehicle exhaust system to the atmosphere. Most of the emissions are inert, non-harmful components, with the regulated components such as hydrocarbons and NO\textsubscript{x} being produced at a low concentration.

EXAMPLE

Gasoline Formulations

Several gasoline fuels were prepared by blending gasoline feedstock selected from one or more of alkylate, desulfurized catalytically cracked gasoline, dehexanizer bottoms, dehexanizer overheads, heavy straight run gasoline, light straight run gasoline, an aromatic saturated gasoline stream, hydrcracker topper light naphtha and butane. The catalytically cracked gasoline feedstock was desulfurized using technology licensed from Catalytic Distillation Technologies under one or more of U.S. Pat. Nos. 5,510,568; 5,595,634; 5,597,476 and 5,807,477 and Canadian published application 2,178,612. MTBE in an amount of about 12% by volume also was blended into the gasoline fuel. The blended gasoline fuels were all found to be in compliance with EPA regulations.

The blended gasoline fuels exhibited the following properties:

<table>
<thead>
<tr>
<th>Blend</th>
<th>RVP (psi)</th>
<th>T\textsubscript{10} (°F)</th>
<th>T\textsubscript{50} (°F)</th>
<th>T\textsubscript{90} (°F)</th>
<th>Sulfur (ppm)</th>
<th>Olefin (Vol. %)</th>
<th>Aromatic (Vol. %)</th>
<th>Octane Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>87 RFG 1</td>
<td>7.2</td>
<td>138</td>
<td>197</td>
<td>313</td>
<td>62</td>
<td>17.7</td>
<td>24.3</td>
<td>88.5</td>
</tr>
<tr>
<td>87 RFG 2</td>
<td>7.0</td>
<td>138</td>
<td>201</td>
<td>316</td>
<td>65</td>
<td>17.8</td>
<td>23.0</td>
<td>89.2</td>
</tr>
<tr>
<td>87 RFG 3</td>
<td>7.2</td>
<td>136</td>
<td>196</td>
<td>313</td>
<td>52</td>
<td>17.8</td>
<td>19.4</td>
<td>88.8</td>
</tr>
</tbody>
</table>

RVP was measured using a Grabner RVP analyzer. The sulfur content was measured using an Antek 9000 Series Total Nitrogen/Sulfur Analyzer employing an Ultraviolet Fluorescent (UV) detector in accordance with ASTM D 5453. The D 86 Distillation Points were measured using a HERZOG MP626 Distillation Apparatus. The compositions of these three samples, in terms of olefin content and aromatic content, were obtained using an AC Reformylizer in accordance with the guidelines in ASTM standard method D 6293.

The present invention has been described with reference to specific embodiments. However, this application is intended to cover those changes and substitutions that may be made by those skilled in the art without departing from the spirit and the scope of the appended claims. In particular, the invention is intended to embrace all gasoline fuels meeting the described gasoline properties and characteristics, whether or not any specific gasoline formulation embraced by the invention satisfactorily meets or exceeds any specific regulatory requirement.

We claim:

1. An unleaded gasoline fuel suitable for operating a spark ignition internal combustion engine of an automobile having an octane value of about 87, said gasoline fuel comprising a mixture of hydrocarbons with

(a) a sulfur content below 100 ppmw
(b) an olefin content of between 15 and 25 vol. %
(c) a 90% D-86 distillation point of greater than 300°F; and
(d) a Reid vapor pressure of less than 9.0 psi.

2. The unleaded gasoline of claim 1 having a 50% D-86 distillation point of less than 230°F.

3. The unleaded gasoline of claim 2 having a 10% D-86 distillation point of less than 150°F.

4. The unleaded gasoline of claim 1 having an aromatics content between 15 and 35 vol. %.

5. The unleaded gasoline of claim 4 having a 50% D-86 distillation point of less than 230°F.

6. The unleaded gasoline of claim 5 having a 10% D-86 distillation point of less than 150°F.

7. The unleaded gasoline of claim 4 having an RVP less than 8.0 psi.

8. The unleaded gasoline of claim 4 having an RVP less than 7.5 psi.

9. The unleaded gasoline of claim 1 having a sulfur content of below 75 ppmw.

10. The unleaded gasoline of claim 9 having a 50% D-86 distillation point of less than 230°F.

11. The unleaded gasoline of claim 10 having a 10% D-86 distillation point of less than 150°F.

12. The unleaded gasoline of claim 11 having an aromatics content between 15 and 35 vol. %.

13. The unleaded gasoline of claim 12 having an RVP less than 8.0 psi.

14. The unleaded gasoline of claim 13 having an RVP less than 7.5 psi.

15. The unleaded gasoline of claim 1 having a sulfur content of below 30 ppmw.

16. The unleaded gasoline of claim 15 having a 50% D-86 distillation point of less than 230°F.

17. The unleaded gasoline of claim 16 having a 10% D-86 distillation point of less than 150°F.

18. The unleaded gasoline of claim 17 having an aromatics content between 15 and 35 vol. %.

19. The unleaded gasoline of claim 18 having an RVP less than 8.0 psi.

20. The unleaded gasoline of claim 18 having an RVP less than 7.5 psi.
21. A process for making an unleaded gasoline having an octane value of about 87 comprising blending at least two hydrocarbon streams boiling in the range of 100°F to about 450°F, one of which has an olefin content of at least 15 volume percent, to produce an unleaded gasoline suitable for combustion in an automobile engine, the unleaded gasoline having the following properties:

(1) a Reid vapor pressure less than 9.0 psi;
(2) a 90% D-86 distillation point greater than 300°F;
(3) an olefin content between 15 and 25 vol. %; and
(4) a sulfur content below 100 ppmw.

22. The process of claim 21 wherein said hydrocarbon streams are selected from the group consisting of an alkylate stream, a catalytically cracked gasoline, a heavy straight run gasoline stream, a dehexanizer bottoms stream, a dehexanizer overheads stream, an aromatic saturated gasoline stream, a light straight run gasoline stream, a hydrocracker top gas from a naphtha and a butane stream.

23. The process of claim 22 wherein the unleaded gasoline has a 50% D-86 distillation point of less than 230°F.

24. The process of claim 23 wherein the unleaded gasoline has a 10% D-86 distillation point of less than 150°F.

25. The process of claim 24 wherein the unleaded gasoline has an aromatics content between 15 and 35 vol. %.

26. The process of claim 21 wherein the unleaded gasoline has a sulfur content of below 75 ppmw.

27. The process of claim 26 wherein the unleaded gasoline has a 50% D-86 distillation point of less than 230°F.

28. The process of claim 27 wherein the unleaded gasoline has a 10% D-86 distillation point of less than 150°F.

29. The process of claim 28 wherein the unleaded gasoline has an aromatics content between 15 and 35 vol. %.

30. The process of claim 29 wherein the unleaded gasoline has an RVP less than 8.0 psi.

31. The process of claim 29 wherein the unleaded gasoline has an RVP less than 7.5 psi.

32. The process of claim 21 wherein the unleaded gasoline has a sulfur content of below 30 ppmw.

33. The process of claim 32 wherein the unleaded gasoline has a 50% D-86 distillation point of less than 230°F.

34. The process of claim 33 wherein the unleaded gasoline has a 10% D-86 distillation point of less than 150°F.

35. The process of claim 34 wherein the unleaded gasoline has an aromatics content between 15 and 35 vol. %.

36. The process of claim 35 wherein the unleaded gasoline has an RVP less than 8.0 psi.

37. The process of claim 35 wherein the unleaded gasoline has an RVP less than 7.5 psi.

38. A method for operating an automobile having a spark-ignition, internal combustion engine and a catalytic converter comprising:

(1) introducing into the engine an unleaded gasoline, suitable for combustion in an automobile engine, said gasoline having a Reid vapor pressure less than 9.0 psi, an octane value of about 87, a 90% D-86 distillation point greater than 300°F, an olefin content between 15 and 25 vol. % and a sulfur content of below 100 ppmw; and thereafter

(2) combusting the unleaded gasoline in said engine;

(3) introducing at least some of the resultant engine exhaust emissions into the catalytic converter; and

(4) discharging emissions from the catalytic converter to the atmosphere.

39. The method of claim 38 wherein the unleaded gasoline has a sulfur content of below 75 ppmw.

40. The method of claim 39 wherein the unleaded gasoline has a 50% D-86 distillation point of less than 230°F.

41. The method of claim 40 wherein the unleaded gasoline has a 10% D-86 distillation point of less than 150°F.

42. The method of claim 41 wherein the unleaded gasoline has an aromatics content between 15 and 35 vol. %.

43. The method of claim 42 wherein the unleaded gasoline has an RVP less than 8.0 psi.

44. The method of claim 42 wherein the unleaded gasoline has an RVP less than 7.5 psi.

45. The method of claim 38 wherein the unleaded gasoline has a sulfur content of below 30 ppmw.

46. The method of claim 45 wherein the unleaded gasoline has a 50% D-86 distillation point of less than 230°F.

47. The method of claim 46 wherein the unleaded gasoline has a 10% D-86 distillation point of less than 150°F.

48. The method of claim 47 wherein the unleaded gasoline has an aromatics content between 15 and 35 vol. %.

49. The method of claim 48 wherein the unleaded gasoline has an RVP less than 8.0 psi.

50. The method of claim 48 wherein the unleaded gasoline has an RVP less than 7.5 psi.