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(54) NOVEL HYDROCARBON FUEL, ITS PREPARATION AND USE

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Description

Field of the Invention

[0001] This invention relates to a new fuel comprising a hydrocarbon mixture being limited to hydrocarbons within the range^C_6 to C_{10}, to a method for producing this fuel, and to a method of operating an improved internal combustion engine using the fuel of the invention.

Background Information

[0002] Present day automotive gasoline consists of a mixture of hydrocarbons which range from C_4 to about C_{12}. The lower molecular weight fraction, such as butane isomers, is more volatile and it has always been the practice to include substantial portions of these volatiles in the fuel to insure proper engine performance. This practice, however, is at best a compromise since the presence of the volatiles, on the one hand, causes an undue risk of explosion during storage and handling; and the inherent evaporative and emission losses contribute to Pollution; but, on the other hand, the volatiles have always been considered necessary for good cold engine starting. Thus, a certain amount of the volatiles have been incorporated in gasoline. The exact amount of the volatiles may vary according to the climate where it is sold. In fact, industry has set voluntary limits so that each area will have a motor fuel having sufficient volatility for the prevailing climate. High levels of volatile components assure satisfactory starting and warm-up at the lowest temperature expected, and low levels of volatile components protect against vapor-lock in high temperature climates.

[0003] Generally current gasolines exhibit high levels of volatiles measured in terms of Reid Vapor Pressure. Reid Vapor Pressure is the accepted measurement of gasoline volatility and it represents the vapor pressure at 100°F (37.78°C). Current fuels require a relatively high amount of volatile components which raises the Reid Vapor Pressure to undesirable levels. It is highly desirable to formulate a fuel which satisfies the volatility requirements without raising the Reid Vapor Pressure to the undesirable level found in the prior art fuels.

[0004] The use of these volatiles in prior art fuels is associated with several problems. One such problem is that because present day engines depend on the volatiles, the spontaneous loss of them in storage results in a fuel which is of inferior quality after a period of storage. Thus, because of varying storage times, the consumer can never be certain if the gas he is purchasing contains the required amount of volatiles at the time of purchase. Naturally, therefore, a fuel whose efficiency and dependability is less dependent on the presence of volatiles is more desirable.

[0005] Another problem arising out of the use of these volatiles is the evaporative loss of gasoline which can occur in the gas tank. Industry has been hard pressed to solve this problem for quite some time. While this problem has been recognized for some time, industry has always been reluctant to solve the problem by reducing the volatility of the gasoline because in doing so they would lose the benefits of the compromise i.e., engine performance). In fact, this point has been expressed in the publication titled Effects of Automotive Emission Requirements on Gasoline Requirements; Symposium, American Society for Testing and Materials; 1971. Here it is stated on page 111 that "Severe volatility reduction could produce other problems. A more effective method than volatility reduction can be seen to be the elimination of evaporative losses by some mechanical device". This invention, however, seeks to reduce volatility or Reid Vapor Pressure and still maintain a fuel which can perform well.

[0006] Present day gasoline also contains, in addition to the volatile light-weight and the intermediate-weight components, a heavy-weight component which, like the volatile component, is also associated with several disadvantages. For example, the gasoline of today, when used as a fuel in present day short stroke engines, results in incomplete combustion because there is insufficient tine or temperature to burn the heavy hydrocarbon components. This results in a certain amount of gasoline being wasted and this contributes to pollution. Conventional C_4-C_{12} has too much energy in it for conventional internal combustion engines in that if combusted with enough air (stoichiometric or slightly above) it will burn too hot for the engine or it will produce high levels of nitrous oxides. Yet, in spite of these shortcomings, the heavy components are left in present day fuel because their presence is considered necessary to provide a fuel having suitable properties for automotive use.

[0007] The presence of these heavy components in conventional C_4-C_{12} gasoline requires considerable front end priming with light components (C_4 and/or C_5) to achieve adequate front end volatility for starting engines equipped with standard carburetion systems. In addition, conventional C_4-C_{12} gasoline which contains these heavy components (C_{11} and C_{12}) cannot be easily gasified and maintained in the gaseous state without recondensing. Consequently, conventional C_4-C_{12} gasoline has limited utility in a more efficient carburetion system of the type which requires gasification in the absence of air before mixing the gasified fuel with air for combustion. Therefore, in view of the shortcomings associated with the heavy weight hydrocarbons, especially C_{11} and C_{12}, it would be highly desirable to formulate a fuel without these heavy components being present while also avoiding the problems associated with the absence of these components.

[0008] The problems associated with volatile and heavy-weight components are also outlined in "Le Pétrole, Raffinage et Génie Chimique, Tome I, p. 19-27 (1972)", where it is stated, that a fuel should contain hydrocarbons in the range from C_4 to C_{10}, and should have a Reid Vapor pressure of not more than 800 g/cm^2 in winter and not more than 650 2/cm^2 in summer. It is, however, not teached to completely eliminate heavy-weight hydrocarbons, but to reduce their content much, that a residue of not more than 3 % remains at 250°C. "Erdöl-Lexikon, 5th edition, p. 206", provides the information that paraffins having from 5 to 10 carbon atoms are present in fuel for Otto engines.

[0009] The use of conventional C_4-C_{12} fuels in standard carbureted internal combustion engines requires that the volatility of the fuel be adjusted to achieve a Reid Vapor Pressure of at least 9 in the summer and 12 in the winter. If the Reid Vapor Pressure of conventional C_4-C_{12} gasoline falls below the above limits, starting and running the engine is severely impaired. The fuels of the present invention will easily start and operate identical engines yet these fuels have a reduced Reid Vapor Pressure in comparison to the above-mention conventional C_4-C_{12} gasoline. Thus the summer fuels of the present invention may have a Reid Vapor Pressure less than 9 and the winter fuels may have a Reid Vapor Pressure of less than 12. In particular, it is been discovered that the fuel of the present invention having a Reid Vapor Pressure as low as 6 in the summer and 9 in the winter will easily start and operate identical engines which require conventional fuels having a Reid Vapor Pressure of 9 in the summer and 12 in the winter. The Reid Vapor Pressures can be reduced even further by using the fuels of the present invention in combination with the improved carburetion system of the present invention.

[0010] The ideal combustion mixture for internal combustion engines consists of a fuel in the vapor or gaseous state thoroughly mixed with adequate air to support combustion. In this condition, fuel-rich pockets, which are responsible for detonation or "knock," are eliminated and carbon deposits responsible for preignition are minimized due to more complete combustion. Because detonation or preignition can damage or ruin an engine, current gasolines have octane boosters such as aromatics contained therein to reduce "knock" since current engines have fuel and air intake systems which produce droplets of fuel that contribute to fuel rich pockets in the combustion chambers of the engines. Slowing the burn with octane boosters lowers the combustion efficiency of the engine and increases the exhaust pollution. Therefore, it would be highly desirable to provide a fuel which avoids octane boosters, is rated at a lower octane value but which has highly desirable burning characteristics so that the fuel does not produce engine knock

[0011] Automotive and aviation gasolines have always had an ASTM average octane number ($^{R+M}/_2$) of 80 or higher; wherein R represents the research octane number and M represents the motor octane number. Current engines generally require an average octane number in excess of 85.

SUMMARY OF THE INVENTION

[0012] A primary object of this invention is to provide an improved fuel which facilitates the achievement of ideal combustion mixtures for internal combustion engines.

[0013] Another object of this invention is to provide a lower octane fuel and method of use so as to further improve the combustion efficiency of the fuel in an internal combustion engine.

[0014] A further object of this invention is to provide a method of operating an internal combustion engine whereby greater combustion efficiencies can be achieved in the engine.

[0015] It is an object of this invention to provide a fuel for automotive engines which minimizes the requirement for volatile components in the fuel without sacrificing adequate engine performance and which lowers the Reid Vapor Pressure while maintaining good front end volatility.

[0016] It is also an object of this invention to provide a fuel having a low Reid Vapor Pressure which combusts more efficiently than conventional gasoline of the type having a hydrocarbon range of C_4-C_{12}.

[0017] It is another object of this invention to provide a fuel which has greater tolerance for alcohol enrichment because of low Reid Vapor Pressure.

[0018] It is yet another object of this invention to provide a fuel which minimizes the priming needed to achieve adequate front end volatility for starting engines equipped with standard carburetion systems.

[0019] It is a further object of this invention to provide an improved fuel which has enhanced gasification characteristics in improved carburetion systems.

[0020] It is another object of this invention to provide an improved process for more completely combusting the fuel of this invention in an engine thus negating the need for fuel injection systems or catalytic converters.

[0021] These and other objects of the invention will become apparent to those skilled in the art from the following disclosure of the invention.

[0022] The objects of the present invention are achieved by the fuel claimed in claim 3, which can be produced by the method claimed in claim 1, and the method of operating an internal combustion engine claimed in claim 9. The respective dependent claims relate to preferred embodiments of the invention.

[0023] Subject matter of the present invention are the methods and the fuel as defined in the claims. In particular, the hydrocarbon mixture of the fuel of the present invention is limited to hydrocarbons within the range C_6-C_{10}. Where C_4 and/or C_5 hydrocarbons are additionally present in the fuel of the present invention, they are a priming agent, said priming agent being present in a minimum effective amount for raising the front end volatility of the fuel to a minimum level for cold engine starting with said minimum effective amount being less than that required for C_4-C_{12} gasoline.

[0024] The present invention is based on the discovery that front-end priming of fuel is not necessary in gasifier type carburetors and that the heavier components in gasoline are not stable as gases in air using gasifier type carburetors. Therefore it was possible to develop a new fuel that has unique benefits not obtained in C_4-C_{12} gasoline. In addition the new gasification method has distinct advantages over the prior art.

[0025] The invention relates to a fuel having an intermediate hydrocarbon range relative to conventional C_4-C_{12} gasoline which contains C_4, C_5, C_6, C_7, C_8, C_{10}, C_{11} and C_{12} hydrocarbons. This fuel of the invention is made by removing the lighter volatile component as well as the heavier component from a conventional gasoline starting material. The resulting fuel is C_6-C_{10}; i.e. the hydrocarbons are limited to those in the range C_6-C_{10}. Also, it may be desirable to further remove the C_{10} component to form a C_6-C_9 fuel for improved winter performance in gasifier type carburetors.

[0026] Suitable starting material to produce the fuel of this invention is conventional gasoline having a range of C_4-C_{12}. Both the heavy and light components are removed by any of the known methods currently available such as heat fractionization or the use of heat and vacuum in the absence of air. Once removed, the heavy component may be "cracked" at the refinery to make more fuel and the volatile component, most of which is being wasted today, may be fully recovered at the refinery.

[0027] Although gasoline having a range of C_4-C_{12} is mentioned as a useful starting material, it is not critical that the starting material be precisely in this range. Rather, it is the essence of this invention to produce a fuel of intermediate carbon range (i.e. C_6-C_{10} or C_6 to C_9) relative to the given range C_4-C_{12} that may be produced directly from refinery hydrocarbon streams.

[0028] It will be apparent, of course, that the C_6-C_{10} and C_6-C_9 fuels of the invention cannot be used efficiently in conventional internal combustion engines without modification of the carburetion system. It has been found, however, that the fuel of this invention can be quickly volatilized in a heated chamber by heating to a temperature above the final boiling point of the fuel at one atmosphere pressure in the absence of air, and such apparatus can be readily installed in an automobile. The resulting vapor (produced as needed) will mix readily with air to form a homogenous mixture without formation of condensed droplets which can wet the wall in an internal combustion engine; will not be subject to liquid phase oxidation prior to ignition; and will ignite well in the gaseous form.

[0029] Since not all the C_6-C_{10} and C_6-C_9 fuel can be used efficiently in a conventional internal combustion engine without modification of the carburetion system, the present invention also provides an improved fuel for use in cars having standard carburetion systems. In connection with this, it has been discovered that the above described C_6-C_{10} and C_6-C_9 fuel can be used in an internal combustion engine having a standard carburetion system by priming the fuel with a minimum amount of C_4,C_5 or a mixture of C_4 and C_5 to produce a fuel having adequate front end volatility for starting cars equipped with standard carburetion systems. Since the fuel may be primed with C_4 and/or C_5 , then the permissible range of the primed fuel will be C_4-C_9 (winter) and C_4-C_{10} (summer). In particular, it has been discovered that the amount of C_4 or C_5 priming necessary for achieving adequate front end volatility for starting engines equipped with a standard carburetion system is less than the amount required with conventional C_4-C_{12} gasoline. Thus, this aspect of the invention provides an improved fuel for standard carbureted engines and this fuel advantageously contains less C_4 or C_5 than conventional C_4-C_{12} gasoline while maintaining adequate front end volatility and reduced Reid Vapor Pressures. In other words, the C_6-C_{10} and C_6-C_9 fuel requires less priming to achieve adequate front end volatility for starting engines equipped with standard carburetion systems than does normal C_4-C_{12} automotive gasoline. This represents a unique and unexpected method of achieving lower Reid Vapor Pressure in automotive fuel while maintaining adequate-front end volatility since one would assume that lighter fuel (C_4-C_9 and C_4-C_{10}) would have higher Reid Vapor Pressure than heavier C_4-C_{12} gasoline.

[0030] The amount of C_4, C_5 or mixture of C_4 and C_5 used to prime the C_6-C_{10} or C_6-C_9 fuel is a minimum effective priming amount necessary to achieve adequate front end volatility for starting a car equipped with a standard carburetor, the priming amount being less than that required for C_4-C_{12} gasoline.

[0031] The C_6-C_{10} and C_6-C_9 fuel, primed with C_4 and/or C_5, can also be made by removing the heavy and light components from gasoline as described above for making C_6-C_{10} and C_6-C_9 with the exception that a minimum effective priming amount of C_4 and/or C_5 is retained in the product to achieve adequate front end volatility for starting a car equipped with a standard carburetor, the priming amount being less than that required for C_4-C_{12} gasoline.

[0032] It has also been discovered that adequate front end volatility for engines equipped with standard carburetion can be achieved by priming with additional C_5 so that adequate front end volatility can be achieved without any C_4 priming, the priming amount being less than that required for C_4-C_{12} gasoline.

[0033] Prior art aviation gasoline having a carbon range of C_4 to C_9 would not require the removal of higher molecular weight constituents to be stable as a vapor or gas in ambient air but the use of such prior art fuels would require the lowering of the octane to increase the speed of burn, thus improving combustion efficiency and lowering the pollutants produced during combustion.

[0034] Since the temperature of intake air used in an engine can vary widely because of seasonable variations or altitudes, the amount of heavy molecules removed can vary, with molecules heavier than C_{10} being completely removed. Preheated intake air systems could utilize more of the energy contained in the dense heavier molecules but this would result in too much loss in volumetric efficiency caused by the preheating or pre-expansion of the intake air.

[0035] The conversion of the fuels of this invention into vapors or gasses, homogenizing these vapors or gasses with intake air (ambient or heated) while maintaining gas or vapor stability and combusting this fuel mixture in an engine represents an improved method for achieving higher combustion efficiency while lowering the pollutants of combustion.

Brief Description of the Drawings

[0036] Figure 1 is a graph which illustrates the fuel efficiency of selected fuels in a 1500 c.c. Volkswagon engine at various engine speeds. The vertical axis shows the efficiency in term of lbs. of fuel/horsepower hour. The horizontal axis measures the engine speed. Figure 1 also illustrates the fuel efficiency of the C_5-primed fuel of this invention combusted in an identical engine equipped with the improved carburetor of this invention.

DETAILED DESCRIPTION OF THE INVENTION AND PREFERRED EMBODIMENTS

[0037] In the manufacture of the fuel in accordance with the present invention, both the lighter volatile component and the heavier, slow-burning component are removed from gasoline in the C_4-C_{12} range. The removal of the volatile component makes the resultant fuel have a slower rate of burning. By also removing the heavy slow-burning component, the resultant fuel is a C_6-C_{10} or C_6-C_9 fuel having a burn rate comparable to or better than the starting stock gasoline (C_4-C_{12}) from which it was made.

[0038] The most abundant of the volatile components in conventional C_4-C_{12} gasoline is butane and pentane. With regard to the removal of the volatile components it is primarily the butane and pentane which is removed from the C_4-C_{12} gasoline in the practice of this invention. If the gasoline contains hydrocarbons lighter than butane, they are removed, too. The heavy, slow-burning component consists primarily of C_{11} and C_{12}, each of which exists in numerous isomeric forms. These are removed and, if the starting stock gasoline contains hydrocarbons greater than C_{12}, they are also removed. The light volatile components and the heavy, slow-burning components are removed according to conventional known methods.

[0039] It is also recognized that the heavy and light components do not exist as absolutes but rather, as points on a continuum with the most volatile being the lighter hydrocarbons, and a gradual reduction in volatility and burning tendency as the weight is increased. This gives rise to certain "border line" components near both ends of the continuum. It is inevitable that some of these will be removed with the heavier and the lighter components. In general, it is recognized that the border line weights are C_6 and C_{10}. According to this invention, a substantial quantity of volatile component, namely hydrocarbons up to 5 carbon atoms, is removed to effectively reduce the potential for explosion and minimize the loss of gasoline due to evaporation. Likewise, the heavy component, namely hydrocarbons having more than more than 10 carbon atoms, is also removed to raise the burn rate of the fuel and effect more complete combustion. Both of these components are removed and this fuel is used with an improvement in fuel combustion efficiency and engine performance.

[0040] This improvement is illustrated in Figure 1. It will be noted that Figure 1 shows a comparison which measures the efficiency of the fuel of the present invention primed with C_5 versus the efficiency of conventional C_4-C_{12} prior art fuels at various engine speeds. The fuel efficiency is measured in terms of Brake Specific Fuel Consumption (lbs. of fuel per horsepower hour). Lower Brake Specific Fuel Consumption values indicate better fuel efficiency.

[0041] The C_6-C_{10} fuel of this invention may be used to run an engine equipped with the improved gasifier carburetor described herein. However, it is not necessary that volatile components be absent from the fuels used in the improved gasifier combustors since their presence in the fuel does not hinder the gasification process. Thus, some volatile C_4 and/or C_5 may be added to the C_6-C_{10} fuel as a primer, the priming amount being less than that required for C_4-C_{12} gasoline, so that the fuel can be used in a standard carbureted engine as well as an engine equipped with the improved gasifier carburetor. For this reason the comparison presented in Figure 1 utilized the C_6-C_{10} fuel of the invention containing some C_5 volatile component as a primer, the priming amount being less than that required for C_4-C_{12} gasoline, so that the resulting C_5-C_{10} fuel will run an engine equipped with an improved gasifier carburetor as well as a standard carbureted engine. The C_5-C_{10} has a boiling point range of about 49°F-345°F (9.4 to 174°C).

[0042] In order to obtain the data shown in Figure 1, identical engines were used to compare conventional C_4-C_{12} unleaded gasoline (line A) with the C_6-C_{10} fuel of this invention, primed with C_5 (line B). An identical engine was used to test the use of the C_6-C_{10} fuel of this invention, primed with C_5, in an improved carburetion system of the present invention (line C). It will be noted by comparing line A with line B that at all engine speeds, more pounds of fuel are required per horsepower hour for the C_4-C_{12} gasoline than for the C_6-C_{10} fuel of the present invention, primed with C_5. Therefore, the C_5-C_{10}, primed with C_5, is significantly more efficient when combusted in identical engines. It will also be noted from Figure 1 that an even greater efficiency is observed when the C_6-C_{10} fuel primed with C_5, is combusted in an identical engine equipped with the improved carburetion system of the present invention.

[0043] In a preferred embodiment of this invention, the C_4-C_{12} gasoline is used as a starting ingredient from which the volatile C_4 and C_5 constituents and the heavy C_{11} and C_{12} components are removed. In the preferred embodiment the starting C_4-C_{12} gasoline contains a mixture of each of the hydrocarbons (i.e., a mixture containing C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11} and C_{12}). Consequently, the C_6-C_9 and C_6-C_{10} fuel of the preferred embodiment will likewise contain the same intermediate hydrocarbons which are present in the starting gasoline. In other words, C_6-C_9 will contain, C_6, C_7, C_8, and C_9 and the C_6-C_{10} fuel will contain, C_6, C_7, C_8, C_9 and C_{10} hydrocarbons.

[0044] The fuels of the present invention have an intermediate hydrocarbon range relative to conventional gasoline which has a hydrocarbon range of C_4-C_{12}. The conventional C_4-C_{12} gasoline contains paraffinic hydrocarbons including C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11} and C_{12} paraffinic hydrocarbons. Thus removing the C_4, C_5, C_{11} and C_{12} paraffinic components of the C_4-C_{12} fuel will result in a fuel which contains paraffinic hydrocarbons, including paraffinic C_9 and C_{10} which were originally present in the C_4-C_{12} paraffinic fuel from which the fuel of this invention is derived.

[0045] In one embodiment of the present invention the light and heavy components are removed from conventional C_4-C_{12} gasoline to produce a fuel having a hydrocarbon range of C_5-C_{10}, with C_5 being a priming agent as defined in claim 4. Such a fuel is identical to the C_6-C_{10} fuel with the exception of the presence of the C_5 priming component in the C_5-C_{10} fuel. Thus the C_5-C_{10} fuel will have a boiling point range of about 49°F-345°F (9.45 to 174°C).

[0046] Although the starting gasoline preferably contains the entire range of hydrocarbons from C_4-C_{12} as described above, it is not absolutely essential that all of the intermediate hydrocarbons be present in the starting gasoline. However, it is critical that the C_6-C_9 fuel contains C_9 hydrocarbon and the C_6-C_{10} fuel contain C_9 and C_{10} hydrocarbon.

[0047] The preferred C_6-C_{10} fuel may be defined as the portion remaining when C_4-C_{12} gasoline has removed therefrom lower weight volatile components (up to C_5) to substantially reduce evaporative loss and explosion potential and higher weight components (C_{11} and higher) to raise the burn rate of the remaining hydrocarbons. The C_6-C_{10} fuel which has these characteristics can be made by removing the volatile and heavy components so that the remaining hydrocarbon mixture will boil within a range of about 121°F-345°F (49.4 to 174°C) at one atmosphere. Such a boiling point range encompasses the boiling point of the lowest boiling C_6 component and the highest boiling C_{10} component. Of course, it is possible that a small amount of C_4, C_5 , C_{11} and C_{12} may remain after the separation process due to imperfections of gasoline fractionation procedures.

[0048] Since the largest hydrocarbon in the C_6-C_{10} fuel is C_{10}, then the final boiling point of such a mixture will be 345°F (174°C). It has been discovered that hydrocarbons having boiling points above 350°F (177°C) must be substantially eliminated so that the fuel can be gasified in a heated chamber in the absence of air, and then mixed with ambient air (i.e., about 70°F or 21°C) without condensing to form droplets of heavy hydrocarbons which could wet the surfaces in an internal combustion engine. This property is an essential aspect of the C_6-C_{10} fuel because the C_6-C_{10} fuel is used in a modified carburetion system in which the fuel is gasified in a heated chamber and then mixed with air for immediate combustion in an automotive internal combustion engine. The absence of condensed droplets allows the fuel to burn much more efficiently than conventional C_4-C_{12} gasoline and, consequently, reduces pollution and improves engine performance. By removing C_{11} and C_{12} components from the starting stock gasoline, the final boiling point will be 345°F (174°C) and, thus, the resulting fuel will have the desired gasification property.

[0049] The gasification system used for the C_6-C_{10} fuel of the present invention requires heating the fuel to lower temperatures that would be required for the gasification of C_4-C_{12} gasoline. When lower temperatures are attained, the volumetric efficiency of the air and gas mixture going into an engine is improved.

[0050] The fuel having hydrocarbons comprised of C_6-C_{10} hydrocarbons will have lower Reid Vapor Pressure than conventional C_4-C_{12} gasoline with functional Reid Vapor Pressures less than two. Nonetheless, the C_6-C_{10} fuel will exhibit good ignition properties in the gaseous state when mixed with air. It will also provide excellent engine starting ability, will have reduced explosive potential and will burn more completely than C_4-C_{12} gasoline. In addition, the C_6-C_{10} fuel will burn cooler in the engine with the modified carburetor and consequently the use of such a fuel will result in less lubrication requirements for the engine.

[0051] Conventional C_4-C_{12} gasoline has high Reid Vapor Pressure and the Reid Vapor Pressure can be adjusted somewhat to provide summer or winter fuels. For example, the Reid Vapor Pressure can be increased by adding volatiles such as C_4 to enhance the winter performance of the conventional gasoline. However, the present C_6-C_{10} fuel of the invention requires lowering the Reid Vapor Pressure by removing the C_4 and C_5 components. Thus it would be expected that ability to formulate winter and summer fuels would be lost if the hydrocarbon range is limited to C_6-C_{10} hydrocarbons. It is therefore surprising that the C_6-C_{10} fuel can be formulated for winter use without additional C_4 priming. It has been discovered that a winter fuel can be made in the same manner as the C_6-C_{10} summer fuel with the exception being that the C_{10} component is additionally separated from the starting C_4-C_{12} gasoline along with the C_4, C_5, C_{11} and C_{12} components to provide a fuel that when gasified will remain substantially a gas when mixed with colder air. Thus, the present invention also provides a winter fuel having hydrocarbons which consists of hydrocarbons in the range C_6-C_9. The C_6-C_9 winter fuel differs from the C_6-C_{10} fuel only in the elimination of the C_{10} component which is left in the C_6-C_{10} summer fuel. Consequently, the winter C_6-C_9 fuel has a final boiling point of 303°F (151°C) and a boiling range of about 121°F-303°F (49 to 151°C).

[0052] The C_6-C_9 fuel must contain the C_9 hydrocarbon component and preferably should contain the remaining intermediate hydrocarbons which are C_6, C_7, and C_8 since these are preferably present in the C_4-C_{12} gasoline. The C_6-C_9 winter fuel is burned in an engine in the same manner described above with respect to the C_6-C_{10} fuel and enjoys the same benefits described above with respect to the C_6-C_{10} fuel.

[0053] The C_6-C_{10} and C_6-C_9 fuel is gasified by heating in a chamber in the absence of air to a temperature above the final boiling point of the fuel. The C_6-C_{10} and C_6-C_9 fuels are preferably heated to a temperature 350°F (177°C). Higher temperatures may be used but are not necessary. Conventional C_4-C_{12} would require a temperature of about 75°F (24°C) higher to gasify and when mixed with air it would still have the problem of forming condensation droplets. Additionally, the higher temperature would lower the volumetric efficiency of the engine.

[0054] It has been emphasized that C_9 and C_{10} must be present in the C_6-C_{10} fuel and C_9 must be present in the C_6-C_9 fuel because heavy molecular components have the highest energy density. Since these are the highest density components capable of being gasified and remaining a gas when mixed with air, it is important that they remain in the fuel for production of engine power.

[0055] It has also been discovered that the C_6-C_{10} and the C_6-C_9 fuels can be adapted for use in engines having standard carburetion i.e., carburetors which do not require gasification in a heated chamber in the absence of air). In particular, it has been discovered that priming the C_6-C_9 and the C_4-C_{10} fuel with a small amount of a volatile component, i.e. a priming agent, will result in the production of an improved fuel which may be used in automobiles equipped with standard carburetion. The priming agent may be C_4, C_5, or a mixture of C_4 and C_5. Consequently the primed fuel will have hydrocarbons which consists of hydrocarbons in the range C_4-C_{10} (summer) and C_4-C_9 (winter). The C_4-C_9 and C_4-C_{10} fuel is the same as the analogous C_6-C_9 and C_6-C_{10} fuel except for the presence of a small amount of priming agent in both the C_4-C_9 and C_4-C_{10} fuel, said small amount being the minimum effective amount for raising the front end volatility of the fuel to a minimum level for cold engine starting with said minimum effective amount being less than that required for C_4-C_{12} gasoline.

[0056] In both the winter and summer fuel, the amount of priming agent is the minimum amount effective to raise the front end volatility so that the fuel can be used in cars equipped with standard carburetion. Thus the C_4-C_9 (primed with C_6-C_9) is particularly suitable for winter use and the C_4-C_{10} (primed with C_6-C_{10}) is particularly suitable for summer use in cars equipped with standard carburetors. It is particularly significant and surprising that the amount of C_4 or C_5 in the C_4-C_9 (primed C_6-C_9) and C_4-C_{10} (primed C_6-C_{10}) fuel is less than the amount of C_4 or C_5 in conventional C_4-C_{12} gasoline without sacrificing any of the desirable properties of the gasoline. It is also surprising that the C_4-C_9 and C_4-C_{10} fuels have adequate front end volatility yet are lower in Reid Vapor Pressure than conventional C_4-C_{12} gasoline. It is believed that this is because removal of C_{11} and C_{12} from C_4-C_{12} gasoline means that the remaining fuel will have a higher percentage of C_4, C_5, and C_6 hydrocarbons. therefore much of the C_4 and some of the C_5 hydrocarbons can be removed from the C_4-C_{10} and C_4-C_9 fuel to obtain a functionally equivalent front end volatility in comparison to the original C_4-C_{12} gasoline. This reduces the Reid Vapor Pressure.

[0057] The fuel of this invention may also contain any of the various additives presently in use or known to be useful in gasoline. In fact, because this invention produces a fuel having a low Reid Vapor Pressure, as compared to normal automotive gasoline, it is possible to add large amounts of alcohol such as ethanol to the fuel of this invention without raising the Reid Vapor Pressure above the current allowable limits. Alcohol addition to conventional gasoline is known to raise the Reid Vapor Pressure above the allowable limits. Additions of alcohol can be added to the fuels of this invention in an amount of 10-20 per cent by weight without exceeding current Reid Vapor Pressure standards.

[0058] It is also possible to add lubricants or anti-knock compounds to the fuel. For example, a suspension of fine synthetic upper end lubricants or small amounts of anti-knock compounds may be added the fuel of this invention.

[0059] It has also been surprisingly discovered that the fuels of this invention when gasified burn almost completely in the engine producing equivalent torques with less fuel and at temperatures which are lower than the temperatures achieved when combusting conventional fuels in engines equipped with standard carburetion systems. This is true at stoichiometric or slightly higher air-to-fuel ratios which would normally result in the development of excessive engine temperature. Therefore, combusting the fuel of this invention produces less nitrous oxide and allows some increase in compression or supercharging without damage to the engine and without environmental contamination.

[0060] The fuel of this invention is a C_6-C_{10} hydrocarbon fuel and naturally exists in the liquid state at standard temperature and pressure. Thus the fuel can be shipped, stored and dispensed like conventional gasoline and requires no further processing for use.

[0061] It has also been discovered that the fuels of this invention burn cooler than conventional C_4-C_{12} fuel.

For this reason it may be advantageous to add an oxygen source to the fuel to obtain more complete combustion. The oxygen source raises the combustion temperature. However, due to the fact that the fuels of the present invention burn cooler than conventional C_4-C_{12} gasoline, the elevated combustion temperature can be tolerated in automobile engines. Thus, an oxygenate compound may be added to the fuels of the present invention to raise combustion temperatures or to effect more complete combustion. Many suitable oxygen source may be used. Typical oxygen sources include oxygenated hydrocarbons such as 1, 2 butylene oxide.

Example 1

[0062] C_5-C_{10} fuel was made by removing the hydrocarbons lighter than C_5 and the hydrocarbons heavier than C_{10} from a conventional C_4-C_{12} gasoline. The C_4-C_{12} gasoline which served as the starting ingredient contains C_5, C_6, C_7, C_8, C_9, and C_{10} hydrocarbons in addition to the heavy and light hydrocarbons which were removed therefrom. The resulting C_5-C_{10} fuel therefore contains C_5, C_6, C_7, C_8, C_9, C_{10} hydrocarbons. The C_5-C_{10} fuel had a Reid Vapor Pressure of 6. The fuel was used to start and run a standard carbureted Volkswagon engine. Measurements of fuel efficiency were taken and the results are shown in Table I, (line B). During the test it was noted that the standard carbureted engines started and ran easily even though the fuel had a Reid Vapor Pressure of only 6.

Example 2

[0063] For the purpose of comparison, the C_4-C_{12} gasoline described in example 1 was used to start and run a Volkswagon engine which was identical to the engine used for testing the C_5-C_{10} fuel in example 1. The C_4-C_{12} gasoline had a Reid Vapor Pressure of 10. The efficiency of the C_4-C_{12} gasoline was measured and the results are shown in Figure 1 (line A).

Example 3

[0064] The C_5-C_{10} fuel used in example 1 was also tested in an engine identical to the engine used in example 1 with the exception that the engine used in example 3 was equipped with an improved carburetion system of the present invention. The fuel efficiency was measured and the results are shown in Table I (line C). During the test it was noted that the C_5-C_{10} fuel easily started and ran the engine equipped with the improved carburetor even though the fuel had a Reid Vapor Pressure of only 6.

Claims

1. Method for producing a fuel for an internal combustion engine wherein the Reid Vapor pressure is reduced compared to conventional C_4-C_{12} gasoline by the steps of:

- taking a conventional C_4-C_{12} gasoline as a starting material,
- producing a hydrocarbon mixture having an intermediate hydrocarbon range relative to said C_4-C_{12} gasoline by substantially removing the lighter volatile components as well as the heavier components from said C_4-C_{12} gasoline so that the hydrocarbons are substantially limited to those in the range of C_6-C_{10} or C_6-C_9.

2. The method of claim 1 containing the additional step of

- priming the intermediate hydrocarbon range mixture with a minimum amount of C_4, C_5 or a mixture of C_4 and C_5, said count being less than the amount of C_4, C_5 or mixture of C_4 and C_5 within the starting material, to produce a fuel having adequate front end volatility so that it can be used in a standard carbureted engine.

3. A fuel, for running an internal combustion engine obtainable by the method of claim 1; said fuel comprising a hydrocarbon mixture being substantially limited to hydrocarbons within the range C_6-C_{10} with C_9 and C_{10} hydrocarbons being present in the mixture and said hydrocarbon mixture having a boiling point range of essentially 121°F - 345°F (49,45°C - 174°C), at one atmosphere pressure; the fuel having a Reid Vapor pressure lower than 9 psi (62 kPa) when containing C_9 and C_{10} hydrocarbons.

4. The fuel of claim 3 which further contains a priming agent, being selected from the group consisting of C_4 and C_5 hydrocarbons and mixtures thereof; said priming agent being present in a minimum effective amount for raising the front end volatility of the fuel to a minimum level for cold engine starting with said minimum effective amount being less than that required for C_4-C_{12} gasoline.

5. The fuel of claim 3 wherein the hydrocarbon mixture is limited to C_6-C_{10} paraffinic hydrocarbons.

6. The fuel of claim 5 wherein the hydrocarbon mixture includes C_6, and C_8 hydrocarbons.

7. The fuel of claim 5 which further includes alcohol.

8. The fuel of claim 3 or 4 which further includes an oxygen source for increasing the combustion temperature or the combustion efficiency of the fuel in an automobile engine.

9. A method of operating an internal combustion engine **characterized by** vaporizing fuel by heating the fuel in a chamber to above the final boiling point of the fuel at one atmosphere pressure in the absence of air; immediately mixing the vaporized fuel with air in a carburetor without forming liquid droplets in the mixture and then immediately combusting the mixture in the engine in a substantially vaporized state; said fuel being the fuel of claim 3.

10. The method of claim 9 wherein the chamber is heated to 425°F ± 25°F (218,35°C ± 14°C).

11. The method of claim 9 wherein the fuel includes C_6, C_7 and C_8 hydrocarbons.

12. The method of claim 9 wherein the fuel further includes alcohol.

Patentansprüche

1. Verfahren zur Herstellung eines Brennstoffs für einen Verbrennungsmotor, wobei der Reid-Dampfdruck verglichen mit herkömmlichem C_4-C_{12}-Benzin vermindert ist durch die Schritte:

- Verwenden eines herkömmlichen C_4-C_{12}-Benzins als Startmaterial,
- Herstellen eines Kohlenwasserstoffgemisches, das im wesentlichen durch Entfernen sowohl der leichter flüchtigen Bestandteile als auch der schwereren Bestandteile aus dem C_4-C_{12}-Benzin relativ zu dem C_4-C_{12}-Benzin einen intermediären Kohlenwasserstoff-Bereich aufweist, so dass die Kohlenwasserstoffe im wesentlichen begrenzt sind auf die, die im Bereich von C_6-C_{10} oder C_6-C_9 liegen.

2. Verfahren nach Anspruch 1, enthaltend den zusätzlichen Schritt

- Versetzen des Gemisches eines intermediären Kohlenwasserstoff-Bereiches mit einer minimalen Menge von C_4, C_5 oder einem Gemisch von C_4 und C_5, wobei die Mange geringer ist, als die Menge von C_4, C_5 oder einem Gemisch von C_4 und C_5 im Startmaterial, um einen Brennstoff herzustellen, der eine ausreichende Eingangs-Flüchtigkeit aufweist, so dass er in einem Standard-Vergasermotor verwendet werden kann.

3. Brennstoff zum Betrieb eines Verbrennungsmotors, der erhältlich ist durch das Verfahren nach Anspruch 1, wobei der Brennsloff eine Kohlenwasserstoffmischung umfasst, die im wesentlichen begrenzt ist auf Kohlenwasserstoffe im Bereich von C_6-C_{10}, mit C_9 und C_{10} Kohlenwasserstoffe im Gemisch vorliegen und die Kohlenwasserstoffmischung einen Siedepunktsbereich von 121 °F-345°F (49,5°C-174°C) bei einem Druck von einer Atmosphäre aufweist, wobei der Brennstoff einen Reid-Dampfdruckgeringer als 9 psi (62 kPa) aufweist, wenn er C_9 und C_{10}-Kohienwasserstoffe enthält.

4. Brennstoff nach Anspruch 3, weiterhin enthaltend ein Zusatzmittel ausgewählt aus der Gruppe bestehend aus C_4 und C_5-Kohlenwasserstoffen und Gemischen davon, wobei das Zusatzmittel in einer minimalen wirksamen Menge zur Erhöhung der Eingangs-Flüchtigkeit des Brennstoffs auf ein minimales Niveau für den Kaltmaschinenstart vorliegt, wobei die minimale wirksame Menge geringer ist als die, die für C_4-C_{12}-Benzin benötigt wird.

5. Brennstoff nach Anspruch 3, worin das Kohlenwasserstoffgemisch begrenzt ist auf paraffinische C_6-C_{10}-kohlenwasserstoffe.

6. Brennstoff nach Anspruch 5, worin das Kohlenwasserstoffgemisch C_6, C_7 und C_8-Kohlenwasserstoffe umfasst.

7. Brennstoff nach Anspruch 5, der weiterhin Alkohl umfasst.

8. Brennstoff nach Anspruch 3 oder 4, der weiterhin eine Sauerstoffquelle zur Erhöhung der Verbrennungstemperatur oder der Verbrennungswirksamkeit des Brennstoffs in einem Kraftfahrzeugmotor umfasst.

9. Verfahren zum Betrieb eines Verbrennungsmotors, **dadurch gekennzeichnet, dass** durch Erhitzen des Brennstoffs in einer Kammer öber den End-Siede-punkt des Brennstoffs hinaus bei einem Druck von einer Atmosphäre in Abwesenheit von Luft Brennstoff verdampft wird; dass der verdampfte Brennstoff sofort in einem Vergaser mit Luft vermischt wird, ohne dass sich Flüssigkeitströpfchen im Gemisch bilden, und das Gemisch dann sofort im Motor in einem im wesentlichen verdampften Zustand verbrannt wird, wobei der Brennstoff der Brennstoff nach Anspruch 3 ist.

10. Verfahren nach Anspruch 9, worin die Kammer auf 425°F ± 25°F (218,35°C ± 14°C) erhitzt wird.

11. Verfahren nach Anspruch 9, worin der Brennstoff C_6, C_7 und C_8-Kohlenwasserstofle umfasst.

12. Verfahren nach Anspruch 9, worin der Brennstoff weiterhin Alkohol umfasst.

Revendications

1. Procédé pour la production d'un carburant destiné à un moteur à combustion interne, dans lequel la tension de vapeur de Reid est réduite par rapport à une essence C_4-C_{12} classique par les opérations consistant à :

- prendre une essence C_4-C_{12} classique comme matériau de départ,
- produire un mélange d'hydrocarbures ayant une plage d'hydrocarbures intermédiaire par rapport à ladite essence C_4-C_{12} en enlevant sensiblement les composants volatils plus légers ainsi que les composants plus lourds de l'essence C_4-C_{12} de sorte que les hydrocarbures sont sensiblement limités à ceux de la plage C_6-C_{10} ou C_6-C_9.

2. Procédé selon la revendication 1, contenant l'étape supplémentaire consistant à :

- ajouter au mélange d'hydrocarbures de plage intermédiaire un agent d'amorçage ayant une quantité minimum de C_4, de C_5 ou d'un mélange de C_4 et C_5, cette quantité étant inférieure à la quantité de C_4, de C_5, ou du mélange de C_4 et C_5 dans le matériau de départ, pour produire un carburant ayant une volatilité finale adéquate de façon à pouvoir être utilisé dans un moteur à carburation standard.

3. Carburant pour le fonctionnement d'un moteur à combustion interne, pouvant être obtenu par le procédé de la revendication 1 ; le carburant comprenant un mélange d'hydrocarbures sensiblement limité à des hydrocarbures dans la plage C_6-C_{10} avec C_9 et C_{10}, présents dans le mélange, et ledit mélange d'hydrocarbures ayant une plage de point d'ébullition de 121°F -345°F (49,45°C)- 174°C), respectivement, à la pression d'une atmosphère ; le carburant ayant une tension de vapeur de Reid inférieure à 9 psi (62 kPa) lorsqu'il contient des hydrocarbures C_9 et C_{10}.

4. Carburant selon la revendication 3, contenant en outre un agent d'amorçage, choisi dans le groupe constitué par des hydrocarbures C_4 et C_5 et leurs mélanges ; l'agent d'amorçage étant présent dans une quantité efficace minimum pour élever la volatilité finale du carburant jusqu'à un niveau minimum pour le démarrage du moteur à froid, la quantité efficace minimum étant intérieure à celle nécessaire pour une essence C_4-C_{12}.

5. Carburant selon la revendication 3, dans lequel le mélange d'hydrocarbures est limité à des hydrocarbures paraffiniques C_6-C_{10}.

6. Carburant selon la revendication 5, dans lequel le mélange d'hydrocarbures comprend des hydrocarbures C_6. C_7 et C_8.

7. Carburant selon la revendication 5, qui comprend en outre de l'alcool.

8. Carburant selon la revendication 3 ou 4, qui comprend en outre une source d'oxygène pour augmenter la température de combustion, ou le rendement de combustion du carburant dans un moteur d'automobile.

9. Procédé de fonctionnement d'un moteur à combustion interne, **caractérisé en ce qu'**on vaporise du carburant en chauffant le carburant dans une chambre au-dessus du point d'ébullition terminal du carburant à la pression d'une atmosphère en l'absence d'air ; **en ce qu'**on mélange immédiatement le carburant vaporisé avec de l'air dans un carburateur sans former de gouttelettes liquides dans le mélange, et **en ce qu'**on fait entrer immédiatement en combustion le mélange dans le moteur dans un état sensiblement vaporisé; ledit carburant étant le carburant de la revendication 3.

10. Procédé selon la revendication 9, dans lequel la chambre est chauffée jusqu'à 425°F ± 25°F (218,35°C ± 14°C).

11. Procédé selon la revendication 9, dans lequel le carburant comprend des hydrocarbures C_6, C_7 et C_8.

12. Procédé selon la revendication 9, dans lequel le carburant comprend en outre de l'alcool.

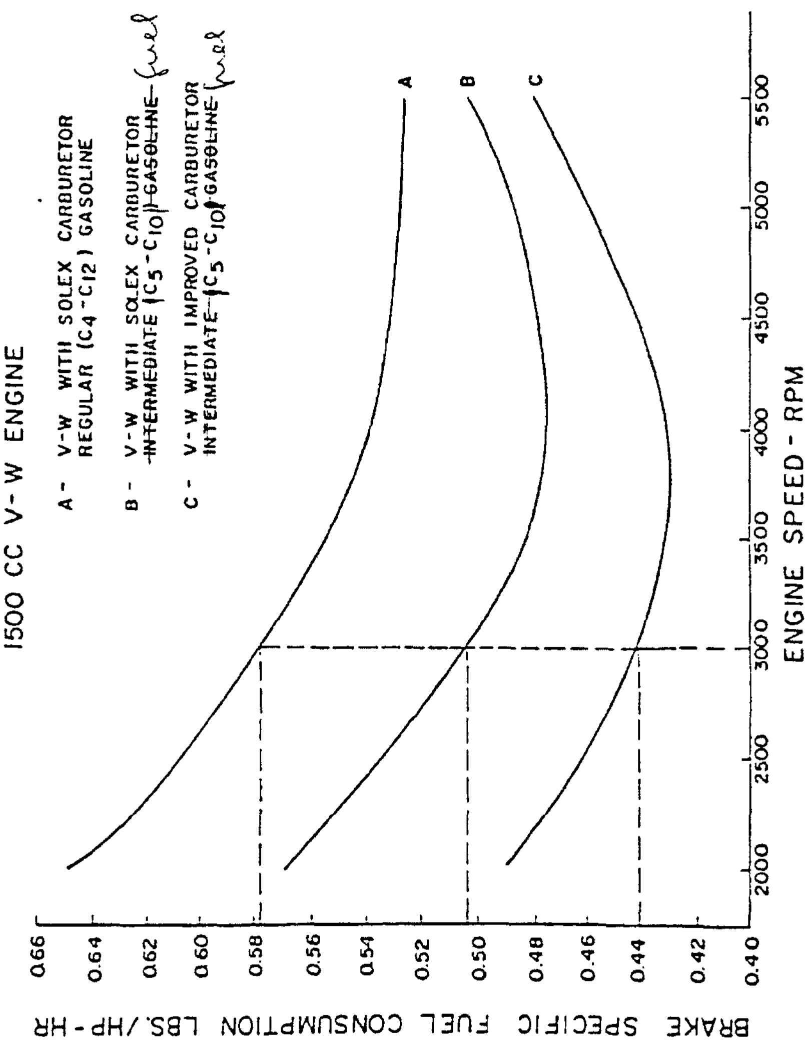
1500 CC V-W ENGINE
A - V-W WITH SOLEX CARBURETOR REGULAR (C4-C12) GASOLINE
B - V-W WITH SOLEX CARBURETOR INTERMEDIATE (C5-C10) GASOLINE fuel
C - V-W WITH IMPROVED CARBURETOR INTERMEDIATE (C5-C10) GASOLINE fuel
A
B
C
BRAKE SPECIFIC FUEL CONSUMPTION LBS./HP-HR
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
2000
2500
3000
3500
4000
4500
5000
5500
ENGINE SPEED - RPM

FIG. 1