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MOTOR FUELS

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In this invention selected alcohols properly blended with certain low molecular weight hydrocarbons provide valuable quick-starting fuels for high-compression spark-ignition engines. These fuels are of special value for developing maximum power and thermal efficiency in high output engines with freedom from vapor locking difficulties.

Although it has been known that alcohols, such as methyl or ethyl alcohol, either pure or blended with gasoline have some advantages as motor fuels, mainly that of high octane rating, they have only limited use in countries where adequate petroleum supplies are readily available. The alcohol-gasoline blends introduce certain operating difficulties; for example, a small amount of water causes separation of the alcohols from the gasoline, meaning that these blends have low water tolerance. These blends, moreover, are subject to vapor locking difficulties, which are more serious than such difficulties incident to the use of the gasoline without the addition of alcohol. The use of the pure alcohols would be advantageous for power, anti-detonating quality, and water tolerance, but the pure alcohols have poor starting characteristics.

In accordance with the present invention, disadvantages of alcohol-gasoline blends and pure alcohols as motor fuels are overcome by blending from 5% to 10% by volume of a selected low molecular weight hydrocarbon component having from 3 to 5 carbon atoms per molecule, with a major proportion of an alcohol having from 1 to 5 carbon atoms per molecule.

I have found that blends of these selected compounds in the proper proportions are not subject to phase separation, even if a considerable amount of water is added. I have also found that these blends satisfactorily keep in storage without excessive vapor loss and satisfactorily mix with intake air on being carbureted for obtaining quick starting of a cold motor. These blends exhibit extraordinary freedom from vapor lock in carbureting systems designed and set for use with ordinary hydrocarbon fuels. In comparison to all alcohol containing fuels hitherto proposed, the exceptional properties of the blends herein provided are of tremendous advantage.

In order to obtain a desired efficiency with these fuel blends, it is important that the volatile hydrocarbon component be blended in a proportion of at least 5% of the blended components and should be lower boiling, or of greater volatility, than hexanes or hexenes. Methane, ethane, and ethylene are at the other extreme, in being too

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low boiling. Limitations on selection and proportioning of the hydrocarbon component are dependent on proper air to fuel ratios in average fuel induction systems.

Fuel blends of the present invention have certain peculiar characteristics in that the low boiling hydrocarbon and the alcohol blended in ascertained proportions do not form ideal solutions but exhibit abnormally large deviations from Raoult's law governing ideal solutions. These deviations appear significant for satisfactory air-fuel ratios with blends herein described. Small amounts of lower and higher boiling hydrocarbons, such as, ethane or hexane, incidentally present in the composition do not destroy the value of the fuel for the intended purpose.

The upper limit of the hydrocarbon component proportion restricted in accordance with empirical determinations on vapor lock tendencies of the blends; for example, a blend of more than 10% of isopentane in ethanol, or more than 10% butane in isopropanol or butanol, at ordinary atmospheric temperatures causes vapor lock in the average fuel system. Thus, about 10% by volume of the hydrocarbon component is the upper practical limit.

Blends of between 5% and 10% by volume of the volatile hydrocarbon component with 95 to 90% by volume of the alcohol component exhibit desirable properties of quick-starting, high anti-knock quality, low vapor-locking tendency and high-power output.

Alcohols used as a major ingredient of the blends are preferably monohydric aliphatic alcohols (alkanols) of 1 to 5 carbon atoms per molecule. Ethyl and methyl alcohols, on account of their availability and large deviations from ideal solutions in the desired blends are useful.

Of alcohols higher boiling than ethyl alcohol, isopropyl and secondary butyl alcohols are outstanding for present purposes. Other alcohols higher boiling than ethyl, but with less preference, are n-propyl, n-butyl, tertiary-butyl, isobutyl, ter-amyl, n-amyl, and sec-amyl alcohols. The preferred alcohols have normal boiling points below 150° C. It is desirable to omit alcohols boiling above 175° C.

Blends formulated for the practice of this invention have unusual distillation and vapor pressure characteristics, which enable them to form a vapor charge which undergoes quick ignition in cold motors at sub-zero temperatures. These blends remain homogeneous even with 10 or more volumes of water added per 100 volumes of the blend. They remain satisfactorily constant in

composition and purity for suitable periods of time for use under various operating conditions.

For illustration, characteristics of blends forming specific embodiments of this invention are presented in the following table:

Table I

Blend	Composition	Reid vapor pressure	Initial boiling point, °F.	90% distilled off at °F.	Dist. loss per cent	Water tolerance vols. of water/100 vols. of blend
1.....	5% n-pentane in methanol.....	7.9	122	149	1.0	22.4
2.....	10% n-pentane in methanol.....	11.4	88	149	0.8	11.9
3.....	5% isopentane in ethanol.....	5.7	135	178	1.7	38.5
4.....	10% isopentane in ethanol.....	9.4	97	178	1.5	29.5
5.....	5% butane cut in isopropanol.....	8.3	131	179	1.9	111.0
6.....	5% butane cut in butanol.....	7.6	185	241	5.0	16.7

The butane cut used in blends 5 and 6 is otherwise known as plant butane, which contains approximately 60 to 70% n-butane, 20 to 25% isobutane, and 10 to 20% butenes.

Another remarkable characteristic of the new fuels is that addition of water up to a certain extent enhances volatility characteristics of the blends. The water may replace a certain minor proportion of the alcohol in the blends without substantially changing the proportions of the hydrocarbon component to form a fuel blend of enhanced volatility characteristics especially suitable for carbureting. This phase of the invention is particularly useful for raising vapor pressures and volatility distribution of the blends. To illustrate this phase of the invention, the following examples are given:

Examples

Blends of n-pentane and isopropyl alcohol were made up with varying amounts of water then subjected to tests for determination of their volatility and vapor pressure characteristics. The compositions of the blends and the inspections obtained on them are summarized below:

Table II

	Blend No.			
	1	2	3	4
Vol. per cent n-pentane.....	10	10	10	10
Vol. per cent isopropanol.....	90	80	70	60
Vol. per cent water.....	0	10	20	30
Inspections:				
Gravity, °A. P. I.....	50.5	43.6	38.2	33.0
Reid V. P., #/sq. in.....	5.0	6.7	11.1	13.5
A. S. T. M. dist.:				
I. B. P., °F.....	122	97	95	91
Per cent at 158° F.....	8.0	9.5	11.0	12.5
Per cent at 212° F.....	---	---	94.0	84
90% at. °F.....	180	176	190	212
Dist. loss, per cent.....	2.0	1.0	1.0	1.0

By investigation of engine performance with blends described in Table II, it was ascertained that such blends combine desired properties for quick starting and increased power at low temperatures with avoidance of vapor lock in ordinary automotive engines. It is important to note, however, that to obtain the desired results in engine performance, the Reid vapor pressure of the blend should be at least of the order of 5 lbs./sq. in. and, in general, should not exceed 13 lbs./sq. in. Thus the added volume of water may be as high as about 30%.

It can also be observed that as the water replaces minor proportions of alcohol, in the limited amounts of about 10, 20, and 30%, the Reid vapor pressure is increased, while at the same time, the blend is given substantial improvement in volatility balance, the amounts of the fuel vaporized at different intermediate temperatures

throughout the boiling range of the fuel being increased. This balancing of the volatility is desirable for more uniform distribution of the combustible mixture. Thus, in characteristics of prime importance for engine performance, the

aqueous alcoholic solutions containing correct amounts of the highly volatile hydrocarbons are fully satisfactory.

As previously set forth, regardless of whether the fuel blend contains water or is substantially free from water, it should preferably contain a hydrocarbon component blended in a proportion of about 5 to about 10% by volume in order to give the blend the desired advantageous characteristics noted. The alcohol component constituted of one or more alkanols having 1 to 5 carbon atoms per molecule is the major ingredient of the fuel blend, i. e., the alcohol, whether anhydrous or aqueous is blended in an amount of at least 60%.

When water is present in the fuel blend to form what is termed an aqueous alcohol component, the proportion of water added should not exceed that amount which is above the water tolerance of the blend, moreover, preferably it should not exceed about 30% by volume.

The ordinarily most useful fuel blends of the present invention are formulated from ½ to 1 part by volume of the 3 to 5 carbon atom hydrocarbon component blended with 6 to 9 parts by volume of the 1 to 5 carbon atom alcohol component and with from 0 to 3 parts by volume of water, the combined parts by volume of the alcohol component and of the water being blended with the hydrocarbon component in a volume ratio of at least about 9 to 1, so that the aqueous alcohol forms at least about 90% by volume of the fuel.

It is not intended to limit the invention to the specific blends shown in the foregoing tables. It will be observed that these tables illustrate how the blends are obtained with varying characteristics so that for a specific purpose, the most efficient blend is provided.

If requirements of a carbureted engine are such that the Reid vapor pressure must come within the range of 7 to 7.5 or 8 pounds per square inch, as in the case of aviation motors, blends meeting this requirement are available among the foregoing types of blends. For example, a blend between 5% and 10% of isopentane in ethanol will clearly have a Reid vapor pressure meeting these requirements. Other properly chosen combinations of the hydrocarbons and alcohols also meet this requirement.

It is to be noted that the preferred blends are obtained by selecting a relatively higher molecular weight hydrocarbon for blending with a lower molecular weight alcohol, e. g., a C₄ to C₅ hydrocarbon with a C₁ to C₂ alcohol, vice versa, a lower hydrocarbon blended with a higher alcohol,

e. g., a C₃ or C₄ hydrocarbon with a C₃ to C₅ alcohol, or with modification by added water. However, for an average automotive engine, blends satisfactorily used have Reid vapor pressures ranging from 5 to as high as about 13 pounds per square inch at 100° F., or even slightly higher in cold climates.

One way of efficiently and economically using the disclosed blends is to supply the carburetor of the engine from an individual tank separate from the main supply tank, so that the alcohol blend can be fed to the engine for starting at low temperatures or acceleration at high power.

The advantageous blends described may also contain small amounts of other ingredients ordinarily useful in motor fuels, e. g., a fraction of 1% of an anti-knock agent, such as tetraethyl or tetramethyl lead. They may also contain a small amount of a dye, thickening agent, or lubricant. By a small amount is meant generally less than about 1%.

The volatile hydrocarbon component, as indicated, is preferably a 3 to 5 carbon atom paraffinic hydrocarbon which is resistant to oxidation and readily available in highly purified form; hence, in general, the disclosed blends are easily obtained in a chemically stable form.

The hydrocarbon component may also contain or be composed of unsaturated hydrocarbons having 3 to 5 carbon atoms per molecule. Such unsaturated hydrocarbons may be mono-olefins or diolefins, but preferably the unsaturated hydrocarbons should not contain more than one double bond, i. e., should not be more unsaturated than a mono-olefin. Also, the 3 to 5 carbon atom cycloalkanes or cycloalkenes may be used. Thus, in general, suitable hydrocarbons for the hydrocarbon component may be characterized as 3 to 5 carbon atom molecules containing no more than two double bonds and preferably no more than one double bond.

The alcohol component may contain small amounts of other low boiling oxygen-containing compounds, such as ethers, ketones, aldehydes, and esters, but ordinarily these should not be present in any substantial amounts to avoid upsetting the effective balance between the preferred components in the blend.

The present application is a continuation in part of application Serial No. 370,787 filed December 19, 1940, now Patent No. 2,365,009, granted December 11, 1944, the claims of which read on a motor fuel containing a substantial amount of water as an essential constituent. The purpose of the present application is to claim motor fuels not containing water but which do contain a major proportion of methanol and a minor amount of a light hydrocarbon of about 3 to 5 carbon atoms.

Several examples have already been given in Table I of blends coming within the scope of the present claims, such as blends 1 and 2 containing 5% and 10%, respectively, of normal pentane in methanol. Other examples of suitable blends are a 5% blend of isopentane in methanol, containing 3 cc. of tetraethyl lead per gallon; an 8% blend of isopentane in methanol containing 4 cc. of tetra-ethyl lead per gallon in the blend; and a 5% blend of cyclopentane in methanol, containing 1 to 4 cc. of tetra-ethyl lead per gallon.

When the normally gaseous hydrocarbon con-

tains more than 3 carbon atoms per molecule it should preferably be branched or cyclic because such hydrocarbons exhibit superior lead susceptibility in blends with the methanol, especially when used in aviation engines under high compression and for high power output at low temperatures.

The methanol to be used as the major constituent of the fuel may be either an absolutely pure methanol, or it may be a commercial methyl alcohol refined to be substantially free from water but still containing small amounts of other organic compounds, such as acetone in the case of methanol made by destructive distillation of wood, or traces of higher alcohols or other organic impurities in the case of methanol made by synthesis from carbon monoxide and hydrogen.

When these fuels are prepared substantially without the addition of any water, the methanol should constitute about 80-98% by volume of the fuel base stock, and the light hydrocarbon should constitute about 20-2% by volume, the amount of the latter usually required being about 5 to 10% for motor fuels having a Reid vapor pressure in the range of about 5 to 10 lbs./sq. in. at 100° F. The exact amount of light hydrocarbons required will, of course, depend upon the desired Reid vapor pressure and upon the particular hydrocarbon used; for instance, a larger proportion of a pentane will be required than of a butane or propane, or of a mixture of propane, butane and pentane.

There are obviously a number of modifications which come within the spirit of this invention and it is not intended that the invention as defined in the appended claims be limited to the specific examples that have been given for the purpose of illustration.

I claim:

1. A motor fuel comprising about 80 to 98% of methanol and a minor proportion of a hydrocarbon of 3 to 5 carbon atoms selected from the group consisting of aliphatic and cyclo-aliphatic hydrocarbons, the amount of said hydrocarbon being sufficient to raise the Reid vapor pressure of the blend to 13 lbs. per square inch at 100° F.

2. A motor fuel having a Reid vapor pressure of about 5 to 13 lbs./sq. in. at 100° F., comprising about 80-98% of methanol and about 20-2% of a hydrocarbon having 4 to 5 carbon atoms selected from the group consisting of aliphatic and cyclo-aliphatic hydrocarbons.

3. A motor fuel according to claim 2 containing a branched hydrocarbon.

4. A motor fuel according to claim 2 containing a normal pentane.

5. A motor fuel especially adapted for cold starting of aviation engines, having a Reid vapor pressure of about 5-13 lbs./sq. in. at 100° F., comprising about 90-95% by volume of methanol and about 10-5% of C₅ saturated hydrocarbons selected from the group consisting of aliphatic and cyclo-aliphatic hydrocarbons.

6. A motor fuel according to claim 5 containing mixed pentanes.

7. Motor fuel according to claim 1 also containing a small amount of a lead alkyl anti-knock agent.

8. Motor fuel according to claim 2 also containing about 1 to 4 cc. of lead tetraethyl per gallon.

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