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MOTOR FUEL

Thomas B. McCulloch, Baytown, Tex., and John E. Pollock, Orpington, England, assignors to Standard Oil Development Company, a corporation of Delaware

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This invention relates to improved motor fuels for internal combustion engines and the method for preparing the same. The invention especially relates to a synthetic motor fuel having a high anti-knock value and which is especially suitable for use under extreme operating conditions as, for example, in aviation motors. The improved motor fuel of the present invention comprises a suitable blend of isopentane, isopropyl ether and a branched chain saturated paraffin of at least 8 carbon atoms in the molecule, having high anti-knock properties and optimum volatility.

It has been known to add materials as, for example, ethers, isopentane, isohexane, isoheptane and other materials to ordinary motor fuels. These materials have been added in order to improve a particular characteristic of the fuel as, for example, to improve the volatility or the anti-knock properties of the fuel. Other materials having knock suppressing properties as, for example, tetraethyl lead, aniline, carbonyls of iron or nickel, have also been added.

Blends of this character are superior to ordinary motor fuels and result in improved engine operation. These blends, however, have the disadvantages that they do not readily combine desired volatility characteristics with a desired specified high anti-knock property as measured by the octane number. It is also difficult to vary their volatility characteristics while maintaining substantially the same high octane number and the respective fuels cannot be readily duplicated. Furthermore, the amount of a knock suppressing material which may be added is limited due to inherent disadvantages produced by utilizing an excessive quantity. When it is considered that optimum engine performance is secured by utilizing fuels having a predetermined specified volatility curve, which is usually measured in terms of the Engler distillation, that these predetermined volatility curves vary for various climatic conditions and with the type of engine and service in which it is to be used, and that the anti-knock characteristics of the fuel should remain substantially the same, the difficulty of preparing a suitable fuel is readily apparent.

These considerations are important in regard to the satisfactory operation of ordinary automobile engines. However, these considerations are extremely critical in regard to the preparation of fuels for aviation motors since these motors operate under extreme temperature differentials and wide variances in fuel demand. The fuel of the present invention is a superior fuel blend having none of the disadvantages enumerated above. This fuel has a substantially constant high anti-knock characteristic as measured by a high octane number as well as desirable volatility characteristics which may be varied and compounded accurately to meet a fuel requirement having a predetermined volatility characteristic. The fuel of the present invention consists of a blend of isopentane, isopropyl ether and a branched chain saturated paraffin of at least 8 carbon atoms. The preferred saturated branched chain paraffin contains 8 carbon atoms in the molecule. This material, known as iso-octane, is preferably secured by condensing olefins, preferably butylenes, followed by the hydrogenation of the condensed polymer to fully saturate the molecule. A preferred material containing more than 8 carbon atoms in the molecule is a butylene polymer which is subsequently hydrogenated to fully saturate the molecule. The fuel of the present invention utilizing these materials has unexpected superior properties unforeseeable from the prior art which may be readily understood by the following description.

In the preparation of a motor fuel, particularly in the preparation of motor fuels suitable for aviation engines, it is very desirable that the fuel have a predetermined vapor pressure usually in the range from 5 to 12 pounds Reid, a high octane number in the range from 70 to 96, preferably above 95 without the addition of any added knock suppressors, and that it have an Engler distillation between approximately 100 and 400° F. It is also very desirable that a relatively high percentage of the fuel, usually from 12 to 40%, be distilled at 158° F. and that the quantity of tetraethyl lead or other knock suppressors necessary to take the fuel to a higher octane number, for example, to 100 octane number, be a minimum. It is also desirable that the residue be less than 1% and that the gum content be low.

The initial materials for the preparation of the blend of the present invention may be secured in any manner whatsoever. The materials may be used in the pure state or may be secured from commercial operations. For example, it may be desirable to take the so-called pentane cut fraction in the refinery operations and separate the isopentane by distillation or by other suitable means as, for example, by solvent treating.

The isopropyl ether may be secured by any of the known processes from any type of suitable initial materials. For example, ethers are generally prepared from the corresponding alcohols. They may also be secured by treating olefins with concentrated 90 to 95% sulphuric acid to form mono alkyl sulfates which are then hydrolyzed with water to form the alcohols. These alcohols then are contacted with strong sulphuric acid and two molecules of the alcohol are condensed with the splitting off of water to form one molecule of ether. Other processes for securing the isopropyl ether as, for example, by contacting it with sulphuric acid of substantially one concentration,

are also satisfactory. Branched chain saturated paraffins containing at least 8 carbon atoms in the molecule are preferably secured by condensing lower molecular weight olefins, followed by hydrogenation of the condensed polymer to produce a fully saturated molecule.

The iso-octane and branched saturated polymers containing more than 8 carbon atoms in the molecule of the present invention are preferably prepared by polymerizing butylenes followed by hydrogenation of the polymer. The preferred polymers are the hydrogenated dimers of isobutylene or the hydrogenated co-polymers of isobutylene and normal butylene.

The olefins may be polymerized, for example, by treating with sulphuric acid at the appropriate temperature. For example, they may be polymerized by treating with 60% sulphuric acid at a temperature of about 50° F., or may be treated with sulphuric acid at a temperature up to 225° F. The olefins may also be polymerized by treating with 70% sulphuric acid at temperatures of 175° F. The preferred conditions are to treat with 60 to 75% sulphuric acid at polymerizing temperature at from 150° to 300° F. It is preferred to have a high ratio of normal to isobutylene reacted. The polymerized butylenes are then hydrogenated under suitable conditions to form the iso-octane product.

In the polymerization of the butylenes under the above conditions, there results a polymer greater than the dimer. This material, upon being hydrogenated along with the dimer, produces a polymer which has somewhat higher boiling range but which is also entirely satisfactory. This latter material is known as a hydrogenated higher polymer.

The relative proportions of the isopentane, isopropyl alcohol and branched chain saturated paraffin containing at least 8 carbon atoms may vary widely. The relative percentages of each constituent present will depend upon the volatility of the particular fuel blend desired. For example, in the preparation of an aviation fuel, it is generally preferred to have a vapor pressure somewhat below 7 pounds Reid. It is also desirable that the octane number be at least 96 without the addition of any knock suppressor as, for example, tetraethyl lead. Thus constituents of aviation fuel blends will vary in order to secure the predetermined desired volatility characteristics of the fuel. For example, in blends comprising isopentane, isopropyl ether and iso-octane or the hydrogenated higher polymer of butylene the concentration of the isopentane is preferably from 5 to 15%. The concentration of the isopropyl ether is preferably from 20 to 50% while the proportion of the iso-octane or of the high hydrogenated polymer is present, preferably in the concentration from 30 to 70%.

The following examples are given for the purposes of illustration and are not to be construed as limiting the invention in any manner whatsoever.

Example 1

Motor fuel blends were prepared by blending iso-pentane, approximately 99% pure, having a boiling point of about 85° F., with isopropyl ether boiling between approximately 147 and 215° F. having 96.2% evaporated at 152° F. with iso-octane boiling in the range from 144 to 274° F. and having 6% evaporated at 199° F. These materials were blended in the following proportions:

Motor fuel blend	A	B	C	D
Isopentane, percent	11	11.5	10	9.5
Isopropyl ether	44.5	35	30	25
Iso-octane	44.5	53.5	60	65.5

These blends were then tested in order to determine the volatility characteristics as measured by the Engler distillation. They were also tested for gravity, Reid vapor pressure and anti-knock characteristics as measured by the octane number. The results of these tests were as follows:

Motor fuel blend	A	B	C	D
Gravity, ° A. P. I.	67.8	69.7	69.7	70.2
I. B. P., ° F.	118	107	118	115
Percent at—				
122	------	1.5	0.5	0.5
140	7.0	8.0	5.0	4.5
146	13.5	13.0	8.0	7.0
149	17.0	15.5	10.0	9.0
158	30.0	26.0	18.0	15.5
164	40.0	30.5	24.0	20.0
167	44.0	35.0	27.0	22.5
195	71.0	63.5	55.0	49.0
203	77.0	72.0	66.5	60.0
212	83.0	84.0	79.0	75.5
257	97.5	98.0	------	97.5
275	------	------	------	------
302	------	------	------	------
F. B. P., ° F.	274	280	255	262
Recovery, percent	98.0	98.5	98.0	98.0
Residue, do	0.6	0.4	1.0	0.6
Loss, do	0.4	1.1	1.1	1.4
Reid V. P., pounds	7.1	7.1	7.0	7.2
Octane number, CFR motor	98.3	98.0	96.4	97.0

Example 2

Motor fuel blends were also prepared by blending isopentane and isopropyl ether as described in Example 1 with the higher hydrogenated polymer boiling in the range from 120 to 374° F. and having 6% evaporated at 188° F. These materials were blended in the following proportion:

Motor fuel blend	E	F	G	H
Isopentane, percent	11	11	11.5	10
Isopropyl ether	30	35	30	25
Higher hydrogenated polymer	59	54	58.5	56

These blends were tested for octane number, gravity and Engler distillation, as described in Example 1, with the following results:

Motor fuel blend	E	F	G	H
Gravity, °A. P. I.	70.3	68.8	69.2	68.8
I. B. P., °F.	110	116	114	112
Percent at—				
122	1.0	0.5	1.5	0.5
140	6.5	4.5	6.0	6.0
146	10.0	9.0	10.0	10.0
149	12.5	11.5	12.5	12.5
158	21.5	22.5	22.0	18.0
164	27.0	29.0	28.0	22.5
167	30.0	32.5	31.0	25.0
195	58.0	61.0	54.5	47.0
203	68.0	69.0	63.0	55.0
212	80.0	76.5	73.0	64.0
257	96.0	92.0	92.0	85.5
275	------	------	------	88.0
302	97.0	93.5	94.0	89.0
F. B. P., °F.	304	364	366	382
Recovery, percent	98.0	98.0	98.5	98.0
Residue, do	0.9	0.8	0.9	0.8
Loss, do	1.1	1.2	0.6	1.2
Reid V. P., pounds	7.0	6.8	6.8	7.2
Octane number, CFR motor	97.5	98.4	98.0	98.0

As may be seen from the above data of the respective blends, the octane number varied from 96.4 to 98.4, the vapor pressure varied from 6.8

to 7.2, the residue varied from 0.4 to 1%, whereas the percentage recovered at 158° was varied over the range 15.5 to 30%.

Example 3

Motor fuel blends comprising isopentane, isopropyl ether and a branched chain saturated paraffin of the present invention were prepared and compared with other relatively high octane number fuels. The compositions of the respective blends having a vapor pressure of about 7.2 pounds Reid were as follows:

Motor fuel blend	I	J	K	L
Isopentane	9.5	10	19.5	19
Isopropyl ether	25	25	-----	-----
Iso-octane	65.5	-----	64	64
Higher hydrogenated polymer	-----	65	-----	-----
2, 3 dimethyl butane	-----	-----	-----	17
2 methyl pentane	-----	-----	16.5	-----

These blends were also tested for octane number, gravity, Engler distillation and the amount of tetraethyl lead necessary to secure a 100 octane number on the blend of the present invention with the following results:

Motor fuel blend	I	J	K	L
Reid vapor pressure ..... pounds	7.2	7.2	7.25	7.2
Gravity ..... ° F	70.2	68.8	78	77.3
I. B. P ..... ° F	115	112	106	107
Final boiling point ..... ° F	262	382	225	226
Octane number (Army method)	98.4	97.4	93.1	94.5
Octane number (Army method)+0.1 ccs. tetraethyl lead	-----	-----	94	95.1
Cubic centimeters tetraethyl lead to 100 octane number (Army method)	0.08	0.15	-----	-----

The above data clearly demonstrate the superior susceptibility of the fuels of the present invention since the improvement secured when using approximately the same quantity of tetraethyl lead was considerably greater even though the improvement was secured over a higher starting octaine number.

Although the present invention comprises isopentane, isopropyl ether and iso-octaine or a higher hydrogenated polymer, it is within the scope of the invention to include similar blends containing knock suppressors as, for example, tetraethyl lead, gum inhibiting substances and color stabilizers.

The above invention is not to be limited by any theory or method of operation, but only by the following claims in which it is desired to claim all novelty in so far as the prior art permits.

We claim:

1. A motor fuel having a vapor pressure in the range from about 6½ pounds to 7½ pounds Reid at 100° F. comprising substantial proportions of isopentane, isopropyl ether and a branched chain saturated paraffin containing at least 8 carbon atoms in the molecule blended to produce a fuel having from 12 to 40% distilled Engler at 158° F.

2. An improved motor fuel in accordance with claim 1 in which said branched chain saturated paraffin is a hydrogenated butylene polymer.

3. Motor fuel in accordance with claim 1 in which said branched chain saturated paraffin is a hydrogenated dimer of isobutylene.

4. Composition in accordance with claim 1 in which said saturated paraffin is iso-octaine produced by polymerizing hydrocarbons containing 4 carbon atoms in the molecule.

5. A motor fuel having a vapor pressure in the range from about 6½ pounds to 7½ pounds Reid at 100° F. and an octane number of at least 96 without the addition of any knock-suppressing agent, the Engler volatility of which may be varied at 158° F. from 12% to 40% comprising 5% to 15% of isopentane, 20% to 50% of isopropyl ether, 40% to 70% of a branched chain saturated paraffin containing at least 8 carbon atoms in the molecule.

6. A motor fuel having a vapor pressure in the range from about 6½ pounds to 7½ pounds Reid at 100° F. and an octane number of at least 96 without the addition of any knock-suppressing agent, the Engler volatility of which may be varied at 158° F. from 15½% to 30% comprising 10% to 12% of isopentane, 25% to 45% of isopropyl ether, and from 44% to 66% of a branched chain saturated paraffin containing at least 8 carbon atoms in the molecule.

THOMAS B. McCULLOCH.
JOHN E. POLLOCK.