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LIQUID FUEL COMPOSITION AND PROCESS
OF MAKING SAME

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The present invention relates to novel liquid hydrocarbon compositions and, particularly, to such compositions adapted for use as fuels in the operation of gas turbine and jet engines.

As those skilled in the art are aware, liquid hydrocarbon compositions adaptable for use in the operation of such engines should desirably possess certain properties and characteristics to a somewhat exacting degree in order to perform satisfactorily over a wide range of operating conditions. In illustration, such compositions should desirably possess volatility characteristics that enable easy starting of the engines and have a minimized tendency to form explosive mixtures in fuel tanks, storage tanks, etc., yet provide for efficient operation thereof at high speeds and, in the case of aircraft, a minimized tendency to loss by vaporization at high altitudes and at high rates of climb. For example, such fuel compositions desirably should not possess Reid vapor pressure characteristics high enough to cause undue losses in volume by said fuels during handling thereof such as in storage and transportation or during use at high altitudes and at high rates of climb such as are encountered in usual operation of jet propelled aircraft. On the other hand, the Reid vapor pressure characteristics of such fuel compositions should not be so low as to cause difficulties due to formation of explosive mixtures in storage and fuel tanks and/or to render, under certain conditions, more difficult starting of such engines to the extent requiring use of an auxiliary fuel for starting purposes. In addition, such fuel compositions should desirably possess suitable distillation characteristics with low distillation loss values to avoid vaporization losses in storage, should be substantially devoid of excessively high boiling constituents but containing a sufficient concentration of relatively high boiling constituents to provide for lubrication of fuel pumps, etc., and should possess adequate heat of combustion values. Furthermore, and along with the aforesaid properties, such fuel compositions should in most instances desirably possess gravity characteristics such that they may be accurately metered volumetrically, freezing point characteristics such that difficulties due to freezing upon use thereof at excessively low temperatures may be obviated or substantially minimized, anti-corrosive characteristics such as not to induce undue corrosion of copper and copper alloys used in fuel lines, valves, etc., and possess stability against gum-forming characteristics so as to obviate or substantially inhibit formation of gums or other deposits in fuel lines, filters, etc. that would normally result in clogging thereof with resultant decrease in performance and operating efficiency of the jet engine.

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The numerous and somewhat exacting requirements desired for fuels adapted for gas turbines and jet engine operation have presented numerous problems and difficulties to certain petroleum refineries, particularly from the viewpoint of producing, in desired high volume and in an economic manner, liquid hydrocarbon fuels adapted for such usage. In particular, such problems and difficulties arise due to the required combination in such fuels of high vapor pressure characteristics with exceptionally low distillation loss values. More particularly, such problems and difficulties are presented to petroleum refineries that do not (for geographic, economic, or other reasons) have ready access to natural gasolines rich in pentane or hexane hydrocarbons, or do not produce in normal refining practice, or produce only in relatively small volumes, substances such as pentanes or other repressurizing agents suitable for blending with stabilized petroleum distillates to provide liquid hydrocarbon compositions possessing desired vaporization characteristics and low distillation loss values. In illustration thereof, compositions adapted for operation of gas turbine and jet engine operation may be prepared by subjecting certain petroleum crudes to fractional distillation to provide a relatively wide boiling overhead distillate with stabilization thereof (as by fractionation) by removal of butanes and hydrocarbons lower boiling than butanes, substantially all of which must be removed from said distillate to impart low distillation loss characteristics thereto. However, and with respect to many available and commonly used crudes, stabilized distillates obtained therefrom possess lower than desired Reid vapor pressure characteristics and, hence, resort is made to repressurization of such distillates to increase the Reid vapor pressure thereof while maintaining distillation loss characteristics at desired low values. For such a purpose, substances such as natural gasolines, rich in volatile pentanes and hexanes and substantially devoid of butanes, having low distillation loss characteristics may be used as repressurizing agents. However, and as aforesaid, the necessity for use of such repressurizing agents imposes certain undesirable limitations on petroleum refiners that do not have ready and/or economic access to adequate supplies of suitable repressurizing agents and who, without undergoing extensive or undesirable alteration of normal refining practices, do not produce, or produce only in small volumes, agents suitable for repressurizing purposes. Hence, there is a distinct need in the art, and particularly with respect to petroleum refineries limited as aforesaid with respect to suitable repressurizing agents, for a liquid hydrocarbon fuel composition, possessing

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properties desired for adaptability thereof for gas turbine and jet engine operation, that is comprised of components readily obtainable in normal refining operations, thus obviating the necessity for use of repressurizing agents and, hence, obviating the necessity for resort to substantial alteration of normal refining operations in order to produce suitable gas turbine and jet engine fuel compositions in an economic manner and in desired high volumes. As will be apparent from the disclosure set forth hereinafter, the present invention provides the art with compositions that fulfill the aforesaid need.

In broad aspect, the liquid hydrocarbon compositions embodied herein, and adaptable for use as fuels for operation of engines such as aforesaid are comprised predominantly or wholly of a light liquid hydrocarbon fraction and a heavy hydrocarbon fraction in a volume ratio of one part of the heavy fraction to about one to about nine parts of the light fraction, said fractions having the properties and characteristics more fully defined hereinafter. In specific aspect, the compositions embodied herein may comprise combinations of the light fraction and the heavy fraction in amounts within the aforesaid ranges sufficient to provide liquid hydrocarbon mixtures possessing a Reid vapor pressure of at least 5.0 but not more than 7.0 pounds per square inch, a distillation loss not in excess of 1.5 per cent by volume, a final boiling point not in excess of 600° F., and further characterized in that the temperature at the 90% evaporated point thereof is not less than about 400° F. In more specific aspect, the compositions embodied herein possess the aforesaid properties and, in addition, have a desirably low freezing point as well as having suitable characteristics with respect to anti-corrosiveness for copper and copper alloys, stability against excessive gum formation, and the like, illustrations of which are set forth in the specific examples shown hereinafter.

In order to illustrate the adaptability of the present invention to preparation of suitable gas turbine and jet engine fuel compositions without need to resort to use of repressurizing agents and without necessitating substantial, if any, alteration in normal refining practices, the following examples are set forth, such examples having been chosen as illustrative, and not limitative, embodiments of the invention.

Example I

A Conroe crude was subjected to fractional distillation without effecting substantial, if any, cracking to provide a light liquid hydrocarbon distillate fraction, a heavy liquid hydrocarbon distillate fraction, and an intermediate liquid hydrocarbon distillate fraction, said fractions having the following properties:

	Light Fraction	Intermediate Fraction	Heavy Fraction
Gravity (° API).....	54.3	44.3	36.7
Initial Boiling Point, ° F.....	114	326	390
Final Boiling Point, ° F.....	340	400	500
10% Evaporated Point, ° F.....	179	330	409
50% Evaporated Point, ° F.....	238	346	444
90% Evaporated Point, ° F.....	297	362	480
Distillation Loss (percent by volume).....	1.9	1.0	1.0
Freezing Point, ° F.....	below -76		-56
Reid Vapor Pressure (p. s. i.) ..	6	(¹)	(¹)

¹ Substantially zero.

By use of the light fraction and the heavy fraction having the aforesaid properties, a com-

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position was prepared comprising by volume 85% of the light fraction and 15% of the heavy fraction, said composition having the following properties and adaptable for use as a fuel in the operation of gas turbine and jet engines:

Gravity (° API).....	51.1.
Freezing point °F.....	-88.
Aromatics (volume %).....	24.
Bromine No.....	less than 1.
Viscosity at -40° F.....	2.0 centistokes.
Accelerated gum.....	2 mg./100 ml.
Air jet residue.....	2 mg./100 ml.
Sulfur (weight %).....	0.022.
Initial boiling point °F.....	127.
Final boiling point °F.....	483.
50% evaporated °F.....	252.
90% evaporated °F.....	430.
Residue.....	1%.
Distillation loss (% by volume) ..	1%.
Reid vapor pressure (p. s. i.).....	5.2.
Heat of combustion.....	18,631 B. t. u.'s per lb.

Whereas the aforesaid example illustrates the adaptability of this invention to preparation of compositions as embodied herein by use of components obtainable from a single crude, the following examples illustrate the adaptability of the invention with respect to refining operations wherein a variety of crudes are employed.

Example II

A Refugio crude was subjected to fractionation to provide a light, an intermediate, and a heavy liquid hydrocarbon distillate fraction, the latter fraction having the following properties:

Gravity (° API).....	30.5.
Initial boiling point °F.....	434.
Final boiling point °F.....	530.
10% evaporated °F.....	458.
50% evaporated °F.....	476.
90% evaporated °F.....	495.
Distillation loss (% by volume) ..	0.6.
Reid vapor pressure (p. s. i.).....	substantially zero.

By use of the Conroe light fraction (having the properties described in Example I) and the heavy fraction obtained from the Refugio crude and having the properties described in this example, a composition was prepared comprising, by volume, 85% of the Conroe light fraction and 15% of the Refugio heavy fraction. Such a composition possessed the following properties and was adapted for use as a fuel in operation of gas turbine and jet engines:

Gravity (° API).....	45.4.
Freezing point °F.....	below -100.
Aromatics (volume %).....	23.3.
Bromine No.....	less than 1.
Accelerated gum.....	2 mg./100 ml.
Air jet residue.....	1 mg./100 ml.
Sulfur (weight %).....	0.028.
Initial boiling point °F.....	127.
Final boiling point °F.....	493.
50% evaporated °F.....	251.
90% evaporated °F.....	462.
Residue.....	1.1.
Distillation loss (% by volume) ..	0.9.
Reid vapor pressure (p. s. i.).....	5.1.
Heat of combustion.....	18,728 B. t. u.'s per lb.

Example III

A composite liquid hydrocarbon mixture was prepared by mixing together, by volume, 34% of a light liquid distillate obtained from a Pennsylvania crude, 26% of a light liquid distillate obtained from a Venice crude, and 40% of a light liquid distillate obtained from an East Texas crude. The composite, possessing a Reid vapor pressure of about 12 pounds per square inch, was stabilized by fractionation under pressure to a stabilized liquid hydrocarbon composite having the following properties:

Gravity (°API).....	63.4
Initial boiling point °F.....	106
Final boiling point °F.....	380
10% evaporated °F.....	151
50% evaporated °F.....	226
90% evaporated °F.....	315
Distillation loss (% by volume).....	1.9
Reid vapor pressure (p. s. i.).....	6.0

A liquid hydrocarbon composition was prepared comprising by volume, 88% of the aforesaid stabilized composite and 12% of the Refugio heavy fraction described in Example II. Such a composition was found to possess the following properties and was adapted for use as a gas turbine and jet engine fuel.

Gravity (°API).....	58.2.
Freezing point °F.....	below -100.
Aromatics (volume %).....	10.5.
Bromine No.....	1.
Accelerated gum.....	2 mg./100 ml.
Air jet residue.....	2 mg./100 ml.
Sulfur (weight %).....	0.029.
Final boiling point °F.....	483.
50% evaporated °F.....	242.
90% evaporated °F.....	427.
Residue.....	1.2.
Distillation loss (volume %).	1.3.
Reid vapor pressure (p. s. i.).....	5.9.
Heat of combustion.....	18,817 B. t. u.'s per lb.

With reference to the foregoing specific examples and using the composition described in Example I for purpose of illustration, it should be observed that a liquid hydrocarbon composition adapted for use as a gas turbine and jet engine fuel was prepared without use of the intermediate distillate fraction as a component of the composition. That suitable fuel compositions having a Reid vapor pressure of at least 5.0 but not more than 7.0 pounds per square inch, a distillation loss of less than 1.5% by volume, a final boiling point not in excess of 600° F., and a 90% evaporated point at a temperature over 400° F. may be prepared without use of such an intermediate fraction in substantial amount is an important aspect of this invention and clearly differentiates the compositions embodied herein over prior art liquid hydrocarbon compositions employed for gas turbine and jet engine operations and which, as far as we are aware, are comprised predominantly of, or contain in substantial amounts, a liquid hydrocarbon mixture having properties similar to the aforescribed intermediate fraction. Thus, an important aspect of this invention is that liquid hydrocarbon compositions suitable for the purpose disclosed herein may be provided that are substantially devoid of, or need not contain substantial amounts of intermediate liquid hydrocarbon fractions such as described in Example I, or in more generic

aspect, such fractions that have a Reid vapor pressure of substantially zero, a 90% evaporated point below 400° F., and are further characterized by containing in predominant proportion constituents boiling within the range of about 325 to 390° F.

Although the invention has been described hereinbefore with particular emphasis to specific aspects of suitable components of compositions embodied herein, it should be apparent to those skilled in the art that the invention is not limited thereto. In broader aspect, the invention embodies use for the light liquid hydrocarbon mixture of a fraction having a Reid vapor pressure of substantially more than 5.0 but not more than 12.0 pounds per square inch, a 90% evaporated point at a temperature not in excess of about 350° F., and in most instances, not in excess of about 325° F., a final boiling point not in excess of 600° F., and a distillation loss value not in excess of about 2.0% by volume and, as the heavy fraction, a liquid hydrocarbon mixture having a Reid vapor pressure of substantially zero, a final boiling point not in excess of 600° F., a distillation loss of substantially less than 1.5% by volume, and containing at least about 50% by volume of constituents boiling above 400° F. Hence, in broad aspect, the compositions embodied herein may comprise, by volume, from about 50 to 90% of such a light fraction and from about 10 to 50% of such a heavy fraction. In a specific embodiment, the compositions as embodied herein comprise about 75 to 88% of the light liquid hydrocarbon fraction and about 12 to 25% of the heavy fraction, the light fraction being characterized by having a Reid vapor pressure of from about 5.5 to 9.0 pounds per square inch and a freezing point below -76° F. and the heavy fraction having a freezing point below -35° F., and preferably substantially lower, e. g., below -50° F. or lower.

In the preparation of compositions as embodied herein and which contain a light liquid hydrocarbon as aforescribed as the major component thereof, it is within the scope of this invention to employ as such fractions liquid hydrocarbon mixtures that may be obtained by processing other than shown in the foregoing examples. In illustration, it is within the scope of this invention to employ, as the light fraction, liquid hydrocarbon fractions obtained from conventional cracking operations (e. g., thermal or catalytic) but which cracked fractions, due to the excessive amounts of unsaturated and gum forming constituents normally present therein, are stabilized by conventional means such as acid extraction (H₂SO₄), polymerization, catalytic or other known methods to improve stability and reduce the gum forming constituents of the cracked fractions whereby use of the stabilized material in accordance with this invention as a light liquid hydrocarbon fraction will provide a fuel composition of suitable stability characteristics and of reduced tendency for gum formation.

Moreover, it should be apparent to those skilled in the art that although the invention has been described hereinbefore with particular emphasis on compositions comprising a light hydrocarbon fraction and a heavy hydrocarbon fraction in controlled proportions, the invention is not limited thereto as, in addition, the novel compositions may also contain small amounts of other ingredients, such as inhibitors against gum formation, viscosity modifiers, etc., that are

effective to impart other desired properties to the composition. Moreover, the novel compositions embodied herein may also contain, in addition to the aforescribed light and heavy fractions, a small amount of other liquid hydrocarbon fractions such, for example, as the intermediate fractions described hereinbefore. Although as aforeshown, compositions as embodied herein may be prepared without use of such intermediate hydrocarbon fractions in substantial, if any, amount, it may in some cases be desired to use such intermediate or other hydrocarbon fractions as diluents or for other purposes, but such use thereof should desirably be limited to amounts that are insufficient to alter the properties of the compositions embodied herein to the extent that the adaptability thereof as fuels for operation of gas turbine and jet engines is not substantially affected in a deleterious manner. Thus, for example, in instances wherein the light fraction has a Reid vapor pressure in the upper range of the aforesaid Reid vapor pressure limits, the compositions embodied herein may contain an intermediate fraction as aforesaid in amounts which are insufficient to decrease the Reid vapor pressure of the composition to below 5.0 pounds per square inch and the 90% evaporated point to below about 400° F.

Although the present invention has been described in conjunction with certain preferred embodiments thereof, those skilled in the art will readily recognize that variations and modifications can be made. Such modifications and variations are to be considered to be within the purview of the specification and scope of the appended claims.

We claim:

1. A method for preparation of a liquid hydrocarbon composition adaptable for use as a fuel for gas turbines and jet engines, said composition being characterized by having distillation loss, 90% evaporated point and Reid vapor pressure characteristics as set forth hereinafter and prepared by use of wide cut distillate fractions from a petroleum crude without need for use of repressurizing agents which comprises distilling a petroleum crude to obtain a light liquid hydrocarbon distillate fraction substantially devoid of butanes and compounds lower boiling than butanes and having a Reid vapor pressure of more than about 5 but not more than about 12 pounds per square inch, a 90% evaporated point at a temperature not in excess of about 350° F., a final boiling point not in excess of 600° F., and a distillation loss not in excess of about 2% by volume, an intermediate liquid hydrocarbon distillate fraction having a Reid vapor pressure of substantially zero, a 90% evaporated point below 400° F., and comprised predominantly of constituents boiling within a range of about 325 to 390° F., and a heavy liquid hydrocarbon distillate fraction having a Reid vapor pressure of substantially zero, a final boiling point not in excess of 600° F., a distillation loss of less than about 1.5% by volume, and containing at least about 50% by volume of constituents boiling above 400° F., and combining said light fraction with said heavy fraction in a volume ratio of one part of said heavy fraction to about one to about nine parts of said light fraction to provide a liquid hydrocarbon composition having a Reid vapor pressure of at least about 5 but not more than about 7 lbs. per square inch, a distillation loss not in excess of about 1.5% by volume and a 90% evaporated point at over 400° F.

2. A method, as defined in claim 1, wherein the light fraction has a Reid vapor pressure of at least about 5.5 but not more than about 9.0 pounds per square inch and the heavy fraction has a freezing point below -35° F.

3. A method for preparation of a liquid hydrocarbon composition adaptable for use as a fuel for gas turbine and jet engines by use of wide cut petroleum fractions without need for use of repressurizing agents to obtain compositions possessing a distillation loss of not over 1.5% by volume, a Reid vapor pressure of 5 to 7 lbs. per square inch and a 90% evaporated point at over 400° F. which comprises combining a light liquid petroleum hydrocarbon mixture and a heavy liquid petroleum hydrocarbon mixture in a volume ratio of about one to about nine parts of the light fraction to one part of the heavy fraction, said light fraction being a wide cut petroleum distillate having a Reid vapor pressure of more than about 5 but not more than about 12 pounds per square inch and substantially devoid of butanes and compounds lower boiling than butanes, a distillation loss not in excess of about 2% by volume, a 90% evaporated point at a temperature not in excess of about 350° F. and a final boiling point not in excess of 600° F. and said heavy fraction being a wide cut petroleum distillate having a Reid vapor pressure of substantially zero, a final boiling point not in excess of 600° F., a distillation loss of less than about 1.5% by volume and containing at least about 50% by volume of constituents boiling above 400° F., said light fraction and said heavy fraction being combined within the aforesaid ratio of parts by volume to produce a composition having a Reid vapor pressure of about 5 to about 7 parts per square inch, a distillation loss not in excess of about 1.5% by volume and a 90% evaporated point at over 400° F.

4. A liquid hydrocarbon composition adapted for use as a gas turbine and jet engine fuel comprising, by volume, about 50 to 90% of a light liquid petroleum hydrocarbon fraction substantially devoid of butanes and compounds lower boiling than butanes having a Reid vapor pressure of more than about 5 but not more than about 12 pounds per square inch, a distillation loss not in excess of about 2% by volume, a 90% evaporated point at a temperature not in excess of about 350° F., and a final boiling point not in excess of 600° F., and about 10 to 50% of a heavy liquid petroleum hydrocarbon fraction having a Reid vapor pressure of substantially zero, a final boiling point not in excess of 600° F., a distillation loss of less than about 1.5% by volume, and containing at least about 50% by volume of constituents boiling above 400° F., said light fraction and said heavy fraction being present in said composition in volume proportions within the aforesaid to provide a composition having a Reid vapor pressure of at least about 5 but not more than about 7 lbs. per square inch, a 90% evaporated point at over 400° F. and a distillation loss not in excess of 1.5% by volume.

5. A composition, as defined in claim 4, wherein the light fraction has a Reid vapor pressure of at least about 5.5 to about 9 pounds per square inch and the heavy fraction has a freezing point of less than -35° F.

6. A method, as defined in claim 3, wherein the light fraction and heavy fraction are straight-run distillate fractions from a petroleum crude.

7. A composition, as defined in claim 4, wherein the light fraction and heavy fraction are straight-run petroleum distillate fractions.

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