This invention relates to liquid hydrocarbon combustion fuels. More particularly, the invention relates to liquid hydrocarbon combustion fuels that are stabilized against screen-clogging, sediment formation, oxidation and metal activity, and to novel additive compositions therefor.

As is well known to those familiar with the art, liquid hydrocarbon combustion fuels, such as fuel oils and gasolines, tend to exhibit certain deleterious characteristics, either after long periods of storage, or under the conditions of operational use. Thus, for example, fuel oils have been found to be unstable in high temperature environments and tend to foul heat-exchange tubes and to cause clogging of screens and plugging of tubes. Sediment formation is another factor often encountered. In gasolines, as well as in fuel oils, oxidation and the effect of metal activity are also undesirable phenomena that are sought to be eliminated. Accordingly, a means for stabilizing such fuels and protecting them against sediment formation, screen clogging, oxidation and metal activity, is highly desirable.

It is, therefore, an object of the present invention to provide improved liquid hydrocarbon combustion fuels. Another object of the invention is to provide improved liquid hydrocarbon combustion fuels and means for protecting them, which are effective sediment stabilizers, antioxidants and metal deactivators.

Other objects and advantages inherent in the invention will become apparent to those skilled in the art from the following description.

In accordance with the present invention, as more fully hereinafter described, it has been found that the above objects can be attained by the addition of small amounts of additive compositions comprising the product obtained by reacting an alkenyl succinic acid anhydride with a polyamine having the formula \( H_2N\left(\text{R} - \text{NH}_2\right)_n\cdot H \), wherein \( \text{R} \) is selected from the group consisting of ethylene and propylene and \( n \) is an integer varying from 1 to 6, and salicylaldehyde. As will become hereinafter apparent, these additive compositions are particularly effective as sediment stabilizers in fuel oils and as antioxidants and metal deactivators in both fuel oils and gasolines.

In the novel additive compositions of the present invention any alkyl succinic acid anhydride, or the corresponding acid, is utilizable. The general structural formulae of these compounds are:

\[
\begin{align*}
\text{Anhydride} & : \quad \text{R}-\text{OH}, \quad \text{R}-\text{CH} \equiv \text{CH} \equiv \text{O} \\
\text{Acid} & : \quad \text{R}-\text{CH} \equiv \text{CH} \equiv \text{NH} \quad \text{R}-\text{OH}, \quad \text{R}-\text{CH} \equiv \text{CH} \equiv \text{O}
\end{align*}
\]

wherein \( \text{R} \) is an alkyl radical. The alkyl radical can be straight-chain or branched-chain; and it can be saturated at the point of unsaturation by the addition of a substance which adds to olefinic double bonds, such as hydrogen, sulfur, bromine, chlorine, or iodine. It is obvious, of course, that there must be at least two carbon atoms in the alkenyl radical, but there is no real upper limit to the number of carbon atoms therein. The alkyl succinic acid anhydrides and the alkyl succinic acids are interchangeable for the purposes of the present invention. Accordingly, when the term "alkenyl succinic acid anhydride," is used herein, it must be clearly understood that it embraces the alkyl succinic acids as well as their anhydrides, and the derivatives thereof in which the olefinic double bond has been saturated, as set forth hereinafter. Non-limiting examples of the alkyl succinic acid anhydride component are ethyl succinic acid anhydride; ethyl succinic acid; ethyl succinic acid anhydride; propanoyl succinic acid anhydride; butenoyl succinic acid; 2-methylbutenoyl succinic acid anhydride; 1,2-dichloropropyl succinic acid anhydride; hexenyl succinic acid anhydride; hexyl succinic acid; sulfurized 3-methylenehexyl succinic acid anhydride; 2,3-dimethylbutenyl succinic acid anhydride; 3,3-dimethylenebutyl succinic acid; 1,2-dibromo-2-ethylbutyl succinic acid; heptenyl succinic acid anhydride; 1,2-diolocutyl succinic acid; octenyl succinic acid anhydride; dibutyl succinic acid anhydride; 2-methylheptenyl succinic acid anhydride; 4-ethylhexenyl succinic acid; 2-isopropylpentenyl succinic acid anhydride; nonenyl succinic acid anhydride; 2-propylhexenyl succinic acid anhydride; decenyl succinic acid; decenyl succinic acid anhydride; 5-methylenehexenyl succinic acid anhydride; 1,2-dibromo-2-ethyloctenyl succinic acid anhydride; decyl succinic acid anhydride; undecenyl succinic acid anhydride; 1,2-dichloroundecyl succinic acid anhydride; 3-ethyl-2-t-butyl-pentenyl succinic acid anhydride; tetrapropenyl succinic acid anhydride; tetrapropenyl succinic acid; trisobutyl succinic acid anhydride; 2-propyl-nonyl succinic acid anhydride; 2-butyloctenyl succinic acid anhydride; tridecenyl succinic acid anhydride; hexadecenyl succinic acid anhydride; sulfurized octadecyl succinic acid; octadecyl succinic acid anhydride; 1,2-dibromo-2-methylpentadecylenyl succinic acid anhydride; 2-phenylpentenyl succinic acid anhydride; eicosenyl succinic acid anhydride; 1,2-dichloro-2-methylnonadecyl succinic acid anhydride; 2-octyldecenyl succinic acid; 1,2-dilodotetraenyl succinic acid anhydride; hexacosyl succinic acid anhydride; and hentriacontenyl succinic acid anhydride.

In general, alkyl succinic acid anhydrides having from about 8 to about 35, and preferably, from about 9 to about 18 carbon atoms in the alkyl group thereof, are most advantageously employed in the novel additive compositions. Methods for preparing the alkyl succinic acid anhydrides are well known to those familiar with the art, the most feasible method comprising the reaction of an olefin with maleic acid anhydride. A more detailed description of the alkyl succinic acid anhydrides suitable for use in the additive compositions of the present invention and their preparation, is disclosed in Patent No. 2,636,450, issued May 12, 1953.

The polyamine reactant, employed with the alkyl succinic acid anhydride and the salicylaldehyde reactants, as indicated above, has the formula \( H_2N\left(\text{R} - \text{NH}_2\right)_n\cdot H \), wherein \( \text{R} \) is selected from the group consisting of ethylene and propylene and \( n \) is an integer varying from 1 to 6. Examples of the polyamine reactant are ethylenediamine, propylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine, dipropylenetriamine, and aminopropyl substituted alkylamines. The aminopropyl substituted alkyl amines have the general formula

\[
\text{RNICH}_2\text{CH}_3\text{CH}_2\text{NH}_2
\]

wherein \( \text{R} \) represents a mixture of alkyl groups derived from a fatty acid.
The polyamine reactant is preferably employed in an amount from about 1 to about 2 moles per mole of alkenyl succinic acid anhydride, and the salicylaldehyde reactant is preferably employed in an amount from about 1 to about 10 moles per mole of alkenyl succinic acid anhydride, in the additive composition.

The additive composition, i.e., the aforementioned reaction product, is added to the fuel in a small amount to attain the objects hereinbefore discussed. In general, the additive composition may vary from about 1 to about 200, and preferably, from about 1 to about 25 pounds per thousand barrels of fuel; or, in corresponding terms of percent, by weight, the concentration of additive composition may vary from about 0.00025% to about 0.1, and preferably, from about 0.00025% to about 0.01 percent, by weight, of the fuel.

The following examples and comparative data are intended to illustrate the novel additive compositions of the present invention and to demonstrate their effectiveness in improving the properties of liquid hydrocarbon combustion fuels. It will be understood, of course, that it is not intended the invention be limited to the particular compositions shown or to the operations or manipulations involved. Various other additive compositions, and other fuels, can be utilized, as those skilled in the art will readily appreciate.

**EXAMPLE 1**

40 grams (½ mole) of ethylenediamine were gradually added at room temperature with stirring to 88.7 grams (½ mole) of tetrapropenylsuccinic acid anhydride, which were diluted with 192 grams of xylene and 100 cc. of benzene. The reaction was exothermic and the temperature rose rapidly to 65°C. At the completion of the addition, the mixture was stirred at 75-80°C. for a period of 30 minutes. To this reaction mixture were then added 81.3 grams (5 mole) of salicylaldehyde at room temperature with stirring. The resulting mixture was then refluxed at 95-100°C. for a period of 3 hours, and then at 130°C. until water could no longer be collected (i.e., after a period of about 2 hours). The amount of water collected was 20 cc., (theory 18 cc.). The reaction product obtained, was found to contain approximately 50 percent, by weight, xylene, and was clear and fluid at 70°C. Upon analysis, this reaction product showed a nitrogen content of 4.71 percent, as against an estimated 4.87 percent, by weight.

**EXAMPLE 2**

49.3 grams (5 mole), equivalent to 61.6 grams of 80 percent propylenediamine, was gradually added to a mixture of 88.7 grams (5 mole) of tetrapropenylsuccinic acid anhydride and 201 grams of xylene at room temperature, with stirring. This mixture was then stirred at 95°C. for a period of two hours. To this reaction mixture were then gradually added 81.3 grams (5 mole) of salicylaldehyde at room temperature, with stirring. The resulting mixture was then slowly heated to reflux temperature (145°C.), and maintained at this temperature until water could no longer be collected (i.e., after a period of about 3 hours). The amount of water collected was 29 cc., (theory 30 cc.). The reaction product obtained was filtered through clay and the final product obtained was found to contain approximately 50 percent, by weight, xylene, and was dark brown in color, clear and fluid at room temperature. Upon analysis this reaction product showed a nitrogen content of 4.9 percent, as against an estimated 4.5 percent, by weight.

**EXAMPLE 3**

51.5 grams (0.5 mole) of diethylenetriamine were gradually added to a mixture of 66.5 grams (0.25 mole) of tetrapropenylsuccinic acid anhydride and 165 grams of xylene, as a diluent, at room temperature with stirring, followed by the addition of 61 grams (0.5 mole) of salicylaldehyde, diluted with 50 cc. of benzene. The mixture was gradually heated to reflux at 135°C., and maintained at this temperature until water could no longer be collected (i.e., after a period of about 3 hours). The amount of water collected was 15 cc., (theory 13.5 cc.). The reaction product was filtered through clay, and the final product obtained was found to contain approximately 50 percent, by weight, xylene, and was clear and fluid at room temperature. Upon analysis this reaction product showed a nitrogen content of 5.87 percent, as against an estimated 6.5 percent, by weight.

**EXAMPLE 4**

73 grams (0.5 mole) of triethylenetetramine were gradually added at room temperature, with stirring, to a mixture of 66.5 grams (0.25 mole) of tetrapropenylsuccinic acid anhydride and 187 grams of xylene, followed by the addition of 61 grams (0.5 mole) of salicylaldehyde diluted with 50 cc. of benzene. This mixture was gradually heated to reflux at 135°C., and was maintained at this temperature until water could no longer be collected (i.e., after a period of about 2 hours). The amount of water collected was 15 cc., (theory 13.5 cc.). The resulting reaction product was then filtered through clay, and the final product obtained was found to contain approximately 50 percent, by weight, xylene, and was clear and fluid at room temperature. Upon analysis, this final reaction product showed a nitrogen content of 7.23 percent, as against an estimated 7.7 percent, by weight.

**EXAMPLE 5**

94.5 grams (0.5 mole) of tetaethylenepentamine were gradually added at room temperature, with stirring, to a mixture of 66.5 grams (0.25 mole) of tetrapropenylsuccinic acid anhydride and 208 grams of xylene, followed by the addition of 61 grams (0.5 mole) of salicylaldehyde, diluted with 50 cc. of benzene. The mixture was gradually heated to reflux at 135°C., and was maintained at this temperature until water could no longer be collected (i.e., after a period of about 3 hours). The amount of water collected was 15 cc., (theory 13.5 cc.). The reaction product obtained was filtered through clay, and the final product obtained was found to contain approximately 50 percent, by weight, xylene, and was clear and fluid at room temperature. Upon analysis, this reaction product showed a nitrogen content of 8.41 percent, as against an estimated 8.4 percent, by weight.

**EXAMPLE 6**

61 grams (0.5 mole) of salicylaldehyde were gradually added to a mixture of 160 grams (0.5 mole) of an amino propyl substituted alkyl amine having the formula

$$\text{RNHCH₂CH₂CH₂NH₃}$$

and 256 grams of xylene at room temperature, with stirring. At the end of the addition, the resulting mixture was gradually heated to reflux at 145°C., and was maintained at this temperature until water could no longer be collected (i.e., after a period of about 2 hours). The amount of water collected was 10 cc., (theory 9 cc.). To this reaction mixture were then added 66.5 grams (0.25 mole) of tetrapropenylsuccinic acid anhydride at room temperature. This resulting mixture was then refluxed at 145°C. until water could no longer be collected (i.e., after a period of about 3 hours). The amount of water collected was 4.5 cc. (theory 4.5 cc.). The resulting reaction product was filtered through clay, and the final product obtained was found to contain approximately 50 percent, by weight, xylene, and was dark red in color, clear and fluid at room temperature. Upon analysis, this final reaction product showed a nitrogen content of 2.93 percent, as against an estimated 2.74 percent, by weight.

**EXAMPLE 7**

30.5 grams (0.25 mole) of salicylaldehyde, diluted with 50 cc. of benzene, were gradually added at room temperature, with stirring, to a mixture of 100 grams (0.25 mole) of an aminopropyl substituted alkyl amine having
the formula RNHCH₂CH₂CH₂NH and 157 grams of xylene. At the end of this addition, the resulting mixture was gradually heated to reflux at a temperature of 126°C, and maintained at this temperature until water could no longer be collected (i.e., after a period of about 2 hours). The amount of water collected was 5.5 cc., (theory 4.5 cc.). To this reaction mixture were then added 33.25 grams (0.125 mole) of tetrapropylpentylcyclohexane and 187 grams of xylene, followed by the addition of 81.3 grams (3 mole) of salicylaldehyde. The resulting mixture was slowly heated to reflux at a temperature of 124–145°C, and maintained at this temperature until water could no longer be collected (i.e., after a period of about 3 hours). The amount of water collected was 23 cc. (theory 23.5 cc.). The reaction product was then filtered through clay, and the final product obtained was found to contain approximately 50 percent, by weight, of xylene, and was clear and fluid at room temperature. Upon analysis, this final reaction product showed a nitrogen content of 2.57 percent, as against an estimated 2.22 percent, by weight.

**EXAMPLE 8**

49.3 grams (5 mole), equivalent to 54.8 grams of 90 percent propylenediamine, was gradually added at room temperature, with stirring, to a mixture of 75 grams (5 mole) of 90 percent propylenediamine and 187 grams of xylene, followed by the addition of 81.3 grams (3 mole) of salicylaldehyde. The resulting mixture was then slowly heated to reflux temperature at 124–145°C, and maintained at this temperature until water could no longer be collected (i.e., after a period of about 3 hours). The amount of water collected was 17.5 cc. (theory 17.5 cc.). The reaction product was then filtered through clay, and the final product obtained was found to contain approximately 50 percent, by weight, of xylene, and was clear and fluid at room temperature. Upon analysis, this reaction product showed a nitrogen content of 4.67 percent, as against 4.71 percent, by weight.

The additive compositions of the present invention impart valuable properties, as hereinbefore indicated, to liquid hydrocarbon combustion fuels, including the distillate fuels, i.e., gasolines and fuel oils. Accordingly, the fuel oils that may be improved in accordance with the present invention are hydrocarbon fractions having an initial boiling point of at least about 100°F. and an end-boiling point no higher than about 750°F., and boiling substantially continuously throughout their distillation range. Such fuels oils are generally known as distillate fuels oils. It is to be understood, however, that this term is not restricted to straight-run distillate fractions. The distillate fuel oils can be straight-run distillate fuel oils, catalytically or thermally cracked (including hydrocracked) distillate fuel oils, or mixtures of straight-run distillate fuel oils, naphthas and the like, with cracked distillate stocks. Moreover, such fuel oils can be treated in accordance with well known commercial methods, such as, acid or caustic treatment, hydrogenation, solvent refining, clay treatment, etc.

The distillate fuel oils are characterized by their relatively low viscosities, pour points, and the like. The principal property which characterizes the contemplated hydrocarbons, however, is the distillation range. As mentioned hereinbefore, this range will lie between about 100°F. and about 750°F. Obviously, the distillation range of each individual fuel oil will cover a narrower boiling range falling, nevertheless, within the above-specified limits. Likewise, each fuel oil will boil substantially continuously throughout its distillation range.

Particularly contemplated among the fuel oils are Nos. 1, 2, and 3 fuel oils used in heating and as diesel fuel oils, and the jet combustions fuels. The domestic fuel oils generally conform to the specifications set forth in A.S.T.M. Specifications D396–48T. Specifications for diesel fuels are defined in A.S.T.M. Specification D975–48T. Typical jet fuels are defined in Military Specification MIL–F–56248B.

The gasolines that are improved by the additive compositions of this invention, are mixtures of hydrocarbons having an initial boiling point falling between about 75°F. and about 135°F. and an end-boiling point falling between about 250°F. and about 450°F. As is well known to the art, motor gasoline can be straight run gasoline or, as is more usual, it can be a blend of two or more cuts or materials including straight run stock, catalytic or thermal reformate, cracked stock, alkylated natural gasolines, and aromatic hydrocarbons.

**Screen clogging**

The anti-screen clogging characteristics of a fuel oil are determined as follows: the test is conducted using a Sunstrand V3 or S1 home fuel oil burner pump with a self-contained 100-mesh Monel metal screen. About 0.05 percent, by weight, of naturally-formed fuel oil sediment, composed of fuel oil, water, dirt, rust, and organic sludge is mixed with 10 liters of the fuel oil. The mixture is circulated by the pump through the screen for 6 hours. Then, the sludge deposit on the screen is washed off with normal pentane and filtered through a tared Gooch crucible. After drying, the material in the Gooch crucible is washed with a 50–50 (volume) acetone-methanol mixture. The total organic sediment is obtained by evaporating the pentane and the acetone-methanol filtrates. Drying and weighing the Gooch crucible yields the amount of inorganic sediment. The sum of the organic and inorganic deposits on the screen can be reported in milligrams recovered or converted into percent screen clogging.

The uninhibited test fuel oil was a blend of 60 percent distillate stock obtained from continuous catalytic cracking and 40 percent straight-run distillate stock, having a boiling range of, approximately, from about 320°F. to about 640°F., and representing a typical No. 2 fuel oil.

Blends of the additives of the examples were prepared in the aforesaid described test oil fuel and subjected to the screen clogging test. Results are set forth in Table I.

<table>
<thead>
<tr>
<th>Additive of Example</th>
<th>Conc'n, lbs./1,000 bbl.</th>
<th>Screen Clogging, Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninhibited fuel blend</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Uninhibited fuel blend + Example 1</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Uninhibited fuel blend + Example 2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Uninhibited fuel blend + Example 3</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Uninhibited fuel blend + Example 4</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Uninhibited fuel blend + Example 5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Uninhibited fuel blend + Example 6</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Uninhibited fuel blend + Example 7</td>
<td>55</td>
<td>5</td>
</tr>
</tbody>
</table>

**Sedimentation**

The test used to determine the sedimentation characteristics of the fuel oils is the 110°F. storage test. In this test, a 500-milliliter sample of the fuel oil under test is placed in a convected oven maintained at 110°F.
for a period of 12 weeks. Then, the sample is removed from the oven and cooled. The cooled sample is filtered through a tared asbestos filter (Gooch crucible) to remove insoluble matter. The weight of such matter in milligrams is reported as the amount of sediment. A sample of the blank, uninhibited oil is run along with a fuel oil blend under test. The effectiveness of a fuel oil containing an inhibitor is determined by comparing the weight of sediment formed in the inhibited oil with that formed in the uninhibited oil.

Additives described in the example were blended in the aforementioned test fuel oil and the blends were subjected to the 110° F. storage test. The test results comparing the blended fuels and uninhibited fuels are set forth in Table II.

### TABLE II—FUEL OIL 110° F. STORAGE TEST—12 WEEKS

<table>
<thead>
<tr>
<th>Additive of Example</th>
<th>Conc’n, lbs.</th>
<th>Sediment mg./liter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibited fuel blend</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 2</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 3</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 4</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 5</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 6</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 7</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 8</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>Inhibited fuel blend + Example 9</td>
<td>25</td>
<td>6</td>
</tr>
</tbody>
</table>

Gasoline storage test

This test was used to determine the quantity of gum increase in both a gasoline blend comprising 100 percent catalytically cracked components and containing 3 cc. tetraethyl lead (TEL) per gallon, and boiling within a 100-400° F. boiling range, and the same gasoline containing, also, the additive compositions of the examples. After being maintained at 110° F. for a period of 16 weeks, the amount of gum increase was determined according to A.S.T.M. Test D-381. The test results comparing the uninhibited gasolines and the same gasolines containing the additive compositions of the examples, are set forth in Table III.

### TABLE III—GASOLINE STORAGE TEST

<table>
<thead>
<tr>
<th>Additive of Example</th>
<th>Conc’n, lbs.</th>
<th>ATSM increase, mg./100 ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal.</td>
<td>16</td>
<td>42.7</td>
</tr>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal. + Example 2</td>
<td>16</td>
<td>42.7</td>
</tr>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal. + Example 3</td>
<td>16</td>
<td>42.7</td>
</tr>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal. + Example 4</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal. + Example 5</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal. + Example 6</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal. + Example 7</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Inhibited gasoline + 3 cc. TEL/gal. + Example 8</td>
<td>16</td>
<td>10</td>
</tr>
</tbody>
</table>

Gasoline storage test with copper

The same test procedure, as described in the Gasoline Storage Test, (supra), was employed, with the same gasoline blends containing 3 cc. tetraethyl lead (TEL) per gallon, and also including 0.2 mg. copper napthenate per liter, as a metal catalyst. The test results comparing the uninhibited gasolines and the same gasolines containing the additive compositions of the examples, are set forth in Table IV.

### TABLE IV.—GASOLINE STORAGE TEST

<table>
<thead>
<tr>
<th>Additive of Example</th>
<th>Conc’n, lbs.</th>
<th>ATSM increase, mg./100 ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal.</td>
<td>16</td>
<td>75.0</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 2</td>
<td>16</td>
<td>5.1</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 3</td>
<td>16</td>
<td>3.9</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 4</td>
<td>16</td>
<td>21.5</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 5</td>
<td>16</td>
<td>12.6</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 6</td>
<td>16</td>
<td>26.5</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 7</td>
<td>16</td>
<td>8.1</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 8</td>
<td>16</td>
<td>21.5</td>
</tr>
<tr>
<td>Uninhibited gasoline + 3 cc. TEL/gal. + Example 9</td>
<td>16</td>
<td>5.0</td>
</tr>
</tbody>
</table>

While the present invention has been described with preferred embodiments, it should be understood that modifications and variations thereof may be resorted to without departing from the spirit of the invention as will be obvious to those skilled in the art.

1. An additive composition comprising the condensation product obtained by reacting an alkyl succinic acid or anhydride having from about 8 to about 35 carbon atoms in the alkyl group thereof, with a polyamine having the formula H2N(—R—NH2)2—H, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

2. An additive composition comprising the condensation product obtained by reacting an alkyl succinic acid or anhydride having from about 9 to about 18 carbon atoms in the alkyl group thereof with a polyamine having the formula H2N(—R—NH)2—H, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

3. An additive composition comprising the condensation product obtained by reacting an alkyl succinic acid or anhydride having from about 9 to about 18 carbon atoms in the alkyl group thereof with a polyamine having the formula H2N(—R—NH)2—H, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

4. An additive composition comprising the condensation product obtained by reacting an alkyl succinic acid or anhydride having from about 9 to about 18 carbon atoms in the alkyl group thereof with a polyamine having the formula H2N(—R—NH)2—H, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

5. An additive composition comprising the condensa-
tion product obtained by reacting an alkenyl succinic acid or anhydride having from about 8 to about 35 carbon atoms in the alkyl group thereof with a polyol selected from the group consisting of ethylenediamine, propylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine and aminopropyl substituted alkylamines, and salicylaldehyde.

6. An additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride selected from the group consisting of tetrapropenyl succinic acid or anhydride, nonenyl succinic acid anhydride and octadecenyl succinic acid or anhydride with a polyamine having the formula

$$H_2N(-R-NH)_2-H$$

wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

7. An additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride selected from the group consisting of tetrapropenyl succinic acid or anhydride, nonenyl succinic acid anhydride and octadecenyl succinic acid or anhydride with from about 1 to about 2 moles of a polyamine selected from the group consisting of ethylenediamine, propylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine and aminopropyl substituted alkylamines, and from about 1 to about 15 moles salicylaldehyde, per mole of alkenyl succinic acid or anhydride.

8. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride having from about 8 to about 35 carbon atoms in the alkyl group thereof with from about 1 to about 2 moles of a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

9. A liquid hydrocarbon combustion fuel containing from about 1 to about 25 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride having from about 8 to about 35 carbon atoms in the alkyl group thereof with a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

10. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride having from about 8 to about 35 carbon atoms in the alkyl group thereof with a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

11. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride having from about 8 to about 18 carbon atoms in the alkyl group thereof with a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

12. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride having from about 8 to about 35 carbon atoms in the alkyl group thereof with from about 1 to about 2 moles of a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde.

13. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride having from about 9 to about 18 carbon atoms in the alkyl group thereof with from about 1 to about 2 moles of a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and salicylaldehyde, per mole of alkenyl succinic acid or anhydride.

14. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride having from about 9 to about 18 carbon atoms in the alkyl group thereof with from about 1 to about 2 moles of a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and with from about 1 to about 10 moles salicylaldehyde, per mole of alkenyl succinic acid or anhydride.

15. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride selected from the group consisting of tetrapropenyl succinic acid or anhydride, nonenyl succinic acid or anhydride and octadecenyl succinic acid or anhydride with a polyamine having the formula $H_2N(-R-NH)_2-H$, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and with from about 1 to about 10 moles salicylaldehyde, per mole of alkenyl succinic acid or anhydride.

16. A liquid hydrocarbon combustion fuel containing from about 1 to about 200 pounds per thousand barrels of fuel of an additive composition comprising the condensation product obtained by reacting an alkenyl succinic acid or anhydride selected from the group consisting of tetrapropenyl succinic acid or anhydride, nonenyl succinic acid or anhydride and octadecenyl succinic acid or anhydride with from about 1 to about 2 moles of a polyamine selected from the group consisting of ethylenediamine, propylenediamine, diethylenetriamine, triethylenetetramine, tetraethylenepentamine and aminopropyl substituted alkylamines, and salicylaldehyde.

17. The reaction product obtained by reacting, under reflux conditions, an acidic substance selected from the group consisting of alkenyl succinic acid and alkenyl succinic anhydride, an amine having the structure formula $H_2N-R-NH_2$ and salicylaldehyde, wherein the alkenyl group contains from about 8 to about 35 carbon atoms and R is selected from the group consisting of ethylene and propylene.

18. The reaction product obtained by reacting, under reflux conditions, an acidic substance selected from the group consisting of alkenyl succinic acid and alkenyl succinic anhydride, an amine having the structure formula $H_2N(-R-NH)_2-H$, and salicylaldehyde, wherein the alkenyl group contains from about 8 to about 35 carbon atoms, R is selected from the group consisting of ethylene and propylene, and n is an integer varying from 2 to 6.

19. The condensation product obtained by reacting an acidic material selected from the group consisting of
alkenyl succinic acid and alkenyl succinic acid anhydride, an amine having the formula H2N—R—NH2, and salicylaldehyde, wherein the alkenyl group contains from about 8 to about 35 carbon atoms and R is selected from the group consisting of ethylene and propylene.

20. The product obtained in accordance with claim 19 wherein said reaction is carried out at a temperature from about 50°C to about 200°C.

21. The condensation product obtained by reacting an acidic material selected from the group consisting of alkenyl succinic acid and alkenyl succinic acid anhydride, an amine having the formula H2N(—R—NH)n—H, and salicylaldehyde, wherein the alkenyl group contains from about 8 to about 35 carbon atoms, R is selected from the group consisting of ethylene and propylene, and n is an integer varying from 2 to 6.

22. The product obtained in accordance with claim 21 wherein said reaction is carried out at a temperature from about 50°C to about 200°C.

23. An additive composition comprising the condensation product obtained by reacting about 1 mole of an alkenyl succinic acid or anhydride having from about 8 to about 35 carbon atoms in the alkenyl group thereof, with about 2 moles of a polyamine having the formula H2N(—R—NH)n—H, wherein R is selected from the group consisting of ethylene and propylene and n is an integer varying from 1 to 6, and about 2 moles of salicylaldehyde.

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PATRICK P. GARVIN, Primary Examiner

U.S. Cl. X.R.
44—63; 260—309,7, 534, 557
United States Patent Office
Certificate of Correction

Patent No. 3,497,334 Dated February 24, 1970

Inventor(s) Paul Y.C. Gee and Harry J. Andress, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 34, for "2-butyloctenyl" read --3-butyloctenyl--
Column 2, line 45, for "hentriacontenyl" read --hentriacontenyl--

Signed and sealed

Jul 14, 1970

(Seal)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

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Commissioner of Patents