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PROCESS FOR DRYING, CLARIFYING AND STABILIZING HYDROCARBON LIQUIDS

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ABSTRACT OF THE DISCLOSURE

A process for drying, clarifying and stabilizing hydrocarbon liquids which are subject to oxidative deterioration, particularly jet fuels, which includes adding to the liquid a material which accelerates the oxidative deterioration of the fuel, such as a polyphenyl substituted aliphatic compound, acetoxy ethyl monobutylether, an alkanol ester of citric acid; passing the hydrocarbon liquid through a body of solid, particulate sodium chloride; passing the liquid through a body of solid, particulate sodium hydroxide; removing oxidation products from the liquid, as by filtering, etc., and thereafter adding a stabilizing material to stabilize the hydrocarbon liquid against further oxidative deterioration.

The present application is a continuation-in-part of application Ser. No. 276,865, filed Apr. 30, 1963, and now abandoned.

The present invention relates to a novel process for refining and/or reclaiming hydrocarbon liquids, such as jet fuels, hydraulic fluids and lubricants and other crude oil derivatives. In a more specific aspect, the present invention relates to a process for refining and/or reclaiming hydrocarbon liquids, including jet fuels, hydraulic fluids and lubricants to improve their properties, particularly, their stability, water content, clarity and lubricity.

It is generally an accepted fact that the production of jet fuels is a most demanding proposition and that any system capable of delivering a clean, dry and stable jet fuel will likewise be capable of processing other hydrocarbon liquids to similar clean, dry and stabilize them. Accordingly, the present discussion will be confined primarily to the treatment of jet fuels with the understanding that the process of the present invention is equally applicable to the treatment of hydrocarbon liquids requiring similar treatments but having specifications which are less stringent.

Hypothetically, the shortest distance between two points would be to connect the production nozzle of a refinery producing jet fuel to the inlet of the combustion nozzle within a jet engine. However, this is obviously physically impossible and to approach it is highly impractical. It must be recognized that refiners or producers of fuel need to blend, store, test and schedule loading and transportation to meet the needs of a customer who, in turn, will need to store a sufficient quantity for normal usage and unexpected contingencies. In most instances, the fuel in question will have had an opportunity to accumulate normal contaminants and to degrade during storage and transit. This normal fuel incipient degradation period during storage and transit provides a useful and natural time for the most deleterious, dynamic physical, chemical and biological kinetic reactions to complete their offensive deterioration of the fuel. In addition, it must be recognized that fuels can vary considerable when originating

from many different crude oil sources, refinery processes, shipping and storage containers, fuel handling procedures, testing procedures and additive treatments.

While it has heretofore been proposed that the by-products of storage and/or transportation, water or other contaminants be removed from the fuel at the use point loading tank farm, no adequate system for this purpose has been provided. Conventionally, most operators suggest that settling at the use point will remove both water and solid contaminants and, in extreme cases, a plurality of what are known as "filter coalescers" are used in series at the aircraft loading tank farm, in addition to settling in storage tanks. However, even these filter coalescers have failed to properly process supersonic jet fuels inasmuch as such fuels must now be essentially free of soluble chemical and biological contaminants, as well as insoluble sediment and water when delivered to the aircraft.

More expensive alternatives to the use of the filter coalescer, or, in addition to the filter coalescer, which have been proposed also, include, over-refining at the production point, redesigning aircraft engines, discarding residual fuel from returning aircraft, flushing the aircraft with clean fuel and discarding the same, speeding the fuel from the refinery in clinically clean facilities and maintaining minimal contact with air during transport. Other equal unattainable or expensive approaches are specifying rigid water content and thermal stability tests for delivered fuel; providing additional new all-purpose additives which will overcome all of the problems of production, transportation, storage and loading; discovering new and better techniques and equipment that will drastically improve jet fuel production, transportation, storage, filtering and loading; or redistilling degraded fuel at the point of use.

A clean jet fuel is defined by the industry as a fuel which contains less than 2.0 milligrams of solids per gallon, retained on a 0.45 micron filter paper. A dry jet fuel is defined as a fuel which contains no free, suspended water but may contain some dissolved water, usually less than 30 p.p.m. (parts per million). A thermally stable jet fuel is defined as a fuel which leaves no visible varnish deposits on heat exchanger metal surfaces and does not form solid particles, tending to plug jet engine fuel filters or fuel injection nozzles.

The deleterious effects of water in hydrocarbon liquids, particularly in jet fuels, is emphasized by the numerous suggestions for checking and rechecking the water content of jet fuels. For example, it is generally recommended that a gross check for water content be conducted on each tank or compartment of fuel when it arrives at the use point as well as periodically during its storage in storage tanks at the use point. Included in this check list are the use of water-detecting pastes, the use of litmus paper on a gauge stick and drawing a sample of fuel in a glass container and observing the sample for the presence of free water (indicated by a cloud, droplets, emulsion, or separate phase). It is further suggested that these same checks be repeated just prior to loading of the use vehicle and in addition, that more complex tests be utilized which generally measure the concentration of suspended water in parts per million; and, specifically, tests capable of measuring amounts of suspended water in concentration of 30 parts per million (p.p.m.) or less. It would thus be highly desirable if a simple process could be provided which would eliminate the necessity of this continuous checking and rechecking and yet would assure that a dry fuel was being provided. Obviously, a process capable of providing a dry fuel which, in addition, was also free of numerous other contaminants would be even more desirable.

It is also well known to those familiar with this art that thermal stability for jet fuels is a most difficult quality to obtain and maintain in practice, yet it is one of the most important properties of the fuel to control.

Jet engines, and particularly the engines of supersonic and hypersonic jet aircraft, are operated at extremely high temperatures. In such use, the fuel is often used as a heat sink for the aircraft via the heat exchangers and injection nozzles in the engine. The fuel may also be subjected to elevated temperatures, during storage in wing tanks on supersonic aircraft, resulting from the absorption of heat from the surface of the wing. In some cases, the fuel may be subjected to elevated temperatures, for several hours prior to combustion, in the range of 400 to 700° F. for supersonic aircraft and to considerably higher temperatures up to the point of initiation of endothermic reactions for hypersonic aircraft. Many, if indeed not all, jet fuels tend to be relatively unstable when subjected to high temperatures below the combustion point, thus tending to form heavy solid or semi-solid particles which, in turn, cause heat exchanger fouling, jet nozzles plugging and other undesirable effects. Fuel thermal instability not only reduces the operational life of the engine but may present a hazard to flight operation. Accordingly, a very serious need to improve the thermal stability of a wide range of jet fuels has arisen.

The thermal stability of jet fuels is measured in the industry by the so called ASTM-CRC standard, modified CRC, and research CRC coker tests. In these tests, a fuel is subjected to conditions generally simulating the adverse conditions to which it is subjected in actual use. In the research coker test, for example, the fuel is heated in a reservoir to a temperature corresponding to the temperature of fuel in the aircraft wing tanks. (In the standard coker test, a heated reservoir is not used, thus, this arrangement corresponds to aircraft when the fuel is essentially at ambient temperatures in the tanks.) From the reservoir the fuel is pumped through a preheater tube at a higher temperature, corresponding to the temperature of the heat exchanger in the jet engine, and on through a filter at a still higher temperature, corresponding to the temperature at the entrance to the combustion nozzle. This filter removes non-liquid particles which have been formed at the elevated temperatures. The hot filter simulates the conditions to which the fuel is subjected as it passes through the fuel injection nozzles in the engine immediately prior to combustion. The operating conditions of the test can be varied to corresponding to various use conditions. Coker test conditions are usually expressed in abreviated form; for example, 200–400/500/6 meaning that the reservoir temperature is 200° F., the preheater temperature 400° F., the filter temperature 500° F., and the fuel flow rate 6 pounds per hour.

At the present time, fuels to be used in Mach 3 plus jet aircraft utilize coker conditions of 300–500/600/6, and, in the future, it is expected that these conditions will be further increased in severity to 300–600/700/6.

The results of the coker tests are expressed in terms of a rating code, indicating relatively the quantity of varnish deposit left in the preheater, ranging from 0 for the best, to 8, for the worst, and in terms of the pressure drop in inches of mercury across the filter, ranging from 0, for the best, to 25 inches for the worst. The high thermal stability demanded of Mach 3 jet fuels is indicated by the fact that they must have a preheater code rating less than 3 and a filter drop of less than 5 inches of mercury.

Considerable difficulty has been experienced in delivering, at the point and time of use, fuels which are dry and will meet and pass the coker test specifications outlined. Even though the fuel may have passed these tests at the refinery, transportation from the refinery to the point of use or standing in storage for a period of time frequently degrades a fuel to a point that it can no longer pass these tests. Such degradation is caused by a whole

host of factors, but in the end the underlying causes of such degradation appear to be extremely complex and are not fully understood by those skilled in the art. It is believed that at least a part of the problem results from both solid and dissolved microimpurities which may exist in, enter, or be formed in the fuel during storage and transit. Most bulk containers, storage facilities and pipe lines used for fuel transportation are being constructed of mild steel. Accordingly, they are subject to flaking-off of metal oxides into the fuel during intermittent filling and unloading. This condition can be minimized by the use of special linings but such linings in themselves introduce some impurities, and even with aluminum, stainless steel, or lined carbon steel shipping and storage containers, large quantities of jet fuel have become degraded with respect to thermal stability and found unsuitable for use at the terminal. Other impurities such as silica-alumina, sulfur, nitrogen, oxygen, halogens, water, bacteria, fungi, gums, peroxides, organic particles, catalysts, treating residues and surfactants may also be present individually or in combinations. These microimpurities are usually not even apparent to the naked eye, yet the normal processing and handling of a fuel may permit sufficient accumulation of such impurities to initiate and propagate dynamic forces which work to degrade the thermal stability of the fuel later on. The effect may be catalytic, in which impurities promote reactions producing thermally unstable compounds in the fuel. The additives themselves, which are incorporated in the fuel to improve its properties are believed to be degraded under some conditions and, in some instances, to cause degradation. In any event, a good part of the difficulty of overcoming degradation of fuels has resulted from the fact that the causes are multitudinous and there are very few which have been isolated and actually proven to be responsible for degradation.

It is therefore an object of the present invention to provide a process for treating hydrocarbon liquids which solves all of the above mentioned problems. Another object of the present invention is to provide a process for refining and/or reclaiming liquid hydrocarbons, particularly jet fuels, hydraulic fluids and lubricants. Still another object of the present invention is to provide a process for refining and/or reclaiming hydrocarbon liquids, including jet fuels, hydraulic fluids and lubricants which is suitable for use either at the point of production or at the point of use. A still further object of the present invention is to provide a process for treating hydrocarbon liquids, capable of converting a good hydrocarbon liquid, particularly aircraft fuel, into a better quality product. A still further object of the present invention is to provide a process for converting a storage degraded hydrocarbon liquid into a high quality product. Another and further object of the present invention is to provide a process for the removal of submicronic particulate matter, soluble chemical and biological contaminants and moisture from degraded hydrocarbon liquids. Yet another object of the present invention is to provide a process for rehabilitating unused hydrocarbon liquids, particularly aircraft fuels, from use vehicles. Another and further object of the present invention is to provide a unitary system which eliminates the necessity of nearly all additives during production, transportation, and storage of hydrocarbon liquids, but which allows for the minimum injection of additives at the point of use and particularly at a jet fuel loading facility. A still further object of the present invention is to provide a process for the treatment of hydrocarbon liquids which will permit the continued use of clean carbon steel containers and/or lined containers in the transportation and storage of hydrocarbon liquids, and particularly aircraft fuels. Another and further object of the present invention is to provide a process for treating hydrocarbon liquids, particularly aircraft fuels, which will permit the use of hydrocarbon products from a wide variety of crude oil sources; which have been subjected to a wide

variety of refining processes; which have been shipped and stored in a large number of different containers; and which have been subjected to a large number of different handling procedures, test procedures and additive treatments. A further object of the present invention is to provide an improved process for treating aircraft fuels which will result in a minimum rejection of degraded fuels and make possible maximum in-flight safety with minimum tankage and inventory at the point of use. A still further object of the present invention is to provide a process for the treatment of hydrocarbon liquids, particularly aircraft fuels, hydraulic fluids and lubricants in an economic manner, yet which produces a clean, dry, thermally stable product and which possesses a high degree of flexibility of use. These and other objects and advantages will be apparent from the following detailed description.

In accordance with the present invention, it has been found that a number of contaminants can be chemically and/or physically converted to readily removable compounds; and water, conventional contaminants, degradation products of hydrocarbon liquids, degradation products of conventional hydrocarbon liquid additives, the chemically changed contaminants mentioned, as well as degradation products produced by a novel group of degradation promoting agents can be removed from the hydrocarbon liquid by passing the fuel through a bed of solid, particulate sodium chloride and through a bed of solid, particulate caustic.

As indicated above, it appears that the treatment of a hydrocarbon liquid in accordance with the present invention not only serves to remove water from the hydrocarbon liquid but the solid caustic also appears to remove normal contaminants from jet fuel and convert some of the normal contaminants or their precursors to readily removable compounds. To illustrate this function of the treatment of the present invention, a jet fuel was passed through solid refined rock salt and, thereafter, through a bed of flake caustic. The fuel, after passage through the caustic, contained a precipitate of synthetic grease which was readily removed by a filter. This greasy film was analyzed and found to contain the ingredients set forth in the table below.

TABLE 1

Contaminant	Weight percent	P.p.m.
Apparent naphthalene	8.00	----------
Sulfur	2.87	----------
Indenes	1.34	13,400
Sulfonates	0.078	777
Antioxidant (phenylenediamine)	0.063	629
Metal deactivator	0.027	272
Peroxides	0.027	266
Iron	0.020	200
Lead Co	0.017	172
Copper	0.0017	17.5
Saponification Number	[1] 0.0	----------
Total contaminants	12.44	----------
Sodium	7.88	
Flake caustic (solid NaOH)	13.70	----------
Ash content	23.68	

[1] Neutral.

The precipitation of the above-mentioned deposit, which can be, as indicated earlier, readily removed by a variety of filter media, obviously removes from the hydrocarbon liquid a number of contaminants not heretofore removed by conventional dryers, filters or filter-coalescers.

The fuel or other hydrocarbon liquid to be treated in accordance with the present invention is preferably treated at the use point before it has been loaded in the use vehicle, such as into an aircraft. Preferably, the fuel is first passed through a layer or bed of solid, particulate sodium chloride, such as refined rock salt. This bed of rock salt will generally comprise several feet of material and the hydrocarbon liquid is passed upwardly through a bed of salt supported by a plate above a settling or collection zone. In passing through the bed of rock salt, coalesced water in the fuel settles out in the settling chamber and can be removed. Water droplets suspended in the fuel also dissolve the salt in the initial or lower portion of the bed of salt and coalesce as salt water which also, being heavier than the fuel, settles out into the settling space below the bed of salt. Dissolved water in the fuel is largely removed by the subsequent passage of the fuel through a bed of solid, particulate caustic. The caustic also appears to remove any ionic chloride carried over in the fuel from the salt treatment.

The following examples illustrate the benefits of the present invention when the process is utilized to treat a jet fuel. In these examples, the jet fuel was a sample taken from an 8000 gallon tank car at an aircraft terminal after the fuel had been transported from the refinery to the terminal. This fuel contained all of the conventional jet fuel additives approved by the military, including conventional antioxidants, metal deactivators, deicers, dispersants and the like, and met all specifications when it left the refinery. The table set forth below shows the results of coker tests to determine the stability of the fuel, measurements of the dirt content of the fuel, and measurements of the moisture content of the fuel. These tests were conducted on the untreated fuel, the fuel after passage through rock salt and, thereafter, through solid caustic, and finally, the thus treated fuel after removal of the precipitate formed by the treating process. The parenthetic numbers indicate the maximum of the measured value specified for an acceptable jet fuel.

TABLE II

	Untreated fuel	Fuel after treatment with solid NaCl and solid NaOH	Fuel after removal of precipitate
Research coker test at 300-500/600/6:			
Preheater, code No. (max. 2)	7	5	3
Filter differential pressure, in Hg (max. 5)	25	18	0.1
Dirt content, mg./gal. (max. 2)	24	21	0.4
Moisture content, p.p.m. (max. 30)	75	20	15

While, as indicated previously, conventional jet fuel additives or other hydrocarbon liquid additives appear to have a catalytic or promoting effect on the removal of contaminants or their conversion during treatment by the present technique, it has also been found that a new group of promoting agents appear to artificially degrade the hydrocarbon liquid, improve the effectiveness of the technique of the present application and improve the life of the treating media of the present invention. Apparently these materials promote oxidation of certain components of the hydrocarbon liquid and speed up certain types of degradation, thus, removing degradation products or precursors of degradation products prior to storage and eventual use. Generally, such pretreatment or addition of promoters should take place at the production point so that the fuel or other hydrocarbon liquid will be both naturally and artificially degraded prior to treatment in accordance with the present invention. However, it has also been found that certain amounts of these promoting agents, as well as conventional hydrocarbon liquid additives, are removed by the treatment of the present invention and, accordingly, it is preferable to add the promoting agents in limited quantities before the treatment and also to add these promoting agents as stabilizing agents after treatment in accordance with the present invention.

One particular promoting agent which has been found somewhat effective in conjunction with the technique of the present invention is a compound selected from the group of polyphenyl substituted aliphatic compounds. These phenyl compounds have been found to have some unexplainable antioxidant or stabilizing effect upon hy-

drocarbon liquids and, particularly, jet fuels, when used alone or in combination with the hereafter mentioned additional promoters and/or conventional hydrocarbon liquid additives, particularly antioxidants and metal deactivators. It has been found that the addition of about 0.0001 to 0.1% by weight of these phenyl compounds to a hydrocarbon liquid will produce improved results. Phenyl compounds within the pervue of the present invention include polyphenyl substituted lower alkanes and polyphenyl substituted lower alkylenes such as diphenylmethane; triphenylmethane; 1,2-diphenylethylene; 1,1,2,2-tetraphenylethylene; 1,1,2-triphenylethane; 1,1,2,2-tetraphenylethane, etc. The following table illustrates the benefits of adding these phenyl promoting agents to a jet fuel and passing the fuel through refined rock salt and flake caustic in accordance with the present invention.

TABLE III.—JP-4 TYPE JET FUEL WITH VARIOUS TREATMENTS OF PHENYL TYPE PROMOTING AGENTS FOLLOWED BY REFINED ROCK SALT AND FLAKE AND FLAKE CAUSTIC FILTRATION

	Coker 300/400/6	
	Preheater code No.	Filter in. Hg
(1) Original fuel with no filtration	5	25
(2) Original fuel with filtration [1]	4	14.5
(3) Original fuel plus 0.001% diphenylmethane then filtered	3	5.2
(4) Original fuel plus 0.001% triphenylmethane then filtered	3	3.1
(5) Original fuel plus 0.001% 1,2-diphenylethylene then filtered	3	2.2
(6) Original fuel plus 0.001% 1,1,2,2-tetraphenylethylene then filtered	2	0.9
(7) Original fuel plus 0.001% 1,1,2-triphenylethane thenfiltered	4	6.9
(8) Original fuel plus 0.001% 1,1,2,2-tetraphenylethane then filtered	1	0.7

[1] Filtration through ten feet of NaCl rock salt and three feet of flake caustic, followed by membrane filtration.

Another promoter which has been found particularly useful for the artificial degradation of hydrocarbon liquids, particularly jet fuels, is butyl "cellosolve" acetate and particularly this material as acetoxy ethyl monobutylether. This material also may be used alone, in combination with the previously-mentioned or the hereinafter-mentioned promoting agents and/or conventional hydrocarbon liquid additives. This particular material appears to have a major effect on the high temperature stability of hydrocabon liquids, and particularly jet fuels. The ether may be added to the hydrocarbon liquid in the same proportions as the previously-mentioned phenyl compounds; and, as previously indicated, may be added at the production point or at the use point prior to treatment in accordance with the present invention. It may also be added both before and after treatment.

The following examples illustrate the effectiveness of the ether compound when combined with treatment in accordance with the present invention.

TABLE IV.—SST TYPE JET FUELS WITH VARIOUS TREATMENTS OF ETHER (ACETOXYETHYLMONOBUTYLETHER) TYPE PROMOTING AGENTS FOLLOWED BY REFINED ROCK SALT AND FLAKE CAUSTIC FILTRATION

	Coker 350/450/6	
	Preheater code No.	Filter in. Hg
(1) Original fuel with no filtration	7	25
(2) Original fuel with filtration [1]	5	25
(3) Original fuel plus 30 lbs. BCA[2]/1,000 bbls. then filtered	4	8.7
(4) Same as Item 3 then inject 30 pounds BCA/1,000 barrels	3	2.6
(5) Original fuel plus 60 pounds BCA/1,000 barrels then filtered	3	4.1
(6) Same as Item 5 then inject 60 pounds BCA/1,000 barrels	2	1.7
(7) Original fuel plus 60 pounds BCA and 3 pounds MD[3]/1,000 barrels then filtered	1	1.4
(8) Original fuel plus 3 pounds MD/1,000 barrels then filtered	6	25

[1] Filtration through ten feet of NaCl rock salt and three feet of flake caustic, followed by membrane filtration.
[2] BCA expressed as acetoxyethylomonobutylether.
[3] MD expressed as conventional metal deactivator.

Still another group of materials found to be effective promoters for the artificial degradation of hydrocarbon liquids are a group of low molecular weight esters of citric acid. Examples of suitable alkanol esters include acetoxy tributyl citrate; tributyl citrate; acetoxy-tri-2-ethylhexyl citrate, etc. These additives can be added to the fuel at the production point or the use point or both, and prior to and after the treatment through solid salt and solid caustic in accordance with the present invention. Amounts of this material included in the hydrocarbon liquid include 0.0001 to about 2% by weight. This material may also be used in conjunction with the other promoters mentioned in the present application, as well as conventional hydrocarbon liquid additives.

The following examples illustrate the effectiveness of the above-mentioned esters when utilized in conjunction with the treating process of the present application.

TABLE V.—SST TYPE JET FUELS WITH VARIOUS TREATMENTS OF CITRIC ACID ESTERS AS PROMOTING AGENTS FOLLOWED BY REFINED ROCK SALT AND FLAKE CAUSTIC FILTRATION

	Coker 350/450/6	
	Preheater code No.	Filter in. Hg
(1) Original fuel with no filtration	6	25
(2) Original fuel with filtration [1]	5	25
(3) Original fuel plus 30 pounds TBC [2]/1,000 barrels then filtered	4	5.7
(4) Same as Item 3 then inject 30 pounds BCA/1,000 barrels	3	3.9
(5) Original fuel plus 30 pounds TBC and 1 pound MD [3]/1,000 barrels then filtered	2	1.2
(6) Original fuel plus 30 pounds TBC and 2 pounds MD/1,000 barrels plus 30 pounds BCA/1,000 barrels fuel then filtered	0	0.6
(7) Same as Item 6 then inject 30 pounds BCA plus 2 pounds MD/1,000 barrels fuel	0	0

[1] Filtration through ten feet of NaCl rock salt and three feet of flake caustic, followed by membrane filtration.
2 TBC expressed as tributylcitrate.
[3] MD expressed as conventional metal deactivator.

It has also been found that in addition to the removal of oxygenated compounds, other impurities and precursors of gums and the like from hydrocarbon liquids, the treating process of the present invention also removes a part of the promoters of the present invention as well as other conventional hydrocarbon liquid additives. Accordingly, the preferred technique in accordance with the present invention is to add only a minimal amount of these promoting agents to the hydrocarbon liquid at the production point immediately after production and before any storage and/or transportation and thereafter, add an additional amount of the promoter as a stabilizing agent and all or a majority of conventional additives after passage of the hydrocarbon liquid through the sodium chloride and caustic. For example, about 0.001 to 2% by volume of these promoters can be added to the hydrocarbon liquid at the production point prior to any substantial storage and/or transportation delay. The fuel or other hydrocarbon liquid is then transported to the use point and stored and is thereafter passed through the sodium chloride and caustic just prior to use. Following passage through the sodium chloride and caustic, and prior to loading of the use vehicle, such as a jet aircraft, an additional 0.1 to 2% by volume of the additive is incorporated in the fuel to improve the stability of the fuel. This same procedure should preferably be followed where conventional antioxidants, metal deactivators and other additives are incorporated in the fuel at the production point and prior to treatment with sodium chloride and caustic.

It has also been discovered in accordance with the present invention that the previously mentioned promoting agents are quite effective when combined with known antioxidants and metal deactivators heretofore used as additives for jet fuels and the like.

One particularly effective additive which, when combined with the previously mentioned promoters, is highly effective in the promotion of artificial degradation of fuels is a material commercially available as a metal deactivator (50 to 100% active ingredient), specifically, an N,N'-disalicylidene-1,2-alkyldiamine, such as N,N'-disalicylidene-1,2-propanediamine or its homolog N,N'-disalicylidene-1,2-ethanediamine. When combined with one of the previously mentioned promoting agents, the proportions should be about 85 to 99% of promoting agent plus 15 to 1% of the diamine. The blend is then utilized in the same amounts previously set forth for the promoters.

Another known additive, heretofore considered an antioxidant for jet fuels is 2,6-ditertiary-butyl-paracresol. This material may also be combined with the previously mentioned promoters in the amounts set forth above to produce a synergistic effect in the promotion of artificial degradation and subsequent stabilization of hydrocarbon liquids, when these materials are added to the liquid prior to treatment with sodium chloride and caustic.

Another group of conventional additives, which have previously been added to some jet fuels as suspending agents or dispersants, is a mixed polyamine product known as "jet fuel additive 5" or "JFA–5." The combination of this material with the promoters set forth above should be approximately the same as previously mentioned for the other blends and may be added to the fuel in the amount previously mentioned prior to adsorptive filtration.

The following examples illustrate the effectiveness of the blends of promoting agent plus additive prior to treatment with sodium chloride and caustic, as well as such additions before and after such treatment.

TABLE VI.—SST TYPE JET FUELS WITH VARIOUS TREATMENTS OF MIXED POLYAMINES AS PROMOTING AGENTS FOLLOWED BY REFINED ROCK SALT AND FLAKE CAUSTIC FILTRATION

	Coker 350/450/6	
	Preheater code No.	Filter in. Hg
(1) Original fuel with no filtration	6	25
(2) Original fuel with filtration [1]	5	25
(3) Original fuel plus 10 pounds JFA-5 [2]/1,000 barrels then filtered	4	0.5
(4) Same as Item 3 then inject 30 pounds BCA [3] and 1 pound MD [4]/1,000 barrels fuel	2	0.2
(5) Original fuel with filtration plus 10 pounds JFA-5/1,000 barrels fuel	4	1.7

[1] Filtration through ten feet of NaCl rock salt and three feet of flake caustic, followed by membrane filtration.
[2] JFA-5 expressed as commercial dispersant jet fuel additive.
[3] BCA expressed as butyl cellosolve acetate.
[4] MD expressed as conventional metal deactivator.

I claim:

1. A method for drying, clarifying and stabilizing a hydrocarbon liquid comprising adding to major proportion of said hydrocarbon liquid a minor proportion of a material for promoting the oxidative deterioration of said hydrocarbon liquid selected from the group consisting of acetoxy ethyl monobutylether, alkanol ester of citric acid, a polyphenyl substituted lower alkane, a polyphenyl substituted lower alkylene and mixtures thereof and thereafter passing said hydrocarbon liquid through a body of solid, particulate sodium chloride and a body of solid, particulate caustic.

2. A method for drying, clarifying and stabilizing a hydrocarbon liquid comprising passing said hydrocarbon liquid through a body of solid, particulate sodium chloride and a body of solid, particulate caustic and thereafter adding to said hydrocarbon liquid a minor amount of a stabilizing agent selected from the group consisting of an acetoxy ethyl monobutyl-ether, alkanol ester of citric acid, polyphenyl substituted lower alkane, a polyphenyl substituted lower alkylene and mixtures thereof.

3. A process in accordance with claim 1 wherein the remaining products of oxidative deterioration are removed from the hydrocarbon liquid after passing said hydrocarbon liquid through the sodium chloride and the sodium hydroxide.

4. A process in accordance with claim 3 wherein the remaining products of oxidative deterioration are removed by filtration.

5. A method in accordance with claim 1 wherein the promoting agent is added in an amount of about 0.0001 to 2% by weight of the total hydrocarbon liquid.

6. A method in accordance with Claim 1 wherein the promoting agent is a polyphenyl substituted aliphatic compound.

7. A method in accordance with claim 1 wherein the promoting agent is acetoxy ethyl monobutylether.

8. A method in accordance with claim 1 wherein the promoting agent is an alkanol ester of citric acid.

9. A method in accordance with claim 1 wherein the promoting agent is a blend of acetoxy ethyl monobutylether and an N,N'-disalicylidene-1,2-alkyldiamine.

10. A method in accordance with claim 1 wherein the the promoting agent is a blend of acetoxy ethyl monobutylether and a mixed polyamine jet fuel additive.

11. A method in accordance with claim 1 wherein the promoting agent in a mixture of an alkanol ester of citric acid and an N,N'-disalicylidene-1,2-alkyldiamine.

12. A method in accordance with claim 1 wherein the promoting agent is a blend of an alkanol ester of citric acid and a mixed polyamine jet fuel additive.

13. A method in accordance with claim 1 wherein a minor proportion of a stabilizing agent for stabilizing the hydrocarbon liquid against further oxidative deterioration selected from the group consisting of acetoxy ethyl monobutylether, alkanol ester of citric acid, a polyphenyl substituted lower alkane, a polyphenyl substituted lower alkylene and mixtures thereof is added to the hydrocarbon liquid after passage of said hydrocarbon liquid through the sodium chloride and the sodium hydroxide.

14. A method in accordance with claim 13 wherein the stabilizing agent is acetoxy ethyl monobutylether.

15. A method in accordance with claim 13 wherein the stabilizing agent is an alkanol ester of citric acid.

16. A method in accordance with claim 13 wherein the stabilizing agent is a blend of acetoxy ethyl monobutylether and an N,N'-disalicylidene-1,2-alkyldiamine.

17. A method in accordance with claim 13 wherein the stabilizing agent is a blend of acetoxy ethyl monobutylether and a mixed polyamine jet fuel additive.

18. A method in accordance with claim 13 wherein the stabilizing agent is a mixture of an alkanol ester of citric acid and an N,N'-disalicylidene-1,2-alkyldiamine..

19. A method in accordance with claim 13 wherein the stabilizing agent is a blend of an alkanol ester of citric acid and a mixed polyamine et fuel additive.

20. A method in accordance with claim 2 wherein the stabilizing agent is acetoxy ethyl monobutylether.

21. A method in accordance with claim 2 wherein the stabilizing agent is an alkanol ester of citric acid.

22. A method in accordance with claim 2 wherein the stabilizing agent is a blend of acetoxy ethyl monobutylether and an N,N'-disalicylidene-1,2-alkyldiamine.

23. A method in accordance with claim 1 wherein the stabilizing agent is a blend of acetoxy ethyl monobutylether and a mixed polyamine jet fuel additive.

24. A method in accordance with claim 2 wherein the stabilizing agent is a mixture of an alkanol ester of citric acid and an N,N'-disalicylidene-1,2-alkyldiamine.

25. A method in accordance with claim 2 wherein the stabilizing agent is a blend of an alkanol ester of citric acid and a mixed polyamine jet fuel additive.

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