United States Patent Office 2,968,618 Patented Jan. 17, 1961

2,968,613

STABILIZED HYDROCARBON OIL

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No Drawing. Filed Sept. 29, 1958, Ser. No. 763,845

10 Claims. (Cl. 252—32.5)

This is a continuation-in-part of my copending application Serial No. 677,804, filed August 12, 1957, now abandoned and relates to the stabilization of organic compounds and more particularly to a novel process for preventing deterioration of organic compounds in storage, during transportation, or in use.

The present invention is particularly advantageous for use in the stabilization of hydrocarbon distillates, which may be cracked, straight run or mixtures thereof. The invention is of especial advantage in the stabilization of hydrocarbon distillates heavier than gasoline including, for example, fuel oil, burner oil, range oil, diesel oil, marine oil, scrubbing oil, cutting oil, rolling oil, soluble oil, drawing oil, slushing oil, lubricating oil, etc., as well as in greases, including petroleum greases, slushing greases, synthetic greases, etc. These oils and greases undergo deterioration in storage, resulting in the formation of sediment, discoloration, etc. The formation of sediment in fuel oils, diesel oils, etc. is objectionable because the sediment tends to plug burner tips, injectors, etc. Discoloration of fuel oil is objectionable for various reasons including customer's preference for light colored oils.

The present invention also is particularly advantageous for use in the stabilization of jet fuels. It will be noted that jet fuels may contain components boiling within the gasoline range as well as above the gasoline range. Jet fuels are subjected to high temperatures, for example, in the heat exchange system used to preheat the fuel prior to combustion. These high temperatures appear to accelerate deterioration of the fuel and cause plugging of the heat exchangers and of the spray nozzles.

Other organic compounds undergo deterioration in storage, transportation or in use. Illustrative examples include gasoline and particularly cracked gasoline and mixtures of cracked and straight run gasoline, glyceridic oils and fats, wax, rubber, plastic, other oils and fats of animal or vegetable origin, alcohols, ethers, chlorinated hydrocarbons, etc.

The novel additive of the present invention also is used to prevent deposit formation in heat exchangers, furnaces or other equipment in which oil is heated as, for example, by being passed through tubes or shells in indirect heat exchange with hotter oil or combustion products. Frequently during such heating of the oil, deposit formation occurs and results in restricting the passage of the oil and, in extreme cases, in plugging thereof. This means that the unit must be shut down in order to replace the exchanger or furnace. It is apparent that this result may be extremely costly, both in the labor and material costs in repairing or replacing the equipment. Also important is the fact that a shut down of the unit results in loss of product to be marketed.

In one embodiment the present invention relates to a process for stabilizing an organic substance normally tending to undergo deterioration which comprises incorporating therein a stabilizing concentration of an inhibitor

comprising the condensation product of an amine and a beta-lactone.

In a specific embodiment the present invention relates to a process for stabilizing hydrocarbon distillates normally tending to undergo deterioration, which comprises incorporating therein the condensation product of beta-propiolactone and an N-alkyl diaminopropane containing at least 8 carbon atoms in the alkyl group.

In another embodiment the present invention relates to an organic substrate and particularly hydrocarbon distillate normally subject to deterioration containing a stabilizing concentration of the inhibitor herein set forth.

Any suitable beta-lactone may be used in preparing the inhibitor of the present invention. Beta-propiolactone generally is preferred because of its ready availability and lower cost. However, other beta-lactones may be utilized in the preparation of the inhibitor of the present invention. Illustrative saturated aliphatic beta-lactones include beta-butyrolactone, beta-valerolactone, beta-isovalerolactone, alpha-methyl-beta-propiolactone, alpha-ethyl-beta-propiolactone, beta-isopropyl beta-propiolactone, beta-methyl beta-valerolactone, etc. While it is preferred to utilize the saturated aliphatic beta-lactones and more particularly these lactones containing a total of 3 to 6 carbon atoms, in some cases, unsaturated lactones or lactones containing a cyclic configuration may be employed as, for example, the lactone of o-(hydroxymethyl)-phenylacetic acid. In some cases a mixture of beta-lactones may be employed. It is understood that the various lactones which may be utilized are not necessarily equivalent and that the particular beta-lactone to be used will be selected with regard to the availability, cost, amine used in the condensation, the specific organic substance in which the condensation product is to be employed as an inhibitor, etc.

Any suitable amine may be used in the preparation of the condensation product. When the condensation product is to be used as an inhibitor in a hydrocarbon distillate, the amine preferably contains at least 8 carbon atoms and still more preferably at least 12 carbon atoms. Usually the amine will contain from 8 and preferably from about 12 to about 30 carbon atoms in one embodiment or up to about 70 carbon atoms in another embodiment. It is understood that the amine will be selected with regard to the particular beta-lactone to be used in the condensation so that the condensation product will contain at least 11 and preferably at least 15 carbon atoms. The amine may be a primary, secondary or tertiary amine. Illustrative primary amines include amyl amine, hexyl amine, heptyl amine, octyl amine, nonyl amine, decyl amine, undecyl amine, dodecyl amine, tridecyl amine, tetradecyl amine, pentadecyl amine, hexadecyl amine, heptadecyl amine, octadecyl amine, nonadecyl amine, eicosyl amine, etc. A number of amines are available commercially, generally as mixtures, and these amines advantageously may be used in preparing the condensation product of the present invention. Illustrative examples of such amines include coconut amine, soy bean amine, tallow amine, stearyl amine, etc., and generally contain from about 8 to about 18 carbon atoms per molecule, while other amines are available containing a higher number of carbon atoms per molecule.

It is understood that polyamines and particularly diamines or triamines containing two primary amino groups may be used in preparing the condensation product. The polyamines preferably contain at least 8 carbon atoms. Illustrative examples of such amines include octamethylene diamine, nonamethylene diamine, decamethylene diamine, undecamethylene diamine, dodecamethylene diamine, etc.

A particularly preferred amine containing a secondary

amino group is N-tallow-1,3-diaminopropane. This substituted amine is available commercially under the trade name of "Duomeen T" or "Diam 26" and contains from about 12 to 20 carbon atoms per alkyl group and mostly 16 to 18 carbon atoms. Other substituted N-alkyl diaminopropanes comprise those in which the alkyl group is derived from lauric acid, coconut, soya, etc. Other secondary amines include dipropyl amine, dibutyl amine, diamyl amine, dihexyl amine, diheptyl amine, dioctyl amine, dinonyl amine, didecyl amine, diundecyl amine, didodecyl amine, etc.

A number of tertiary amines are available commercially and are advantageously used in preparing the condensation product. One such amine is stearyl dimethyl amine. Other tertiary amines include tripropyl amine, tributyl amine, triamyl amine, trihexyl amine, triheptyl amine, trioctyl amine, trinonyl amine, tridecyl amine, etc., as well as tertiary amines in which all of the tertiary alkyl groups are not the same chain lengths.

In another embodiment the amine used for condensation with the beta-lactone may be prepared by the condensation of an amine with another compound. For example, an effective inhibitor was obtained by first condensing Duomeen T with formaldehyde and then further condensing this condensation product with beta-propiolactone. In this embodiment the Duomeen T and formaldehyde preferably are condensed in equal molar proportions at a temperature of from ambient to about 100° C., although different proportions and temperatures may be used in some cases.

In another example, an effective inhibitor was obtained by condensing Duomeen T and ethylene diamine with epichlorohydrin and then condensing the product with beta-propiolactone. In this embodiment a total of 1 or 2 mols of the amine preferably are reacted with 1 mol of epichlorohydrin and generally at a temperature of from ambient to about 100° C. although, in some cases, different proportions and temperatures may be employed.

In still another example a satisfactory inhibitor was obtained by condensing tallow amine and tetraethylene pentamine with epichlorohydrin and then condensing the product with beta-propiolactone. In this embodiment a total of 1 or 2 mols of the amine preferably are reacted with 1 mol of epichlorohydrin and generally at a temperature of from ambient to about 100° C. although in some cases different proportions and temperatures may be employed.

In some cases the amine may be selected from aryl-substituted aliphatic amines as, for example, benzyl amine, phenyl ethyl amine, para xylene amine, etc., from aromatic amines as, for example, aniline, toluidine, xylidine, naphthylamine, etc., heterocyclic amines as, for example, pyridyl amines, quinolyl amines, etc., and amines containing oxygen as, for example, N-furfuryl amine, morpholine, beta-ethoxy ethyl amine, pentanol amine, hexanol amine, heptanol amine, octanol amine, etc., tris-(hydroxymethyl)-aminomethane, polyethanol amines, etc. In still other cases, the amine may contain sulfur or halogen as, for example, in compounds as chloroamyl amine, chlorohexyl amine, chloroheptyl amine, chlorooctyl amine, etc., polychloro amines, aminoethyl ethyl sulfide, beta, beta'-diamino butyl sulfide, mercaptoamyl amine, mercaptohexyl amine, mercaptooctyl amine, etc., cistene, astine, taurine, etc.

As hereinbefore set forth, the specific amine utilized in the preparation of the condensation product will be selected with regard to availability, cost, specific beta-lactone with which it is to be condensed, specific substrate in which the condensation product is to be used, etc. It is understood that the condensation products formed from the different amines are not necessarily equivalent in the same or different substrates. In most cases, the condensation product will comprise a mixture of different compounds and probably a mixture of different classes of compounds, depending upon the particular beta-lactone and the particular amine employed. It is believed that these reaction products include beta-N-substituted amino carboxylic acids, probably existing as a zwitter-ion, N-substituted hydracrylamides, and mixtures thereof. As hereinbefore set forth, these condensation products are effective inhibitors and may be used as such without the added time and expense to separate specific compounds therefrom, although in some cases further treatment to concentrate desired compounds may be justified.

The condensation of the amine with the beta-lactone is effected in any suitable manner. In general, this condensation is readily effected by mixing the amine and beta-lactone. Generally an excess of amine is preferred in order to insure complete reaction with the beta-lactone and to avoid polymerization of the lactone. In a preferred method, the beta-lactone is added to a stirred solution of the amine. While the reaction may be effected at ambient temperature, an elevated temperature generally is preferred in order to accelerate the reaction. The temperature usually will be within the range of from about 50° to about 100° C., although a higher temperature may be employed when utilizing super-atmospheric pressure to maintain the reactants in liquid phase. The reaction is effected readily in the absence of a solvent. However, when desired, a suitable solvent may be employed. The solvent must not react with the amine or beta-lactone. Inert solvents include hydrocarbons, esters, etc.

The condensation is effected using the beta-lactone in a concentration sufficient to react with from about 10% to about 100% of the nitrogen contained in the amine. For example, when a monoamine is used in the condensation, equal molar proportions of beta-lactone and amine will result in reaction of the beta-lactone with 100% of the nitrogen. However, when a diamine is used in the condensation, equal molar proportions of lactone and amine will result in the reaction of 50% of the nitrogen contained in the amine. When it is desired to react 100% of the nitrogen, 2 mols of lactone are used per mol of the diamine. Similarly, when a triamine is used for condensing with the lactone, equal molar proportions of lactone and amine will result in the reaction of one-third of the nitrogen. Accordingly, 3 mols of lactone per mol of triamine should be used to obtain 100% reaction of the nitrogen. Similarly, when the amine contains 6 nitrogens, it will be necessary to utilize 6 molar proportions of beta-lactone to obtain 100% reaction of the nitrogens. In any event, the lactone must be used in a concentration to obtain reaction of at least 10% of the nitrogen contained in the amine.

When the amine is condensed with beta-lactone in a concentration below that necessary to react with 100% of the nitrogen, in another embodiment of the invention, all or a portion of the unreacted nitrogen may be neutralized with an inorganic acid and particularly phosphoric acid and still more particularly alkyl esters of phosphoric acid. While the inorganic acid may comprise hydrogen halide, alkyl halide and particularly hydrogen chloride and alkyl chloride, sulfuric acid and particularly alkyl sulphates, etc., as hereinbefore set forth, it is preferred that alkyl esters of phosphoric acid be utilized. The alkyl esters may be mono- and/or dialkyl acid phosphates and particularly the orthophosphates in which at least one alkyl group contains from 5 to about 30 carbon atoms.

Particularly preferred phosphates include mixtures of mono- and diamyl acid orthophosphates, mono- and dioctyl acid orthophosphates, mono- and didecyl acid orthophosphates, mono- and didodecyl acid orthophosphates, as well as phosphates prepared from fatty alcohols in which one or both of the alkyl radicals are selected from capryl, lauryl, stearyl, myristyl, palmityl, ceryl, etc. In other examples the phosphate may comprise ethyl lauryl acid orthophosphate, ethyl stearyl acid orthophosphate, etc. It is understood that these are

preferred phosphates and that other suitable alkyl esters of phosphoric acid may be employed.

The reaction product generally is recovered as a viscous liquid and may be marketed or used as such or utilized as a solution in a solvent. Conveniently, the solvent will comprise the same solvent, when employed, used in preparing the condensation product and is recovered in admixture with at least a portion of the solvent, thereby avoiding the necessity of removing all of the solvent and subsequently adding it back. When a more dilute solution is desired than is recovered in the manner hereinbefore set forth, it is understood that the same or different solvent may be commingled with the mixture to form a solution of the desired concentration.

The concentration of the condensation product to be used as an inhibitor will depend upon the particular organic substance in which it is to be used and the particular benefits desired. In general, the inhibitor will be used in a concentration of from about 0.0001% to about 5% by weight or more and usually will be used in a concentration of from about 0.001% to about 1% by weight of the organic substance. The inhibitor may be used along with other additives which are incorporated in the organic substance for specific purposes including, for example, metal deactivator, synergist, dye, fuel, improver, etc.

The condensation product may be incorporated in the organic substance to be stabilized in any suitable manner. As hereinbefore set forth, the condensation product conveniently is marketed as a solution in a suitable solvent, including hydrocarbons and particularly aromatic hydrocarbons as, benzene, toluene, xylene, cumene, etc., or alcohols, ketones, etc. When the inhibitor is to be incorporated in a liquid substrate, it may be added thereto in the desired amount and the resultant mixture suitable agitated in order to obtain intimate admixing of the inhibitor in the substrate. When the inhibitor is incorporated in a flowing stream of oil, the inhibitor is intimately dispersed therein by the turbulence normally encountered in the flowing stream. When the inhibitor is to be incorporated in a normally solid substrate, the substrate may be heated to form a liquid composition and the inhibitor added thereto or the inhibitor may be incorporated in the solid substrate in any other suitable manner.

As hereinbefore set forth, the inhibitor of the present invention also is used to prevent deposit formation in heat exchangers. Such heat exchange is utilized, for example, in a hydrotreating process in which oil is subjected to hydrogen treating in the presence of a catalyst comprising alumina-molybdenum oxide-cobalt oxide, alumina-molybdenum sulfide-cobalt sulfide, or other suitable catalyst. The oil, which may comprise gasoline, kerosene, gas oil or mixtures thereof, is introduced into the process at a temperature of from about ambient to 200° F. and is passed in heat exchange with reactor effluent products being withdrawn at a temperature of from about 500° to about 800° F. The charge is heated by such exchange to a temperature of from about 300° to about 600° F., then is heated in a furnace or otherwise to a temperature of from about 625° to about 800° F. and passed with hydrogen into contact with the catalyst. This treatment serves to remove impurities and to hydrogenate unsaturates contained in the charge. Another illustration is a reforming process in which gasoline is contacted with hydrogen in the presence of a platinum-containing catalyst at a temperature of from about 700° to about 1000° F. and the hot effluent product from the reaction zone is passed into heat exchange with the charge in order to cool the former and to heat the latter.

An example in which oil is subjected to fractionation and the charge is passed in heat exchange with the hot effluent products is in a crude column. In this column, crude oil is subjected to distillation at a temperature of from about 600° to about 700° F. in order to remove lighter components as overhead and/or side streams. In some cases the charge first is passed in heat exchange with the overhead and/or side streams from this column and then is passed in heat exchange with the hotter products withdrawn from the bottom of the crude column. In this way the charge is progressively heated and the hotter products are cooled.

The above examples are illustrative of typical uses of heat exchange to effect economies in the process. However, difficulty is experienced in the heat exchange due to deposit formation, with the consequent necessity of interrupting plant operation as hereinbefore set forth. In accordance with the present invention, deposit formation in the heat exchanger is reduced to an extent that normal plant operation need not be interrupted for this reason.

It is understood that the advantages of the present invention may be obtained in any suitable heat exchange equipment. In general, this equipment comprises a series of tubes or a coil positioned within a shell. One of the fluids is passed through the tubes or coils, while the other fluid is passed through the shell. The heat exchange equipment generally is positioned externally to a fractionator or reactor. However, in some cases, the heat exchanger takes the form of a reboiler or condenser, and either a tube, coil or a shell containing tubes is positioned within the lower or upper portion of the fractionator or reactor.

The following examples are introduced to illustrate further the novelty and utility of the present invention but not with the intention of unduly limiting the same.

EXAMPLE I

The inhibitor used in this example was prepared by the condensation of a primary amine with beta-propiolactone. The amine used in this preparation is "Primene 81—R," marketed by Rohm and Haas Co., Inc., and is a mixture of tertiary alkyl primary amines containing from 15 to 18 carbon atoms per alkyl group. The amine was heated to a temperature of 60° C. with stirring and beta-propiolactone was gradually added to the amine. The proportions of beta-propiolactone and amine were equimolar. The condensation product was recovered as a viscous liquid.

The condensation product prepared in the above manner was used as an inhibitor in a commercial fuel oil. The fuel oil was stored at 100° F. for 43 days and the amount of sediment formed during such storage was determined. A sample of the fuel oil not containing an additive, after storage for 43 days at 100° F., developed 8.7 mg. per 100 ml. of sediment. On the other hand, another sample of the fuel oil containing 0.01% by weight of the condensation product prepared in the above manner, after storage for 43 days at 100° F., developed only 3.2 mg. per 100 ml. of sediment. It will be noted that the sediment formation was reduced to approximately one-third of that obtained in the absence of the condensation product.

EXAMPLE II

Another method of evaluating inhibitors is by a test known as the "Filtration Test" in which successive 500 cc. portions of a commercial fuel oil is passed through a small piece of 400 mesh screen at a constant pressure, and the time in seconds for each successive 400 cc. portion to pass through the screen is measured. It is apparent that the time required for the successive portions to pass through the screen is an indication of deterioration of the oil, the longer time indicating greater deterioration.

The following table reports results obtained when using a control sample of the fuel oil (not containing the additive) and when using a sample of the fuel oil containing another portion of the condensation product described in Example I. The condensation product was used in a

concentration of 0.01% by weight of the oil. The results of these runs are shown in the following table:

Table I

Inhibitor	Time in seconds for successive 400 cc. portions to pass		
	1	2	3
None	23	34	55
Condensation Product	21	22	24

From the data in the above table, it will be noted that the sample of oil which did not contain an inhibitor required 55 seconds for the third portion of the oil to pass through the screen, thus showing considerable deterioration of the oil. On the other hand, the third portion of the sample of oil containing the condensation product passed through the screen in 24 seconds, thus showing an increase of only two seconds over that required for the first portion of oil to pass through the screen. It is apparent that the condensation product was very effective in retarding deterioration of the oil.

EXAMPLE III

The inhibitor of this example was prepared by the condensation of stearyl dimethyl amine and beta-propiolactone. This condensation product was prepared by the same general method as described in Example I. 0.01% of the condensation product was incorporated in another sample of the oil described in Example II and stored in the same manner as described therein. After 43 days in storage at 100° F., the sample of oil containing this inhibitor developed only 2.7 mg. per 100 ml. of sediment. It will be recalled that the sample of oil not containing an inhibitor developed 8.7 mg. per 100 ml. of sediment after similar storage. Here again, it will be noted that the condensation product of the present invention was very effective in inhibiting sediment formation in the oil.

EXAMPLE IV

The inhibitor of this example was prepared by condensing Duomeen T (N-tallow-1,3-diaminopropane) with formaldehyde and then condensing the product with beta-propiolactone. The first condensation was effected using equimolar proportions of reactants. Formaldehyde was gradually introduced into a stirred and heated (50° C.) solution of Duomeen T in isopropyl alcohol. After completion of the reaction, beta-propiolactone was gradually passed into the mixture in an equimolar proportion to the Duomeen T. The solvent subsequently was removed by distillation.

The condensation product prepared in the above manner was evaluated in another commercial No. 2 fuel oil in the Filtration Test hereinbefore described. The results of a control sample of the fuel oil (not containing an inhibitor) and a sample of the fuel oil containing 0.005% by weight of the condensation product prepared in the above manner are shown in the following table.

Table II

Inhibitor	Time in seconds for successive 400 cc. portions to pass		
	1	2	3
None	22	30	41
Condensation Product	21	22	23

Here again, it will be noted that the condensation product was very effective in improving the fuel oil and, as hereinbefore set forth, will avoid plugging of burner nozzles, etc.

EXAMPLE V

The condensation product of the present invention was prepared by condensing beta-propiolactone with a mixed commercial amine. The amine is marketed under the name of Primene JMT by Rohm and Haas Co., Inc., and is a tertiary alkyl primary amine, the tertiary alkyl groups containing from 24 to 27 carbon atoms each. This condensation was effected in substantially the same manner as hereinbefore described.

0.005% of the condensation product prepared in the above manner was incorporated in another sample of the fuel oil described in Example IV and was stored for 167 days at 100° F. After such storage, the sediment was 3.3 mg. per 100 ml. On the other hand, another sample of the oil not containing an inhibitor developed a sediment content of 5.7 mg. per 100 ml. after 152 days in storage at 100° F. It will be noted that the inhibitor served to reduce sediment formation.

EXAMPLE VI

As hereinbefore set forth, the beta-lactone may react with all or a portion of the amino nitrogen present in the amine or intermediate product. The present example illustrates the case in which the beta-lactone reacts with 100% of the amino nitrogen.

1550 grams of Duomeen T (8.6 mols of amino nitrogen) were heated to 55° C. and vigorously stirred. 142 grams of 91% para-formaldehyde (4.3 mols) were added to the stirred Duomeen T over a period of an hour. The reaction was exothermic and was cooled to maintain the temperature between 55° and 73° C. 500 cc. of hexane solvent was added and the mixture was refluxed at 73°–90° C. 102 cc. of water was collected. Subsequently the hexane solvent was removed by distillation under vacuum at a maximum temperature of 90° C. 1580 grams of product were recovered.

1563 grams of the product prepared in the above manner (8.5 mols of amino nitrogen) were vigorously stirred and heated to a temperature of 61° C. 605 grams of beta-propiolactone (8.5 mols) were added over a period of an hour and at a temperature controlled to maintain it between 63° and 72° C. Approximately the theoretical yield of reaction product was recovered and, upon cooling, was a viscous liquid which is readily soluble in heptane.

The condensation product prepared in the above manner is incorporated in a commercial fuel oil. The fuel oil is stored at 100° F. for 43 days and the amount of sediment formed during such storage is determined. A sample of the fuel oil not containing an additive after storage for 43 days at 100° F. developed 8.7 mg. per 100 ml. of sediment. On the other hand, another sample of the fuel oil containing 0.005% by weight of the condensation product prepared in the above manner developed considerably less sediment during storage at 100° F. for 43 days.

EXAMPLE VII

This example describes 5 preparations in which 0.167, 0.333, 0.5, 0.667 and 0.833 molar proportions, respectively, of beta-propiolactone are reacted with 1 molar proportion of amino nitrogen in the reaction product of Duomeen T and formaldehyde. The Doumeen T-formaldehyde reaction product was prepared substantially in the same manner as described in Example IV. The different condensation reactions with beta-propiolactone were effected in substantially the same manner as described in Example VI except that the different molar proportions of beta-propiolactone were used. The products were recovered as viscous liquids.

When evaluated in a commercial No. 2 fuel oil in the Filtration Test described in Example II, each inhibitor incorporated in the oil in a concentration of 0.02% by weight, all served to reduce deterioration of the oil and

to reduce the time required for the successive 400 cc. portions of oil to pass through the screen.

EXAMPLE VIII

As hereinbefore set forth, another embodiment of the invention includes the reaction of the amine with beta-lactone in a concentration to react with only a portion of the nitrogen and then neutralizing the product with an alkyl ester of phosphoric acid. This example illustrates a preparation in accordance with this embodiment of the invention. The inhibitor was prepared by reacting 3 molar proportions of beta-propiolactone with the Duomeen T-formaldhyde product prepared in substantially the same manner as described in Example VI. This product then was reacted with mixed mono- and diisooctyl acid orthophosphates by commingling 40 grams of the Duomeen T-formaldehyde-lactone reaction product with 26.7 grams of mixed mono- and diisooctyl acid orthophosphates, and heating the mixture with vigorous stirring to a temperature of 60° C. for 0.5 hour. The product was recovered as a viscous liquid.

The condensation product prepared in the above manner is incorporated, in a concentration of 50 parts per million, in a naphtha charge being passed in heat exchange with a hot effluent product from the reactor of a treating process in which naphtha is passed with hydrogen into contact with an alumina-cobalt oxide-molybdenum oxide catalyst to decompose sulfur, nitrogen and oxygen compounds into H_2S, ammonia and water, respectively, and to hydrogenate unsaturates contained in the naphtha. During such heat exchange, the naphtha charge is heated from 120° F. to 500° F. and then is heated in an externally fired furnace to a temperature of 715° F. and passed into contact with the catalyst.

The condensation product serves to reduce deposit formation in the heat exchanger and to avoid premature shutting down of the unit because of heat exchanger plugging.

I claim as my invention:

1. Hydrocarbon oil normally tending to deteriorate containing from about 0.0001% to about 5% by weight of the condensation product, formed at a temperature of from about ambient to about 100° C., of a beta-lactone containing from about 3 to about 6 carbon atoms per molecule and a polyamine containing from about 8 to about 70 carbon atoms per molecule, said lactone reacting with from about 10% to about 100% of the nitrogen in said amine.

2. The hydrocarbon oil composition of claim 1 further characterized in that said lactone and said polyamine are reacted in equimolar proportions.

3. Hydrocarbon oil containing from about 0.0001% to about 5% by weight of the condensation product, formed at a temperature of from about 50° to about 100° C., of beta-propiolactone and N-tallow-1,3-diaminopropane, said lactone reacting with from about 10% to about 100% of the nitrogen in said amine.

4. The hydrocarbon oil composition of claim 3 further characterized in that said lactone and said amine are reacted in equimolar proportions.

5. Hydrocarbon oil containing from about 0.0001% to about 5% by weight of the condensation product, formed at a temperature of from about 50° to about 100° C., of beta-propiolactone with the condensation product of N-tallow-1,3-diaminopropane and formaldehyde, said lactone reacting with from about 10% to about 100% of the nitrogen in the last-mentioned condensation product.

6. Hydrocarbon oil containing from about 0.0001% to about 5% by weight of the condensation product, formed at a temperature of from about 50° to 100° C., of beta-propiolactone with the condensation product of N-tallow-1,3-diaminopropane and epichlorohydrin, said lactone reacting with from about 10% to about 100% of the nitrogen in the last-mentioned condensation product.

7. Hydrocarbon oil containing from about 0.0001% to about 5% by weight of the condensation product, formed at a temperature of from about 50° to 100° C., of beta-propiolactone with the condensation product of tallow amine and tetraethylene pentamine with epichlorohydrin, said lactone reacting with from about 10% to about 100% of the nitrogen in the last-mentioned condensation product.

8. Hydrocarbon oil containing from about 0.0001% to about 5% by weight of the condensation product, formed at a temperature of from about 50° to 100° C., of beta-propiolactone with the condensation product of N-tallow-1,3-diaminopropane and formaldehyde, said lactone reacting with less than all but at least about 10% of the nitrogen in the last-mentioned condensation product and at least a portion of the unreacted nitrogen being neutralized with an inorganic acid.

9. The hydrocarbon oil composition of claim 8 further characterized in that said inorganic acid is an alkyl ester of phosphoric acid.

10. The hydrocarbon oil composition of claim 9 further characterized in that said alkyl ester is a mixture of mono- and diisooctyl acid orthophosphates.

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