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FUEL OIL COMPOSITION

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This invention relates to distillate fuel oil compositions containing multi-functional addition agents. More particularly, this invention relates to distillate fuel oil compositions containing addition agents capable of depressing pour point and imparting oxidation stability to the distillate fuel oil.

In storage and use of heavy oils, such as lubricating oils, problems associated with pour point have long been in existence and have been recognized in the art. The pour point of an oil is defined as the lowest temperature at which the oil will pour or flow when chilled without disturbance under specified conditions. Recently, it has been discovered that pour point problems also exist in the storage and use of distillate fuel oils, particularly at low temperatures. Pour point problems arise through the formation of solid or semi-solid waxy particles within an oil composition. For example, in the storage of furnace oils or diesel oils during the winter months, temperatures may decrease to a point as low as -15 to -25° F. The decreased temperatures often cause crystallization and solidification of wax in the distillate fuel oil. This problem has been in part remedied by lowering the end point of oils used for blending furnace and diesel oils. It has also been suggested that the distillate fuel oils may be dewaxed such as by urea dewaxing. However, readjustment of end point causes loss of valuable product as blending material to distillate fuel oil stocks. Further, dewaxing operations are expensive.

Another approach in solving the problem has been to attempt to find a pour point depressor which will decrease the pour point of a distillate fuel oil. However, it has been found that the pour point depressors normally used for lubricating oils and other heavy oils are generally ineffective in lowering the pour point of a distillate fuel oil.

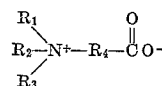
Another problem occurring in storage of distillate fuel oil compositions is the problem of inhibiting oxidative deterioration of the fuel oil under storage conditions. The deterioration of distillate fuels through oxidation under conditions of storage manifests itself in the appearance of darker colors, sediment, etc. in the oil. Sediment formation is often the most troublesome problem with which formulators of fuel oils are concerned because sediment formation normally may result in clogging of fuel system equipment such as filters, screens, nozzles, burners, etc., with sludge formed from sediment. The deterioration of fuel oils is much more prevalent where the fuel oil contains cracked materials and because of recent tendencies to blend fuel oils by mixing virgin furnace oil fractions with cracked components, oxidative deterioration has become a problem associated with many commercial fuel oil blends. The oxidative deterioration problem has, therefore attracted much study and as a result has been successful lessened using addition agents known as "fuel oil stabilizers."

In addition to the two problems discussed hereinabove, addition agents may also be necessary, such as dispersants, to improve filterability of the fuel oil, rust inhibitors to inhibit rusting of storage tanks by water accumulating in the fuel oil in both the oil layer and the water layer, corrosion inhibitors to inhibit acidic corrosion of storage tanks, etc. Throughout recent years, the needs for more and more addition agents for fuel oils have emerged through changes in refining and blending practices or have been recognized through modern research techniques and

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use of modern fuel system equipment. Each new agent which is added to fuel oils displaces or substitutes for oil in the fuel oil so that the amount of energy released from a given fuel oil is often correspondingly decreased because the substituted addition agents often do not burn with release of energy equal to that released in burning a corresponding amount of oil. Further, many such addition agents are costly. Thus, there has arisen a need for additives which may be used to perform more than one necessary function to lessen the total amount of addition agents needed and to lessen total cost of addition agents. Such additives performing more than one function may be termed "multipurpose" addition agents.

I have now discovered a multi-function addition agent useful in distillate fuel oil compositions as a pour point depressor and fuel oil stabilizer. The addition agent of this invention is an oil-soluble betaine of a quaternary ammonium salt and corresponds to the structural formula:



wherein the groups R_1 , R_2 and R_3 are the same or different aliphatic hydrocarbon groups having from about 1 to about 22 carbon atoms and R_4 is an alkylene group of from 1 to 7 carbon atoms. Thus, the betaine is a derivative of a tertiary alkyl amine. The distillate fuel oil composition of this invention comprises a distillate fuel oil containing from about 0.001 to about 5 weight percent, and more advantageously from about 0.01 to about 0.5 weight percent, of the betaine defined herein. The preferred distillate fuel oil composition of this invention contains the betaine in an amount of from about 0.03 to about 0.1 weight percent. The betaines may also be formulated in addition agent concentrates in a suitable organic solvent as is more particularly described below.

If the betaine used has low solubility in the distillate fuel oil, solvents such as aromatic hydrocarbons and alcohols may be used in the distillate fuel oil in sufficient amounts to solubilize the betaine.

In addition to functioning in distillate fuel oils as pour point depressors and fuel oil stabilizers, the betaines used herein may also function in distillate fuel oil media as rust inhibitors, antistatic agents, dispersants and corrosion inhibitors.

In accordance with this invention, more particularly, the betaines may more advantageously be those defined by the above structural formula wherein at least one of the R_1 , R_2 and R_3 groups is an aliphatic hydrocarbon group having from 10 to 22 carbon atoms and preferably all of the R_1 , R_2 and R_3 groups are alkyl groups having from about 16 to about 20 carbon atoms. Further, R_4 may advantageously be an alkylene group of from 1 to 4 carbon atoms and preferably is a methylene group. Thus, the betaines used herein are derivatives of tertiary fatty amines.

The aliphatic hydrocarbon groups of the betaines may be saturated or ethylenically unsaturated aliphatic groups, e.g. alkyl groups, alkenyl groups, alkydienyl groups, cycloalkyl groups, etc. Saturated hydrocarbon groups are preferred because the unsaturated groups may tend to react slightly with other materials present in the distillate fuel oil composition. Such reaction, however, is not generally undesirable and, wherever such reactions do occur and are considered undesirable, sufficient amounts of the betaine may be used in the distillate fuel oil to complete such reactions and provide an additional amount of betaine sufficient to perform the desired function.

Typical examples of useable betaines are those in which the R_1 , R_2 , R_3 and R_4 groups of the above formula are

the groups defined in the following table with regard to each enumerated example:

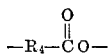
M2HT (methyl di-hydrogenated tallow amine), Armeen DM16 (di-methyl hexadecyl amine), Armeen DM18D

Example	R ₁	R ₂	R ₃	R ₄
1	methyl	methyl	eicosyl	methylene.
2	isopropyl	isopropyl	heptadecyl	Do.
3	hexyl	hexyl	hexadecyl	Do.
4	octyl	heptadecyl	heptadecyl	isopropylpropylene.
5	octadecyl	ethyl	octadecyl	isobutylene.
6	methyl	lauryl	lauryl	heptylene.
7	lauryl	do.	do.	methylene.
8	caprylyl	caprylyl	caprylyl	Do.
9	docosyl	docosyl	docosyl	ethylene.
10	methyl	hydrogenated tal- low. ¹	hydrogenated tal- low. ¹	methylene.
11	coco ¹	coco ¹	coco ¹	Do.
12	hydrogenated tal- low. ¹	hydrogenated tal- low. ¹	hydrogenated tal- low. ¹	Do.
13	methyl	methyl	stearyl	Do.
14	do.	do.	hexadecyl	Do.
15	do.	do.	coco ¹	Do.
16	do.	do.	soybean ¹	butylene.
17	hexenyl	hexenyl	decyl	methylene.
18	oleyl	oleyl	oleyl	Do.
19	dodecenyl	dodecenyl	dodecenyl	Do.
20	ethylhexyl	ethylhexyl	do.	Do.

¹ Terms such as "coco", "soybean," and "tallow" indicate the source of acid from which the particular group may be derived. The acid from these sources are mixed acids of natural origin. For example, "coco" denotes a mixture of groups averaging about C₁₂ derived from coconut fatty acids.

The foregoing betaines all may be used as distillate fuel oil addition agents in accordance herewith. Other betaines which may be used will be evident to those skilled in the art from the disclosure herein.

The betaines may be prepared by reaction of the corresponding tertiary amine with a suitable salt or ester of a monohalogenated aliphatic carboxylic acid. The reaction may be carried out in the presence of a solvent such as benzene, ethanol, n-butanol, isopropanol, etc., and in the presence of a promoter such as an inorganic iodide, e.g. potassium iodide. The reaction may conveniently be carried out at the reflux temperature of the solvent and may take from two to fifty hours for substantial completion. An acceptable temperature for the reaction may be in the range of from about 50° F. to about 200° F. although higher or lower temperatures may be used. The reaction proceeds to form a betaine product wherein the



portion of the betaine is derived from the ester of salt of the monohalogenated aliphatic carboxylic acid. Thus, the size and configurations of the R₄ alkylene group is determined by the aliphatic group of the monohalogenated aliphatic carboxylic acid salt or ester and may be pre-selected by any chemist of ordinary skill by selection of the appropriate acid salt or ester.

Examples of salts or esters of the monohalogenated aliphatic carboxylic acids which may be used in the above exemplified procedure of preparation of the betaines of this invention are: sodium chloroacetate, sodium bromoacetate, methyl chloroacetate, butyl bromoacetate, sodium α-chlorobutyrate, sodium chlorovalerate, methyl bromo-valerate, sodium chlorocaproate, sodium bromocaprylate, isopropyl monobromo butyrate, sodium chloroethylhexanoate, sodium chloro-dimethyl-valerate, etc. Of course, the corresponding calcium, magnesium, potassium or other salts may also be used in lieu of the sodium salts but may be less available or more expensive.

Examples of tertiary alkyl amines which may be used in the above procedure of preparation of the betaines of this invention are: di-methyl eicosyl amine, di-isopropyl heptadecyl amine, di-hexyl hexa-decyl amine, octyl di-heptadecyl amine, ethyl di-octadecyl amine, tri-dodecyl amine, tri-lauryl amine, tri-capryl amine, tri-nonyl amine, di-isopropyl heneicosyl amine, tri-dodecenyl amine, methyl di-hexylhexadecyl amine, tri-docosyl amine, di-hexenyl isodecyl amine, etc., and homologues and isomers of the above. Additionally, commercial tertiary amines may be used to form the betaines useful in this invention. Such commercial tertiary amines include those marketed under the trade name of "Armeen," such as Armeen

(di-methyl stearyl amine), Armeen DMCD (di-methyl coco amine), and Armeen DMSD (di-methyl soybean amine. Other tertiary amines which may be used are the Adogen 340 (tri-hydrogenated tallow amine), Adogen 363 (tri-lauryl amine) and Adogen 360 (tri-coco amine) which are commercially available and Alamine 336 (tri-capryl amine) which is also commercially available. In the nomenclature of commercial amines, terms such as "coco," "soybean," "tallow," and the like indicate the source of acid from which the group indicated thereby was derived. Each such group is usually a mixture of carbon chains differing slightly in length and/or configuration. However, these groups are well known in the additive art. The commercial amines are very useful and recommended because of their availability and relative low cost.

The following are examples of the preparation of betaines which may be used in accordance herewith:

Preparation of Betaine of Tri-(hydrogenated tallow) Amine

A betaine of tri-(hydrogenated tallow) amine was prepared by reacting 5 g. of Adogen 340 with 0.80 g. of sodium chloroacetate in the presence of one crystal of potassium iodide (promoter) and 50 ml. n-butanol (solvent) at reflux temperature (about 115 to 120° C.) for about 24 hours. Adogen 340 is a tri-hydrogenated tallow) amine having an average molecular weight of about 750. After refluxing for about 24 hours, the sodium chloride formed during the reaction was removed by filtration and the n-butanol was distilled from the product under vacuum to yield a waxy residue product. The waxy product was a betaine of tri-(hydrogenated tallow) amine.

Preparation of Betaine of Tri-coco Amine

A betaine of tri-coco amine was prepared by reacting 10 g. of Adogen 360 with 2.0 g. of sodium chloroacetate in the presence of one crystal of potassium iodide (promoter) and 50 ml. n-butanol (solvent at reflux temperature (about 115 to 120° C.) for about 24 hours. Adogen 360 is a tri-coco amine having an average molecular weight of about 520. After refluxing for about 24 hours, the sodium chloride formed during the reaction was removed by filtration and the n-butanol was distilled from the product under vacuum to yield a waxy residue product. The waxy product was a betaine of tri-coco amine.

Preparation of Betaine of Tri-lauryl Amine

A betaine of tri-lauryl amine was prepared by reacting 10 g. of Adogen 363 (tri-lauryl amine) with 2.25 g. of sodium chloroacetate in the presence of one crystal of potassium iodide (promoter) and 50 ml. n-butanol (sol-

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vent) at reflux temperature (about 115 to 120° C.) for about 24 hours. After refluxing for about 24 hours, the mixture was cooled and the sodium chloride formed during the reaction was removed by filtration. The n-butanol was then distilled from the product under vacuum to yield a waxy residue product. The waxy product was a betaine of tri-lauryl amine.

Preparation of Betaine of Tri-caprylyl Amine

A betaine of tri-caprylyl amine was prepared by reacting 10 g. of Alamine 336 (tri-caprylyl amine) with 3.3 g. of sodium chloroacetate in the presence of one crystal of potassium iodide (promoter) and 50 ml. n-butanol (solvent) at reflux temperature (about 115 to 120° C.) for about 24 hours. After refluxing for about 24 hours, the sodium chloride formed during the reaction and any insoluble amine reactant were removed by filtration. The n-butanol was then distilled from the product under vacuum to yield a waxy residue product. The waxy product was a betaine of tri-caprylyl amine.

The distillate oil or distillate fuel oil in which the betaines are used in accordance herewith is a hydrocarbon oil, such as for example, a diesel fuel, a jet fuel, a heavy industrial residual fuel (e.g. bunker C), a furnace oil, a heater oil fraction, kerosene, a gas oil, or any other like light oil. Of course, any mixtures of distillate oils are also intended. The distillate fuel oil may be virgin or cracked petroleum distillate fuel oil. The distillate fuel oil may advantageously boil in the range of from about 200 to about 700° F., and preferably in the range of 350 to 650° F. The distillate fuel oil may contain or consist of cracked components, such as for example, those derived from cycle oils or cycle oil cuts boiling heavier than gasoline, usually in the range of from about 450 to about 750° F. and may be derived by catalytic or thermal cracking. High-sulfur-containing and low-sulfur-containing oils such as diesel oils and the like may also be used. The distillate oil may, of course, contain other components such as addition agents used to perform particular functions.

The preferred distillate fuel oils have a initial boiling point in the range of from about 350 to about 475° F. and an end point in the range of from about 500 to about 650° F. The distillate fuel oil may advantageously have an A.P.I. gravity of about at least 30 and a flash point (Tag closed cup) not lower than about 110° F. and preferably above about 115° F.

To illustrate this invention, a betaine was added to various distillate fuel oils and effect of the betaine in varying amounts on pour point of the fuel oil was measured. The following distillate fuel oils were used:

Fuel A-----Desulfurized gas oil.
Fuel B-----Light catalytic cycle oil (ASTM distillation: initial 420° F., and end point 621° F.).
Fuel C-----Light catalytic cycle oil (ASTM distillation: initial 405° F., end point 638° F.).
Fuel D-----A blend of 535 parts of light catalytic cycle oil and 215 parts of middle catalytic cycle oil.
Fuel E-----A blend of equal parts light catalytic cycle oil (ASTM distillation: initial 404° F., end point 577° F.) and virgin diesel fuel oil.
Fuel F-----A blend of 2 parts desulfurized gas oil and one part kerosene diesel oil.
Fuel G-----A blend of 530 parts light catalytic cycle oil (ASTM distillation: initial 420° F., end point 621° F.) and 227 parts diesel oil.
Fuel H-----A blend of 250 parts virgin gas oil, 280 parts heater oil, 167 parts middle catalytic cycle oil, and 60 parts light catalytic cycle oil.
Fuel J-----A blend of 187 parts light catalytic cycle oil, 75 parts middle catalytic cycle oil, 338 parts virgin furnace oil, and 150 parts heater oil.
Fuel K-----A blend of 150 parts light catalytic cycle oil, 75 parts middle catalytic cycle oil, 38 parts virgin furnace oil and 487 parts heater oil.
Fuel L-----Light catalytic cycle oil.

The parts referred to in the above compositions of fuels A through L are parts by volume.

To each distillate fuel composition listed above, the

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betaine of tri-(hydrogenated tallow) amine, prepared as by the above specific example of preparation, was added in amounts indicated in the following table to form distillate fuel oil samples. Blank samples were also prepared. Each sample was tested for pour point with results as recorded below:

Sample	Distillate Fuel Oil	Betaine, Wt. percent	Pour Point, ° F.
1-----	A-----	0.00	1-11
2-----	A-----	0.01	-13
3-----	A-----	0.03	-51
4-----	A-----	0.05	-54
5-----	A-----	0.1	-64
6-----	B-----	0.00	1-12
7-----	B-----	0.01	-12
8-----	B-----	0.03	-24
9-----	B-----	0.05	-39
10-----	B-----	0.1	-54
11-----	C-----	0.00	1-14
12-----	C-----	0.05	-13
13-----	C-----	0.1	-35
14-----	D-----	0.00	1-25
15-----	D-----	0.01	-26
16-----	D-----	0.03	-70
17-----	D-----	0.05	-70
18-----	D-----	0.1	-70
19-----	E-----	0.00	1-16
20-----	E-----	0.01	-17
21-----	E-----	0.03	-47
22-----	E-----	0.05	-50
23-----	E-----	0.1	-65
24-----	F-----	0.00	1-20
25-----	F-----	0.01	-28
26-----	F-----	0.03	-48
27-----	F-----	0.05	-54
28-----	F-----	0.1	-68
29-----	G-----	0.00	1-23
30-----	G-----	0.01	-39
31-----	G-----	0.03	-54
32-----	G-----	0.05	-62
33-----	G-----	0.1	-70
34-----	H-----	0.00	10
35-----	H-----	0.01	-6
36-----	H-----	0.03	-14
37-----	H-----	0.05	-26
38-----	H-----	0.1	-32
39-----	J-----	0.00	1-1
40-----	J-----	0.01	-2
41-----	J-----	0.03	-15
42-----	J-----	0.05	-38
43-----	J-----	0.1	-51
44-----	K-----	0.00	1-39
45-----	K-----	0.05	-42
46-----	K-----	0.1	-50
47-----	L-----	0.00	1-23
48-----	L-----	0.01	-23
49-----	L-----	0.03	-61
50-----	L-----	0.05	-70
51-----	L-----	0.1	-70

¹ Average of two runs.

The data presented in the above table demonstrate the remarkable ability of the addition agents of this invention in decreasing the pour point of distillate fuel oils. It is evident from the data that the pour point depressors described herein are effective in very small concentrations, i.e., as little as 0.01 weight percent is often effective in noticeable lowering of pour point. It is also evident that often the pour point is depressed greatly using a concentration of 0.05 weight percent and, therefore, the preferred range of use is from about 0.01 to about 0.05 weight percent although it may be advantageous, in many cases, to employ up to about 0.5 weight percent or more of the addition agent.

The above data also demonstrate variances in amounts of pour point depressing ability of a given betaine in different distillate fuel oils. Thus, the betaine should be used in an amount sufficient or effective to depress the pour point of the distillate fuel oil.

The betaines of tri-coco amine and tri-lauryl amine prepared as above were also tested as pour point depressants in some of the fuel oils listed above and were found to be highly effective. The betaine of tri-caprylyl amine prepared above may not be as effective as the betaines having longer alkyl chains but may still be acceptable in performance as a fuel oil stabilizer at higher concentrations, e.g. up to 0.5 weight percent or higher.

In addition to depressing pour points of fuel oils, the betaines defined hereinabove are effective fuel oil stabilizers. As a demonstration of this property or use, a

fuel oil sample was prepared by adding the betaine of tri- (halogenated tallow) amine to a fuel oil in an amount sufficient to provide 0.1 weight percent of betaine. The fuel oil used was a 50-50 blend of light catalytic cycle oil and virgin gas oil. The prepared fuel oil sample and a blank consisting solely of the fuel oil without betaine added were subjected to acceleration oxidation conditions the following outlined test procedure:

Stabilization test procedure.—A 350 ml. sample is used and is suction filtered through a crucible prior to the test. Each sample to be tested is then heated to a temperature of $210^{\circ}\text{F.} \pm 0.2^{\circ}$ and is aged at that temperature for 16 hours while continuously bubbling oxygen through the sample. The sample is then permitted to cool to room temperature (about two hours) in the dark. The entire sample is then suction filtered through a tarred crucible washing the sample container and oxygen delivery tube with three rinsings (about 50 ml. each) of a previously filtered hydrocarbon solvent, e.g. n-pentane, n-hexane, n-heptane, iso-octane, or ASTM naphtha and the washings are filtered through the crucible. The crucible is then washed with the hydrocarbon solvent until the issuing filtrate is clear and the crucible is oil free. The crucible is then dried at 210°F. for one hour, cooled in a desiccator and weighed to determine the weight of filterable insolubles. After the final washing with hydrocarbon solvent, any adherent gum on the walls of the sample container and on the oxygen delivery tube are washed with a solvent mixture of equal parts of reagent grade acetone, methanol and benzene; the solvent mixture is then evaporated by the air-jet method (ASTM D-381) and the weight of the residue of adherent insolubles is determined. Total insolubles in mgs./100 ml. after aging are calculated as follows:

$$\text{Total insolubles} = \frac{A+B}{3.5}$$

where A is the weight in mgs. of filterable insolubles and B is the weight in mgs. of adherent insolubles.

The results obtained by testing the above sample containing 0.1% betaine and the blank were as follows:

	Filterable Insolubles, Mgs.	Adherent Insolubles, Mgs.	Total Insolubles, Mg./100 ml.
Sample containing betaine.....	1.6	0.3	0.54
Blank.....	11.2	2.5	3.92

The above data demonstrate the ability of the betaines in inhibiting oxidative deterioration of a distillate fuel oil and preventing ultimate formation or deposition of sludge or sediment. The betaines, when used in distillate fuel oil compositions, may also act as rust inhibitors, dispersants, anti-static agents and corrosion inhibitors.

The betaines may, for convenience, be prepared as addition agent concentrates. Accordingly, the betaine is prepared in or dissolved in a suitable organic solvent therefor in amounts greater than 10% and preferably from about 25% to about 65%. The solvent in such concentrate may conveniently be present in amounts from about 35% to about 75%. The organic solvent preferably boils within the range of from about 100°F. to about 700°F. The preferred organic solvents are hydrocarbon solvents, for example, petroleum fractions such as naphtha, heater oil, mineral spirits and the like, because of their clean burning properties. The solvent selected should, of course, be selected with regard to possible beneficial or adverse effects it may have on the ultimate fuel oil composition. Thus, the solvent should preferably burn without leaving a residue and should be non-corrosive with regard to metal, and especially ferrous metals.

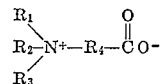
Other desirable properties are obvious from the intended use of the solvent.

All percentages given herein are percentages by weight unless otherwise indicated.

It is evident from the foregoing that I have provided distillate fuel oil compositions containing defined betaines as multi-purpose addition agents effective in very small amounts.

I claim:

1. A fuel oil composition comprising a major amount of distillate fuel oil and from about 0.001 to about 5 weight percent of a betaine having the structural formula:



wherein R_1 , R_2 and R_3 are aliphatic hydrocarbon groups containing from 10 to about 22 carbon atoms and R_4 is alkylene group containing from one to about 7 carbon atoms.

2. The fuel oil composition of claim 1 wherein said R_1 , R_2 and R_3 groups are alkyl groups having from about 16 to about 20 carbon atoms.

3. The fuel oil composition of claim 2 wherein said distillate fuel oil is a mixture of virgin and cracked petroleum distillate fuel oils.

4. The fuel oil composition of claim 3 wherein the cracked component is derived by cracking a cycle oil boiling heavier than gasoline.

5. The fuel oil composition of claim 2 wherein R_1 , R_2 and R_3 are derived from lauric acid.

6. The fuel oil composition of claim 2 wherein said distillate fuel oil boils in the range of 350° to 650°F.

7. The fuel oil composition of claim 2 wherein R_1 , R_2 and R_3 are derived from hydrogenated tallow fatty acid.

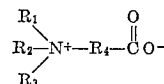
8. The fuel oil composition of claim 2 wherein R_1 , R_2 and R_3 are derived from coconut fatty acid.

9. The fuel oil composition of claim 2 wherein R_1 , R_2 and R_3 are derived from caprylic acid.

10. The fuel oil composition of claim 2 wherein said weight percent of said betaine is from about 0.01 to about 0.05 weight percent.

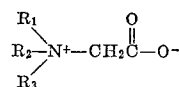
11. The fuel oil composition of claim 2 wherein R_4 is a methylene group.

12. A fuel oil composition comprising a major amount of petroleum distillate fuel oil and from about 0.01 to about 0.5 weight percent of a betaine derivative of a tertiary alkyl amine, said betaine derivative having the structural formula:



wherein R_1 , R_2 and R_3 are aliphatic hydrocarbon groups containing from 16 to about 22 carbon atoms and R_4 is an alkylene group containing from one to about 7 carbon atoms.

13. A fuel oil composition comprising a major amount of distillate fuel oil and a small amount of a betaine having the structural formula:



wherein R_1 , R_2 and R_3 are derived from higher fatty acids and contain from 16 to 20 carbon atoms, said small amount being sufficient to stabilize said distillate fuel oil against oxidative deterioration and being sufficient also to depress the pour point of said distillate fuel oil.

14. A fuel oil composition concentrate containing from

about 25% to about 65% of the betaine of claim 1 and from about 35% to about 75% of a hydrocarbon solvent boiling at a temperature in the range of from about 100° F. to about 700° F., said concentrate being capable of dilution with a distillate fuel oil to a betaine concentration in the range of from about 0.01 to about 0.5%. 5

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