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(54) **Corrosion inhibiting additive combination for turbine oils**

(57) Turbine oils of improved corrosion resistance comprise a synthetic ester base stock and additives comprising a combination of a dibasic carboxylic acid and a second component selected from N-acyl derivative of C₁₀-C₂₀ linear or branched alkyl or alkenyl mono-

carboxylic acid, alkyl or alkenyl succinic acid/anhydride ester or hemi-linear or branched ester and hydroxylated derivatives of such esters or hemi esters, and linear or branched alkyl or alkenyl substituted succinimide or amino substituted succinimide.

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Description

BACKGROUND OF THE INVENTION

5 [0001] The present invention relates to turbine oils, particularly aviation turbine oils containing additives exhibiting enhanced corrosion resistance.

RELATED ART

10 [0002] While the use of polyol ester base stocks produces turbine lubricating oils which possess outstanding thermal stability, a satisfactory level of oxidation stability and corrosion resistance can be achieved only by the use of additives.

[0003] To the end, a wide assortment of different additives have been proposed and utilized.

15 [0004] U.S. Patent 3,790,478 describes a lubricant for aviation turbines comprising hindered esters as base stock and containing alkylated diphenyl amines, and an alkylated phenyl naphthylamine as anti oxidants, a copper passivator, dispersant polymers and a neutral organic phosphate as load carrying additive. The lubricant may also contain hydrolytic stabilizers and lead corrosion inhibitors, e.g., a C₁-C₂₀ alkyl gallate, neopentyl glycol dibacate, sebacic acid or quinizarin.

20 [0005] U.S. Patent 3,790,481 is similar to U.S. Patent 3,790,478 in being directed to an aviation turbine oil and also recites the presence of lead corrosion inhibitors selected from the group consisting of C₁-C₂₀ alkyl gallate, neopentyl glycol, dibacate, sebacic acid, and quinizarin.

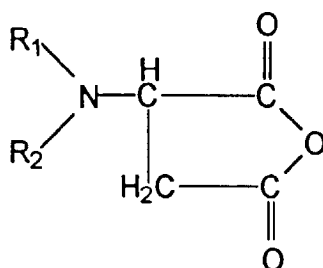
[0006] U.S. Patent 3,585,137 is directed to a synthetic ester aviation turbine oil containing an anthranilamide type metal passivator, antioxidants, phosphate esters, dimer acids. A formulation is disclosed containing p,p'dioctyldiphenylamine, phenothiazine, sebacic acid, benzotriazole, a mixture of phosphate esters and, in other examples, various other additive ingredient. In all cases, however, sebacic acid is indicated as present in the formulation.

25 [0007] U.S. Patent 3,912,640 teaches a gas turbine lubricant comprising a base stock of a blend of carboxylate ester and low viscosity mineral oil and various additives including anti oxidants such as phenothiazines or derivatives thereof and secondary diaryl amines. Methylene linked hindered bisphenol may be substituted for a portion of the phenothiazine material. Additional additives present in the examples include benzotriazole, sebacic acid, tricresyl phosphate. Benzotriazole, tolyltriazole, N,N'-disalicylidene dialkyl amines and sebacic acid are identified as well known metal deactivators. They can be present in the formulations in amounts of from about 0.005 to about 1.0 wt%. See also GB

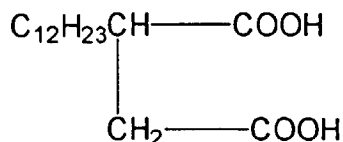
30 1,420,824. [0008] WO 95/29214 discloses a synthetic ester based lubricant for helicopter transmissions comprising a synthetic ester base stock, an antioxidant, a neutral organic phosphate, a dicarboxylic acid component, a monocarboxylic acid component, a triazole and a phosphorus containing extreme pressure additive.

35 [0009] WO 94/10270 discloses a synthetic ester based aviation turbine oil containing saturated or unsaturated dicarboxylic acids, e.g., sebacic acid, in combination with a triazole derivative and specified monocarboxylic acids or an ester thereof. The combination is reported as being particularly effective in inhibiting corrosion.

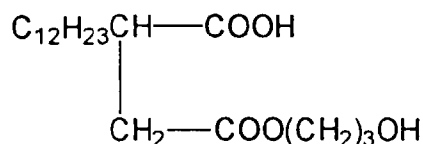
40 [0010] U.S. Patent 5,397,487/U.S. Patent 5,225,094 are directed to lubricating oils having enhanced rust inhibitor capability containing a minor synergistic rust inhibiting amount of a combination of two additives, the first being a material of the Mobilad C 603 type, reported in the '487 patent as being a succinic anhydride amine derivative of the formula:



55 where R₁ and R₂ are each independently alkyl or alkenyl of from 1 to 20 carbons, and a second material of the Lubrizol LZ 859 type, reported in 5,397,487 as being a mixture of about 74.5 wt% unreacted tetrapropenyl succinic acid of the formula

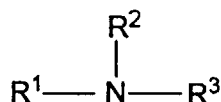


and about 25.5 wt% of a partially esterified tetrapropenyl succinic acid of the formula



[0011] The patents recite that the lubricant can be natural oil or synthetic oil based, synthetic oils including synthetic ester. The lubricants are described as useful in automotive applications, e.g., engine oils, transmission oils, aviation piston engines, turbines and the like. The lubricant can contain other additives which include dispersants, anti-wear agents, anti-oxidants, corrosion inhibitors, detergents, pour point depressants, extreme pressure additives, viscosity index improvers, friction modifiers and the like. Specifics of these other additives were not provided and there were no examples presented employing such other additives.

[0012] USP 5,599,779 is directed to a synergistic rust inhibiting composition consisting of (a) N-acylsarcosine compound, (b) dicarboxylic acid having 6 to 48 carbon atoms and (c) an amine selected from primary, secondary or tertiary amines or imidazoline compounds. The primary, secondary, or tertiary amine is described as being one selected from the group of compounds of the formula:



wherein R¹, R², R³ are independently selected from hydrogen, alkyl having up to 14 carbons, hydroxyalkyl, cycloalkyl, or polyalkyleneoxy groups.

[0013] It would be highly desirable if the corrosion inhibiting performance of synthetic ester based aviation turbine oils could be improved employing a combination of readily available additives.

DESCRIPTION OF THE INVENTION

[0014] The present invention is a synthetic ester based turbine oil of enhanced corrosion inhibiting capacity comprising a major amount of a synthetic ester oil base stock and a minor amount of a corrosion inhibiting additive selected from the group consisting of (1) N acyl derivatives of C₁₀ to C₂₀ linear or branched alkyl or alkenyl mono carboxylic acid as a first component and a dicarboxylic acid as a second component in the absence of aliphatic primary, secondary, or tertiary amines or imidazolines, (2) a combination of as a first component one or more dicarboxylic acids such as sebacic acid, azelaic acid, dioleic acid (known as dimer acids) and a second component selected from (a) linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivatives of such esters or hemi esters, and (b) linear or branched alkyl or alkenyl substituted succinimides or amino substituted succinimides, (3) longer chain dicarboxylic acids containing 36 to 54 carbons as the first component and hydrocarbyl substituted imidazolines as the second component.

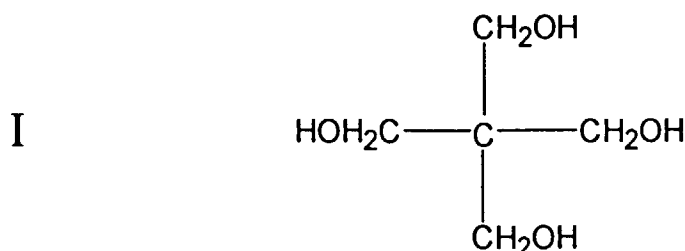
[0015] The diesters that can be used as base oils for the improved turbo oil of the present invention are formed by esterification of linear or branched C₆-C₁₅ aliphatic alcohols with one of such dibasic acids as adipic, sebacic, or azelaic acids. Examples of diesters are di-2-ethylhexyl sebacate and dioctyl adipate.

[0016] The synthetic polyol ester which can be used as the base oil is formed by the esterification of an aliphatic polyol with carboxylic acid. The aliphatic polyol contains from 4 to 15 carbon atoms and has from 2 to 8 esterifiable hydroxyl groups. Examples of polyol are trimethylolpropane, pentaerythritol, dipentaerythritol, neopentyl glycol, tripenaerythritol and mixtures thereof.

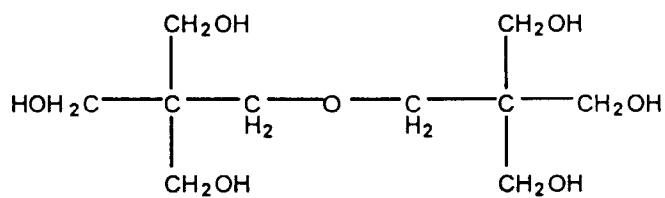
[0017] The carboxylic acid reactant used to produce the synthetic polyol ester base oil is selected from aliphatic

monocarboxylic acid or a mixture of aliphatic monocarboxylic acid and aliphatic dicarboxylic acid. The carboxylic acid contains from 4 to 12 carbon atoms and includes the straight and branched chain aliphatic acids, and mixtures of monocarboxylic acids may be used.

[0018] The preferred polyol ester base oil is one prepared from technical pentaerythritol and a mixture of C₄-C₁₂ carboxylic acids. Technical pentaerythritol is a mixture which includes about 85 to 92% monopentaerythritol and 8 to 15% dipentaerythritol. A typical commercial technical pentaerythritol contains about 88% monopentaerythritol having the formula



and about 12% of dipentaerythritol having the formula



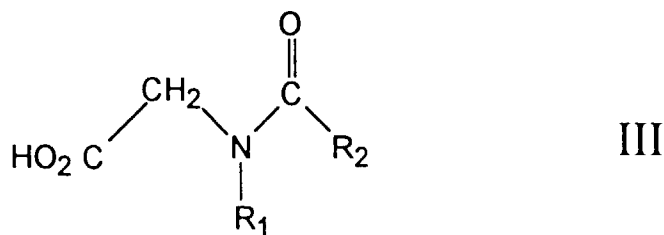
The technical pentaerythritol may also contain some tri and tetra pentaerythritol that is normally formed as by-products during the manufacture of technical pentaerythritol.

[0019] The preparation of esters from alcohols and carboxylic acids can be accomplished using conventional methods and techniques known and familiar to those skilled in the art. In general, technical pentaerythritol is heated with the desired carboxylic acid mixture optionally in the presence of a catalyst. Generally, a slight excess of acid is employed to force the reaction to completion. Water is removed during the reaction and any excess acid is then stripped from the reaction mixture. The esters of technical pentaerythritol may be used without further purification or may be further purified using conventional techniques such as distillation.

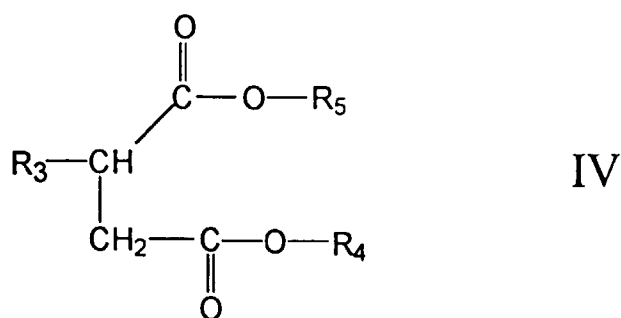
[0020] For the purposes of this specification and the following claims, the term "technical pentaerythritol ester" is understood as meaning the polyol ester base oil prepared from technical pentaerythritol and a mixture of C₄-C₁₂ carboxylic acids.

[0021] The dibasic carboxylic acid comprising one component of the combination additive added to the base stock to enhance the corrosion inhibiting performance of the lubricant is a C₈ to C₄₀ total carbon number dicarboxylic acid or mixture of such acids, preferably a C₉ to C₃₆ dicarboxylic acid or mixture thereof. The dicarboxylic acids can be any n-alkyl, branched alkyl, aryl, or alkyl substituted aryl dicarboxylic acid or mixture thereof having a total number of carbons within the above recited ranges. Preferred dicarboxylic acids are selected from the group consisting of the commercially available di-oleic acids known as "dimer acids", sebacic acid, azelaic acid and mixtures thereof. These acids are added to the turbo oil formulations in an amount in the range of 100 to 1000 ppm, preferably 200 to 500 ppm, more preferably 200 to 400 ppm.

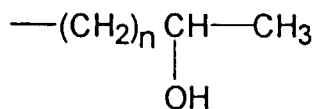
[0022] The second component of the corrosion inhibiting additive combination is selected from the group consisting of (a) N-acyl derivatives of C₁₀-C₂₀ linear or branched chain alkyl or alkenyl mono carboxylic acids, said material having the structural formula:



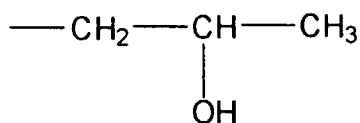
10 where R_1 is linear or branched C_1 - C_6 alkyl and R_2 is C_{10} - C_{20} linear or branched alkyl or alkenyl group; preferably R_1 is CH_3 and R_2 is oleic (a commercial material called Sarkosyl O, available from Ciba Geigy Corporation, which is the N-acyl derivative of the amine acid sarcosine is an example of one such suitable material); (b) linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivatives of such esters or hemi-ester, said material having the structural formula:



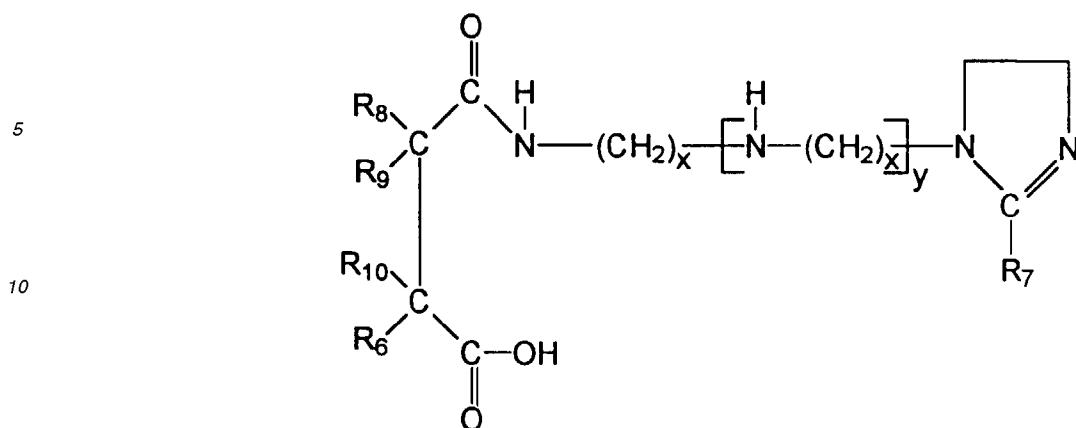
30 wherein R_3 is a C_8 - C_{16} linear or branched alkyl or alkenyl, R_4 and R_5 are the same or different and are hydrogen, C_1 - C_4 alkyl or C_2 - C_4 alkenyl or



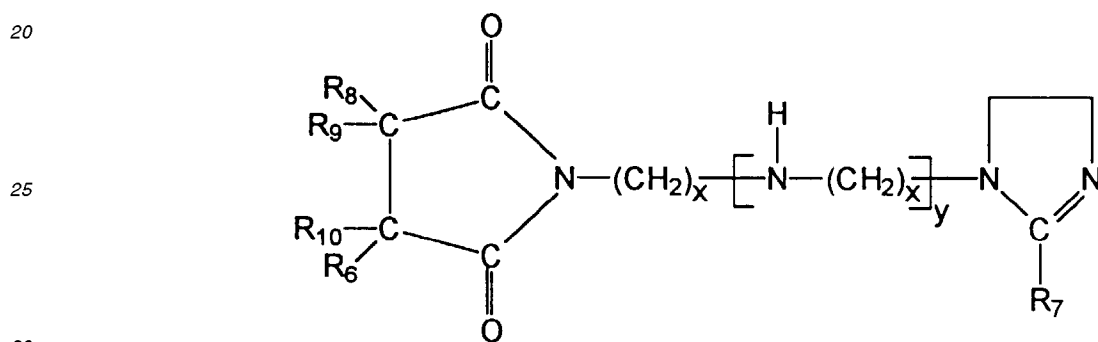
40 where n can be an integer from zero to 5, preferably R_3 is C_{10-12} branched alkenyl, R_4 is H and R_5 is



50 and n and m are each 1, (commercial materials such as Lubrizol 859 from the Lubrizol Corporation or Parabar 302 from Exxon Chemical Company being representative of such materials) and (c) reaction product of linear or branched alkyl or alkenyl substituted succinic anhydride with substituted aminoimidazolines resulting in what are believed to be linear or branched alkyl or alkenyl substituted succinimide or amine substituted succinimides, which are believed to be of the structural formula:



and

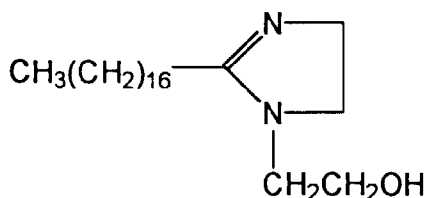


and mixtures thereof, wherein R_6 , R_8 , R_9 and R_{10} are the same or different and are H or a C_1 - C_{16} , linear or branched alkyl or alkenyl wherein at least one of R_6 , R_8 , R_9 or R_{10} is hydrocarbyl, preferably at least one of R_6 , R_8 , R_9 or R_{10} is a C_{10} - C_{14} hydrocarbyl, more preferably a C_{12} hydrocarbyl, e.g., tetra propenyl, and R_7 is C_8 - C_{20} , preferably C_{16} - C_{18} , linear or branched alkyl or alkenyl and x is 2 to 10, preferably 2 and y is 0 or 1, preferably 0. Commercially available material known as Mobilad C-603 from Mobil Chemical Company and Hitec H 536 from Ethyl are believed to be examples of such materials.

[0023] This second component is added to the turbo oil formulation in an amount in the range 100 to 1000 ppm, preferably 300 to 1000 ppm, more preferably 300 to 500 ppm.

[0024] When the combination which is employed is the combination of dibasic carboxylic acid and the N acyl derivative of C_{10} - C_{20} linear or branched chain alkyl or alkenyl monocarboxylic acid, the combination is employed in the turbine oil formulation in the absence of any aliphatic primary, secondary, or tertiary amines or imidazolines.

[0025] In an alternate embodiment, longer chain dicarboxylic acids such as dimers and trimers of C_{18} dicarboxylic acids, e.g., C_{36} - C_{54} poly carboxylic acids, exemplified by EMPOL 1022 can be used in combination with hydrocarbyl substituted imidazole, such as 2-(heptadecenyl)-4,5-dihydro-1H-imidazole-1-ethanol, represented by the formula



and available commercially from Ciba Geigy as Amine O. In this embodiment, the acid is employed in an amount in the range of about 100 to 300 ppm and the imidazole is employed in an amount in the range of about 100 to 500 ppm.

[0026] The turbine oil of the present invention may also contain any of the other, typical additives which are usually or preferably present in such fully formulated products. Thus, a fully formulated turbine oil may contain one or more of

the following classes of additives: antioxidants, antiwear agents, extreme pressure additives, antifoamants, detergents, hydrolytic stabilizers, metal deactivators, other rust inhibitors, etc. Total amounts of such other additives can be in the range 0.5 to 15 wt% preferably 2 to 10 wt%, most preferably 3 to 8 wt%.

[0027] Antioxidants which can be used include aryl amines, e.g. phenyl-naphthylamines and dialkyl diphenyl amines and mixtures thereof, hindered phenols, phenothiazines, and their derivatives.

[0028] The antioxidants are typically used in an amount in the range 1 to 5 wt%.

[0029] Antiwear/extreme pressure additives include hydrocarbyl phosphate esters, particularly trihydrocarbyl phosphate esters in which the hydrocarbyl radical is an aryl or alkaryl radical or mixture thereof. Particular antiwear/extreme pressure additives include tricresyl phosphate, triaryl phosphate and mixtures thereof. Other or additional anti wear/extreme pressure additives may also be used.

[0030] The antiwear/extreme pressure additives are typically used in an amount in the range 0 to 4 wt%, preferably 1 to 3 wt%.

[0031] Industry standard corrosive inhibitors may also be included in the turbo oil. Such known corrosion inhibitors include the various triazols, for example, tolyltriazol, 1,2,4 benzotriazol, 1,2,3 benzotriazol, carboxy benzotriazole, alkylated benzotriazol.

[0032] The standard corrosion inhibitor additive can be used in an amount in the range 0.02 to .5 wt%, preferably 0.05 to 0.25 wt%.

[0033] Other rust inhibitors common to the industry include the various hydrocarbyl amine phosphates and/or amine phosphates.

[0034] As previously indicated, other additives can also be employed including hydrolytic stabilizers pour point depressants, anti foaming agents, viscosity and viscosity index improver, etc.

[0035] The invention is further described by reference to the following non-limiting examples and comparative examples.

[0036] Base Formulation 1 is a Tech-PE polyol ester additized with tricresylphosphate, arylamine antioxidants, benzotriazole derivative copper deactivator, an amine phosphate extreme pressure agent. To this base formulation individual corrosion inhibitors were added and D665A rust results were obtained as shown in Table 1. Values reported are percent rust in the D665A rust test. A passing result requires that no rust be present.

[0037] Additive combination of sebacic acid with alternatively Hitec 536, Mobilad-C603, Parabar 302 or Sarkosyl-0 are reported in Table 2. At lower concentrations the additive combinations show improvement over the base case in Table 1. With the combination of 200 ppm sebacic acid and 300 ppm of the other corrosion inhibitor, passing results are obtained which are not achievable via a single corrosion inhibitor. It is desirable to limit the concentration of dicarboxylic acid component because higher levels of acidity can catalyze polyol ester hydrolysis. By using the combination of corrosion inhibitors total acidity is reduced while anti-corrosion performance equal to or exceeding that achieved with high concentrations of acid are obtained.

[0038] Table 3 shows additive combinations in Base Formulation 2. Base Formulation 2 differs from Base Formulation 1 only in that the antioxidant treat rate is somewhat higher. Again combination of corrosion inhibitors at certain concentrations are more effective than either inhibitor used alone.

[0039] Table 4 gives the base line results for single corrosion inhibitors in base Formulation 3. Base Formulation 3 is similar to Base Formulation 2 except that an alternate antioxidant is substituted at the same treat rate. Several observations can be made. Only Amine-0 is capable of yielding passing results when used alone. Sebacic acid is much more efficient alone than the longer chain dicarboxylic acid Empol 1022, a mixture of dimers and trimers of C₁₈ unsaturated dicarboxylic fatty acids.

[0040] Table 5 provides results for Base Formulation 3 with a combination of corrosion inhibitors. Passing results are achieved for 400 ppm sebacic acid with 1000 ppm of the second corrosion inhibitor.

[0041] Table 6 reports the results with Empol 1022 and Amine O showing that for the apparently severe Base Formulation 3 the combination achieves passing results at concentration of as low as 100 ppm of each of Empol 1022 and Amine O.

[0042] While Amine O can be an effective corrosion inhibitor when used alone, in combination with other acidic components typically present in formulated turbine oils, incompatibilities can be observed, especially at higher concentrations. For this reason, therefore, Amine O is not a preferred corrosion inhibitor for formulated turbine oils.

TABLE 1

BASE FORMULATION #1 PLUS ONE CORROSION INHIBITOR					
AVERAGE	----- CONCENTRATION, ppm -----				
D665 - % Rust	Sebacic Acid	Hitec 536	Mobilad-C603	PAR-302	SAR-0
73	---				

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TABLE 1 (continued)

BASE FORMULATION #1 PLUS ONE CORROSION INHIBITOR					
AVERAGE	----- CONCENTRATION, ppm -----				
D665 - % Rust	Sebacic Acid	Hitec 536	Mobilad-C603	PAR-302	SAR-0
50	50				
16	100				
18	200				
2	500				
90		50			
65			50		
45				50	
75					50
80		100			
80			100		
75				100	
80					100
80		200			
70			200		
45				200	
60					200
20		500			
10			500		
25				500	
30					500

TABLE 2

BASE FORMULATION #1 PLUS COMBINATION OF CORROSION INHIBITORS					
AVERAGE	----- CONCENTRATION, ppm -----				
D665 - % Rust	Sebacic Acid	Hitec 536	Mobilad-C603	PAR-302	SAR-0
60	50	50			
90	50		50		
70	50			50	
40	50				50
50	100	100			
30	100		100		
15	100			100	
50	100				100
5	200	100			50
5	200	200			
1	200	300			

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TABLE 2 (continued)

BASE FORMULATION #1 PLUS COMBINATION OF CORROSION INHIBITORS					
AVERAGE	----- CONCENTRATION, ppm -----				
D665 - % Rust	Sebacic Acid	Hitec 536	Mobilad-C603	PAR-302	SAR-0
Pass	200		300		
Pass	200			300	
3	200				300
7	300	100			
5	300	200			
3	300	300			
13	100	200			
10	100	300			
5	200	200			
35	100	100			
12	150	150			

TABLE 3

BASE FORMULATION #2 PLUS COMBINATION OF CORROSION INHIBITORS			
AVERAGE	----- CONCENTRATION, ppm -----		
D665 - % Rust	Sebacic Acid	Hitec 536	Mobilad-C603
5	50	100	
6	50	200	
Pass	50	300	
Pass	50	500	
Pass	400	300	
Pass	400	500	
5	200		300
1	400		300

TABLE 4

BASE FORMULATION #3 PLUS ONE CORROSION INHIBITOR						
AVERAGE	----- CONCENTRATION, ppm -----					
D665 - % Rust	Sebacic Acid	Empol 1022	H-536	Mobilad C603	SAR-0	Amine-0
50	(None)					
60		100				
65		200				
50		500				
45		1000				
15	100					
3	200					

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TABLE 4 (continued)

BASE FORMULATION #3 PLUS ONE CORROSION INHIBITOR						
AVERAGE	----- CONCENTRATION, ppm -----					
D665 - % Rust	Sebacic Acid	Empol 1022	H-536	Mobilad C603	SAR-0	Amine-0
1	500					
1	1000					
40			300			
10			500			
35				300		
7				500		
40					300	
45					500	
Pass						300
Pass						500
1			1000			
1				1000		
30					1000	
Pass						1000

TABLE 5

BASE FORMULATION #3 PLUS COMBINATION OF CORROSION INHIBITORS					
AVERAGE	----- CONCENTRATION, ppm -----				
D65 - % Rust	Sebacic Acid	H-536	Mobilad C603	PAR-302	SAR-0
30	200	100			
1	200	500			
1	400	500			
7	200				300
2	400				300
1	400				100
5	200				500
1	400				500
10	200		100		
2	200		300		
1	200		500		
5	400		100		
2	400		300		
1	400		500		
15	200			100	
1	200			300	
5	200			500	

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TABLE 5 (continued)

BASE FORMULATION #3 PLUS COMBINATION OF CORROSION INHIBITORS					
AVERAGE	----- CONCENTRATION, ppm -----				
D65 - % Rust	Sebacic Acid	H-536	Mobilad C603	PAR-302	SAR-0
1	400			100	
1	400			300	
1	400			500	
10	200	300			
7	400	500			
1	600	500			

TABLE 5

BASE FORMULATION #3 PLUS COMBINATION OF CORROSION INHIBITORS (continued)					
AVERAGE	----- CONCENTRATION, ppm -----				
D65 - % Rust	Sebacic Acid	H-536	Mobilad C603	PAR-302	SAR-0
B/L	600	1000			
Pass	400	1000			
1	600		500		
Pass	600		1000		
3	400		500		
Pass	400		1000		
B/L	600				500
1	600				1000
3	400				500
B/L	400				1000

TABLE 6

BASE FORMULATION #3 PLUS COMBINATION OF CORROSION INHIBITORS					
AVERAGE	----- CONCENTRATION, ppm -----				
D665 - % Rust	Empol 1022	H-536	Mobilad C603	SAR-0	Amine-0
75	200	300			
40	200		300		
60	200			300	
1	200				300
40	200	500			
25	200		500		
55	200			500	
Pass	200				500
Pass	100				100
Pass	200				300

TABLE 6 (continued)

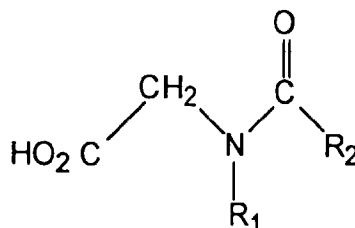
BASE FORMULATION #3 PLUS COMBINATION OF CORROSION INHIBITORS					
AVERAGE	----- CONCENTRATION, ppm -----				
D665 - % Rust	Empol 1022	H-536	Mobilad C603	SAR-0	Amine-0
Pass	200				500
1	400				100
Pass	400				300

[0043] When considering the data in these Tables, one needs to bear several factors in mind. Rust tests are highly variable. Thus, for those skilled in the art, it is the trend in rust results with increasing additive concentration which is most important. When all of the data are examined, it is clear that none of the additives alone (except for Amine O, which has its own unique drawbacks associated with it), are able to provide passing results. Combinations of rust inhibitors, however, are able to achieve passing results at concentration levels which do not have harmful secondary effects.

[0044] Even when the test results are not a pass, the combination of rust inhibitors provides an improved rust rating than either additive alone. This trend clearly indicates a synergistic interaction of the combined corrosion inhibitors.

Claims

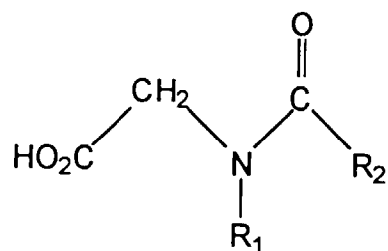
1. A turbine oil composition exhibiting enhanced corrosion inhibiting capacity comprising a major amount of a synthetic ester oil base stock and a minor amount of corrosion inhibiting additive, said corrosion inhibiting additive being selected from the group consisting of (1) as a first component, one or more C₈-C₄₀ dicarboxylic acids in combination with, as a second component, an N-acyl derivative of C₁₀-C₂₀ linear or branched alkyl or alkenyl monocarboxylic acid, said N-acyl derivative being of the formula



wherein R₁ is linear or branched C₁-C₆ alkyl and R₂ is C₁₀-C₂₀ linear or branched alkyl or alkenyl group, in the absence of aliphatic primary, secondary, tertiary amines or imidazolines, or (2) a combination of as a first component one or more C₈-C₄₀ dicarboxylic acids and a second component selected from (a) linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivative of such esters or hemi esters and (b) linear or branched alkyl or alkenyl substituted succinimides or amino-substituted succinimides, or (3) larger chain dicarboxylic acid containing 36 to 54 carbons as the first component present in an amount in the range of 100 to 300 ppm, and hydrocarbyl substituted imidazolines as the second component present in an amount in the range 100 to 500 ppm.

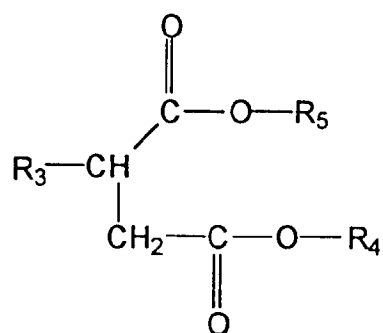
2. The turbine oil composition of claim 1 wherein the dicarboxylic acid employed in combination with the N-acyl derivative component or linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivative of such esters or hemi esters or linear or branched alkyl or alkenyl substituted succinimides or amine substituted succinimides is added to the turbine oil composition in an amount in the range of 100 to 1000 ppm.
3. The turbine oil composition of claim 2 wherein the dicarboxylic acid is selected from dioleic acid, sebacic acid, azelaic acid and mixture thereof.
4. The turbine oil composition of claim 1, 2, or 3 wherein

(a) the N-acyl derivative is of the formula:

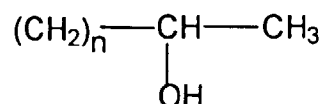


wherein R_1 is CH_3 and R_2 is oleic;

(b) the linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivative of such ester or hemi ester is of the formula:

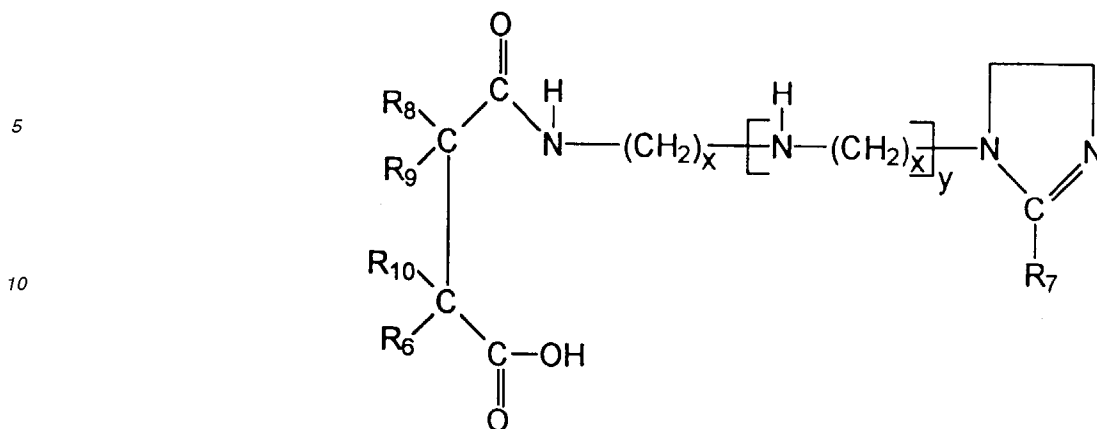


where R_3 is a C_8 - C_{16} linear or branched alkyl or alkenyl, R_4 and R_5 are different and are hydrogen, C_1 - C_4 alkyl, C_2 - C_4 alkenyl or:

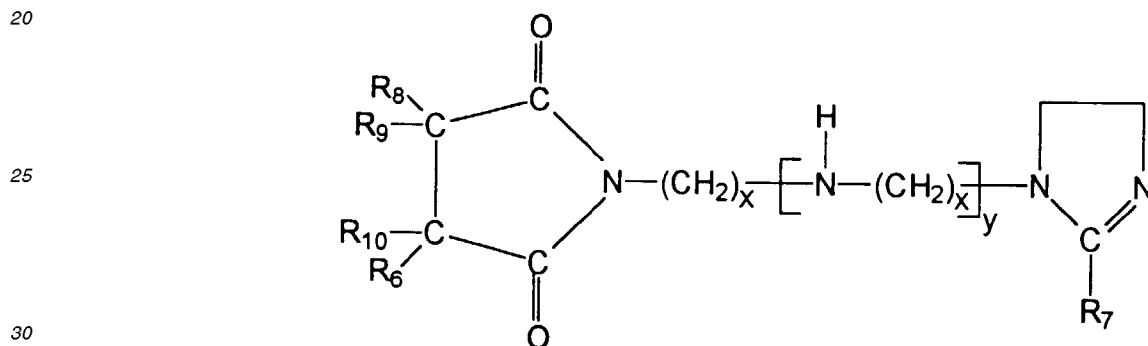


where n can be an integer from zero to five;

(c) the linear or branched alkyl or alkenyl substituted succinimide or amine substituted succinimide is of the formula:

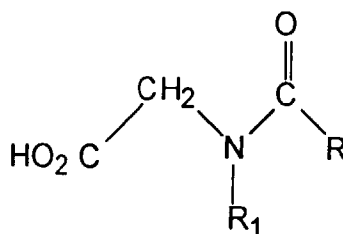


or



and mixture hereof, wherein R₆, R₈, R₉, and R₁₀ are the same or different and are H or a C₁-C₁₆ linear a branched alkyl or alkenyl wherein at least one of R₆, R₈, R₉, and R₁₀ is hydrocarbyl, and R₇ is C₈-C₂₀ linear or branched alkyl or alkenyl, x is 2 to 10 and y is 0 or 1, said material being present in the turbine oil composition in an amount in the range of 100 to 1000 ppm.

5. A method for enhancing the corrosion inhibiting capacity of turbine oil composition comprising adding to a synthetic ester oil base stock a minor amount of corrosion inhibiting additive wherein said corrosion inhibiting additive is selected from the group consisting of (1) as a first component, one or more C₈-C₄₀ dicarboxylic acid in combination with, as a second component, an N-acyl, derivative of C₁₀-C₂₀ linear or branched alkyl or alkenyl monocarboxylic acid, said N-acyl derivative being of the formula



wherein R₁ is linear or branched C₁-C₆ alkyl and R₂ is C₁₀-C₂₀ linear or branched alkyl or alkenyl group, in the absence of aliphatic primary, secondary, or tertiary amines or imidazolines, or (2) a combination of as a first component one or more C₈-C₄₀ dicarboxylic acid and a second component selected from (a) linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivative of such ester or hemi ester and (b) linear or branched alkyl or alkenyl substituted succinimides or aminosubstituted succinimides, or (3) longer chain dicarboxylic acids containing 36 to 54 carbons as the first component present in an amount in the range of

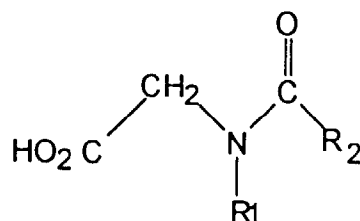
100 to 300 ppm and hydrocarbyl substituted imidazolines as the second component present in an amount in the range of 100 to 500 ppm.

- 5 6. The method of claim 5 wherein the dicarboxylic acid employed in combination with the N-acyl derivative compound or linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivative of such esters or hemi esters or linear or branched alkyl or alkenyl substituted succinimides or amino substituted succinimides is added to the turbine oil composition in an amount in the range of 100 to 1000 ppm.
- 10 7. The method of claim 6 wherein the dicarboxylic acid is selected from dioleic acid, sebacic acid, azelaic acid and mixtures thereof.
- 15 8. The method of claim 5, 6, or 7 wherein

(a) the N-acyl derivative is of the formula:

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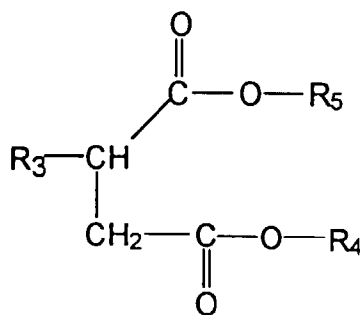
wherein R₁ is CH₃ and R₂ is oleic;

(b) the linear or branched alkyl or alkenyl succinic acid/anhydride ester or hemi ester or hydroxylated derivatives of such ester or hemi ester is of the formula:

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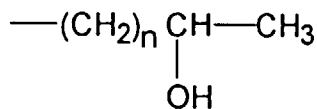
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wherein R₃ is a C₈-C₁₆ linear or branched alkyl or alkenyl, R₄ and R₅ are different and are hydrogen, C₁-C₄ alkyl, C₂-C₄ alkenyl or:

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where n can be an integer from zero to five;

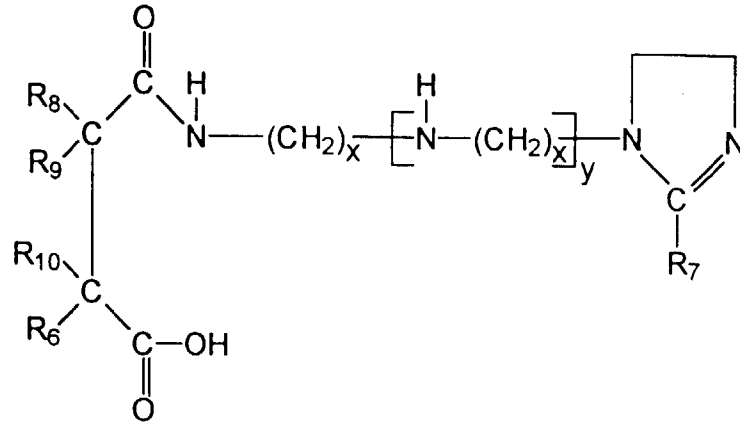
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(c) the linear or branched alkyl or alkenyl substituted succinimide or amine substituted succinimide is of the formula:

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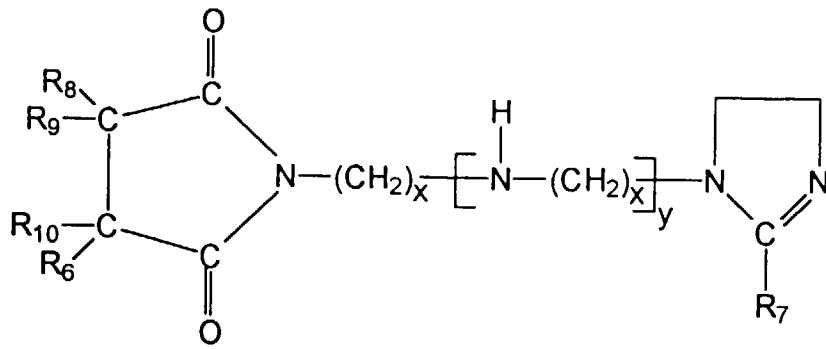


or

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and mixtures thereof, wherein R_6 , R_8 , R_9 , and R_{10} are the same or different and are H or a C_1 - C_{16} linear or branched alkyl or alkenyl wherein at least one of R_6 , R_8 , R_9 , and R_{10} is hydrocarbyl, and R_7 is C_8 - C_{20} linear or branched alkyl or alkenyl, x is 2 to 10 and y is 0 or 1, said materials being present in turbine oil composition in an amount in the range of 100 to 1000 ppm.



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 6777

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP 0 359 071 A (BP CHEM INT LTD) 21 March 1990 * example 10 * ---	1,2,4-6, 8	C10M169/04 //(C10M169/04, 105:38,129:42, 129:72,129:93, 133:12,133:16, 133:44,133:46, 137:04,137:08)
X	US 4 101 429 A (BIRKE AUGUST H) 18 July 1978 * examples 1,2,6-13; table III * ---	1-3,5-7	
X	US 2 794 782 A (CUNNINGHAM ET AL) 4 June 1957 * column 13; examples VIII,X * ---	1-3,5-7	
X,D	US 5 397 487 A (PILLON LILIANA Z ET AL) 14 March 1995 * column 1, line 53 - column 2, line 53; examples 2,4 * ---	1,2,4-6, 8	
A,D	US 3 912 640 A (ANZENBERGER SR JOSEPH F) 14 October 1975 * the whole document * ---	1-8	
A,D	US 5 599 779 A (KAROL THOMAS J ET AL) 4 February 1997 ---		
A	US 3 282 836 A (MILLER JAMES R ET AL) 1 November 1966 * column 2, line 46; examples II,V,VII; table 1 * -----		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			C10M
Place of search	Date of completion of the search	Examiner	
MUNICH	18 December 1998	Kazemi, P	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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18-12-1998

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82