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(71) Applicant: **BP Corporation North America Inc.
Warrenville, IL 60555 (US)**

(72) Inventors:

- **Godici, Patrick E.
Naperville Illinois 60565 (US)**

- **Kim, Jeenok T.**

Faifax Virginia 22033 (US)

- **Krevalis, Martin A.**

Houston Texas 77059 (US)

- **Pafford, Bernie J.**

Berkeley Heights, NJ 07922 (US)

- **Aldrich, Haven S.**

Baton Rouge Louisiana 70808 (US)

- **Schlosberg, Richard H.**

Bridgewater, NJ 08807 (US)

(74) Representative: **Ritter, Stephen David et al**

Mathys & Squire

100 Gray's Inn Road

London WC1X 8AL (GB)

(54) **High temperature stability polyol ester lubricant composition containing short chain acids and method for making the same**

(57) This invention generally relates to a high temperature stable polyol ester lubricant composition containing short chain carboxylic esters and a process for making the same. The polyol ester lubricant compositions are preferably formed from pentaerythritol and a mixture of C₂ to C₁₀ carboxylic acids in which (1) from 95 to 80 mole%, based on total acids, are C₅ to C₁₀ carboxylic acid, and (2) from 5 to 20 mole%, based on total acids, are at least one C₂ to C₄ carboxylic acid. The poly-

ol ester lubricant compositions of the present invention, specifically those using at least one C₂ to C₄ carboxylic acid, are useful as base stock for high temperature application such as Aviation Turbine Oils and exhibit enhanced anti-deposition and oxidation stability compared with the base polyol ester compositions while maintaining a good viscosity index.

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Description**FIELD OF THE INVENTION**

[0001] The present invention relates, generally, to a high temperature stable lubricant polyol ester composition containing short chain acids and a process of making the same. More particularly, this invention relates to ester derivatives of pentaerythritol and a mixture of aliphatic carboxylic acids containing at least one C₂ to C₄ chain acids.

BACKGROUND OF THE INVENTION

[0002] Organic compositions, such as mineral oils and lubricating compositions, are subject to deterioration by oxidation and in particular are subject to such deterioration at high temperatures in the presence of air. This deterioration often leads to buildup of insoluble deposits that can foul engine parts, deteriorate performance, and increase maintenance. This is particularly the case for lubricating oils used in jet aircraft where wide temperature ranges and extreme operating conditions are likely to be encountered. Proper lubricating of aircraft gas turbines, for example, requires ability to function at bulk oil temperatures from as low as minus 60°C to as high as 230°-280°C. Such an extreme temperature range places unique demands on the characteristics of the lubricant. Aviation jet turbine lubricants require superior thermal and oxidative stability, good viscosity-temperature characteristics (high VI), low volatility and a low pour point. Organic hydrocarbon-based oils are typically not robust enough to satisfy these requirements. Thus, aviation applications have relied on the superior performance characteristics of synthetic ester lubricants.

[0003] Ester base lubricating oil compositions prepared from polyols such as neopentyl glycol, trimethylolpropane or pentaerythritol, and a mixture of fatty acids and containing selected additive combinations are well known. These lubricants are functional over a wide temperature range and exhibit good thermal and oxidative stability. An ester base lubricant composition that will operate under more severe conditions, however, is a major goal of lubricant manufacturers. This invention addresses that continuing need by providing a polyol ester basestock composition containing short chain acids having higher temperature stability. These polyol esters exhibit enhanced anti-deposition and oxidation stability over polyol ester to which short chain acids were not added.

[0004] Many prior art references generally discuss the use of short chain acids to form synthetic ester base lubricants. However, none of the references address the need for higher thermal and oxidative stability in certain esters used in aviation turbo oils ("ATO"s) and the benefits provided by the use of at least one C₂ to C₄ chain acids.

[0005] U.S. Patent No. 3,681,440 to Monsanto Company discloses the use of C₁ to C₁₂ aromatic or aliphatic carboxylic acids to provide new esters of tetrahydroxy dineoalkyl ethers and their use as lubricant basestocks.

[0006] U.S. Patent No. 3,756,952 to Texaco Inc. discloses a synthetic lubricating oil composition comprising a major portion of aliphatic ester base oil formed by the reaction of pentaerythritol or trimethylolpropane and an organic monocarboxylic acid having 2 to 18 carbon atoms per molecule containing a certain weight percent of ammonium thiocyanate.

[0007] U.K. Patent No. 1,180,388 to The British Petroleum Company discloses an ester basestock consisting of a synthetic lubricant for aero gas turbines prepared by reacting together under esterification conditions an aliphatic mono- and/or polyhydric alcohol having 5-15 carbon atoms per molecule and an aliphatic mono- and/or polycarboxylic acid having 2-14 carbon atoms per molecule.

[0008] U.K. Patent No. 1,402,697 to Texaco Development Corporation discloses a synthetic lubricating oil composition comprising a major portion of an aliphatic ester base oil having lubricating properties formed from the reaction of pentaerythritol, a polypentaerythritol or trimethylolpropane and an organic monocarboxylic acid having from 2 to 18 carbon atoms and a critically balanced blend of additives.

[0009] U.S. Patent No. 5,503,761 is directed to a synthetic ester base stock having reduced deposit formation. The base stock is the esterified product of technical pentaerythritol and a mixture of C₅ to C₁₀ carboxylic acids. Notwithstanding the benefits of such base stock, there remains a need for synthetic ester base stocks that have even further reduced tendencies to form deposits under conditions of use.

SUMMARY OF THE INVENTION

[0010] It has now been discovered that polyol ester lubricant compositions formed from polyols and a mixture of C₂ to C₁₀ aliphatic carboxylic acids in which the mixture comprises (1) 95 to 80 mole%, based on total acids of C₅ to C₁₀ carboxylic acid, and (2) from 5 to 20 mole%, based on total acids, of at least one C₂ to C₄ carboxylic acid exhibit enhanced thermal and oxidative stability compared to polyol ester lubricant compositions that do not contain at least one C₂ to C₄ carboxylic acid.

[0011] The polyol ester lubricant compositions of the present invention, specifically those using least one C₂ to C₄ carboxylic acid, are useful as base stock for high temperature application such as ATOS and exhibit enhanced anti-deposition and oxidation stability compared with the base polyol ester compositions while maintaining a good viscosity

index.

[0012] The polyol ester base stock of the present invention may be blended with additive packages to provide a turbo oil composition with improved cleanliness.

DETAILED DESCRIPTION OF THE INVENTION

[0013] In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular acids, esterification processes, testing procedures, etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. Detailed descriptions of well-known processes, acids, and methods for manufacturing the same are omitted so as not to obscure the description of the present invention.

[0014] The polyol ester lubricant compositions of the present invention, comprise: a polyol ester, wherein the carboxylic acid portion of the ester, comprises: (a) short chain carboxylic acids and (b) conventional acids, and the alcohol portion of the ester, comprises: an aliphatic polyol. Polyol esters from a mixture of acids ester, as used herein, is intended to mean a polyol ester having at least two different carboxylic acids (e.g., C₂ to C₄ short chain carboxylic acid and C₅ to C₁₀ conventional carboxylic acid) attached to the same polyol molecule. The amount of each individual carboxylic acid present during esterification will determine how many of the polyol molecules present in the esterification process will form esters having short chain acids. One of ordinary skill in the art will recognize that during an esterification process to form polyol esters having short chain acids, a portion of polyol esters without short chain acids will likely be formed. Thus, the present polyol ester compositions are intended to cover compositions comprising a mixture of short chain acids and conventional C₅ to C₁₀ acids mixed polyol esters having the defined mole percentages of short chain carboxylic acids.

[0015] Preferably, the carboxylic acid portion of the ester comprises: 5, 10, 15, to 20 mole% of the short chain carboxylic acid and the remaining portion being the conventional acids. Preferably, the ester comprises 10 to 15 mole% of the short chain acids. One of ordinary skill in the art would recognize that the amount of short chain carboxylic acid used would depend on the viscometric specifications required for the desired application.

[0016] Conventional acids, as used herein, are carboxylic acids typically used in lubricating compositions. Preferably, these are C₅ to C₁₀ aliphatic acids. The C₅ to C₁₀ carboxylic acids which are used to prepare the synthetic ester lubricant base stock are aliphatic carboxylic acids having minimal number of reactive hydrogens while meeting MIL-L-23699 specifications on the low temperature flow and elastomer compatibility. The aliphatic acids are monocarboxylic acids or a mixture of mono- and di-carboxylic acids and are linear or branched. Preferably, the aliphatic acids are monocarboxylic acids. Even more preferably, the acids are a mixture of C₅, i-C₉, and linear C₇₋₁₀ acids. It is noted that C₇₋₁₀ is intended to represent a mixture of C₇, C₈, C₉, and C₁₀ acids. Preferably, this mixture comprises only linear acids. Even more preferably, this mixture comprises linear C₇, linear C₈, and linear C₁₀. Still more preferably, the acids are a mixture of a C₅, i-C₉, and linear C₇ (e.g., n-heptanoic acid), C₈ (e.g., n-octanoic acid), and C₁₀ (e.g., n-decanoic acid) acids. A preferred C₅ acid is valeric acid. A preferred i-C₉ acid is 3,5,5-trimethylhexanoic acid.

[0017] The carboxylic acid portion of the polyol ester preferably, comprises: 5-20 mole% of the short chain acid, 30-70 mole% C₅, 0-15 mole% i-C₉, and 10-60 mole% C₇₋₁₀. More preferably, the carboxylic acid portion of the polyol ester, comprises: 10-20 mole% of the short chain acid, 30-60% C₅, 0-10 mole% i-C₉, and 10-55 mole% of linear C₇₋₁₀. Even more preferably, the carboxylic acid portion of the mixed polyol ester, comprises: 10-15 mole% of the short chain acid, 30-60 mole% C₅, 0-10 mole% i-C₉, and 10-55 mole% of a mixture of n-heptanoic acid, n-octanoic acid, and n-decanoic acid. Still more preferably, the carboxylic acid portion of the polyol ester, comprises: 10-15 mole% of the short chain acid, 30-60 mole% of valeric acid, 0-10 mole% of 3,5,5-trimethylhexanoic acid, and 10-55 mole% of a mixture of n-heptanoic acid, n-octanoic acid, and n-decanoic acid. The preferred distribution of C₅ to C₁₀ carboxylic acids is described in U.S. Patent No. 5,503,761.

[0018] The alcohol used to form the ester portion of the polyol ester lubricant composition of the present invention may be any one or more of neopentyl glycol, trimethylolpropane, pentaerythritol, dipentaerythritol, tripentaerythritol or tetrapentaerythritol. The preferred polyol is pentaerythritol or Technical pentaerythritol (TechPE). Technical pentaerythritol is a mixture that includes about 85 to 92 wt% monopentaerythritol and 8 to 15 wt% dipentaerythritol. A typical commercial technical pentaerythritol contains about 88 wt% monopentaerythritol and about 12 wt% of dipentaerythritol. The technical pentaerythritol may also contain some tri and tetra pentaerythritol which are typically formed as by-products during the production of technical pentaerythritol.

[0019] The polyol ester of the present invention can be prepared by esterifying the short chain acid(s) and conventional acid(s) with the aliphatic polyol. Thus, a process of making the present composition, comprises: (a) contacting 5-20 mole% of a short chain carboxylic acid and 95-80 mole% of a C₅₋₂₀ aliphatic carboxylic acid; and, (b) esterifying the resulting mixture with an aliphatic polyol. Alternatively, a process of making the present composition, comprises: (a) esterifying a short chain carboxylic acid with an aliphatic polyol; and, (b) contacting the esterification mixture with a C₅₋₂₀ aliphatic carboxylic acid. Alternatively, a process of making the present composition comprises: (a) esterifying

a C₅₋₂₀ aliphatic carboxylic acid with an aliphatic polyol; and, (b) contacting the esterification mixture with a short chain carboxylic acid. In both of the alternative processes, the second component can be added during esterification of the first component or after esterification of the first component. As one of ordinary skill in the art recognizes, different acids esterify at different rates. Thus, the selection of the method of esterification may depend on the activity of the chosen short chain carboxylic acid(s), conventional acid(s) and the aliphatic polyol. In addition, the choice of when to add the second component will also be based on the reactivity of the first component. Thus, one could choose to completely form an ester from either short chain acid(s) or conventional acid(s) with the polyol, and then the mixed polyol ester could be formed. Alternatively, an ester of short chains acid(s) could be partially formed at the time the second component is introduced. Preferably, the addition of the acids to the polyol is staged with the lower boiling point acid being added first. Regardless of the chosen route, the desired outcome is a polyol ester, wherein the carboxylic acid portion of the ester, comprises: (a) 5-20 mole% of a short chain carboxylic acid and (b) 95-80 mole% of conventional acids, and the alcohol portion of the ester, comprises: an aliphatic polyol.

[0020] The esterification reaction can be run using conventional methods and techniques known to those skilled in the art. For example, technical pentaerythritol can be heated with the desired short chain and conventional acid mixture, optionally in the presence of a catalyst. Generally, a slight excess of the acids 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. The process may be carried out continuously or discontinuously.

[0021] The lubricant composition of the present invention preferably has at least one of the following uses: crankcase engine oils, two-cycle engine oils, catapult oils, hydraulic fluids, drilling fluids, turbine oils (e.g., aircraft turbine oils), greases, compressor oils, gear oils and functional fluids. Preferably, the lubricant composition of the present invention is used in an aero-derived, gas turbine engines (e.g., jet turbine engines, marine engines, and power generating applications).

[0022] The lubricant compositions of the present invention may also comprise other conventional lubricant additives. Lubricating oil additives are described generally in "Lubricants and Related Products" by Dieter Klamann, Verlag Chemie, Deerfield, Fla., 1984, and also in "Lubricant Additives" by C. V. Smalheer and R. Kennedy Smith, 1967, pp. 1-11, the contents of which are incorporated herein by reference. Lubricating oil additives are also described in U.S. Patent Nos. 6,043,199, 5,856,280, and 5,698,502, the contents of which are incorporated herein by reference.

[0023] The lubricant composition according to the present invention preferably comprises about 0 to 15%, preferably 2 to 10 wt%, most preferably 3 to 8% by weight of a lubricant additive package. Thus, the lubricant composition according to the present invention would comprise about 85 to 99.5 wt% polyol ester base stock and about 0.5 to 15 wt% conventional additive package.

[0024] Thus, fully formulated turbine oils 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. in addition to the dispersant of the present invention. 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% of the fully formulated lubricant.

[0025] Antioxidants, which can be used, include aryl amines, e.g. phenylnaphthylamines and dialkyl diphenylamines and mixtures thereof, hindered phenols, phenothiazines, and their derivatives. The antioxidants are typically used in an amount in the range 1 to 5 wt% of the fully formulated lubricant.

[0026] 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. The antiwear/extreme pressure additives are typically used in an amount in the range 0 to 4 wt%, preferably 1 to 3 wt% of the fully formulated lubricant.

[0027] 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, allylated benzotriazol. The standard corrosion inhibitor additive can be used in an amount in the range 0.02 to 0.5 wt%, preferably 0.05 to 0.25 wt% of the fully formulated lubricant. Other rust inhibitors common to the industry include the various hydrocarbyl amine phosphates and/or amine phosphates.

[0028] Foam control can be provided by many compounds including an antifoamant of the polysiloxane type, e.g., silicone oil or polydimethyl siloxane.

[0029] Another additive that can be used is an anti-deposition and oxidative additive. A typical anti-deposition and oxidation additive is a sulfur containing carboxylic acid (SCCA) as described in U.S. Patent No. 5,856,280. The SCCA derivative is used in an amount in the range 100 to 2000 ppm, preferably 200 to 1000 ppm, most preferably 300 to 600 ppm.

[0030] As previously indicated, other additives can also be employed including hydrolytic stabilizers, pour point depressants, anti foaming agents, viscosity and viscosity index improver, as well as other additives useful in lubricating oil compositions.

[0031] The individual additives may be incorporated into the present lubricant composition in any convenient way. Thus, each of the components can be added directly to the base stock by dispersing or dissolving it in the base stock at the desired level of concentration. Such blending may occur at ambient temperature or at an elevated temperature. Preferably, all the additives except for the viscosity modifier and the pour point depressant are blended into a concentrate or additive package, which is subsequently blended into base stock to make finished lubricant. Use of such concentrates in this manner is conventional. The concentrate will typically be formulated to contain the additive(s) in proper amounts to provide the desired concentration in the final formulation when the concentrate is combined with a predetermined amount of base lubricant. The concentrate is preferably made in accordance with the method described in U.S. Patent No. 4,938,880, the contents of which are incorporated herein by reference. That patent describes making a pre-mix of ashless dispersant and metal detergents that is pre-blended at a temperature of at least about 100°C. Thereafter, the pre-mix is cooled to at least 85°C and the additional components are added.

[0032] The present invention is further described by reference to the following nonlimiting examples. These examples are provided for purposes of explanation and not limitation. Specific polyols, carboxylic acids and esterification processes are used in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific examples.

EXAMPLE 1

Synthesis of Novel Ester Containing C₂ to C₄ Carboxylic Acid

[0033] The procedure for preparing the polyol esters of the present invention was generally as follows:

[0034] A multi-necked round bottom flask was used for the reaction vessel. This reactor was fitted with a means of stirring, an inlet for nitrogen (reactor is purged with N₂ prior to the run and an N₂ flow is maintained during the run), and a connection to a Dean-Stark apparatus and a condenser. The polyol (technical grade pentaerythritol) plus the C₅ to C₁₀ acids were charged to the reactor. In at least two of the runs, a small amount of entrainer (xylene) was also added. The reaction mixture was heated to 220°C and the mixture refluxed to remove the water of reaction (oil/water are separated in the Dean-Stark apparatus and the oil returned to the reactor). Vacuum is pulled as needed to maintain the reflux. The reaction was continued under these conditions until approximately the stoichiometric amount of water was removed from the reactor.

[0035] At this stage, the reaction mixture was cooled to a temperature below the boiling point of the acid anhydride to be added (acetic anhydride, propionic anhydride or butyric anhydride.) The anhydride was slowly added dropwise using an additional funnel. Once addition was complete, the reaction mixture was heated until reflux began, then maintained at reflux for approximately three hours.

[0036] At the end of the reaction period, unreacted acids were removed at 220°C under vacuum. The reaction mixture was then neutralized with an Na₂CO₃ solution (only if acid number is above target of 0.05 mg KOH/g), and de-colored using "admix," a blend of activated carbon and filter aid. The neutralization/de-coloring step was carried out at 90°C for 2-3 hours. At the end of this time, a vacuum was pulled on the reactor and the temperature was raised to 100°C to remove water. The mixture was then filtered, giving the desired product.

[0037] Details of the runs, along with the results from the analytical tests carried out, are provided in Tables I-IV below.

[0038] Based on the weight of acids charged to the reactor, the distribution of acids for each run is as follows. The actual acid content of each ester is likely to be somewhat different than that based on the feed to the reactor, as the acids do have different reactivities.

Table I -

	Acid Feed Content (Mole%)						
	Acid Content, Mole% (based on feed to reaction)						
Run Number	n-C ₅	N-C ₇	n-C _{8/10}	i-C ₉	C ₂	C ₃	C ₄
1038-88	41.6	19.2	12.4	6.8	20.0	0	0
1038-90	41.6	19.2	12.4	6.8	0	0	20.0
1038-94	46.8	21.6	14.0	7.6	10.0	0	0
1038-97	46.8	21.6	14.0	7.6	0	0	10.0
1038-138	41.6	19.2	12.4	6.8	0	20.0	0

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Table I - (continued)

Acid Feed Content (Mole%)							
Acid Content, Mole% (based on feed to reaction)							
Run Number	n-C ₅	N-C ₇	n-C _{8/10}	i-C ₉	C ₂	C ₃	C ₄
1038-140	46.8	21.6	14.0	7.6	0	10.0	0
Control Base Ester	54.0	22.8	15.0	8.2	0	0	0

Table II -

Acid Feed Content (grams)							
FeedAmount,g							
Run Number	Tech PE	n-C ₅	n-C ₇	n-C _{8/10}	i-C ₉	Short Chain Acid	Amount
1038-88	335.5	390.4	229.6	176.8	98.9	C ₂	224.4
1038-90	333.5	390.4	229.6	176.8	98.9	C ₄	349.6
1038-94	319.0	420.0	247.1	190.3	106.3	C ₂	107.8
1038-97	304.5	400.9	235.8	181.7	101.4	C ₄	159.4
1038-138	333.5	390.4	229.6	176.8	98.9	C ₃	287.0
1038-140	319.0	420.0	247.1	190.3	106.3	C ₃	137.4

Table III

Analytical Tests								
	Stage 1		Anhydride Addition Temp, °C	Kinematic Viscosity eSt		VI	HPDSC, min	OH# by FTIR
	Theoretica H ₂ O,g	Actual H ₂ O,g		40°C	100°C			
1038-88	133	128	133	25.77	4.81	107	41.85	10.07
1038-90	133	130	188	22.88	4.66	123	NA	0.15
1038-94	143	142	130	24.74	4.78	114	42.99	5.56
1038-97	136.5	130+	188	23.38	4.73	124	47.05	6.07
1038-138	133	135	160	22.06	4.51	118	27.82	2.94
1038-140	149	148+	160	23.23	4.69	121	43.23	9.55
Control Base Ester				26.01	4.98	118		

Table III demonstrates that a polyol ester base oil of approximately 5 centistokes was produced in accordance with industry standard.

Example II — Performance Testing

Inclined Panel Deposit Test (IPDT)

[0039] The IPDT is generally used to predict field performance in the oil-washed areas of the engine, and successfully correlates with more expensive bearing rig tests. The IPDT is typically employed as a screener test for additives in base stocks and fully formulated lubricants.

Test Procedure

[0040] During the IPDT, the test oil flows at a rate of 60 mL/h over a heated panel (stainless steel 304) that is inclined at an angle of 4 degrees with respect to the horizontal. Moist air flows through the system continuously during the test at a rate of 12 Uh. The panel is heated to a specified temperature (up to 600°F) and is held constant for the entire test duration of 24 hours. Oil flowing off the panel is collected in a sump and is continuously recirculated by a positive displacement pump.

[0041] When the test is complete, the deposit formed on the panel during the test is rated using a demerit rating scale. The IPDT uses the same deposit demerit system as the High Temperature Bearing Test. (FED. Test Method STD. No. 791 C, Method 3410.1). During the rating process, the total deposit is portioned into different deposit types, depending on the severity of the deposit. Each type of deposit is assigned a demerit factor related to the deposit severity. The demerit factor is multiplied by the area of the deposit type to obtain the demerits for that particular deposit type. The total number of demerits is then obtained by adding together the demerits for each deposit type. Dividing the total number of demerits by the total area of the deposits gives the final deposit demerit panel rating. Only the oil wetted areas of the panel are rated. Varnish deposits rate from 0 (clean metal) to 5 (heavy varnish). Sludge deposits rate from 6 (light) to 8 (heavy). Carbon deposits rate from 9 (light carbon) to 11 (heavy/thick carbon). Higher ratings (12 to 20) are given to carbon deposits that crinkle or flake away from the metal surface during the test. The total weight of the deposit formed in 24 hours is also measured.

[0042] Table 1 shows IPDT rating and deposit weight of short chain acid esters made in Example 2 and compares their performance with that of the base ester without the short chain acids. The additive system was held constant in all of these compositions. The deposit control capability of each experimental formulation was tested by IPDT at two separate temperatures: 580°F and 590°F.

[0043] In the IPDT runs at 580°F and 590°F, the incorporation of 10 or 20% C₂, C₃ or C₄ acids gave noticeable improvement in the panel rating. In addition, increasing the short chain acid concentration to 20% resulted in better anti-deposition performance for the C₄ acid at both 580°F and 590°F and for the C₂ acid at 590°F.

TABLE IV

IPDT Performance of Esters With or Without Short Chain Acids					
Run Number	Molar % of Short Chain Acid	IPDT @ 580°F		IPDT @ 590°F	
		Panel Rating	Deposit (g)	Panel Rating	Deposit(g)
Control	None ¹	4.07	0.30	5.23	0.39
1038-94	10%C ₂	2.82	0.21	4.73	0.34
1038-140	10%C ₃	2.49	0.11	3.62	0.29
1038-97	10%C ₄	3.03	0.24	3.85	0.36
1038-88	20%C ₂	Not available	Not available	4.19	0.34
1038-138	20%C ₃	3.81	0.33	4.34	0.39
1038-90	20%C ₄	2.69	0.14	3.46	0.15

¹- median value of 33 samples

Claims

1. A lubricant composition, comprising: a mixed polyol ester, wherein the carboxylic acid portion of the ester, comprises:

- (a) 5-20 mole% of short chain acids; and,
- (b) 80-95 mole% of a C₅₋₁₀ aliphatic carboxylic acid;

and the alcohol portion of the ester, comprises: an aliphatic polyol.

2. A lubricant composition according to Claim 1, wherein the carboxylic acid portion of the ester, comprises:

- (a) 5-20 mole% of a C₂₋₄ carboxylic acid;

- (b1) 30-70 mole% of a C₅ carboxylic acid;
- (b2) 0-15 mole% of an i-C₉ carboxylic acid; and
- (b3) 10-60 mole% of C₇₋₁₀ carboxylic acids.

3. A lubricant composition according to Claim 2, wherein the carboxylic acid portion of the ester, comprises:

- (a) 10-20 mole% of a C₂₋₄ carboxylic acid;
- (b1) 30-60 mole% of a C₅ carboxylic acid;
- (b2) 0-10 mole% of an i-C₉ carboxylic acid; and
- (b3) 10-55 mole% of linear C₇₋₁₀ carboxylic acids.

4. A lubricant composition according to Claim 3, wherein the carboxylic acid portion of the ester, comprises:

- (a) 10-15 mole% of a C₂₋₄ carboxylic acid;
- (b1) 30-60 mole% of valeric acid;
- (b2) 0-10 mole% of 3,3,5-trimethylhexanoic acid; and
- (b3) 10-55 mole% of a mixture of n-heptanoic acid, n-octanoic acid, and n-decanoic acid.

5. A lubricant composition according to any preceding claim, wherein the aliphatic polyol, comprises: 4-7 carbon atoms and 2-4 esterifiable hydroxyl groups.

6. A lubricant composition according to Claim 5, wherein the aliphatic polyol is selected from neopentyl glycol, 2,2-dimethylol butane, trimethylol ethane, trimethylol propane, trimethylol butane, mono-pentaerythritol, technical grade pentaerythritol, dipentaerythritol, tri-pentaerythritol, ethylene glycol, propylene glycol and polyalkylene glycols.

7. A lubricant composition according to Claim 6, wherein the aliphatic polyol is selected from trimethylolpropane, technical grade pentaerythritol, monopentaerythritol, dipentaerythritol, neopentyl glycol, and tripentaerythritol.

8. A lubricant composition according to Claim 7, wherein the aliphatic polyol is selected from technical grade pentaerythritol, trimethylolpropane, and neopentyl glycol.

9. A lubricant composition according to Claim 8, wherein the aliphatic polyol is technical grade pentaerythritol.

10. A lubricant composition according to any preceding claim, wherein mixed polyol ester is formed by esterifying a mixture of the short chain C₂₋₄ carboxylic acids and the C₇₋₁₀ carboxylic acids.

11. A lubricant composition according to any preceding claim having an inclined panel rating at 580°F of less than 4.00.

12. A lubricant composition according to any preceding claim having an inclined panel rating at 590°F of less than 5.00.

13. A lubricant composition according to any preceding claim further comprising 0.5 to 15 wt% of a lubricant additive package.

14. A process for preparing a mixed polyol ester, comprising:

- (i) contacting 5-20 mole% of short chain C₂₋₄ carboxylic acids with 80-95 mole% of a C₅₋₁₀ aliphatic carboxylic acid; and,
- (ii) esterifying the resulting mixture with an aliphatic polyol.

15. A process for preparing a mixed polyol ester, comprising:

- (i) esterifying a short chain C₂₋₄ carboxylic acid with an aliphatic polyol; and,
- (ii) contacting the esterification mixture with a C₅₋₁₀ aliphatic carboxylic acid;

wherein the resulting ester is a mixed ester and the carboxylic acid portion of the ester, comprises: (a) 5-20 mole% of short chain C₂₋₄ carboxylic acids; and, (b) 80-95 mole% of a C₅₋₁₀ aliphatic carboxylic acid.

16. A process for preparing a mixed polyol ester, comprising:

- (i) esterifying a C₅₋₁₀ aliphatic carboxylic acid with an aliphatic polyol; and,
- (ii) contacting the esterification mixture with short chain C₂₋₄ carboxylic acids;

wherein the resulting ester is a mixed ester and the carboxylic acid portion of the ester, comprises: (a) 5-20 mole% of short chain C₂₋₄ carboxylic acids; and, (b) 80-95 mole% of a C₅₋₁₀ aliphatic carboxylic acid.

17. A method of lubricating a turbine engine comprising operating the engine and lubricating the engine with a lubricant composition as claimed in any of Claims 1 to 13.

18. The use of the lubricant composition as defined in any of Claims 1 to 13 for enhancing the thermal and oxidative stability of a lubricating oil.