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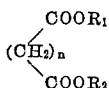
SYNTHETIC LUBRICANT COMPOSITIONS

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5 Claims. (Cl. 252—49.6)

This invention relates to lubricants, and more particularly to new synthetic lubricant compositions of improved lubricity characteristics.

A wide variety of ester type synthetic lubricants have been suggested for various applications in the functional fluid area, especially where good viscosity-temperature characteristics, low pour points and high-temperature stability are desired. Among the synthetic ester type lubricants which are well known in the art are the diesters formed by the reaction of a dibasic acid, such as adipic, azelaic and sebacic acids, with a monohydric alcohol. These ester types have been found especially useful as lubricants for aircraft turbine engines having high compression ratios and increased power outputs, e.g., turbojet and turboprop combustion engines, where it has been made possible to extend the range of ambient temperatures encountered and allow an increase in engine operating temperatures. Although various esters of this type possess one or more desired characteristics more so, for example, than mineral oils of the corresponding viscosity level, the synthetic base lubricants sometimes fail to provide satisfactory lubricity characteristics. For example, the lubricity problem encountered with such lubricants is evident in turbojet engines where the lubricant is required to prevent the seizure of moving parts operating at close clearances under high temperatures and heavy loads. Although the lubricity problem can be alleviated to some extent by utilizing high viscosity lubricants, recent efforts for the improvement of lubricity characteristics have been directed to the use of lubricity additives.

The present invention is predicated upon the discovery that synthetic lubricants characterized by improved lubricity and load-carrying properties can be obtained by adding to a suitable diester base fluid diphenylsilanediol in amounts ranging from about 0.001 to 2.0%, preferably about 0.01 to 1.0%, by weight, based on the synthetic base fluid. The diphenylsilanediol may be alkyl-substituted if desired, in one or more positions on the benzene nucleus, e.g., di(nonylphenyl)silanediol. In addition to being extremely effective as a lubricity agent, the use of diphenylsilanediol provides the further advantage of increased film strength and/or decreased wear of metal parts in contact with the synthetic base fluid to which it is added. The various synthetic lubricants used in accordance with the invention include the aromatic, aliphatic and cycloaliphatic esters of organic dicarboxylic acids. The preferred lubricants are diesters represented by the following general formula:



in which n is an integer of 2 to 18, preferably 2 to 12, and R_1 and R_2 are alkyl or cycloalkyl radicals, alike or different, branched chain or straight chain, which contain from about 5 to 24 carbons, and preferably about 5 to 18 carbon atoms. Specific examples of dicarboxylic acids from which the esters can be derived include suberic, adipic, glutaric, pimelic, azelaic, isosebacic, sebacic, brassilic

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and janic acids. One or more of the hydrogen atoms in the $-(\text{CH}_2)_n-$ radical can be alkyl-substituted, e.g., 3-methylglutaric acid, providing, however, such substitution does not increase the freezing point of the diester to above about 0°F. and/or detract from the viscosity-temperature properties. The preferred acids are the aliphatic dicarboxylic acids of 4 to 12 carbon atoms such as adipic, sebacic and azelaic acids.

The alcohols used to form the diester of the acid include, among others, 2-ethylhexyl alcohol, isooctyl alcohol, isodecyl alcohol, 2-ethylbutyl alcohol, n-octyl alcohol, amyl alcohol, 2-butyloctyl alcohol, methyl and dimethyl cyclohexanol, and the "Oxo" alcohols, such as the mixed branched chain nonanols, prepared from the reaction of carbon monoxide and hydrogen upon olefins which normally have a branched chain structure.

The diesters of dicarboxylic acids illustrated above are prepared by conventional methods of esterification. For example, the desired alcohol and acid can be mixed and heated in the presence of about 0.05 to 5.0 weight percent of a suitable esterification catalyst such as sulfuric acid, phosphoric acid, butyl titanate, toluenesulfonic acid, etc., until the theoretical yield of water is obtained. The water of reaction can be removed by means of a water trap connected to a refluxing condenser, or a water entraining solvent such as toluene, benzene, xylene, etc., with which the water forms an azeotropic mixture, can be employed. Any excess solvent can be removed by vacuum stripping.

Representative synthetic lubricants which can be used in accordance with the invention include di-(2-ethylhexyl) sebacate, di-(2-ethylhexyl)azelate, di-(2-ethylhexyl, isodecyl) azelate, di-(isooctyl)azelate, di-(1-methylcyclohexylmethyl) sebacate, di(2-ethylhexyl decyl)azelate, di-(2-ethylhexyl-2-propylheptyl)azelate, di-(2,2,4-trimethylpentyl)sebacate, di-(2-methylpentyl decyl)azelate, di-(1-ethylpropyl)adipate, di-(3-methylbutyl)adipate, di-(1,3-dimethylbutyl)adipate, di-(2-ethylbutyl)adipate, di-(2-ethylhexyl)adipate, di-(isooctyl) adipate, di-(undecyl)adipate, di(tetradecyl)adipate, di-(heptadecyl)adipate, di-(2,2,4-trimethylpentyl) adipate, di-(1-methylcyclohexylmethyl)adipate, di-(1-ethylpropyl)azelate, di-(3-methylbutyl) azelate, di-(2-ethylbutyl)azelate, di-(1-ethylpropyl) sebacate, di-(3-methylbutyl)sebacate, di-(1,3-dimethylbutyl) sebacate, di-(2-ethylbutyl)sebacate, di-(2-ethylhexyl)sebacate, di-(2-(2'-ethylbutoxy)ethyl) sebacate, di-(undecyl) sebacate, di-(tetradecyl)sebacate, di-(heptadecyl) sebacate, di-(2-ethylhexyl)glutarate, di-(undecyl)glutarate, di-(tetradecyl)glutarate, di-(2-ethylhexyl)phthalate and the like. Other lubricants which can be used include neopentyl glycol di-2-ethylhexoate, neopentyl glycol dipelargonate, diethylene glycol dipelargonate, and various other diesters of diols.

The lubricant composition may have incorporated therein various known additives such as sulfonates, selenides, phosphates, amines, silicones, etc., which are designed to improve one or more characteristics of oxidation stability, anti-rusting properties, anti-wear properties, and the like. Exemplary additives include phenothiazine, tricresyl phosphate, phenyl- α -naphthylamine, phenyl- β -naphthylamine, $\beta\beta$ -dinaphthylamine, 4-methyl-2,6-ditertiarybutyl phenol, quinizarin, etc., employed in amounts ranging from 0.001% to about 10.0%, preferably about 0.05% to 3.0%, by weight, based on the finished blend.

The improved lubricity and load carrying properties obtained by adding diphenylsilanediol to diester base fluids are shown by the results of the Falex lubricant test set forth in Table I below.

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Table I

Composition	Wt., Percent	Diphenyl- silanediol Wt., Percent	Falex Fail- ure Load lb./in. ²
1. C ₈ -C ₁₀ Azelate*-----	99.49	0.001	1450-1500
Phenothiazine-----	0.50		
Quinizarin-----	0.01		
2. C ₈ -C ₁₀ Azelate-----	99.49	0.50	1750
Phenothiazine-----	0.50		
Quinizarin-----	0.01		
3. C ₈ -C ₁₀ Azelate-----	98.99	0.5	2000
Phenothiazine-----	0.50		
Quinizarin-----	0.01		
4. Di-(2-ethylhexyl)-sebacate-----	99.5	0.5	1600
Phenothiazine-----	0.5		
5. Di-(2-ethylhexyl)-sebacate-----	99.0		2150
Phenothiazine-----	0.5	0.5	
6. 2,2,4-trimethylpentyl sebacate-----	100.0		1400
7. 2,2,4-trimethylpentyl sebacate-----	99.5		1950
8. Di-(2-ethylhexyl)-phthalate-----	100.0	0.25	1550
9. Di-(2-ethylhexyl)-phthalate-----	99.75		1700
10. Di-(2-ethylhexyl)-azelate-----	99.5		1550
Phenothiazine-----	0.5	0.5	
11. Di-(2-ethylhexyl)-azelate-----	99.0		1850
Phenothiazine-----	0.5		

*DI-[mixed-(2-ethylhexyl, isodecyl)]azelate

Various synthetic lubricants were also tested for wear properties by operating the Falex machine at a constant load of 100 pounds for a continuous eight-hour period while maintaining the temperature of the test oil at 15° F. The wear rate was determined by noting the number of notches of take-up required on the loading wheel to bring the jaw load to 100 pounds at the conclusion of the test. The wear rate was then converted to inches per year. The jaw load was adjusted to 100 pounds at intervals of approximately one hour. The combined weight loss of the two test blocks and the test pin was used as an additional measure of wear. The results obtained are shown below in Table II.

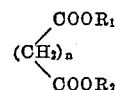
Table II

Composition	Wt., Percent	Diphenyl- silane- diol Wt., Percent	Falex Wear Test	
			Wear, In./Yr.	Weight Loss, g.
1. C ₈ -C ₁₀ Azelate-----	99.49	0.5	1.19	0.056
Phenothiazine-----	0.50			
Quinizarin-----	0.01			
2. C ₈ -C ₁₀ Azelate-----	98.99	0.5	0.310	0.005
Phenothiazine-----	0.50			
Quinizarin-----	0.01			
3. Di-(2-ethylhexyl)-sebacate-----	99.49	0.5	1.26	0.046
Phenothiazine-----	0.50			
Quinizarin-----	0.01			
4. Di-(2-ethylhexyl)-sebacate-----	98.99	0.5	1.16	0.036
Phenothiazine-----	0.50			
Quinizarin-----	0.01			

What is claimed is:

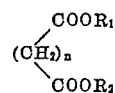
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1. A lubricant composition comprising a major amount of a synthetic ester lubricant and a minor amount of diphenylsilanediol sufficient to improve lubricity and load-carrying properties thereof, said ester having the formula:



wherein R₁ and R₂ are members selected from the group consisting of aromatic, alkyl and cycloalkyl radicals and n is an integer of 2 to 18.

2. A lubricant composition comprising a major amount of a synthetic ester lubricant and from about 0.001 to 2.0% by weight of diphenylsilanediol, said ester having the formula:



wherein n is an integer of 2 to 18 and R₁ and R₂ are alkyl radicals of 5 to 24 carbon atoms.

3. The lubricant composition of claim 2 wherein the lubricant is di-(2-ethylhexyl, isodecyl)azelate.

4. The lubricant composition of claim 2 wherein the lubricant is di-(2-ethylhexyl)sebacate.

5. The lubricant composition of claim 2 wherein the lubricant is di-(2-ethylhexyl)adipate.

References Cited in the file of this patent

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