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SYNTHETIC ESTER BASE LUBRICATING COMPOSITION CONTAINING A COPPER OR COBALT ACETYLACETONATE

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ABSTRACT OF THE DISCLOSURE

A synthetic lubricating oil composition for turbine engines is disclosed comprising a synthetic base oil and a metal bis(trifluoroacetylacetonate) from the class consisting of copper (II) and cobalt (II) in an amount ranging from 0.01 to 1.0 weight percent based on the weight of the lubricating oil composition.

This invention relates to a lubricating composition designed for the lubrication of turbine engines which operate over a wide temperature range and under severe operating conditions. More particularly, this invention relates to a synthetic lubricating oil composition having good deposit-inhibiting and oxidation resisting properties.

Synthetic base lubricants have been found to be useful for the lubrication of modern high performance turboprop, turbojet and turbofan engines. However, even these superior base oils must be modified to meet the stringent performance requirements set by the military and by commercial aircraft engine manufacturers. It is particularly difficult to achieve a synthetic oil composition having all the properties to withstand extreme thermal and oxidative stress without laying down deposits and becoming corrosive due to excessive oxidation of components of the synthetic oil.

Various additives and additive combinations have been employed to formulate synthetic lubricating oil compositions. Unfortunately, many of the compounded synthetic lubricating oils tend to promote corrosion of vital metal components of turbine engines, do not sufficiently inhibit oxidation of the synthetic oil base, or have an unsatisfactory level of deposit laydown and/or load-carrying properties. Deposit laydown and corrosiveness have been particularly severe problems with halogen-containing additives. A synthetic lubricating oil composition has now been discovered which has superior oxidation resistance and deposit inhibiting properties while retaining an effective high level or over-all lubricating properties.

The lubricating composition of this invention broadly comprises a synthetic base fluad having lubricating properties containing a metal derivative of bis(trifluoroacetylacetonate). More specifically, the additive is a metal bis(trifluoroacetylacetonate) from the class of metals consisting of copper (II) and cobalt (II). The additive is employed in an amount ranging from about 0.01 to 1 weight percent based on the weight of the lubricating oil composition, the preferred concentration being from 0.05 to 0.3 weight percent. In a preferred form of this invention, the synthetic lubricating oil composition also contains a hydrocarbyl amine antioxidant to further enhance the extremely low deposit laydown of the lubricating oil composition.

The function of the particular bis(trifluoroacetylacetonates) of this invention appears to be unique. Metal acetylacetonates, in general, have been unsatisfactory in lubricating oil compositions because of the formation of and deposition of solids from the oils. Likewise, the use of fluorine-containing additives in lubricating oils has produced compositions having unacceptable high levels of corrosion. The properties of bis(trifluoroacetylacetonate)

copper (III) and cobalt (II) appear to be unique even within the class of metal trifluoroacetylacetonates in that they impart good oxidation resistance and deposit laydown properties.

Synthetic ester-type base synthetic fluids are preferred for the lubricating composition of the invention. The base can be an aliphatic diester of an organic dicarboxylic acid. The dicarboxylic acid component is usually an aliphatic dicarboxylic acid containing 6 to 12 carbon atoms although glutaric acid esters and succinic acid esters can also be used. From the standpoint of cost and availability, the dibasic acids, adipic acid, sebacic acid and azelaic acid are favored. The aliphatic alcohols used to form the diesters usually contain at least 4 carbon atoms and may contain 20 or more carbon atoms, with C_6 to C_{10} alcohols being preferred.

Specific examples of the dialkyl esters of aliphatic dicarboxylic acids are as follows: di-isooctyl azelate, di-2-ethylhexyl sebacate, di-2-ethylhexyl azelate, di-2-ethylhexyl adipate, dilauryl azelate, di-sec-amyl-sebacate, di-2-ethylhexyl alkenylsuccinate, di-2-ethoxy ethyl sebacate, di-2-(2′-methoxyethoxy) ethyl sebacate, di-2(2′-butoxyethoxy) ethyl alkenylsuccinate, etc.

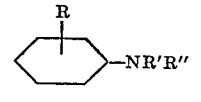
In addition the aliphatic dicarboxylic acid esters described above, polyesters and complex ester lubricants formed by a reaction of an aliphatic dicarboxylic acid, a glycol and a monofunctional compound which is either an aliphatic monohydroxy alcohol or an aliphatic monocarboxylic acid in specified mole ratios are also employed as a synthetic lubricating base in the composition of this invention. Polyesters of this type are described in U.S. 2,628,974. Complex esters by reaction of a mixture containing specified amounts of 2-ethyl-1,3-hexane-diol, sebacic acid and 2-ethyl hexanol, and by reaction of a mixture containing adipic acid, diethylene glycol and 2-ethylhexanoic acid illustrate this class of synthetic polyester lubricating base.

Esters formed by the reaction of a monocarboxylic acid and a glycol or polyol may also be used as the ester components. The acid component is usually an aliphatic acid containing 3 to 20 carbon atoms and preferaly 4 to 10 carbon atoms. The glycol or polyol component is advantageously a straight glycol, such as 1,5-hexane diol, but ether glycols, such as tetraethylene glycol may also be used. Sterically hindered neopentyl type glycols, such as 2-methyl, 2-ethyl, 1,3-propanediol, are favored for enhanced thermal stability.

Specific examples of the diesters of glycols are the following: di-n-decanoate of 1,4-butanediol, di-2-ethylhexanote of 1,6-hexanediol, dilaurate of 1,4-hexanediol, dioctanoate of 1,5-pentanediol. Examples of triesters are trimethyl propane triheptanoate and trioctanoate. Examples of tetraesters are pentaerythritol tetracaproate and pentaerythritol esters with mixtures of aliphatic acids generally containing from three to ten carbon atoms.

Complex esters formed by reacting trimethylol and tetramethylol alkanes with various mole ratios of dibasic acids and monobasic acids or alcohols are other examples of polyesters useful for the base fluid of the lubricants of this invention. Pentaerythritol tetraesters of C_{12-12} aliphatic carboxylic acids are a preferred class of polyester lubricating oils. Polyphenyl ethers are also suitable for the lubricating oil base.

The optional antioxidant component for enhancing the deposit forming properties of the lubricating oil of the invention comprises an aromatic amine having the formula:



in which R is an alkyl radical having from 1 to 8 carbon atoms, R' is hydrogen or an alkyl radical having from 1 to 6 carbon atoms and R'' is hydrogen, or a phenyl, naphthyl, aminophenyl or an alkyl-substituted phenyl radical in which the alkyl radical has from 1 to 8 carbon atoms. Examples of these antioxidants include p-p'-dioctyl diphenylamine, N-phenyl-1-naphthylamine, N-phenyl-p-phenylene diamine, N-N'-diphenyl-p-phenylene diamine, N,N'-bis(octylphenyl)-p-phenylene diamine, p-hydroxy-diphenylamine, N-phenyl-N-isopropyl-p-phenylene diamine, and N,N'-dioctyl-p-phenylene diamine. The amines are employed in amounts ranging from 0.1 to about 5 percent by weight of the lubricant composition with the preferred amount being from about 0.5 to 3 percent.

grade pentaerythritol esterified with a mixture of 38% valeric, 13% 2-methylpentanoic, 32% octanoic and 17% pelargonic acid. This base fluid had the following properties:

Viscosity, cs. at 210° F.	4.93
Viscosity, cs. at 100° F.	25.6
Viscosity, cs. at −40° F.	7023
Viscosity index	131
Flash, F.	490

The synthetic lubricating oil of the invention was prepared by mixing the additive into the base oil. The properties of the lubricating oils of the invention and of the base oil are given in Table I below:

TABLE I

	Base Oil	Base Oil+0.1% bis(trifluoroacetylacetonate) Cu(II)	Base Oil+0.1% bis(trifluoroacetylacetonate) Cu(II) 1% p,p'-deoctyldiphenylamine	Base Oil+0.1% tris(trifluoroacetylacetonate) Fe(III)	Base Oil+0.1% bis(trifluoroacetylacetonate) Mg(II)	Base Oil+0.1% bis(trifluoroacetylacetonate) Co(II)
450° F. Antioxidant Test: Percent Vis. increase:						
24 hours	700	77.6	----------	505	438	----------
48 hours	(1)	326	----------	(2)	>4,000	----------
Total Acid No.:						
24 hours	6.5	3.0	----------			
48 hours	19.4	5.5	----------			
600° F. Oil Mist Test, g. deposit/1,000 g. oil	13.9	0.8	0.1	27.5	8.3	3.2(590° F.)

[1] Semi-solid.
[2] Solid.

Other additive components can be advantageously incorporated in the lubricant composition of the invention. For example, it is conventional to add small concentrations of methacrylate polymers to improve dispersancy. An anti-foam agent, such as a hydrocarbon or kerosene concentrate of dimethyl silicone in an amount ranging from about 0.0001 to 0.01 percent by weight, is generally added to the lubricating oil. Detergents, such as the metal salts of phenates and sulfonates, are also used to advantage. In particular, barium sulfonates have been found useful since they inhibit corrosion and rusting.

The oxidation-corrosion resistance and deposit forming properties of the lubricating oils of the invention were determined in the following tests.

The 450° F. Antioxidant Test is conducted in accordance with method 5308.4 of Federal Test Method Standard No. 791*a* (issued Dec. 31, 1961) except for certain modifications to conform to Pratt and Whitney Aircraft Specification 521–B (Type II). The bath temperature is maintained at 450° F.±1° F., instead of at 250° F. This test was run for 48 hours with determination of viscosity increase and total acid number taken at 24 hours and 48 hours.

The Oil Mist Test was described in a paper presented at the ASLE/ASME Lubrication Conference in Minneapolis, Minn., Oct. 18–20, 1966 by Bartholomaei, Massey and Holstedt. This test is conducted by passing a mist of oil through a glass tube containing a steel liner (shim stock) through the entire length of the tube. The tube is maintained at 600° F. while the oil mist is continuously passed through over a period of 16 hours. At the end of the test period, the steel liner is removed, solvent washed and weighed. The amount of tenacious material adhering to the liner is determined and is reported as grams of deposit per one thousand grams of oil put through the system. This test represents the formation of breather tube deposits in a jet engine.

The base oil employed in the tests below was technical

The foregoing data show that the lubricating oil of the invention was greatly improved in essential lubricating and deposit forming properties while oil compositions containing similar additives were substantially degraded or rendered totally ineffective.

Obviously, many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A synthetic lubricating oil composition comprising a major portion of a synthetic ester base having lubricating properties and deposit and oxidation reducing amounts of a metal bis(trifluoroacetylacetonate) additive, said metal being selected from the class consisting of copper (II) and cobalt (II).

2. A lubricating oil according to claim **1** containing from 0.01 to 1 weight percent of said metal bis(trifluoroacetylacetonate).

3. A lubricating oil according to claim **1** in which said additive is bis(trifluoroacetylacetonate) copper (II).

4. A lubricating oil according to claim **1** in which said synthetic oil base is an ester base lubricating oil.

5. A lubricating oil according to claim **4** in which said synthetic oil base is an ester pentaerythritol.

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