(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 017 072**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **80101408.5**

(22) Date of filing: **18.03.80**

(51) Int. Cl.³: **C 10 M 3/20**
C 10 M 3/22

(30) Priority: **02.04.79 US 26269**

(43) Date of publication of application:
15.10.80 Bulletin 80/21

(84) Designated Contracting States:
BE DE FR GB IT NL SE

(71) Applicant: **THE DOW CHEMICAL COMPANY**
2030 Abbott Road Post Office Box 1967
Midland, Michigan 48640(US)

(72) Inventor: **Carswell, Robert**
306 Narcissus
Lake Jackson Texas(US)

(74) Representative: **Casalonga, Alain et al,**
Bureau D.A. Casalonga Lilienstrasse 77
D-8000 München 80(DE)

(54) **Water-resistant lubricant for compressors and marine engines.**

(57) Synthetic lubricants containing (A) 15 to 45 weight percent of an ester of a hindered polyhydric alcohol having 3 to 6 hydroxy groups and 5 to 10 carbon atoms with one or more alkanoic acids having 4 to 18 carbon atoms blended with (B) 85 to 55 weight percent of one or more polyoxyalkylene glycols or their mono- or dialkyl ethers having a 400-5000 number average molecular weight. The blends are compounded with antioxidants, corrosion inhibitors, and metal deactivators to produce a superior lubricant for rotary screw compressors that has a long life.

EP 0 017 072 A2

WATER-RESISTANT LUBRICANT FOR COMPRESSORS AND MARINE ENGINES

This invention relates to water-resistant lubricants for compressors and marine engines, especially for use in rotary screw compressors.

Rotary screw air compressors are well-known in the art as can be seen from U.S. Patent 3,073,513, issued to Bailey, January 15, 1963.

It is well-known to use hydrocarbon lubricating oils to seal the rotors of the foregoing rotary screw air compressors, lubricate the bearing and cool the compressed gases. Due to the high temperature and pressure of the air, it has been found that these hydrocarbon oils break down and create a sludge in a relatively short time, i.e., about 1000 hours or less.

In attempts to increase the intervals between changes of the lubricants, silicone fluids have been used. However, these fluids are very expensive and represent a considerable capital investment because a new compressor unit with different bearings and seals is required.

It is known that synthetic esters made from dicarboxylic acids have been used in an attempt to develop a relatively inexpensive and long-lasting lubricant. However, it has been found that these synthetic esters are not hydrolytically stable, and therefore do not have the long life required for use in air compressors.

Synthetic lubricants comprising a major amount of a polyester and a minor amount of a monocapped polyglycol are known from British Patent 1,162,818, I.C.I., August, 1969. However, these compositions are disclosed to be only useful in aircraft gas turbines where gross contamination with water is not a problem.

It now has been found that a suitably inhibited blend of hindered alkanoic esters of aliphatic polyhydric alcohols having 3 to 6 hydroxyl groups and 5 to 10 carbon atoms with polyoxyalkylene glycols and their mono or dialkyl ethers has the required high temperature viscosity and stability to oxygen and water.

The present invention is a lubricant composition characterized in that it contains

(A) 15 to 45 weight percent of an ester of a hindered polyhydric alcohol having 3 to 6 hydroxyl groups and from 5 to 10 carbon atoms with one or more alkanoic acids having 4 to 18 carbon atoms, and

(B) 85 to 55 weight percent of one or more compositions having a flash point greater than 191°C and having the formula

$$R\text{--}(O\text{-}CH_2\text{-}\underset{R'}{CH})_n\text{--}OR$$

where R is hydrogen or an alkyl group of 1-6 carbon atoms, R' is hydrogen or methyl, and n is a number having an average value which will give a molecular weight range from 400 to 5000.

An additional aspect of the present invention comprises the above base lubricant with the addition of effective amounts of oxidation inhibitors, corrosion inhibitors, and metal or copper deactivators.

While the lubricants of this invention are useful in rotary screw, sliding vane, and reciprocation piston compressors, they are also useful in other mechanical devices where hydrolytic stability is desired or necessary, such as outboard motors or marine engines in general.

The combination of the foregoing polyoxyalkylene glycols and esters with and without additives can also find utility in industry for other lubricating applications, such as mold release agents, lubricants for glass making machinery, gears, gasoline or diesel engines, textile machinery, fiber lubricants and metal working fluids.

The neutral esters used in this invention are commercially available. Examples of suitable hindered esters are esters of trimethylol ethane with alkanoic acids of 4-18 carbon atoms, esters of trimethylol propane with alkanoic acids of 4-18 carbon atoms, esters of trimethylol butane with alkanoic acids of 4-18 carbon atoms, and esters of pentaerythritol or dipentaerythritol with alkanoic acids of 4-18 carbon atoms.

Specific examples of these esters are trimethylolethane tricaproate, trimethylolpropane trivalerate, trimethylolpropane tri n-heptanoate, trimethylolpropane tripelargonate, trimethylolpropane tricaprate, pentaerythritol tetracaproate, dipentaerythritol hexabutyrate, pentaerythritol tetrastearate and the related esters with mixed acid moieties.

Examples of the polyoxyalkylene glycols used in this invention are those derived from ethylene, propylene, 1-2, or 2-3 butylene oxide. The above oxides may be polymerized alone or in combination. The combined oxides may also be combined in a random or block addition. While some of the above compounds may be of a hydrophyllic nature, those of a hydrophobic nature are preferred, such as those derived from propylene oxide, butylene oxides or combinations thereof.

Examples of suitable capped polyoxyalkylene glycols are those derived from ethylene, propylene, and butylene oxides wherein the alkylene oxides are initiated from monofunctional alkanols having 1-6 carbon atoms in a known manner. The above monoalkyl ethers of polyoxyalkylene glycols can be further modified in a known manner to give the dialkyl ethers.

The foregoing glycols should have a flash point greater than 191°C and preferably greater than 232°C. They also should have a number average molecular weight range from about 400 to 5000 and preferably in the range 700 to 2500.

The foregoing esters and glycols are blended to give a base lubricant composition containing 15 to 45 weight percent of the esters and 85 to 55 weight percent of the glycol with the ranges 22 to 35 and 78 to 65 being the preferred ranges, respectively.

The compositions of this invention are selected so as to have a viscosity in the range of 5 to 25 centistokes at 99°C and preferably 6 to 16 centistokes at 99°C and a pour point in the range of -17.8° to -54°C.

The final lubricant compositions of this invention contain effective amounts of conventional antioxidants, corrosion inhibitors and metal or copper deactivators.

Examples of useful antioxidants which can be used herein are phenyl naphthylamines, i.e., both alpha- and beta-naphthyl amines, diphenyl amine, iminodibenzyl, p,p'-dioctyl-diphenylamine, and related aromatic amines. Other suitable antioxidants are hindered phenolics such as 6-t-butyl phenol, 2,6-di-t-butyl phenol and 4-methyl--2,6-di-t-butyl phenol.

Examples of suitable corrosion inhibitors are the metal sulfonates such as calcium petroleum sulfonate, barium dinonylnaphthalene sulfonate and basic barium dinonylnaphthalene sulfonate (carbonated or noncarbonated).

Examples of suitable N-heterocyclic metal or copper deactivators are imidazole, benzimidazole, pyrazole, benzotriazole, tolutriazole, 2-methyl benzimidazole, 3,5-dimethyl pyrazole, and methylene bisbenzotriazole.

An effective amount of the foregoing additives is generally in the range from 0.1 to 5.0 percent by weight for the antioxidants, 0.1 to 5.0 percent by weight for the corrosion inhibitors, and 0.001 to 0.5 percent by weight for the metal deactivators, all percentages being based on the total weight of the esters and the glycols. It is to be understood that more or less of the additives may be used depending upon the circumstances for which the final composition is to be used.

The following examples illustrate the invention.

Example 1

The following composition was prepared.

175 Pounds (79.4 kg) polypropylene glycol (number average molecular weight 1200), 75 pounds (34.0 kg) pentaerythritol tetraester of alkanoic acids, 3.75 pounds (1.70 kg) p,p'-dioctyl diphenylamine, 1.25 pounds (0.57 kg) basic barium dinonylnaphthalene sulfonate in mineral oil, and 0.125 pound (0.28 kg) benzotriazole.

The polyglycol and the ester were weighed into a 30 U.S. gallon (114 l) stainless steel mixing vessel, equipped with a paddle stirrer and a controllable electric heating element. The temperature was raised to 45°-55°C with stirring. The additives were then weighed in, in the order given above.

The above 25 U.S. gallon (94.5 l) mixture was allowed to stir with the heating maintained at 45°-55°C until a clear solution was obtained. A clear light brown

solution was obtained and was drained from the mixing vessel by opening a valve situated in the base of the vessel. The blend was collected into 5 U.S. gallon (1.89 l) containers. The fluid was retained for testing as described in the following manner. This example illustrates the preparation of a blend of 70 weight percent polyglycol and 30 weight percent of a polyester.

50 Grams of fluid prepared above was sealed in a rotary bomb and tested for oxidation resistance in accordance with American Society for Testing Materials (ASTM) Test D-2272. The fluid gave 18.5 hours in the oxidation test.

It is to be noted in this example and the following examples that the number of hours in the oxidation test can vary about two hours over and under the given numbers because the test procedure is not exactly reproducible.

300 ml of the above fluid was tested for corrosion resistance in accordance with ASTM Test D-665 (procedure A). The fluid passed the test.

Four and one-half U.S. gallons (17.0 l) of the above fluid was placed in a 100 cubic feet (2.83 m^3) per minute rotary screw air compressor and the compressor was run for 6000 continuous hours with periodic shutdowns at 1000-hour intervals to take a 4-ounce (113 g) sample for analysis. Four ounces (113 g) of new fluid replaced the withdrawn sample. The test was terminated at 6000 hours due to a breakdown of the compressor which was not associated with the lubricant. Upon examination the fluid

withdrawn from the compressor was found to be in excellent condition. Similar results will be obtained with the corresponding dibutyl ether or butyl ether of polypropylene glycol having a similar molecular weight.

Example 2

Following the procedures set forth in Example 1, a blend of 76 weight percent of the polypropylene glycol and 24 weight percent of trimethylolpropane tripelargonate was prepared with the same percentages of the additives. This formulation when tested by the above oxidation test gave 16 hours and 50 minutes and passed the corrosion test.

Example 3

Following the procedures set forth in Example 1 with the same additives, a blend of 20 weight percent of the polypropylene glycol and 80 weight percent of a trimethylolpropane fatty acid ester was prepared. This formulation gave 15 hours and 10 minutes in the above oxidation test and passed the corrosion test.

Controls 1-3

Following the oxidation test of Example 1, a hydrocarbon lubricant (Control #1), a petroleum oil (Control #2) and a synthetic fluid based on a dicarboxylic acid ester (Control #3) were tested. The above three lubricants have been recommended for use in rotary screw compressors by lubrication engineers. The results are shown in Table I.

TABLE I

Control	Oxidation Test
1	2 hours 12 minutes
2	1 hour 5 minutes
3	9 hours 50 minutes

From the foregoing, it is indicated that lubricating oils have a relatively short life span and that while dicarboxylic acid esters are better than lubricating oils they are less effective than the compositions of this invention. Furthermore, the compositions containing trimethylolpropane esters of Example 2 are vastly improved over the known esters of Control 3. Likewise, the compositions containing esters of Example 1 are even more improved over Example 2 and Control 1.

1. A lubricant composition characterized in that it contains

(A) 15 to 45 weight percent of an ester of a hindered polyhydric alcohol having 3 to 6 hydroxyl groups and from 5 to 10 carbon atoms with one or more alkanoic acids having 4 to 18 carbon atoms, and

(B) 85 to 55 weight percent of one or more compositions having a flash point greater than 191°C and having the formula

$$R\text{--}(O\text{-}CH_2\text{-}\underset{R'}{CH})_n\text{--}OR$$

where R is hydrogen or an alkyl group of 1-6 carbon atoms, R' is hydrogen or methyl, and n is a number having an average value which will give a molecular weight range from 400 to 5000.

2. The lubricant composition of Claim 1 and further characterized in that the weight percent of the ester ranges from 22 to 35 and the weight percent of the glycol ranges from 78 to 65.

3. A lubricant composition characterized in that it contains

(A) 15 to 45 weight percent of an ester of pentaerythritol with one or more alkanoic acids having 4 to 18 carbon atoms, and

(B) 85 to 55 weight percent of one or more polyoxyalkylene glycols having a flash point greater than 191°C and having a number molecular weight range from 700 to 2500 and mixtures thereof.

4. The lubricant composition of Claim 3 and further characterized in that the weight percent of the ester ranges from 22 to 35 and the weight percent of the polyglycol ranges from 78 to 65.

5. The lubricant composition of Claim 4 wherein the glycol is polypropylene glycol having a number average molecular weight of 1200.

6. The lubricant composition of Claim 5 which comprises 30 weight percent of said ester and 70 weight percent of said polypropylene glycol.

7. The composition of Claim 1 and further characterized in that it also contains

(A) an effective amount of an antioxidant,

(B) an effective amount of a ferrous metal corrosion inhibitor, and

(C) an effective amount of a metal deactivator.

8. The composition of Claim 1 and further characterized in that it also contains

(A) 0.1 to 5.0 weight percent of an aromatic amine antioxidant,

(B) 0.1 to 5.0 weight percent of a metal salt of an aromatic sulfonic acid, and

(C) 0.001 to 0.5 weight percent of a N-heterocyclic metal deactivator.