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BIODEGRADABLE LUBRICANTS

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ABSTRACT OF THE DISCLOSURE

Biodegradable water-in-oil emulsion lubricants are provided, comprising, by weight, a major amount of water dispersed in a continuous phase comprising a biodegradable compound of the general formula: R_nX, in which:

R is a straight-chain alkyl group having from 1 to 18 carbon atoms;
X is a straight-chain ester of a fatty organic acid having from 1 to 20 carbon atoms or benzene; and
n is 1 or 2.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to lubricant compositions and, in one of its aspects, relates more particularly to lubricant compositions which are biodegradable. Still more particularly in this aspect, the invention relates to lubricant compositions, in the form of water-in-oil emulsions which are biodegradable and especially suited for such purposes as hydraulic fluids and various other applications, in which biodegradability of the lubricant is a requisite.

(2) Description of the prior art

The use of water-in-oil emulsion fluids as lubricants in industrial applications, for example, as hydraulic fluids, metal working lubricants and in other areas where lubricants are necessitated, is known to those skilled in this art. An essential component of water-in-oil emulsion lubricants, particularly where these lubricants are employed as hydraulic fluids, is the presence of mineral oil as the continuous phase with water dispersed therein and comprising about 40 percent, by weight, of the total emulsion fluid. However, by reason of the presence of such relatively low water-content, and the relatively high non-biodegradable mineral oil content, the resulting fluid has not been found to be biodegradable to the extent that it can satisfactory pass certain standardized requirements for biodegradability.

Heretofore, attempts have been made to incorporate substantially greater amounts than the 40 percent, by weight, of water to assist in imparting increased biodegradability, particularly in hydraulic fluid applications. However, since the mineral oil is in the continuous phase, its viscosity also affects the viscosity of the finished emulsion thereby decreasing the efficacy of the fluid. To offset this effect it has been attempted to employ mineral oils having lower viscosities than those normally employed, e.g. 100 SUS at 100° F. viscosity grade. However, in such modifications, the flash point of the oil is lowered, thereby nullifying the benefit gained through the use of increased amounts of water. In addition, in certain instances, hydraulic pump wear rates tend to be increased above an acceptable level. Hence, prior to the present invention, no commercial water-in-oil emulsion lubricant fluids, with water contents substantially over

40 percent, by weight, and/or employing an oil significantly below 100 SUS at 100° F., are available.

SUMMARY OF THE INVENTION

In accordance with the present invention, and in accordance with its objects, there are provided biodegradable water-in-oil emulsion lubricants in which the heretofore-employed non-biodegradable oils, as the continuous phase, are replaced with biodegradable materials, which have viscosities substantially below 100 SUS at 100° F. and flash points approximately equal to that of the aforementioned mineral oils. More specifically, as more fully hereinfurther described, the biodegradable water-in-oil emulsion lubricants of the present invention comprise, by weight, a major amount of water dispersed in a continuous phase comprising a biodegradable compound of the general formula: R_nX, in which:

R is a straight-chain alkyl group having from 1 to 18 carbon atoms;
X is a straight-chain ester of a fatty organic acid having from 1 to 20 carbon atoms or benzene; and
n is 1 or 2.

With respect to the above-described R_nX formulation, it is found that when other than straight-chain alkyl groups or other than straight-chain esters are employed in the respective R and X substituents, e.g. branched-chain alkyl groups or straight-chain esters, the resulting emulsion formulation is not biodegradable, thereby resulting in an unsatisfactory emulsion fluid. Still more significantly, it is found that where the R substituent represents an alkyl group having more than 18 carbon atoms, the resulting emulsion formulation becomes too viscous and exhibits an unsatisfactory pour point at relatively high temperature operating conditions. With respect to the R substituent, it is also found that when the compound contains more than two R groups (i.e. where *n* is greater than 2) the emulsion tends to solidify, thus impairing satisfactory utilization for its intended purpose. Insofar as the X substituent is concerned, it is found that where X is a straight-chain ester of a fatty organic acid having more than 20 carbon atoms, poor pour point characteristics are here also exhibited at relatively high operating temperature conditions. In particularly preferred formulations, R represents straight-chain alkyl groups having from 1 to 5 carbon atoms, and X represents straight-chain esters of fatty organic acids having from 10 to 20 carbon atoms.

As hereinbefore indicated, the biodegradable emulsion fluids of the present invention comprise a major amount, by weight, of water. Preferably, water is employed in an amount from about 50 to about 65 percent, by weight. Insofar as the biodegradable compound R_nX, itself, is concerned, this compound is employed in general, in an amount from about 25 to about 48 percent, and preferably in an amount from about 30 to about 48 percent, by weight, of the total emulsion fluid. The required emulsifying agent is preferably employed in an amount from about 2 to about 5 percent, by weight, of the total emulsion fluid.

A wide variety of biodegradable compounds may be employed within the scope of the above-described R_nX structural formulation. Representative thereof, but not intended as limiting are: methyl laurate; methyl soyate; butyl palmitate; methyl margarate; methyl stearate; ethyl stearate; ethyl oleate; lauryl laurate; lauryl caprylate; lauryl myristate; stearyl formate; stearyl butylate; myristyl caprate; diisooctyl adipate; di - 2 - ethyl adipate; n-

dodecyl benzene; n-decyl hexylbenzene; n-decyl octylbenzene; n-undecyl benzene; n-undecyl hexylbenzene; and n-undecyl octylbenzene.

It will, of course, be apparent that other desirable additive materials may also be incorporated in the novel emulsion fluids of the present invention such as antioxidants, anti-wear agents, anti-freeze agents, dyes, anti-foaming agents, fire-resistant materials, viscosity improvers and the like.

DESCRIPTION OF SPECIFIC EMBODIMENTS

The following examples and comparative data will serve to illustrate the novel biodegradable water-in-oil emulsion lubricants of the present invention, in which the non-biodegradable oil components heretofore employed in the emulsions of the prior art are replaced by a biodegradable compound, viz, the R_nX component hereinbefore described and the improved results obtained by such substitution.

EXAMPLE 1

A water-in-oil emulsion representative of the novel biodegradable water-in-oil emulsions of the present invention, was prepared, employing as the oil component (i.e. the hereinbefore described R_nX component), a mixture of methyl soyate and methyl laurate, in accordance with the following formulation:

	Wt. percent
Methyl soyate	24.0
Methyl laurate	5.0
150″ polyisobutylene (m. wt. 400) (viscosity improver)	5.0
Emulsifier—Reaction product of tetraethylpentamine polybutene succinic anhydride and zinc cracked wax-benzene sulfonate complex	3.0
Mixed isopropylaminoethanols—Vapor space inhibitor	0.3
Ethylene glycol	3.0
Water	59.7

The above-described water-in-oil emulsion was next submitted to a series of formulation tests and evaluations, and the results obtained are shown in the following table:

TABLE I

Pour point, ° F.	+15
Viscosity, SUS at 100° F.	400
Vikers pump V104–3 (2 g.p.m.) Test—140° F., 1200 r.p.m., 1000 p.s.i., vane+ring wear (100 hrs.), mg.	38
B.O.D.$_5$ (5 day biological orygen demand), mg./l.	183,000

With respect to the above-identified results obtained with the emulsion of Example 1, the Vikers Pump V104–E (2 g.p.m.) Test comprises circulating the test fluid per 100 hours at 1000 p.s.i. by a fixed displacement vane pump. The flow rate varies between 1½ and 2½ gallons per minute, depending on the viscosity of the test oil. The temperature is maintained at 140° F. in the reservoir. The weight loss of the cam ring and vanes and the appearance of the pump components indicate test fluid performance.

The acceptability reading for this test should not exceed 100 mg. total wear per 100 hours.

The 5-day biodegradable oxygen demand test (B.O.D.$_5$) comprises the measurement of a biological uptake of oxygen by sewage bacteria in a 5-day period under standard comditions as described on page 415 "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, the American Water Works Association and the Water Pollution Control Federation. A value of at least 100,000 mg./l. is considered as being biodegradable.

EXAMPLE 2

In order to illustrate the importance of having an oil component of the type characterized by the aforementioned R_nX compounds of the present invention, present for the purpose of imparting biodegradability to the water-in-oil emulsion, a second water-in-oil emulsion was prepared, identical in all respects with the water-in-oil emulsion of Example 1 except that additional polyisobutylene was substituted for the methyl soyate and methyl laurate components. This second formulation contained the following components:

	Wt. percent
150″ polyisobutylene (m. wt. 400) (viscosity improver)	34.0
Emulsifier—Reaction product of tetraethylpentamine polybutene succinic anhydride and zinc cracked wax-benzene sulfonate complex	3.0
Mixed Isopropylaminoethanols—Vapor space inhibitor	0.3
Ethylene glycol	3.0
Water	59.7

As in Example 1, the above formulation of Example 2 was subjected to the same tests and evaluations, and the results obtained are shown in the following table:

TABLE II

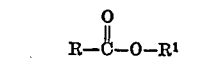
Pour point, ° F.	−5
Viscosity, SUS at 100° F.	450
Vikers pump V104–E (2 g.p.m.) Test—140° F., 1200 r.p.m., 1000 p.s.i., vane+ring wear (100 hrs.), mg.	2000
B.O.D.$_5$ (5 day biological oxygen demand), mg./l.	12,000

As will be seen from a comparison of the respective results obtained with respect to the water-in-oil emulsions of Example 1 and Example 2, the emulsion fluids of the present invention exhibit highly acceptable biodegradability in addition to other desirable characteristics, making these emulsions suitable for a wide variety of useful applications.

It will be, of course, apparent that other compounds, as hereinbefore indicated, may be substituted for those of the R_nX designation. Although the present invention has been described herein by means of certain specific embodiments and illustrative examples, it is not intended that the scope thereof be limited in any way, and is capable of various modifications and adaptations, as those skilled in the art will readily appreciate.

I claim:

1. A biodegradable water-in-oil emulsion lubricant consisting essentially of, by weight, a major amount of water dispersed in a continuous phase of a biodegradable compound of the general formula:



in which R is a straight-chain alkyl group having from 1 to 19 carbon atoms and R^1 is a straight-chain alkyl group having from 1 to 18 carbon atoms.

2. A lubricant as defined in claim **1** wherein R^1 has from 1 to about 5 carbon atoms.

3. A lubricant as defined in claim **1** wherein R has from about 9 to about 19 carbon atoms.

4. A lubricant as defined in claim **1** wherein water is present in an amount from about 50 to about 65 percent by weight.

5. A lubricant as defined in claim **1** wherein said biodegradable compound is present in an amount from about 25 to about 48 percent, by weight.

6. A lubricant as defined in claim **1** wherein said biodegradable compound is present in an amount from about 30 to about 48 percent, by weight.

7. A lubricant as defined in claim 1 containing an emulsifying agent in an amount from about 2 to about 5 percent, by weight.

8. A lubricant as defined in claim 1 wherein said biodegradable compound comprises methyl soyate.

9. A lubricant as defined in claim 1 wherein said biodegradable compound comprises methyl laurate.

10. A lubricant as defined in claim 1 wherein said biodegradable compound comprises butyl palmitate.

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PATRICK P. GARVIN, Primary Examiner

U.S. Cl. X.R.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,791,975 Dated February 12, 1974

Inventor(s) NICHOLAS HALKIAS

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1 line 51 "satisfactory" should read -- satisfactorily --

Column 3 line 49 "V104-3" should read -- V104-E --

Signed and sealed this 11th day of June 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents