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3,558,489

EMULSIFIABLE LUBRICATING COMPOSITIONS

Howard J. Matson, Harvey, Ill., assignor to Sinclair Research, Inc., New York, N.Y., a corporation of Delaware

No Drawing. Filed Feb. 14, 1968, Ser. No. 705,286

Int. Cl. C10m 3/40

U.S. Cl. 252—32.5

11 Claims

ABSTRACT OF THE DISCLOSURE

An oil-in-water emulsion having superior lubricating and cooling properties is comprised of about 50–99 weight percent water and about 1 to 50 weight percent of an oleaginous component containing a mineral oil, an unsaturated fatty ester of a monohydric alcohol, and an alkanolamine salt of an aliphatic alcohol polyalkyleneoxy phosphate ester acid. It is preferred that the mineral oil have a viscosity of about 100 to 2000 SUS at 100° F., and typically the alkanolamine used to form the salt of the phosphate ester can be triethanolamine. The viscosity of the emulsion and an improvement in its adhesive properties can be obtained by including a hydrocolloid in the water of the emulsion.

This invention is concerned with a novel lubricating composition having superior cooling and lubricating properties, particularly for metal working operations. More specifically, the invention is concerned with a lubricating composition comprising an aqueous emulsion of a mineral oil, an unsaturated aliphatic acid ester of a monohydric alcohol, and an alkanolamine salt of an aliphatic alcohol polyalkyleneoxy phosphate ester acid.

Metal working operations such as cutting, grinding, broaching, tapping, rolling, drawing and extruding, in which large amounts of metal are removed or displaced, require lubricating fluids which must perform several functions. Although the relative importance of the various functions of the lubricant may vary somewhat according to the particular operation involved, three major functions required in most metal working processes are removing heat generated by the operation, providing lubrication and reducing friction at contacts between the working tool and the metal work piece, and preventing welding and adhesion between the working tool and the metal removed or displaced from the work piece. Each of these functions is in itself significant and each may, to an extent, be performed by substances or compositions known in the art. For example, water can effect some improvement in metal working due to its superior heat extraction properties. Similarly, mineral oils alone or in combination with various additives may provide sufficient lubrication and synthetic materials such as carbon tetrachloride can be used to prevent welding or adhesion. Although all of these materials have been used, none is completely satisfactory in actual machine practice. Water does not have sufficient lubricating or antiweld properties; mineral oil is deficient in cooling and antiweld properties; and carbon tetrachloride is too toxic for general use.

To overcome these objections to individual fluids, and to combine the individual advantages of each, various oil-water emulsions have been proposed. These emulsions usually consist essentially of mineral oil, water and one or more emulsifiers. They may also contain various additives such as a bactericide, rust preventive, foam inhibitor and the like. Where special lubricity or antiweld properties are required, other additives such as a lard oil, sulfurized lard oil, chlorinated wax and the like have been used.

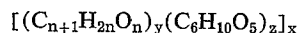
Accordingly, it is the purpose of this invention to provide a new lubricating composition which has superior

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cooling and lubricating properties for metal working operations. More particularly, it is the objective of this invention to combine the superior cooling properties of water with the superior lubricating properties of mineral oil in an single composition comprising an oil-in-water emulsion. It is a further objective to provide additives which are soluble in the mineral oil of the emulsion which increase both lubricating and emulsifying characteristics. It is another objective to provide additives which are soluble in the water of the emulsion which increase viscosity and adhesive properties.

These objectives are realized in the novel lubricating compositions of this invention which are oil-in-water emulsions comprising about 50–99 weight percent water and about 1 to 50 weight percent of an oleaginous component or dispersed phase containing about 6 to 14 parts by weight of a hydrocarbon mineral lubricating oil, often having a viscosity in the range of about 40 to 3000 SUS at 100° F., preferably in the range of about 100 to 2000 SUS at about 100° F.; about 1 to 4 parts by weight of an unsaturated fatty acid ester of a monohydric alcohol; and about 2 to 8 parts by weight of an alkanolamine salt of an aliphatic alcohol polyalkyleneoxy phosphate ester acid. If desired, this emulsion can be prepared by first combining approximately equal parts by weight of water and the separately mixed oleaginous component and then, if desired, diluting further with water to concentrations as low as one part of oleaginous component per 100 or more parts by weight of water, or the more dilute emulsion can be prepared directly with one water addition. Often the lubricating composition may contain from about 5 to 40% up to about 50% by weight of the oleaginous component and the remainder water. The water may contain a minor amount, e.g. 0.1 to 5 weight percent based on the water, of a hydrocolloid as a thickening and tactifying agent and the emulsion may also contain other additives such as rust and foam inhibitors, etc.

The hydrocolloid or polysaccharide components, which can be employed in this composition are complex, high molecular weight, water-soluble polymers derived from synthetic or natural products such as guar seed, trees, shrubs, and marine algae seaweed. Compounds of this type are commercially available and include those compounds having the general formula



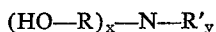
where $n=4$ or 5 , x =about 20 to 150, $y=1$ to 3 , and $z=2$ to 10 . In some compounds, e.g. mannose-galactose polymers $n=5$, $y=1$ to 3 and $z=2$ to 5 , while in, for instance, arabinose-galactose polymers $n=4$. The total molecular weight of the carbohydrate polymers is often about 15,000 to 100,000. Thus these vegetable colloids (hydrocolloids, polysaccharides) are high molecular weight polymers made up of carbohydrate molecules linked together. The particular carbohydrate units involved depend on the source and any chemical processing which has taken place.

The unsaturated fatty ester component can be a synthetic product derived, for example, from a natural fatty oil such as sperm oil. Natural sperm oil can contain about two-thirds fatty alcohol esters of fatty acids, and about one-third triglyceride esters of fatty acids. In the synthetic fatty oil of this invention, the triglyceride portion has been converted to methyl esters and the glycerine removed. These methyl esters of fatty acids, together with the natural higher alcohol esters of fatty acids, act as oiliness agents and emulsify somewhat more readily than triglycerides. Thus, it is preferred that the ester be substantially free of triglycerides. The total synthetic ester product will typically show an iodine value of about 40 to 120. The unsaturation content of this product, as indicated by

the iodine value, is especially important in providing the improved lubrication shown by the emulsions of this invention since molecules containing unsaturated linkages are capable of bonding with metal surfaces. A preferred material of this type is a methyl ester of sperm oil. The synthetic fatty acid ester component can also be derived, for example, from monohydric alcohols of about 1-30, preferably about 1 to 20, carbon atoms, such as allyl and oleyl alcohols, oxo alcohols, methanol and the like saturated and unsaturated aliphatic hydrocarbon alcohols, and fatty or aliphatic monocarboxylic acids of about 10 to 24 carbon atoms such as stearic, oleic, palmitic, linoleic, caproic, and the like saturated and unsaturated aliphatic hydrocarbon acids. In order to provide unsaturation in the fatty acid ester either the alcohol and/or the acid from which the ester is derived should be olefinically-unsaturated. Thus vinyl stearate and allyl stearate may be used in place of the methyl sperm ester.

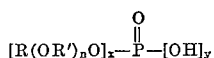
The fatty alcohol polyethyleneoxy phosphate ester alkanolamine salt component, has at least a dual function in the total composition namely, it acts as an emulsifying agent due to the presence of both hydrophilic and lipophilic groups in the molecule, and as an extreme pressure agent with antiwear and antiweld properties. This component may also function to improve lubricity and also to inhibit rust and improve wet-out from the emulsion due to its surface active properties.

These fatty alcohol polyethyleneoxy phosphate ester amine salts can be prepared by reacting the phosphate ester acid with an alkanolamine having the structure:



where R is an alkylene radical of 1 to 5 carbon atoms, R' is hydrogen or an alkyl radical of 1 to 5 carbon atoms, $x=1$ to 3, $y=0-2$ and x plus $y=3$. A ratio of less than one part alkanolamine for each part of phosphate ester can be employed in order to retain a greater degree of oil solubility. Preferably, the mole ratio of alkanolamine to phosphate ester reacted will be about 1:4 to 1:2.

The phosphate ester acids from which the alkanolamine salts are derived may be prepared by conventional methods. For example, the fatty alcohol may be treated with an alkylene oxide, followed by reaction with phosphorus pentoxide. The phosphate ester acids resulting from this reaction are complex mixtures; however, they can be generally described by the following formula



where:

R is an aliphatic hydrocarbon group ranging from about 5 to 30, preferably about 8 to 20, carbon atoms, R' is an alkylene group ranging from about 2 to 10 carbon atoms, preferably 2 carbon atoms, n is an integer of about 2 to 30, x and y are integers of 1 or 2, and the total of x and y is 3.

These phosphate ester acids are commercially available. Although alkyl groups are preferred as the R groups, in view of the lubricity and biodegradable factors associated with such radicals, a mixed alkyl group or an unsaturated aliphatic structure such as dodecenyl or octadecenyl groups can be R in the above formula.

The hydrophilic-lipophilic balance in the above formula is generally controlled by the R and R' groups. Oil-solubility tends to increase as the carbon-carbon chain length increases, and water solubility tends to increase with larger values for the n integer. Depending somewhat on the size of the R and R' groups, values of n below about 5 tend to give oil-soluble compositions, and above about 8 or 10, the compositions tend to be water-soluble. The hydrophilic properties of these phosphate ester acids are further increased by reacting with the alkanolamine.

The fatty ester component and the phosphate ester alkanolamine salt component of this invention possess yet

another advantage due to their linear fatty type structure; namely, biodegradability. This property can be important in assuring eventual degradation and thus avoid polluting natural water sources such as rivers and lakes.

The principals of this invention will be further illustrated by the following examples.

EXAMPLE A

2.5 parts methyl sperm oil and 5 parts of an oil-soluble polyethyleneoxy phosphate ester acid containing 4 ethyleneoxy groups, and derived from predominantly oleyl alcohol, characterized by an acid number of 140-160 and a phosphorous content of 5.0 percent, were dissolved in 10 parts of a 300 SUS/100° F. mineral oil, and 2.5 parts triethanolamine were added to form the amine salt of the phosphate ester acid. Soluble oil A was prepared by dispersing 40 parts of this base oil concentrate in 60 parts water.

EXAMPLE B

2.5 parts methyl sperm oil and 5 parts of an oil-soluble polyethyleneoxy phosphate ester acid containing 5 ethyleneoxy groups and derived from predominantly C₁₂ aliphatic alcohol, characterized by an acid number of about 170-190 and a phosphorous content of about 6.1 percent, were dissolved in 10 parts of a 300 SUS/100° F. mineral oil. To this blend were added 2.5 parts triethanolamine. 40 parts of this base oil concentrate were dispersed in 60 parts water to make Soluble Oil B.

EXAMPLE C

In order to increase the tackiness and viscosity properties of the finished soluble oil, a water solution of a hydrocolloid was prepared by dispersing 0.6 part of a high molecular weight polysaccharide, Polyhall 705D-163 (Stein, Hall and Co., New York) in 99.4 parts water. This concentration of this hydrocolloid polysaccharide provides water with a viscosity of about 800 to 1000 cps., or approximately 1000 times greater than water. Soluble Oil C was prepared by dispersing 40 parts of the mineral base oil concentrate of Example B in 60 parts of the hydrocolloid solution. Soluble Oil C, in addition to higher viscosity, has "stringiness" or tacky properties, as readily evidenced by placing a drop of the soluble oil between thumb and forefinger and slowly drawing the fingers apart.

The metal working properties of these lubricants were evaluated by means of a tapping test. This test was conducted using ½ x 13 NC express tap designed for extrusion rather than cutting, and using a lead screw for self-feed. The metal cylinder blanks were ¾ inch long by ⅞ inch OD, with a 1⅝ inch double drilled and reamed inside hole. These metal blanks were enclosed in a rubber holding cup for test, to which about 15 ml. of the test fluid were added. Tests are run at 162 r.p.m., and each test is about 20 seconds duration. The torque developed by the tap as it extruded the metal on its passage through the cylinder blank was measured by a Sanborn torque recorder through a strain gage pickup.

The reduced torque requirements of the compositions of this invention are shown in Table I.

TABLE I

Lubricant	Inch pounds torque	
	Aluminum	1117 stainless steel
Water.....	500	500
Uncompounded mineral oil.....	400-500	450
Mineral oil plus 5% methyl sperm oil.....	240	405
EP cutting oil, sulfur-chloride additive.....	315	180
Conventional soluble oil.....	235	336
EP soluble oil, sulfur-chloride additive.....	257	210
Soluble oil A.....	195	172
Soluble oil B.....	207	171
Soluble oil C.....	209	167

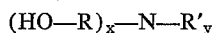
The above data clearly show that the composition of this invention, as incorporated in Soluble oils A, B and C, provides a significant torque advantage in metal working operations involving both aluminum and stainless

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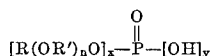
steel. It is, in fact, particularly surprising to note that application of the lubricant of this invention to steel results in a definite torque advantage over that obtained with historically-used powerful but corrosive sulfur and chlorine additives as employed in either mineral oil or soluble oil formulations. Further, the magnitude of the torque reductions in all cases is surprising and unexpected. Compare, for example, torque reduction on aluminum using Soluble oils A, B and C with that obtained using methyl sperm oil in mineral oil, soluble oil, EP cutting or EP soluble oil.

I claim:

1. An oil-in-water composition containing about 50-99 weight percent water and about 1 to 50 weight percent of a dispersed phase comprising about 2 to 8 parts by weight of an alkanolamine salt of an aliphatic alcohol polyalkyleneoxy phosphate ester acid, said alkanolamine having the structure:



where R is an alkylene radical of 1 to 5 carbon atoms, R' is hydrogen or an alkyl radical of 1 to 5 carbon atoms, x is 1 to 3, y is 0-2 and $x+y=3$, and said phosphate ester acid having the structure:



wherein R is an aliphatic hydrocarbon group of about 5 to 30 carbon atoms, R' is an alkylene group of about 2 to 10 carbon atoms, n is about 2 to 30, x and y are 1 to 2 and $x+y$ is 3; about 6 to 14 parts by weight of a hydrocarbon lubricating oil; and about 1 to 4 parts by weight of a fatty acid ester of aliphatic monohydric alcohol, the acid group of said ester having about 10 to 24 carbon atoms and the alcohol group of said ester having about 1 to 30 carbon atoms, and at least one of said acid and alcohol groups being olefinically-unsaturated.

2. The composition of claim 1 in which R of the phosphate ester acid is an alkyl group of about 8 to 30 carbon atoms, and the fatty acid ester is substantially free of triglycerides.

3. The composition of claim 2 in which the alkanolamine is triethanolamine.

4. The composition of claim 2 which contains a minor effective amount of a water-soluble polysaccharide carbohydrate polymer having a molecular weight of about 15,000 to 100,000.

5. The composition of claim 3 in which the hydrocarbon oil has a viscosity of from about 100 to 2000 SUS at 100° F. and the fatty acid ester is methyl sperm oil.

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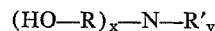
6. The composition of claim 3 which contains about 0.1 to 5 weight percent based on the water of said carbohydrate polymer.

7. The composition of claim 3 in which the fatty acid ester has an iodine value of about 40 to 120.

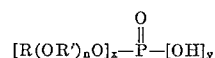
8. The composition of claim 7 wherein the phosphate ester is oil-soluble and R' is ethylene.

9. The composition of claim 1 wherein the phosphate ester is oil-soluble and R' is ethylene.

10. A composition comprising about 2 to 8 parts by weight of an alkanolamine salt of an aliphatic alcohol polyalkyleneoxy phosphate ester, said alkanolamine having the structure.



where R is an alkylene radical of 1 to 5 carbon atoms, R' is hydrogen or an alkyl radical of 1 to 5 carbon atoms, x is 1 to 3, y is 0 to 2 and $x+y=3$, and said phosphate ester acid having the structure:



wherein R is an aliphatic hydrocarbon group of about 5 to 30 carbon atoms, R' is an alkylene group of about 2 to 10 carbon atoms, n is about 2 to 30, x and y are 1 to 2 and $x+y$ is 3, about 6 to 14 parts by weight of a hydrocarbon lubricating oil and about 1 to 4 parts by weight of a fatty acid ester of aliphatic monohydric alcohol, the acid group of said ester having about 10 to 24 carbon atoms and the alcohol group of said ester having about 1 to 30 carbon atoms and at least one of said acid and alcohol groups being olefinically-unsaturated.

11. The composition of claim 10 in which R of the phosphate ester acid is an alkyl group of about 8 to 30 carbon atoms and the fatty acid ester is substantially free of triglycerides.

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DANIEL E. WYMAN, Primary Examiner

I. VAUGHN, Assistant Examiner

U.S. Cl. X.R.

72-42; 252-49.5