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METAL WORKING LUBRICANT COMPOSITIONS

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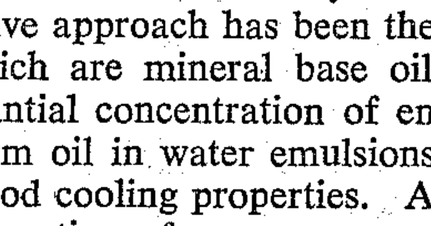
This invention relates to an aqueous cutting oil composition possessing outstanding anti-rust properties and lubricity. More particularly, this invention relates to a cutting oil composition comprising water and a salt of a sebacic acid amide, which possesses the high heat capacity of water while retaining the desirable properties of petroleum base cutting oils. This application is a continuation-in-part application of S.N. 203,442, filed on June 19, 1962.

The use of high machine speeds in metal working operations such as cutting, drilling, broaching, drawing, and the like has placed severe demands on the lubricant employed to cool and lubricate the tool and metal work piece. The enormous amount of heat generated at the tool-work piece interface must be quickly dissipated in order to prevent damage to the tool and work piece. The second major requirement of metal working lubricants is the reduction of friction between the tool and work piece to prevent wear, scoring, and welding of the contacting parts. The requirements of cooling and lubricating place severe restrictions on the composition of metal working lubricants. Water is an excellent cooling fluid because of its high heat capacity, but it is almost completely deficient in lubricating properties. Mineral lubricating oils afford excellent lubrication and reduce friction but are relatively poor coolants.

A number of metal working lubricants have been formulated to provide both lubricity and high heat capacity. One effective approach has been the development of soluble oils which are mineral base oil lubricants containing a substantial concentration of emulsifying agents so that they form oil in water emulsions possessing both lubricity and good cooling properties. Another approach involves the formation of an aqueous non-corrosive cutting solution comprising water, alkylphenol-ethylene oxide reaction products, an alkali metal nitrite and/or an inorganic phosphate. In this composition, the alkylphenol-ethylene oxide product acts as a surface active agent while the nitrite-phosphate combination functions as a corrosion inhibitor. A novel metal working lubricant has now been discovered which possesses substantial advantages in lubricity, stability, transparency and anti-rust properties.

The metal working lubricant composition of this invention comprises water and 5 to 50 weight percent of an alkali metal salt of a substituted amide of sebacic acid having the formula:



in which M represents an alkali metal, and R and R′ each represent a hydroxyalkyl radical having from 1 to 4 carbon atoms. This lubricating composition is characterized by its outstanding anti-rust properties, lubricity and excellent stability. A still more effective metal working lubricant of the invention having enhanced anti-rust and lubricity properties comprises the foregoing composition containing, in addition, 2 to 15 weight percent of an aliphatic alkanolamine corresponding to the formula:

NRR′R″

wherein R is selected from the group consisting of hydrogen, an alkyl radical and a hydroxy-substituted alkyl radical, R′ is selected from the group consisting of an alkyl radical and a hydroxy-substituted alkyl radical, and R″ is a hydroxy- substituted alkyl radical, said alkyl and hydroxy-substituted alkyl radicals containing 1 to 8 carbon atoms and preferably 1 to 4 carbon atoms.

It is essential that the anti-rust and lubricity component of the invention be a derivative of sebacic acid. Salts of monoamides of dibasic acids of similar structure, as shown below, are ineffective for preparing metal working lubricant compositions. The alkali metal salts of substituted monoamides of sebacic acid defined hereinabove are all effective for the invention. The lubricant composition will generally contain 5 to 50 weight percent of the sebacic acid amide with the preferred proportion being from 10 to 30 weight percent.

Suitable alkali metal salts of sebacic acid amides of the invention include sodium N,N-bis(2-hydroxyethyl)-sebacamate, potassium N,N-bis(2-hydroxyethyl)sebacamate, sodium N,N-bis(2-hydroxypropyl)sebacamate, potassium N,N - bis(2 - hydroxypropyl)sebacamate, sodium N,N-bis(2-hydroxybutyl)sebacamate, sodium N,N-bis(3-hydroxybutyl)sebacamate, and the like.

The secondary and tertiary alkanolamines defined hereinabove are optionally employed in preparing the lubricant of the invention. When employed, the alkanolamine enhances both the anti-rust and lubricity of the metal working lubricant composition. While these can be employed in the proportion of 2 to 15 weight percent, it is preferred to employ 5 to 12 weight percent of the alkanolamine in the preferred lubricant compositions.

Examples of alkanolamines useful in formulating the preferred cutting fluids of the invention are triethanolamine, diethanolamine, tri-(4-hydroxy - n - butyl)amine, triisopropanolamine, diisopropanolamine, dimethylethanolamine, monoethylethanolamine, methyl-(4-hydroxy-n-butyl)amine, 2-aminoethylethanolamine and aminoethyl isopropanolamine. Mixtures of secondary and tertiary alkanolamines, such as mixed isopropanolamines containing primary, secondary and tertiary isopropanolamines, are also useful in the preferred formulation of the cutting fluids of the invention. Exceptionally high rust protection is obtained when the alkali metal salt of sebacic acid amide is employed with triethanolamine.

The use of other components to further improve the lubricity and anti-rust properties of the aqueous cutting oil composition is also contemplated. For example, while the cutting oil of the invention provides outstanding anti-rust properties, these properties may be enhanced by the addition of minor amounts of water-soluble anti-rust agents, such as the alkali metal nitrites in combination with the sebacic acid amide.

It is further contemplated that the lubricity of the cutting oil composition can be improved by employing water-soluble glycols or polyglycols, such as the polyethylene glycols having molecular weights in the range of about 200 to 1,000, in combination with the sebacic acid amide. The incorporation of other beneficiating components is also contemplated including oiliness agents, such as a triethanolamine-oleic acid reaction product, water-soluble phosphates, such as potassium pyrophosphate and potassium phosphate with potassium thiocyanate. The use of bactericides and anti-foam agents is also contemplated.

The outstanding anti-rust properties of the cutting fluids of the invention were shown in a rust test which is specifically designed to evaluate the rust protection afforded by soluble oils and aqueous cutting fluids and which involves the determination of that dilution of a soluble oil or cutting fluid with synthetic hard water which causes the rusting of cast iron.

The procedure involves placing portions of solutions formed by diluting the cutting fluid with varying amounts of synthetic hard water on a polished cast iron plate 11" x 5½" x ½" which is cross hatched into equal 9/16" squares. Drops of solutions ranging from a 10:1 dilution to 90:1 dilution in increments of 5 are placed on different squares of the polished cast iron plate. The plate containing the various dilutions is allowed to stand over night in a humidity controlled room under which conditions the drops are evaporated in 1 to 2 hours. The squares are examined for signs of rust and the highest dilution showing no rust whatever is noted and reported as "No Rust" and the lowest dilution showing rust is noted and recorded as the "Rust" dilution. The synthetic hard water contained 125 p.p.m. hardness and was prepared by dissolving 2.63 grams of anhydrous calcium chloride in 5 gallons of distilled water. The pH was adjusted to 6.5 to 7.5 by the addition of 10% sulfuric acid or 10% sodium bicarbonate as required.

In Table I there are shown the rust protection afforded by the following aqueous cutting fluids in the above described rust test.

Composition A:
10% sodium N,N-bis(2-hydroxyethyl)glutamate
90% water
Composition B:
10% sodium N,N-bis(2-hydroxyethyl)adipamate
90% water
Composition C:
10% sodium N,N-bis(2-hydroxyethyl)isosebacamate
90% water
Composition D:
10% sodium N,N-bis(2-hydroxyethyl)sebacamate
90% water
Composition E:
10% sodium N,N-bis(2-hydroxyethyl)sebacamate
10% triethanolamine
80% water
Composition F:
10% sodium N,N-bis(2-hydroxyethyl)glutamate
10% triethanolamine
80% water
Composition G:
10% sodium N,N-bis(2-hydroxyethyl)isosebacamate
10% triethanolamine
80% water
Composition H:
10% sodium N,N-bis(2-hydroxyethyl)malonamate
10% triethanolamine
80% water
Composition I:
10% triethanolamine
90% water

TABLE I

Composition	No Rust	Rust
A		10
B		10
C	10	15
D	60	65
E	90	
F	10	15
G	30	35
H		10
I	40	45

The aqueous cutting oil composition of the invention has substantially improved lubricity in comparison to other aqueous cutting oils. The lubricity of cutting oil compositions is determined on a device called a "Stick-Slip Test Apparatus" manufactured by the Laboratory Equipment Corporation. This device is suitable for evaluating the frictional properties of lubricants including the water-based cutting oil compositions of the invention. The principles underlining this test are described in an

article entitled, "Characteristics of Typical Polar and Non-Polar Lubricant Additives Under Stick-Slip Conditions," by M. Eugene Merchant, which appeared on pages 56–61 of the June 1946 issue of "Lubrication Engineering." The test results are expressed in static and kinetic coefficients of friction.

The commercial aqueous cutting oil composition used for comparison in this example consisted of polyethylene glycol 600, sodium nitrite, ethanolamine, and water. Composition E of this invention described in Example I above was compared to the foregoing commercial cutting oil. Both cutting oils were employed in 50:1 dilutions. The test results are given in Table II below.

TABLE II

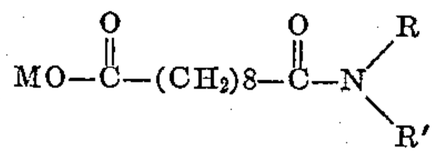
Stick-Slip Test

	Coefficient of Friction			
	Commercial Aqueous Cutting Oil		Composition E	
	Static	Kinetic	Static	Kinetic
10 lb. load	.48	.33	.41	.37
50 lb. load	.55	.38	.43	.38
90 lb. load	Off scale		.42	.37

The foregoing results show a substantial improvement in lubricity as evidenced by the coefficients of friction of Composition E of this invention, particularly in the static coefficient of friction.

We claim:

1. A metal working lubricant composition comprising water and 5 to 50 weight percent of an alkali metal salt of sebacic acid amide having the formula:



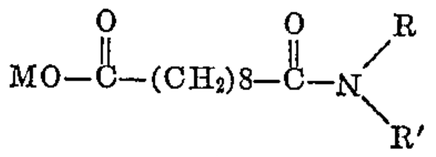
in which M is an alkali metal and R and R′ each represent a hydroxylalkyl radical having from 1 to 4 carbon atoms.

2. A composition according to claim 1 in which said alkali metal is sodium.

3. A metal working composition according to claim 1 in which said sebacic acid amide amounts to 10 to 30 weight percent.

4. A composition according to claim 1 in which R and R′ each represent a 2-hydroxyethyl radical.

5. A metal working lubricant composition comprising water, 5 to 50 weight percent of an alkali metal salt of sebacic acid amide having the formula:



in which M is an alkali metal and R and R′ each represent a hydroxyalkyl radical having from 1 to 4 carbon atoms and 2 to 15 weight percent of an alkanolamine having the formula:

NRR′R″

in which R is selected from the group consisting of hydrogen, an alkyl radical and a hydroxy-substituted alkyl radical, R″ is selected from the group consisting of an alkyl radical and a hydroxy-substituted alkyl radical and R″ is a hydroxy-substituted alkyl radical, said alkyl and hydroxy-substituted alkyl radicals containing 1 to 8 carbon atoms.

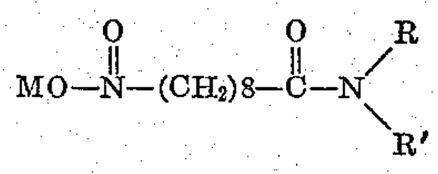
6. A composition according to claim 5 in which said alkanolamine is triethanolamine.

7. A metal working lubricant composition comprising water and 5 to 50 weight percent of sodium N,N-bis(2-hydroxyethyl)sebacamate.

8. A metal working lubricant composition comprising water, 5 to 50 weight percent of sodium N,N-bis(2-hy-

droxyethyl)sebacamate and 2 to 15 weight percent of triethanolamine.

9. A metal working lubricant composition consisting essentially of water and from 5 to 50 weight percent of an alkali metal salt of sebacic acid amide having the formula:



in which M is an alkali metal and R and R' each represent a hydroxyalkyl radical having from 1 to 4 carbon atoms.

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