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METALWORKING LUBRICANT

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1

This invention relates to an improved lubricating composition and more particularly to a composition especially adapted for lubricating metals during processing operations such as cutting, drilling, tapping, milling, drawing and the like. By way of conventional designation in the art, the lubricating compositions with which the present invention is concerned fall within the class commonly referred to as "soluble oils." These, as is well known, comprise a lubricating oil having dissolved or dispersed therein an emulsifying material imparting to the oil a capacity for substantial aqueous dilution to form a stable oil-in-water emulsion.

The emulsion so formed is utilized by pouring over the tool and the work in a steady stream, and functions to dissipate the heat from both the tool and the work; improve the quality of the surface produced; lubricate the surfaces in contact between the tool and the work; wash away the chips; and to provide lubrication between the chip and the tool, thus reducing the pressure of the chip on the tool. Oil emulsions are normally used where roughing cuts are being made. In roughing cuts, the primary object is to remove material and the quality of the surface produced has been considered secondary. However, since in the subsequent finishing cut only a very small amount of material is removed, the preceding rough cut should not leave the work in such a condition that the finishing cut will not remove the scars left by the rough cut. Therefore, the nature of the cutting oil used during the roughing cut should be such as to improve the quality of the surface being worked. There is ordinarily an enormous pressure exerted between the cutting edge of the tool and the metal being machined and in addition, due to the inherent resiliency of the metal, heavy pressures are maintained between the work and the surface of the tool just under the cutting edge and between the chips and the surface of the tool just back of the cutting edge. Therefore, it is requisite that a lubricant be provided which is capable of affording a high load-carrying film of lubricant between the cutting tool and the work being machined.

It has heretofore been the practice to improve the film strength of soluble oil lubricants by the incorporation therein of various compounds of sulfur, phosphorus, chlorine, fatty materials or combinations thereof. Such additive materials, however, have not been found to be entirely satisfactory and in addition to being comparatively expensive have the accompanying disadvantages

2

of tendency toward corrosion and rancidity particularly where the soluble oil containing the same is exposed to the atmosphere for an extended period of time, either before use or during use in a circulating type system in which the same oil is continuously recycled over the metal being worked.

It is accordingly an object of the present invention to provide an improved composition adapted for lubrication during metal processing operations, free of the aforementioned disadvantages. A further object is to provide an improved metal processing lubricant and particularly a lubricant which is stable and non-corrosive toward metals. A still further object is the provision of a low cost, commercially attractive metal lubricating composition.

The above and other objects which will be apparent to those skilled in the art are attained in accordance with the present invention, which comprises a soluble oil containing an organophilic bentonite. It has been found that the resulting compositions are effective lubricants for metal processing operations and afford lubricants of high film strength useful in various metal machining operations, including cutting, drawing, tapping, milling, and the like.

Bentonite, in its natural state, is a highly hydrophilic mineral consisting principally of montmorillonite, which is a hydrous aluminum silicate with a micaceous structure and an exceptionally small ultimate particle size. It occurs customarily as the salt of a moderately strong acid in which the cation is predominately sodium. It has heretofore been known that bentonite may be converted into a hydrophobic and organophilic condition by the introduction of long chain hydrocarbon radicals into the surface of the montmorillonite clay particles. The nature and preparation of organophilic bentonites has been described in detail by J. W. Jordan in the Journal of Physical and Colloid Chemistry, vol. 53, No. 2, 1949, pages 294-306. Briefly, however, the preparation of an organophilic bentonite involves hydration of the montmorillonite in a very dilute dispersion to separate the unit particles and to achieve complete removal of non-clay impurities. This step is resorted to since most montmorillonite in the crude state contain relatively large quantities of quartz which, if allowed to remain, would impart an abrasive character to the resulting product. The reactive sodium atoms of the clay particles are then replaced by organic cations and the product is washed, filtered, and dried. By proper choice of the or-

3

ganic cation, the properties of the resulting bentonite product can be controlled. Generally, for imparting organophilic properties to the bentonite, an organic ammonium compound having a hydrocarbon chain of at least 10 carbon atoms is employed. Increasing the chain length of the ammonium compound gives a product of increasing organophilic properties. The ammonium compounds are usually converted to the form of salts before use. Thus, organophilic bentonites have been prepared by the reaction of bentonite with various aliphatic ammonium salts, including the salts of long chain amines, and quaternary ammonium salts having one or more long aliphatic chains. The resulting products are generally referred to as alkyl ammonium bentonites and are more commonly known to the trade as "Bentones." The figure following the trade name "Bentone" indicates the number of carbon atoms in the hydrocarbon radical attached to the silicate structure of the bentonite. Thus, "Bentone 18" designates an organophilic bentonite having a chain of 18 carbon atoms. These bentonite products have substantially no affinity for water but because of the long hydrocarbon chains coating the particles and the platelets of clay, they are subject to ready dispersion in organic liquids.

It has been discovered, in accordance with the instant invention, that the machining efficiency of soluble cutting oils is considerably enhanced by the presence therein of an organophilic bentonite. The characterizing ingredients of the presently discussed composition accordingly include a soluble oil capable of forming an oil-in-water emulsion, an emulsifying agent present in a proportion sufficient to form a substantially stable emulsion and an organophilic bentonite.

As an example of the soluble cutting oil emulsions of this invention, the following is representative:

EXAMPLE

	Weight per cent
Mineral oil	10.0
"Bentone 18"	10.0
Oleic acid	4.5
Triethanolamine	1.5
Water	74.0

The procedure for the preparation of the above emulsified cutting lubricant is as follows: Individual "Bentone" is dispersed in the mineral oil-oleic acid mixture with an electric propeller-type mixer. The mixture is added to the water containing triethanolamine and homogenized in a high-pressure homogenizer. Heating is not necessary.

The emulsifier capable of forming oil-in-water emulsions utilized in the instant compositions may be any of the usual emulsifiers so employed. A very typical and usual material of this type is a soap of a long chain fatty acid. Thus, in the above illustrative composition, the oleic acid and triethanolamine in combination formed a soap which served as the emulsifier. Likewise, sodium or potassium soaps of animal and vegetable fats may similarly be employed. Numerous other common emulsifying agents such as the alkali soaps of rosin, oleic acid, naphthenic acids, etc., may also be used. These emulsifying agents may either be prepared "in situ" as the amine soap above or employed in already prepared form. The proportion of the emulsifying agent may be varied widely and will be largely dependent upon the effectiveness thereof as an emulsifying agent. For

4

practical purposes, it will be understood that the emulsifying agent is present in a minor proportion sufficient to provide a substantially stable emulsion.

Although a wide range of mineral lubricating oils may be employed as the base for the soluble cutting oils described herein, in general the base oil comprises an oil having a Saybolt Universal viscosity at 100° F. in the range of from about 40 to about 200 seconds and an A. P. I. gravity of 19° to 36°. However, in preparing the present compositions, it is preferred to use a light oil as the base, that is, one having a gravity in the range of from 20° to 36° A. P. I. and a viscosity at 100° F. of from 40 to 100 seconds.

The concentration of organophilic bentonite in the soluble oil composition is such as to improve the machining efficiency thereof and may be varied widely in accordance with the use to which it is to be put. Where the emulsion is to be employed as a coolant, as well as a lubricant and applied by a circulating pump or the like, the organophilic bentonite should ordinarily be present in a concentration of from about 0.1% to about 5%. Where the lubricant is to be applied to the work and tool by brushing or the like, the organophilic bentonite component will be present in the emulsion in a concentration of approximately 10% by weight. Generally, the emulsion will be marketed as a concentrate to be further diluted for use as required. In such concentrate, the organophilic bentonite component will usually be present in a concentration of from about 10% to about 20%. The concentrated emulsion may contain higher concentrations of organophilic bentonite up to about 50%, but such concentrations will usually be undesirable as they are quite viscous and difficult to stir into water to obtain the desired diluted emulsion for use. Thus, the composition of the present invention contemplates the presence of organophilic bentonites in soluble cutting oils in widely varying amounts.

The compositions of this invention accordingly comprise the combination of recited components in the following proportions:

	Broad Range	Preferred Range
	Percent by Weight	Percent by Weight
Mineral Lubricating Oil	5.0-25.0	5.0-15.0
Organophilic Bentonite	0.1-20.0	3.0-12.0
Emulsifier	0.5-10.0	4.0-6.0
Water	94.4-45.0	83.0-67.0

An evaluation of the tapping efficiency of a typical soluble oil emulsion with and without an organophilic bentonite was obtained by subjecting samples of the oils to the following test:

Tapping test

In the measurement of tapping efficiency of an oil, a series of holes is accurately drilled in a test metal, namely, SAE 1020 hot rolled steel. These holes are subsequently tapped with a series of taps in a drill press equipped with a table, which is free to rotate about the center, being mounted on ball bearings. A torque arm is attached to this "floating" table and this arm in turn actuates a spring scale so that the actual torque during tapping with the oil being evaluated is measured directly. The same taps used in evaluating the test oil are employed in tapping with a standard reference oil, which has arbitrarily been assigned an efficiency of 100 per cent. The aver-

5

age torque for the test oil is compared to that of the standard and a relative efficiency is calculated on a percentage basis. For example:

Torque with standard reference oil..... 19.3
Torque with test oil..... 19.8
Relative efficiency of test oil

$$\frac{19.3}{19.8} \times 100 = 97.4\%$$

The results of the above-described test in evaluating lubricants of the following composition are set forth below:

10.0% mineral seal oil.....	"As is"	(1 part product, 10 parts water)	73
4.5% oleic acid.....			
1.5% triethanolamine.....			
84.0% water.....			
Tapping efficiency, percent.....	96		
10.0% "Bentone 18".....	"As is"	(1 part product, 10 parts water)	88
10.0% mineral seal oil.....			
4.5% oleic acid.....			
1.5% triethanolamine.....			
74.0% water.....			
Tapping efficiency, percent.....	98		

From the foregoing, it will be seen that the presence of an organophilic bentonite in the soluble oil composition enhanced the tapping efficiency thereof. It will further be seen that a 1:10 dilution of the compositions with water indicated a marked improvement of the "Bentone"-containing soluble oil as compared with the diluted composition wherein "Bentone" was absent. Without being limited by any theory, it is believed that in the more concentrated composition, the soap content was sufficient to provide fairly good tapping efficiency, but as the compositions were diluted, the concentration of soap decreased and the improving benefits of the organophilic bentonite became more apparent. In every instance, improvement in machining efficiency was noted when an organophilic bentonite was present.

It is to be understood that the above description is merely illustrative of preferred embodiments of the invention of which many variations may be made within the scope of the following claims by those skilled in the art without departing from the spirit thereof.

I claim:

1. An aqueous soluble cutting oil emulsion consisting essentially of mineral lubricating oil dispersed in water, an oil-in-water type emulsifier present in minor proportion sufficient to form a substantially stable oil-in-water emulsion and between about 0.1 per cent and about 50 per cent by weight of an organophilic bentonite character-

6

ized by a hydrocarbon chain of at least 10 carbon atoms.

2. An aqueous soluble cutting oil emulsion consisting essentially of a mineral lubricating oil dispersed in water, stabilized with an oil-in-water type emulsifying agent present in a minor proportion sufficient to form a substantially stable oil-in-water emulsion, and containing an organophilic bentonite having a hydrocarbon chain of at least 10 carbon atoms present in amount sufficient to improve the tapping efficiency of said emulsion.

3. An aqueous soluble cutting oil emulsion consisting essentially of a mineral lubricating oil dispersed in water, stabilized with an oil-in-water type emulsifying agent present in a minor proportion sufficient to form a substantially stable oil-in-water emulsion, and containing an organophilic bentonite having a hydrocarbon chain of at least 10 carbon atoms, said organophilic bentonite being present in an amount sufficient to improve the tapping efficiency of said emulsion.

4. A composition capable of forming a substantially stable aqueous emulsion comprising the following components:

	Per cent by weight
Mineral lubricating oil.....	5.0-25.0
Organophilic bentonite having a hydrocarbon chain of at least 10 carbon atoms	0.1-20.0
Emulsifier (oil-in-water type)	0.5-10.0
Water	94.4-45.0

5. A composition capable of forming a substantially stable aqueous emulsion comprising the following components:

	Per cent by weight
Mineral lubricating oil.....	5.0-15.0
Organophilic bentonite having a hydrocarbon chain of at least 10 carbon atoms	8.0-12.0
Emulsifier (oil-in-water type)	4.0- 6.0
Water	83.0-67.0

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,517,577	Olsson	Dec. 2, 1924
2,291,066	Waugh	July 28, 1942
2,531,440	Jordan	Nov. 28, 1950