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SOLUBLE CUTTING OIL

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The present invention relates to soluble cutting oils of superior metal cutting performance and of improved stability in aqueous solution. It relates particularly to a metal working soluble oil composition which comprises, in combination, optimum proportions of sulfur-containing fatty oils and solubilizing agents such as the oil soluble metal petroleum sulfonates. The composition is further improved by incorporating a minor proportion, preferably from 0.5 to about 1% by weight, of a surface active agent of the type exemplified by the "Spans" and "Tweens" which are manufactured by the Atlas Powder Company. These are respectively partial fatty esters of sorbitan and the polyoxyethylene derivatives of such partial esters. The latter are preferred for the present invention. The fatty acid radicals of both types of esters are selected from those having not less than about 12, nor more than about 22 carbon atoms. Preferred compositions are the mono-, di- and trioleates and stearates of sorbitan, the polyoxyethylene tri-oleates and tri-stearates being specifically preferred.

In the prior art numerous inventors have combined various emulsifying agents with mineral oil to produce cutting oils. The use of sulfurized fatty oils also has long been known in the art. Sulfurized fatty oils are desirable constituents for cutting oils because they impart increased load bearing capacity, reducing damage to cutting tools and to the metal being worked and also reducing power consumption for metal working operations.

However, in the soluble cutting oils, as distinguished from the straight or non-emulsified cutting oils, the use of fatty oils and especially sulfurized fatty oils has definite limitations. They tend to destabilize the emulsion. They tend frequently to promote staining or rusting of the machined surfaces.

The present invention is based on the discovery that soluble cutting oils may be improved in their cutting performance, their emulsion stability, and their metal staining or rust promoting tendencies by combining certain modifiers with the principal emulsifier and the fatty oil or sulfurized fatty oil. In particular, the invention contemplates addition of 0.1 to about 3% by weight, preferably from 0.5 to 1%, of the polyoxyethylene partial fatty acid esters of polyhydric alcohols mentioned

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above. These are preferably used in combination with oil soluble sodium petroleum sulfonate and sodium naphthenate. It is desirable, also, to add a small amount of an alcohol such as isopropanol, ethylene glycol, or the like. Proportions of sodium naphthenate or equivalent should be between 0.1 and 10%, preferably between 4 and 10%. Some free acid, 0.1 to 2%, is desirable. The alcohol or glycol is used in proportions of 0.5 to 3%, preferably about 1 to 2%, and a small amount of water, usually accompanying some of these materials, is not objectionable.

As previously indicated a polyoxyethylene sorbitan tri-oleate ("Tween 85") is preferred as the partial ester although a closely comparable material polyoxyethylene sorbitan tri-stearate ("Tween 65") may be used satisfactorily.

The invention will be more fully understood by reference to the following examples:

EXAMPLE I

A composition was prepared consisting of:

71.5% by weight of mineral oil 105 S. S. U. viscosity @ 210° F.
10.3% sulfurized sperm oil (12% sulfur content)
5.8% oil soluble sodium petroleum sulfonate
7.4% naphthenic acid
0.9% flake NaOH
1.8% isopropanol (95%)
2.3% water

A blend of one part of the above with 9 parts of water was tested. This material showed excellent cutting performance. Tool life on a lathe cutting steel was increased by 30 to 100% over standard commercial soluble oils designated "A" and "B" below. This material was tested also for emulsion stability. Such stability is measured by forming the emulsion and measuring the volume in cubic centimeters of oil which separates from the emulsion after standing one hour and 24 hours respectively. The composition described above showed a separation of 1.5 cc. of oil after one hour in hard water and 2.5% cc. of oil after 24 hours. With soft water the only separation was a noticeable oil ring on the side of the glass container. With hard water there was also about 1 cc. of a "cream" (or light colored layer which can readily be redispersed) after one hour and 1/2 cc. of "cream" after 24 hours. In

soft water on the other hand there remained 3 cc. of "cream" after one hour and 2 cc. after 24 hours.

When 0.1% of "Tween 85" (polyoxyethylene sorbitan tri-oleate) was added to the above there was a noticeable oil layer after one hour in hard water but not of volume sufficient to measure. After 24 hours the oil showed a separation of 2.5 cc. In soft water the results were as before.

EXAMPLE II

Example I was repeated using 0.5% by weight, based on the total composition, of "Tween 85." In this case there was a formation of 1 cc. of light "cream" in hard water after one hour, 4 cc. of "cream" after 24 hours, and only 1 cc. of "cream" after 24 hours in soft water.

EXAMPLE III

Example II was repeated using, however, "Tween 65" which is the polyoxyethylene derivative of sorbitan tri-stearate. Results were very similar to those in Example II except that slightly more "cream" was found in hard water after one hour.

EXAMPLE IV

A composition was prepared exactly as in Example I, adding however 0.74% by weight, based on the total composition, of "Tween 85" and 0.30% of pine oil.

A comparison between Example I and Example IV showed that both gave equally good cutting performance. Example I was deficient in emulsion stability whereas Example IV was entirely satisfactory. Compared with standard commercial products, both showed superior rust prevention on the finished machined work. They were equivalent or superior, also, in gum forming tendencies.

EXAMPLE V

By increasing the concentration of "Tween 85" to 1% as compared with 0.5% in Example II, the only separation found in hard water was a light cream ring after one hour and 0.5 cc. of cream after 24 hours. In soft water there was no separation after one hour and only 0.5 cc. of cream after 24 hours.

The product of Example II was tested in a

cants of the same general type were not acceptable. For carbide tools in a turret lathe it showed superior performance compared to the two standard lubricants A and B. For threading stainless steel it was comparable to the best and better than a standard cutting oil which is commonly combined with white lead for superior performance.

The product of Example II proved to be the only soluble cutting oil of those tested which is entirely satisfactory for a particularly difficult threading operation. The results of various commercial tests indicate general superiority over the prior art products. See Table II below.

In general sulfurized sperm oil is preferred as the fatty oil and it may have a sulfur content in the range of 6 to 20% by weight. The preferred material has about 12% sulfur content by weight. A preferred combination is one to two parts by weight of the oil soluble petroleum sulfonate, preferably sodium petroleum sulfonate (although calcium sulfonate may be substituted in some cases), combined with one to two parts by weight of the sulfurized fatty oil of 6 to 20% weight of sulfur content. To these should be added the partial ester and other modifiers mentioned above. These are considered optimum ranges for the combination of sulfonate and sulfurized fatty oil because they show both an excellent cutting performance and a superior stability in solution.

As indicated in the data of the above examples, the addition of small proportions of the partial ester wetting agent, specifically at least one of the partial esters of sorbitan, and more specifically the polyoxyethylene derivatives of such esters, substantially improves emulsion stability. The use of proportions of 0.5 to 1% of such derivatives is a specific feature of the present invention which shows substantial advantage.

For some types of operation the odor of cutting oils of the above formulations may be somewhat objectionable. The odor may be considerably improved by addition of a small amount, for example 0.1 to about 1% of pine oil, a specific preferred proportion being about 0.30% by weight, based on the total composition. Such was used in Example IV.

The data of Examples I to V inclusive, are summarized in the following table:

Table I

	Hard Water		Soft Water	
	1 Hour	24 Hours	1 Hour	24 Hours
Untreated.....	1.5 cc. Oil.....	2.5 cc. Oil.....	Oil Ring.....	Oil Ring.....
Soluble Oil.....	1.0 cc. Cream.....	0.5 cc. Cream.....	3 cc. Cream.....	2 cc. Cream.....
	(Oil Layer.....)	2.5 cc. Oil.....	Oil Ring.....	Oil Ring.....
0.1 Wt. Percent Tween 85.....	1.5 cc. Heavy Cream.....	1 cc. Cream.....	2.5 cc. Cream.....	2.5 cc. Cream.....
	(1.5 cc. Light Cream.....)			
0.5 Wt. Percent Tween 85.....	1 cc. Light Cream.....	4 cc. Cream.....	No Separation.....	1 cc. Cream.....
0.5 Wt. Percent Tween 65.....	2 cc. Cream.....	3.5 cc. Cream.....	do.....	Do.....
0.75 Wt. Percent Tween 85.....	Cream Ring.....	1 cc. Cream.....	do.....	Do.....
1.0 Wt. Percent Tween 85.....	do.....	.5 cc. Cream.....	do.....	.5 cc. Cream.....

lathe for cutting steel using a heavy cut with single point cutting. It showed superior tool life and finish, on the machined product, over the standard commercial soluble oil A and for milling tough steel it was superior to standard commercial product B and only very slightly inferior to a most expensive special composition G which is sometimes used commercially for fine work. For turret lathe threading it showed highly satisfactory performance whereas two commercial lubri-

Results of commercial field tests, run by various independent manufacturers, on the soluble oil of the present invention, specifically that described in Example IV above, are summarized in Table II below.

It will be understood that other modifiers of conventional type such as anti-oxidants, rust inhibitors, anti-foamants, and the like, may be added to the composition of the present invention as is well understood in the art.

TABLE II
FIELD TESTS ON SOLUBLE CUTTING OILS

Operation	Oil	Relative Ratings ¹	Results
Single Point Turning SAE 4340 Molybdenum Steel.	{ Example IV..... } 10:1 Emulsions..... {	1 65 Min.	Tool Life at Cutting Speed of 100 F. P. M., 10/1 Emulsions.
	Comm. Prod. C.....	2 33 Min.	
	Comm. Prod. A.....	3 30 Min.	
	Comm. Prod. B.....	4 29 Min.	
Threading SAE 4140 Molybdenum Steel, 1 3/4" Diameter Bolt.	Example I, 8/1 Emulsion.....	1 72 Pieces per Set of Chasers; Thread 6 1/4" along Bolt.	
	Commercial Prod. D.....	2 40 Pieces per Set of Chasers; Thread 2 1/4" along Bolt.	
Milling SAE 3140 Ni-Cr Steel.....	{ Example IV, 10/1 Emulsion.....	2 88 Pieces per Set of Cutters.	
	Comm. Prod. E.....	3 80 Pieces per Set of Cutters.	
	Comm. Prod. F.....	4 Not Acceptable.	
	Comm. Prod. G.....	1 200 Pieces per Set of Cutters.	
	Example I, 12/1 Emulsion.....	1 300 Pieces per Grind of Form Tool.	
Turning and Threading 1/8" 430 Stainless Steel Rod.		1 800 Pieces per Set of Chasers. Superior Threads.	
	Comm. Prod. H.....	1 300 Pieces per Grind of Form Tool.	
	Example I, 8/1 Emulsion.....	1 900 Pieces per Set of Chasers.	
Vertical Milling SAE 1025 Carbon Steel.		1 35 Pieces First Cutter Grind, 54 Pieces at End of Production on Second Cutter Grind. Superior Finish.	
Turning and Drilling of Cast Iron.	Comm. Prod. H.....	2 Average 50 Pieces per Grind.	
	Example I, 8/1 Emulsion.....	1 Equivalent to Commercial Product B in Tool and Machine Upkeep. Less Chatter, More Smoke and Odor than Commercial Product B.	
Turret Lathe Including Threading.	{ Example IV.....	1 Job Completed with Example IV where Other	
	Comm. Prod. J.....	2 Oils Failed Completely.	
General Turret Lathe.....	{ Example IV.....	1 Superior to Competition.	
	Comm. Prod. K.....	2	
	Example IV.....	1	
Turret Lathe and Carbide Tools.....	Comm. Prod. L.....	1 "Far Superior."	
	Comm. Prod. M.....	3	

¹ On basis of cutting performance, machine upkeep, surface finish, 1=best.

What is claimed is:

1. A soluble metal working oil composition comprising a major proportion of mineral base lubricating oil, a minor emulsifying proportion of an oil-soluble sulfonate, a minor proportion of sulfurized fatty oil of 6-20 wt. % sulfur content, sufficient to increase the load-carrying capacity of said composition, the weight ratio of said sulfonate to said sulfurized fatty oil being about 1:2 to about 2:1, and about 0.1 to about 3% by weight of total composition of a polyoxyethylene fatty acid tri-ester of sorbitan.

2. Composition according to claim 1 to which is added 0.1 to 1% of pine oil.

3. A composition consisting essentially of 8 to 12% by weight of sulfurized sperm oil of 6 to 20 weight percent sulfur content, 0.5 to 2% of a polyoxyethylene fatty acid tri-ester of sorbitan wherein the fatty acid radical contains between 12 and 22 carbon atoms, 5 to 10% of oil soluble petroleum sulfonate, 0.1 to 10% of sodium naphthenate, 0.5 to 3% of alcohol and about 45 to 80% mineral base lubricating oil.

4. A composition consisting essentially of about 10 to 11% by weight of sulfurized sperm oil of 6 to 20 weight percent sulfur content, 0.5 to 1%

30 of polyoxyethylene sorbitan tri-oleate, 5 to 6% of oil soluble sodium petroleum sulfonate, 5 to 10% of sodium naphthenate, 1 to 2% alcohol, and 60 to 78.5% mineral oil.

5. A composition consisting essentially of approximately the following formula by weight:

	Percent
Mineral lubricating oil.....	70-75
Sodium petroleum sulfonate.....	5.8-10.2
Sodium naphthenate.....	2.9-8.2
40 Alcohol.....	1.2-1.3
Sulfurized sperm oil (12% sulfur content).....	10.2-10.3
Polyoxyethylene fatty acid tri-ester of sorbitan.....	0.1-1
45 Pine oil.....	0-1
Water.....	1-3

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