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CUTTING OIL

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This invention relates to sulfurized lubricants, such as cutting oils, and more particularly to light colored or transparent cutting oils of this character.

Cutting oils as heretofore employed have frequently been composed of fatty or animal oils, and blends of mineral oil with fatty oils. It has also been proposed to sulfurize blends of animal oil and mineral oil, but in such case, the sulfur is taken up almost entirely by the more reactive fatty oil to produce a product in which the sulfur is in stable tightly combined form with the fatty oil and diluted by the mineral oil. Cutting oils have also been prepared by incorporating sulfur directly with mineral oil, generally under relatively high temperatures and frequently under superatmospheric pressure to produce a product in which the sulfur is sufficiently combined with the mineral oil as to resist sulfur separation and sedimentation upon storage.

The earlier cutting oils consisting of simple fatty oils or blends thereof, as well as the sulfurized blends of mineral oil and fatty oil where the sulfur is taken up almost entirely by the fatty oil, do not possess the high cutting efficiency demanded by high speed cutting operations of the present time. The same is true of the straight sulfurized mineral oils where the sulfur is stably and tightly combined with the mineral oil.

In my copending application Serial No. 180,573, filed December 18, 1937, now U. S. Patent No. 2,167,439, dated July 25, 1939, the production of a cutting oil of superior cutting efficiency is described by sulfurizing a straight mineral lubricating oil with uncombined sulfur in the absence of added fatty oil or other highly reactive constituents which would preferentially combine with the sulfur, at a relatively low and critical temperature range of the order of about 310–360° F. and at atmospheric pressure to give approximately 2–3% of loosely combined sulfur in the mineral oil, and then stabilizing this sulfurized oil against sulfur separation and sedimentation by the addition of about 2–3% of a fatty oil or a separately sulfurized fatty oil. While such a product is outstanding in cutting efficiency and is eminently satisfactory for most cutting tool operations, it is comparatively dark in color and does not fall under the classification of a transparent cutting oil.

For some time, the trade has been seeking a light colored transparent cutting oil having high cutting efficiency which is particularly suitable for certain specialized cutting operations where

good visibility of the cutting tool and work is required. While there have been scattered products on the market termed transparent cutting oils, these have either been too dark in color to properly fall under this classification, or else have been lacking in cutting efficiency and unsuitable for high speed operations.

It is an object of the present invention to provide a transparent cutting oil which meets the demand both with respect to color and transparency as well as high cutting efficiency.

I have discovered that a satisfactory transparent cutting oil of this character can be produced by sulfurizing a light colored pale mineral lubricating oil under controlled conditions of comparatively low temperature and at atmospheric pressure so as to provide about 1.0–1.75% loosely combined sulfur in the oil, and then enhancing the cutting efficiency and at the same time stabilizing the sulfurized oil by the addition of a small proportion of certain oil soluble materials of the character of extreme pressure bases, such as tricresyl phosphate.

In the preparation of my improved product, a mineral lubricating oil or lubricating oil blend, containing light colored pale lubricating oils having a Saybolt Universal viscosity at 100° F. of about 100–180° seconds, is sulfurized by heating with free sulfur in the absence of added fatty oil or other constituents highly reactive with sulfur at a temperature of about 300–340° F. and preferably about 320° F. for a controlled period of time. The quantity of sulfur employed is calculated to give about 1.0–1.75% of loosely combined sulfur in the mineral oil, such that it is in a condition to provide high cutting efficiency. The quantity of sulfur added is above the range which will enter into simple solution in a light colored pale oil; and the composition is to be distinguished from a simple solution or suspension of sulfur in mineral oil which in concentrations of about 1% or more of sulfur will not withstand storage at low temperatures without sedimentation, even in the presence of stabilizers. The temperature and time of heating are critical and are found to lie within the limits of about 300–340° F. with a period of heating of from about 1–4 hours at the upper temperature specified, in order to give a product of good color with a light colored pale oil in which the sulfur is actually reacted with the mineral lubricating oil in a loosely bound form possessing the required high cutting efficiency, and yet can be stabilized against objectionable sulfur sedimentation upon storage at low temperatures by the

addition of small amounts of effective stabilizers of this invention.

To the sulfurized mineral oil prepared as above described, and containing sulfur in a loosely bound form, is added a material which dissolves in lubricating oil to a clear light colored solution, which possesses extreme pressure properties, and which functions as a stabilizer for the sulfurized mineral oil. Satisfactory materials of this type are the organic phosphate and phosphite esters, such as tricresyl phosphate, tricresyl phosphite, triphenyl phosphate, triphenyl phosphite, dibutyl phosphate and dibutyl phosphite. Other suitable extreme pressure bases may be employed, such as halogenated or chlorinated aromatic or aliphatic compounds of the character of chlorinated diphenyl, chlorinated fats and fatty oils, chlorinated wax, and sulfurized diphenyl. Any suitable material known in the art to possess extreme pressure properties and which satisfies the requirements set out above may be employed. Of the materials listed, tricresyl phosphate is preferred from the standpoint of effectiveness, availability and cheapness of product. The extreme pressure base or material is generally added in the proportion of about 1-3% and preferably about 1-1.5%. The extreme pressure material may be added following the sulfurization of the mineral oil and while the same is still at an elevated temperature. Or the extreme pressure material may be first admixed with the mineral oil and then the mixture sulfurized under the conditions set out above.

In order to further disclose the invention, the following example is given, it being understood that the example is merely for purposes of illustration and the invention is not restricted thereto:

A blend of 135.6 pounds of 100 E pale oil and 67.8 pounds of 180 C pale oil was used. These oils were light colored paraffin base lubricating distillates having the following tests respectively:

	100 E pale oil	180 C pale oil
Gravity.....	28.8	27.1
Flash.....°F	350	375
Fire.....°F	395	435
Viscosity at 100° F., S. U.....	98	184
Pour.....°F	+20	+20
Color—Lovibond.....	95/6"	130/6"

The resulting blend had a viscosity at 100° F. of approximately 125. This blend was mixed with two pounds of tricresyl phosphate in an ordinary grease kettle, and heating and stirring were started to bring the temperature up to approximately 300° F. in about one hour. While holding the temperature at about 300-310° F., two pounds of sulfur were added slowly over a period of approximately ½ hour and heating was then continued for another half hour at this temperature. The mix was then allowed to cool gradually for several hours and was drawn off through a 100 mesh screen to remove any suspended solids. The resulting product was a light pale oil having the following tests:

Gravity A. P. I.....	27.3
Viscosity at 100° F., S. U.....	119
Color—Lovibond ½" cell.....	35
Sulfur—per cent.....	1.15
Tricresyl phosphate—per cent.....	1.0

In a freezing test wherein the product was main-

tained for 120 hours at 30-35° F., it showed a slight wax cloud but no sulfur separation. Cutting tests showed it to be comparable in efficiency to the best cutting oils on the market, including the dark colored products of high sulfur content which are too dark to be classified under transparent cutting oils.

While the combination of the extreme pressure base with the sulfurized mineral oil prepared as set out above gives this superior type of transparent product having high cutting efficiency, it is found that the simple addition of these extreme pressure bases to a pale mineral oil of this character, even in substantial proportions, does not produce a cutting oil possessing satisfactory cutting efficiency.

As pointed out above, higher percentages of added sulfur than about 1.5% may not as a rule be loosely combined with a pale lubricating oil to produce a light-colored transparent cutting oil which can be stabilized against sulfur separation on storage at low temperatures. However, I have further found that a transparent cutting oil of satisfactory color but containing a higher percentage of overall sulfur content can be produced by sulfurizing a high sulfur containing distillate lubricating oil of pale color. For example, a distillate lubricating oil containing about 1.5-3.5% of naturally occurring sulfur, while not possessing high cutting efficiency such as to be suitable for a cutting oil of this type in its naturally produced state, can be sulfurized under substantially similar conditions to those set out above with about 0.8-1.5% of added free sulfur to give a highly effective product having an overall sulfur content of about 2.3-5.0% sulfur, and which is stable against sulfur separation and sedimentation by the use of similar quantities of the extreme pressure bases set out above. Consequently, where specifications call for a transparent cutting oil of reasonably good color having high sulfur content and which is suitable for high speed cutting operations, such a product is prepared from a high sulfur containing distillate lubricating oil of this character.

As an example of a cutting oil of this type, the following is given. A so-called Sultal 100 viscosity stock, which is a dewaxed high sulfur containing distillate lubricating oil of pale color from a naphthene base or Coastal crude, was selected having the following tests:

Viscosity at 100° F., S. U.....	105
Four, °F.....	+15
Color—Lovibond.....	10½"
Sulfur—per cent.....	2.53

38.2 pounds of the said oil were mixed with 0.4 pound of tricresyl phosphate in the mixing kettle, and heated and stirred to bring up to 300° F. 0.4 pound of sulfur were then slowly added while the temperature was maintained at about 300° F., heating being continued at this temperature for approximately one hour. The resulting product was then drawn through a 100-mesh screen, giving a pale-colored oil having the following tests:

Gravity, A. P. I.....	23.6
Viscosity at 100° F., S. U.....	106
Color—Lovibond ½" cell.....	25
Sulfur, per cent.....	3.61
Tricresyl phosphate—per cent.....	1.0

In a freezing test at 30-35° F. for 120 hours, only a slight cloudiness developed but no sulfur separated. In cutting tests, the product rated

better than the most effective cutting oils now on the market.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claim.

I claim:

A transparent cutting oil of good color consisting essentially of a pale mineral lubricating oil initially containing about 1.5-3.5% of naturally-occurring sulfur and sulfurized by heating

with sulfur in the absence of added fatty oil under temperatures of about 300-340° F. and at substantially atmospheric pressure to produce a loosely combined sulfur content providing an overall sulfur content in excess of about 2.3% and less than about 5.0%, and stabilized with about 1-3% of an extreme pressure material selected from the group consisting of chlorinated diphenyl, chlorinated fats, chlorinated fatty oils, chlorinated wax, sulfurized diphenyl, and aryl, alkyl and aralkyl esters of acids of phosphorus.

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