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SOLUBLE CUTTING OIL BASE

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This invention relates to a sulfurized transparent cutting oil base and more particularly to a cutting oil which will provide a high load-carrying, transparent, film of lubricant between the cutting tool and the work being machined. The present application is a continuation-in-part of our prior application Serial No. 471,015, filed January 1, 1943 (now abandoned).

Cutting fluids are generally sulfurized cutting oils and in use are poured over the tool and the work in a steady stream and function 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 work; prevent "build-up" on the tool or the welding of the work to the tool; to wash away the chips and to provide lubrication between the chip and the tool, thus reducing the pressure of the chip on the tool. These oils are used principally where roughing cuts are being made. In roughing cuts the primary object is to remove material, and the quality of the surface produced is secondary. However, since in the following 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. During these operations, particularly during the rough cut, the surface of the work should at all times be visible so that it may be determined by visual inspection without stopping the machine whether or not the tool is gouging and tearing the work rather than cutting. Therefore a superior cutting fluid should help to improve the quality of the surface produced during the roughing cut. There is normally an enormous pressure 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 lubricant be provided which is capable of providing lubrication even under heavy loads.

It has heretofore been recognized that the presence of sulfur and sulfur compounds improve the load-bearing characteristics of an oil and the load-bearing characteristics of the oil are increased by raising the normal quantity of sulfur found in the oil by the addition of elemental sulfur or organic oil-soluble sulfides or polysulfides, such as phenol polysulfides or alkylated phenol polysulfides, such as tertiary amyl phenol disulfide or di-iso-octyl phenol disulfide.

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For most effective use, the oil should contain from 8-15% of sulfur. Elemental sulfur is relatively ineffective for the reason that it is not sufficiently soluble in the oil. Therefore, direct sulfurization of the oil with sulfur or sulfur chloride, which discolors the oil, is generally resorted to as the most effective way of getting sulfur into the oil and the cutting fluid. This discoloration is generally to the extent that the resulting sulfurized oils are quite black and the cutting fluids made from these oils actually obscure the metal being fabricated, from view, thus making the required careful inspection of the work while machining quite impossible. The need for a transparent oil or cutting fluid is therefore obvious.

Many sulfurized oils, in addition to being dark in color, possess the objectionable feature of precipitating a large part of their sulfur content as a sediment on standing for any appreciable time. Unless care is taken to stir up the sediment from the bottom of the storage drum a large part of the effectiveness of the sulfur is lost by not being put into the cutting fluid and even where care is taken to stir up all of this sedimentized sulfur, some of its effectiveness is lost through settling in the sump which is part of the equipment of all machines using cutting fluid. A transparent sulfurized cutting oil base, which is free from sedimentation is therefore quite desirable.

It is therefore an object of the present invention to produce a sulfurized cutting oil base and cutting oil fluid of high load-carrying ability and capable of producing a transparent film of lubricant. Another object is the production of a sulfurized cutting oil base which is free from sedimentation. A particular object is to make possible the use of dark crude rosin derivatives by treating them, prior to sulfurization, in a manner which will clarify them and remove their objectionable color impurities. These and other objects will be apparent to those skilled in the art upon reading the following description.

Rosin is a mixture of pyroligneous acids, oleaginous in character, chief of which is abietic acid, an unsaturated acid of 20 carbon atoms. Rosin and rosin acids have been sulfurized in the past to produce sulfurized cutting oil bases, but such processes have not met with much success. The rosin acids have also been partially hydrogenated and then esterified with an aliphatic alcohol to yield esters which are oily liquids. These esters, particularly when derived from dark crude rosins, are quite dark in color

but they may be considerably lightened in color by repeated distillation.

As described in our earlier Patent No. 2,262,813, it has been found previously that certain esters of hydrogenated rosin acids can be sulfurized with a sulfurizing agent such as flowers of sulfur or sulfur chloride, to yield a sulfurized cutting oil base from which the sulfur will not precipitate or sedimentize. The product obtained from the purified esters may contain as high as 15% of sulfur, is clear, transparent and of a light red color, is completely soluble in highly refined Coastal lubricating oil, does not darken the color of the oil and when in solution in the oil no sedimentation occurs even after long standing.

In attempting to employ crude rosin esters, which are originally dark in color, we have found that such crude esters will react with as much sulfur as the purified ester but the resulting product is completely black and opaque. Except for color, the crude esters form just as good a sulfurized cutting oil base and are much more economical.

We have now discovered that if a small amount of phosphorus halide, preferably trihalide, is incorporated in the crude esters and reacted therewith, the resulting product is just as clear, transparent, bright red in color, soluble in lubricating oil and as stable in oil solution as is the product previously made by sulfurizing the purified aliphatic esters of hydrogenated rosin acid.

According to the preferred embodiment of the present invention crude aliphatic esters of hydrogenated rosin acids such as the methyl esters of the hydrogenated rosin acids are first treated with a suitable phosphorus halide, preferably a trihalide and more particularly phosphorus trichloride. The tribromide, trifluoride, or other halides may be used. Only a very small amount of the latter is used, for example about 0.5 to 1.0%, based on the weight of the ester to be treated. These proportions may vary, however, from 0.1 to 2%. The treatment involves mild heating, preferably somewhere around the boiling point of the phosphorus halide although the temperature may be varied rather widely. The time of heating required is relatively short but should be long enough to effect the desired decolorization of the ester.

The decolorized or clarified ester probably contains a very small amount of phosphorus, although it appears that the phosphorus halide combines largely with the impurities to form a complex. The complex probably disappears in solution, although some of the phosphorus halide as well as the complex may be evaporated. For example PCl_3 , which boils at about 168°F ., would evaporate rather rapidly if the temperature of treatment for decolorization or clarification were in excess of that figure. A temperature between 150° and 200°F . is preferred for PCl_3 although these limits may vary somewhat. For other halides the temperature will be different, being considerably higher, for example if the bromide is used. A reaction time of 1 to 10 minutes appears to be satisfactory for the temperature range of 150° to 200°F . with PCl_3 .

The decolorized or clarified ester, with whatever residue of phosphorus halide or reaction product which may be present, is next subjected to the step of sulfurization. For example, the treated esters may be sulfurized with from 8-15% of a sulfurizing agent such as flowers of sulfur for from 30 minutes to 2 hours at a temperature between 300° and 400°F . The resulting product is

clear, transparent, light red in color and stable in mineral lubricating oil solution.

Although a wide range of lubricating oils may be employed as the base for the cutting oils, in general the base oil comprises an oil having a viscosity at 100°F . in the range of from about 90-500 seconds, an A. P. I. gravity of 23° - 33° , and a flash point above 300°F . However, in preparing compositions of this character, we prefer to use a light Coastal oil as a base, that is one having a gravity in the range of from 25° A. P. I. to 31° and a viscosity at 100°F . of from 100-300 seconds.

Due to the structural non-uniformity between metal test pieces and other factors, a cutting test upon soluble cutting oils is difficult of reproduction. However, the Almen machine test is easily reproducible and furnishes an accurate comparison of the load-bearing characteristics of the oil tested. This test is conducted as described in U. S. Patent 2,001,861, issued to J. O. Almen.

The invention will be more readily understood from the following example which is given for the purpose of illustration:

As an example of our invention, 89 parts of a crude dark-colored methyl ester of hydrogenated rosin acids was treated with one part of phosphorus trichloride at a temperature of 150° to 200°F . for 5 minutes. Thereafter the treated ester and 10 parts by weight of sulfur were placed in a kettle, heated to 350°F . and held at this temperature while stirring for 45 minutes. The resultant product was clear, transparent, light red in color and contained 8.39% of sulfur.

10 parts by weight of the sulfurized product were blended in 90 parts by weight of a highly refined Coastal oil of 40 S. S. U. at 210°F . When subjected to the Almen test this blend carried 15 weights gradual loading and 8 weights shock loading.

A separate sample of 90 parts by weight of the crude methyl ester of hydrogenated rosin acid was sulfurized with 10 parts by weight of flowers of sulfur in the absence of phosphorus trichloride but following the time and temperature conditions outlined above. The resulting product was black and opaque. A 10% blend of this product in a 40 S. S. U. at 210°F . highly refined Coastal lubricating oil carried 15 weights gradual loading and eight weights shock loading on the Almen machine, thus showing that phosphorus trichloride gave no added load-carrying capacity. Neither of the above blends, even after standing several months, showed any tendency to separate or gave any evidence of sedimentation.

The amount of sulfur which is added obviously may be varied, though it will normally be between 2 and 20%, preferably 8 to 15%. Likewise, the amount of the base which is used in oil may be varied widely, for example from 1 to 20% or more, depending upon the particular purpose.

We claim:

1. The method of producing a sulfurized cutting oil base which comprises treating a crude dark colored aliphatic ester of hydrogenated rosin acids with 0.1 to 2.0% of a phosphorus chloride by weight, based on said ester, at a temperature of approximately the boiling point of said phosphorus chloride, for a period of time sufficient to substantially clarify said ester, and thereafter reacting said clarified ester with 8 to 15% flowers of sulfur at a temperature of 300° to 400°F . for a period of $\frac{1}{2}$ to 2 hours.

2. The method of producing a sulfurized cutting oil base which comprises treating a crude dark

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colored aliphatic ester of hydrogenated rosin acids with 0.1 to 2.0% based on the weight of said ester of phosphorus trichloride at a temperature between 150° and 200° F., for a period of time sufficient to substantially clarify said ester and thereafter reacting said treated ester with 8 to 15% by weight of flowers of sulfur at a temperature of 300° to 400° F. for a period of ½ to 2 hours.

3. The method of producing a sulfurized cutting oil base which comprises treating a crude aliphatic ester of hydrogenated rosin acids, which contains dark colored material, with 0.1 to 2.0% by weight, based on the weight of the ester, of phosphorus trichloride at a temperature of 150° to 200° F. for 1 to 10 minutes, and thereafter sulfurizing said treated ester by reacting it with a material selected from the group consist-

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ing of sulfur and sulfur chloride to a sulfur content of 2 to 20% at a temperature of about 300° to 400° F. for a period of ½ to 2 hours.

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