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GRINDING OIL COMPOSITION

Everett C. Hughes, Cleveland Heights, and Franklin Veatch, Cleveland, Ohio, assignors to The Standard Oil Company, Cleveland, Ohio, a corporation of Ohio

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This invention relates to grinding oils of a superior nature, more particularly to an improved grinding oil composition which greatly increases the efficiency of grinding operations and improves the results, and to a method of grinding with such an oil.

Grinding oils are used when grinding metal with an abrasive grinding wheel. Under many conditions during such a grinding operation, the metal, usually steel, may become discolored. The color may or may not indicate a deterioration in the quality of the metal, but it is very undesirable commercially. After the wheel has been used to an extent where the so-called temper color readily shows in the steel, it is usually necessary to redress the grinding wheel, i. e., to resurface it by running a diamond point over the wheel surface to even out rough and worn spots or to greatly slow down the grinding rate.

In plant practice where articles are being manufactured by a process involving a grinding step, the grinding oil used is often a very important part of the economics of the operation. The quality of surface finish and amount of machine down time, for grinding wheel redressing, adjustment, etc., for example, may depend to a great extent on the nature of the grinding lubricant used, particularly in the cases of grinding very tough materials such as alloy tool steels and similar materials.

Occurrences leading to machine stoppage for grinding wheel dressing or adjustment frequently depend on two effects. One of these is wheel wear resulting in changes of dimension of the article outside the specification limits and the other is discoloration of the ground surface due to the heat of the grinding operation. This discoloration is called "temper color" and frequently is so serious that it alone is the limiting factor in the grinding operation. Any grinding oil which will decrease this temper color formation is an important asset to many grinding operations since it will allow more metal to be removed per pass without discoloration ("temper color") of the work piece or in other cases allow many more passes to be taken before wheel redressing is necessary. It is customary, therefore, to appraise grinding oil in terms of the amount of grinding that can be done with a wheel before it must be redressed.

We have discovered that grinding efficiency as indicated by the amount of work done in performing a given grinding operation is greatly dependent on the nature of lubricant used. It has been found, in accordance with the invention, that the efficiency of grinding operations may be considerably increased by the use of a grinding

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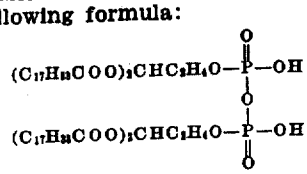
oil composition containing an "anti-temper color additive." The use of such an additive, especially in the type of oil to be described, results in a large decrease in the tendency for temper color formation, so that more grinding can be done before redressing the grinding tool. The oil of this invention, therefore, delays the temper color formation sufficiently to allow the use of a wheel for many grinding operations so as to approach more nearly its limit of usefulness as far as its surface is concerned. As far as we are advised, the addition of such additives to an oil to inhibit temper color formation has not been proposed heretofore.

Grinding oils are to be distinguished from cutting oils. Some oils which are good for cutting purposes are not good for grinding and vice versa. A cutting oil is generally used in cutting steel or other metal with a cutting tool, such as in a lathe, whereas a grinding oil is used in grinding steel or other metal with an abrasive wheel or with a loose abrasive. The grindability of steel is extremely sensitive to the type of grinding oil used, particularly under severe conditions of operation.

The objects achieved by the invention include the provision of grinding oil compositions containing an anti-temper color additive by the use of which a great increase in grinding efficiency is obtained; the method of using the new composition; and other objects which will become apparent as the invention is described hereinafter.

The anti-temper color additive is an oil soluble compound having a hydrocarbon or fatty radical in the molecule and which is believed to decompose under heat to form a heat-stable protective film which shields the hot metal from oxidation by air. The hydrocarbon or fatty radical should have at least 10 carbon atoms, and may be the fatty radical derived from stearic, oleic, palmitic acids, etc. or hydrocarbon radicals derived from aromatic and olefinic polymer type hydrocarbons, and the compound should be oil soluble. Those compounds containing phosphorus have been found to be particularly suitable. The phosphatidic compounds are illustrative of the phosphorus containing fatty compounds and mention may be made of the phosphatides, a well recognized group of phospholipins of which lecithin and cephalin are the best known and most readily available illustrative examples. Another general group of phosphatidic compounds includes the phosphatidic acids, which are phosphoric acids containing a fatty radical. Examples of these materials include diethanolamino ethyl phosphatidic acid (available from Victor Chemical Works) and pyrophosphatidic acid, which is

essentially a fatty ester of pyrophosphoric acid (also available from Victor Chemical Works) and has the following formula:



Another phosphorus containing anti-temper color additive is the reaction product of P_2O_5 with castor oil rendered soluble in mineral oil by a treatment which decreases the number of free hydroxyl groups without increasing the unsaturation. This may be accomplished by partially etherifying the hydroxyl groups, e. g., by methylation, or by partially dehydrating and then hydrogenating the castor oil to its original iodine number. Still other phosphorus containing anti-temper color additives are the reaction products of P_2O_5 with higher amines such as dioctadecylamine or monohexadecylamine, with degras, with a hydrogenated sperm oil, with cetyl alcohol, and with many other fatty, waxy and hydrocarbon materials which contain an aliphatic radical of at least 10 carbon atoms such as oils, fats, fatty acids, waxes, alcohols, amines, amides, nitriles, ketones, hydrocarbons, especially olefinic polymers, etc., as well as reaction products of a P_2S_5 with oils, fats, fatty acids, waxes, alcohols, amines, amides, nitriles, ketones, hydrocarbons, especially olefinic polymers, etc.

The following examples are illustrative of grinding oils which may be made up containing additives for inhibiting the development of temper color.

Example 1

A grinding oil is prepared by incorporating 6% lecithin in an oil base in the type described hereinafter. If desired, about 0.1 to 0.3% of ethyl sulfate may be added to greatly reduce or eliminate any objectionable odor which may arise under severe operating conditions due to the lecithin.

Example 2

Pyrophosphatidic acid in an amount of 1% is added to the grinding oil base to provide a grinding oil which is markedly effective in inhibiting temper color formation.

Example 3

An anti-temper color additive is prepared by reacting 500 grams of mineral oil soluble castor oil with 58 grams of P_2O_5 at a temperature of 120° to 130° C. for two hours. The reaction product was decanted and found to contain 3.26% phosphorus. This was added in an amount of 5% to the grinding oil base.

Example 4

Hydrogenated sperm oil is reacted with 20% phosphorus pentasulfide at a temperature of about 300° F. for about four hours. The hydrogenated sperm oil has an iodine value of 6 to 7, a melting point of 50 to 52° C., a free fatty acid content (as oleic acid) of 1 to 2%, a saponification value of about 135 to 138, and about 36% of unsaponifiables. After the reaction is complete, the reaction product is decanted from a residue and filtered. The reaction product is added to the grinding oil base in an amount of 5%.

Example 5

A commercial grade of dioctadecylamine (a mixture of about three parts by weight of dioctadecylamine and one part by weight of trioctadecylamine) in an amount of 800 grams is reacted with 281 grams of phosphorus pentasulfide in a diluent of 1200 grams of No. 225 Red Oil (a conventional acid treated Mid-continent lubricating oil base stock SAE 20) and 1200 grams of No. 300 Red Oil (a conventional acid treated Mid-continent lubricating oil base stock SAE 30). This reaction is carried out at a temperature of 500° F. for about thirty minutes. Elemental sulfur in an amount of 16 grams was added to the reaction mass which was maintained at a temperature of 300° F. for one hour and the product filtered hot. The reaction product was added to the grinding oil base in an amount of 5%.

In order to evaluate the effectiveness of an anti-temper color additive, the temper color cone test was developed. The test piece to be utilized is a short length of ½ inch steel bar stock, the tip of which is turned smooth in the shape of a cone. The turning is done at a low temperature so as not to overheat the piece before the test. The test piece is dipped in the grinding oil containing the anti-temper color additive that is to be tested and immersed for 30 seconds. The excess oil is then removed from all of the piece except the cone shaped tip. The test piece is then placed in a heated salt bath of a depth so that the test piece is immersed except for the cone surface which remains exposed to the air. The salt bath used is composed of equal parts by weight of sodium nitrate and potassium nitrate and is maintained at a temperature of 275° C. The test surface is thus heated indirectly by conduction for five minutes. The piece is then removed from the bath and cooled and the conical surface cleaned with chloroform to remove any adhering film, The conditions of the test are more severe than those encountered in actual grinding operations, but have been found by the test to be the best conditions to distinguish between good and bad additives.

The effectiveness of the additive is judged by the color of the cone after it is cleaned. The color ranges from a deep purple-brownish color for an oil not containing any additive, to a white (absence of any color) for an oil containing an effective additive.

The temper color cone test has also been correlated with actual field operations and additives which are shown to be effective by this test are of about equal effectiveness in actual grinding operations.

The grinding oils containing the additives described in the five examples heretofore were tested by the temper cone color test and compared with the same base oil not containing the anti-temper color additive. The results are set forth in the following table:

Anti-Temper Color Additive	Cone Color
None	Dark Brown to Purple.
Example 1	White.
Example 2	Do.
Example 3	Almost White.
Example 4	White.
Example 5	Almost White.

The amount of the anti-temper color additive used may vary, depending upon the particular compound and the extent of the anti-temper

color requirements of the grinding oil. In general it may vary within the range of 0.5% to 10%. Even somewhat smaller amounts reflect a noticeable improvement under certain conditions. In general it is not economic to use larger amounts, since an improvement is not reflected corresponding to the increased cost. The amount, therefore, is not particularly critical as long as the desirable anti-temper color effects are obtained.

The oil base used preferably is comprised of two mineral oils of widely divergent viscosities. One of the oils may have a relatively low viscosity of not over 100 SUS at 100° F. and may be, for example, a straw oil. It should not be so light as to flash under grinding conditions. The other oil has a very high viscosity in the range of 2000 to 6000 SUS at 100° F. (Generally the viscosity is measured at 210° F. and that at 100° F. calculated in a manner well known in the art). This heavier oil may be, for example, a so-called "bright stock" and the following are given as examples with the viscosities (SUS) at 100° F. and 210° F.:

SUS at 210° F.___	165	185	133	160	156
SUS at 100° F.___	3740	4300	2100	3500	2218

These heavy viscosity oils are also characterized by their high boiling points.

The oil base preferably should comprise from about 53 to 78 weight per cent of the low viscosity oil and from about 47 to 22 weight per cent of the high viscosity oil. These proportions are subject to the further qualification that they be selected within the above ranges so that the mixture of oil should have a viscosity in the range of 150 to 300 SUS at 100° F., in order that the oil may flow properly as it is fed to the wheel during grinding. The above oil mixture should comprise at least 90% of the base oil, since the presence of about 10% of other oils or oil-like components do not interfere with the beneficial results from a composition, the major portion of which is made in accordance with the invention. This oil base is preferred and is used in the further description of our invention. This type of oil base is further described in our copending applications Serial Nos. 628,352 and 703,288.

Several of the oils were tested in practical grinding tests by industrial companies using grinding oils and it was found that those of the invention show marked superiority in practical grinding operations.

The marked efficiency of the grinding oil composition of the invention as compared with two of the best commercial grinding oils available on the open market, and as compared with a similar base oil not containing the additive, is illustrated by the following tests. These tests were made by grinding twist drills of the same size with automatic machines under identical conditions. The following results are typical:

Oil

	No. of drills/dressing of the grinding wheel
Commercial Grinding Oil No. 1	60–70
Commercial Grinding Oil No. 2	40–50
75 SUS at 100° F. 65%	
4300 SUS at 100° F. 35%	300–330
Oils containing additives—	
Example 2:	
75 SUS at 100° F. 61%	
4300 SUS at 100° F. 31%	
Lecithin 6%	700–800
Oil of invention—	
Example 3:	
75 SUS at 100° F. 64.7%	
4300 SUS at 100° F. 34.3%	
Pyrophosphatidic acid 1%	700–800

The mechanism of action of the anti-temper color additives is obscure. Temper colors are believed to consist of layers of oxides on the surfaces of the metal. The oxidation may be due to the action of either air or oil soluble materials contacting the hot metal surface.

The anti-temper color additive, however, does not act merely as an anti-oxidant; rather it is thought to protect the metal surface because under the high temperature conditions it either decomposes or is otherwise transformed so as to form a protective lacquerlike film which is stable under the high temperature conditions and protects the surface from oxidation by air.

In order to demonstrate that the action of the anti-temper color additive is not merely that of a lubricating oil anti-oxidant, the same grinding oil base was prepared with one of the most effective oil anti-oxidants, namely, tetramethyldiaminodiphenylmethane, known as "methane base." The grinding oil base containing this additive was tested by the temper cone color test with the following results:

Additive	Cone Color
1% Methane Base	Brown.
14% Methane Base	Dark Straw.

In view of the foregoing disclosure, variations and modifications of the invention will be apparent to one skilled in the art. The invention contemplates all such variations and modifications as come within the scope of the appended claims.

We claim:

1. A mineral grinding oil composition comprising at least 90 weight per cent of a base oil which is composed of a mixture of an amount of a mineral oil of not over 100 SUS at 100° F. within the range of 53 to 78 weight per cent and an amount of a mineral oil of 2000 to 6000 SUS at 100° F. within the range of 47 to 22 weight per cent to provide a viscosity in the range of 150 to 300 SUS at 100° F., and from 0.5 to 10% of an oil soluble phosphorus compound containing a fatty acid radical having at least ten carbon atoms.

2. A mineral grinding oil composition comprising at least 90 weight per cent of a base oil which is composed of a mixture of an amount of a mineral oil of not over 100 SUS at 100° F. within the range of 53 to 78 weight per cent and an amount of a mineral oil of 2000 to 6000 SUS at 100° F. within the range of 47 to 22 weight per cent to provide a viscosity in the range of 150 to 300 SUS at 100° F., and from 0.5 to 10% of the reaction product of P_2O_5 with castor oil to inhibit the development of temper color, said castor oil having been rendered soluble in mineral oil by a treatment which reduces the number of free hydroxyl groups without increasing the unsaturation.

3. A mineral grinding oil composition comprising at least 90 weight per cent of a base oil which is composed of a mixture of an amount of a mineral oil of not over 100 SUS at 100° F. within the range of 53 to 78 weight per cent and an amount of a mineral oil of 2000 to 6000 SUS at 100° F. within the range of 47 to 22 weight per cent to provide a viscosity in the range of 150 to 300 SUS at 100° F., and from 0.5 to 10% of pyrophosphatidic acid to inhibit the development of temper color.

4. A method of grinding which comprises grinding metal with an abrasive in the presence of a grinding oil comprising at least 90 weight per cent of a base oil which is composed of a

ixture of an amount of a mineral oil of not ver 100 SUS at 100° F. within the range of 53 78 weight per cent and an amount of a min-al oil of 2000 to 6000 SUS at 100° F. within the ange of 47 to 22 weight per cent to provide a iscosity in the range of 150 to 300 SUS at 100° ., and from 0.5 to 10% of an oil soluble phos-horus compound containing a fatty acid radical aving at least ten carbon atoms.

5. A method of grinding which comprises rinding metal with an abrasive in the presence of a grinding oil comprising at least 90 weight per cent of a base oil which is composed of a mixture of an amount of a mineral oil of not over 100 SUS at 100° F. within the range of 53 to 78 weight per cent and an amount of a mineral oil of 2000 to 6000 SUS at 100° F. within the range of 47 to 22 weight per cent to provide a viscosity in the range of 150 to 300 SUS at 100° F., and from 0.5 to 10% of the reaction product of P_2O_5 with mineral soluble castor oil to inhibit the development of temper color.

6. A method of grinding which comprises grinding metal with an abrasive in the presence of a grinding oil comprising at least 90 weight per cent of a base oil which is composed of a mixture of an amount of a mineral oil of not over 100 SUS at 100° F. within the range of 53 to 78 weight per cent and an amount of a mineral oil of 2000 to 6000 SUS at 100° F. within the range of 47 to 22 weight per cent to provide a viscosity in the range of 150 to 300 SUS at 100° F., and from 0.5 to 10% of pyrophosphatidic acid to inhibit the development of temper color.

7. A method of grinding which comprises grinding metal with an abrasive in the presence of a grinding oil comprising at least 90 weight per cent of a base oil which is composed of a mixture of about 65 weight per cent of mineral oil of viscosity of about 75 SUS at 100° F. and about 35 weight per cent of mineral oil of viscosity of about 4300 SUS at 100° F., which mixture has a viscosity of about 210 SUS at 100° F., and from 0.5 to 10% of an oil soluble phosphorus compound containing a fatty acid radical having at least ten carbon atoms.

8. A mineral grinding oil composition comprising at least 90 weight per cent of a base oil which is composed of a mixture of about 65 weight per cent of mineral oil of viscosity of about 75 SUS at 100° F. and about 35 weight per cent of mineral oil of viscosity of about 4300 SUS at 100° F., which mixture has a viscosity of about 210 SUS at 100° F., and from 0.5 to 10% of an oil soluble phosphorus compound containing a fatty acid radical having at least ten carbon atoms.

EVERETT C. HUGHES.
FRANKLIN VEATCH.

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