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LUBRICATING OIL FOR USE IN ROLLING METAL

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1 Claim. (Cl. 252—55)

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This inventon relates generally to lubricating oils and particularly to new and improved lubricating oils for use in the cold rolling or cold reducing of metal, particularly ferrous metal in strip or sheet form.

In cold rolling or reducing metals into sheets and strips it has long been customary to apply oil to the surface of the metal or to the rolling surfaces of the rolls to reduce the friction between the rolls and metal. Vegetable oils, such as palm oil, have been used for this purpose because they were preferable to mineral oils, but they have never been entirely satisfactory and have always been quite expensive and sometimes difficult to obtain in the necessary quantities. Modified mineral oil, such as mineral oil which has been treated with oxygen in the customary manner so that it has a neutralization number of 8 to 12 and saponification number of 20 to 170, is not suitable for this purpose. To our knowledge, attempts to use such modified mineral oils have given serious trouble in rolling operations and have invariably resulted in the failure of the mills to reduce metal uniformly and to produce satisfactory metal sheets and strips.

The present invention aims to provide economically an oil which is suitable for use in rolling or reducing metal into sheet and strip form, which is made from raw materials that are fairly inexpensive and abundant, and which is at least as satisfactory as the vegetable oils heretofore used.

Our present invention is predicated upon our surprising discovery that mineral oils can be modified in certain respects and rendered suitable for the above purpose, and that the modification operation can be effected in such a manner that the resulting products will be less expensive to use than the vegetable oils heretofore generally employed.

Briefly stated, this invention comprises the steps of treating certain types and kinds of hydrocarbon oils so that they will contain certain critical quantities of oxygen substantially all of which will exist as organic acids, alcohols and esters of relatively high molecular weight.

Hereafter in this specification and in the appended claims the term "relatively low molecular weight" will, for convenience, connote compounds containing one or two carbon atoms per molecule such as formic or acetic acids. The term "relatively high molecular weight" will similarly be used to connote compounds containing between about 6 and about 18 carbon atoms per molecule.

Mineral oils of the paraffin (C_nH_{2n+2}) or olefin (C_nH_{2n}) series of hydrocarbons, or mixtures of members of either or of both series, may be used in practicing the present invention. We prefer

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to employ only such of those oils as have from about 6 to 18 carbon atoms per molecule, have boiling points between 70° C. and 320° C., and have viscosities beween about thirty seconds and about five hundred seconds at 100° F., as determined by the Universal Saybolt procedure. Preferably, the oils selected should contain not more than about 0.5% of residual carbon.

The selected oil, whether consisting of one or more members of either or both of the paraffin or olefin series, is provided with between about 0.01% and about 2.0% of oxygen in chemically combined form. Oxygen may be incorporated in the selected oil by direct oxidation of the oil, as by passing air containing oxygen through it under suitable time and temperature circumstances.

While there are various ways of effecting this type of direct oxidation, we prefer to do it by blowing air through oil having a temperature of about 320° F. and containing pieces of copper to serve as a catalyst. Several hours of this treatment results in an increase in viscosity of the oil from 65 seconds to 105 seconds at 100° F., as determined by the Universal Saybolt procedure. For example, if the starting oil had a viscosity of 30 seconds, after this treatment its viscosity might be from 95 to 135 seconds; and if its starting viscosity was 500 seconds, its viscosity after the foregoing treatment might range between 565 seconds and 605 seconds. At the same time, the color changes from a pale straw to a very dark red, that is, from about 1½ to about 6 as measured by the American Society of Testing Materials Standard Colorimeter Test, and the neutralization number changes from 0 to 4 milligrams of potassium hydroxide.

The following table sets forth the results we obtained on one typical occasion in the practice of this process:

	Hydrocarbon Oil	
	Unoxidized	Oxidized
Per Cent Carbon	85.3	85.3
Per Cent Hydrogen	12.95	12.95
Per Cent Sulfur	0.55	0.55
Per Cent Nitrogen	1.05	0.00
Per Cent Oxygen	0.15	1.20
Per Cent Oxygen as Acid	0.024	0.78
Per Cent Oxygen as Ester	0.126	0.26
Per Cent Oxygen as Alcohol	0.00	0.16
Neutralization Number	0.049	1.36
Saponification Number	0.265	1.83
Per Cent Hydroxyl	0.000	0.17
Molecular Weight	352	352
Ash	0.05	0.04
Phenol	0.00	0.00
Aldehyde and Ketone	0.00	0.00

A convenient means of determining whether

or not the treated oil contains a sufficient amount of oxygen to be suited for the present purposes is to determine the acidity of the oil by the American Society of Testing Materials Standard Neutralization Test. When this test shows that the oil has an acidity equivalent to from about 0.05 mg. KOH to about 5.0 mg. KOH, the oxygen content will be within the foregoing ranges and the oil will be suitable for use in the rolling or cold reducing of sheet and strip metal.

The oxidation of the above described oils apparently has several beneficial effects on them. Apparently such oxidation lowers the surface tension and increases the adhesiveness and film strength of the oils. Furthermore, it apparently confers improved metal wetting characteristics on the oils and confers substantial emulsifying characteristics on said oils. It apparently increases the specific gravity, neutralization number, viscosity, saponification number and pour point of the oils. All these properties are desirable in an oil for use in the cold rolling or reducing of metal and they are possessed to a considerable and sufficient degree by oils embodying the present invention.

In the course of preparation of the compositions of this invention, whether by the foregoing procedure, or otherwise, formic acid and acetic acid may be formed during the oxidation period. We have found that compositions of hydrocarbon oils containing these acids in substantial quantities, but otherwise resembling the compositions of this invention, are undesirable as lubricants for rolling mills. It is not, however, essential that the compositions of this invention be entirely free from these acids, but the amounts thereof should be limited to less than about one tenth of the total acid content of the compositions. Compositions prepared in accordance with the above procedure will not normally contain objectionable amounts of these acids because they will be driven off as gases during the oxidation period. As nearly as we can determine, the oxygen in our compositions exists essentially as relatively high molecular weight organic acids, alcohols and esters, and our compositions are substantially free from other types of oxygen containing organic substances such as aldehydes and ketones. In these respects these compositions differ from those of the prior art, and their success in the face of the failure of prior oils and oxidized oils in lubricating rolling mill operations is probably in large part attributable to these differences.

The foregoing ranges of oxygen contents refer to compositions which have been prepared in the presence of a copper catalyst as above described, and which are substantially free from catalyst and catalyst derivatives. It will be understood, however, that if a reactive catalyst is employed, and derivatives of the catalyst are therefore present in the final product or composition, the range of oxygen content of the product will vary accordingly.

The following examples, which are illustrative only and are not limiting in any respect, are offered to inform those skilled in the art further as to the nature of the present invention and certain important properties of the compositions of our invention.

Example I

A composition of this invention prepared as above described and containing about 0.78% of oxygen, was employed in a commercial rolling operation in which a four-stand, four-high mill was used to produce 0.0147 inch strip from 0.070 inch strip stock. The operation was substantially continuous over a period of hours, with the mill rolling at a rate of 1750 feet per minute and the new stock being brought into the mill and finished strips being removed therefrom in the usual manner. The lubricating composition was applied as required and the lubrication of the mill and stock was satisfactory at all times.

Example II

In another rolling operation in which roofing stock of 0.017 inch thickness was produced from charge stock of 0.083 inch thickness by a three-stand, four-high mill operating at a maximum rate of 800 ft. per minute, a composition of this invention prepared as above and containing 0.5% oxygen was used as the lubricant. The oxygen of the composition, again, existed only in the form of organic acids, alcohols and esters of relatively high molecular weight. The operation of the mill was continued for several hours and lubrication was satisfactory throughout the entire period.

In general, we have found that the most satisfactory compositions of this invention are those containing between about 0.5% and about 1.0% oxygen, as they may be successfully in any rolling operation from the highest to the lowest speed. In the slow speed mills, compositions of this invention containing a minimum of 0.01% of oxygen may be successfully used. The oxygen content thus is a general measure, over the range from between about 0.01% to about 1.0%, of the lubricity of the compositions. As for the compositions containing between about 1% and 2% of oxygen, little difference in lubricity has been established. For practical reasons, however, we prefer to limit the oxygen content to about 1% as such compositions are more economical to produce than those containing substantially more oxygen. A composition containing substantially in excess 2% of oxygen, regardless of the form in which the oxygen exists, in not generally satisfactory for the purposes to which this invention is addressed. As stated above, compositions containing large quantities, compared with our 2% maximum, are actually detrimental to rolling mill operations.

Herein and in the appended claims the ratios and percentages stated refer to the weight rather than the volume basis.

This application is a continuation-in-part of our copending application 482,486, filed on or about April 9, 1943, and allowed on or about July 22, 1946. This application is now abandoned.

Having thus described the present invention so that those skilled in the art may be able to understand and practice the same, we state that what we desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

A composition of matter possessing cold metal reducing lubricity and consisting essentially of an unoxidized aliphatic hydrocarbon mineral oil containing oxidized hydrocarbons having between about 6 and about 18 carbon atoms per molecule and between about 0.01% and about 2.0% of oxygen existing essentially as organic acids, alcohols and esters of relatively high molecular weight substantially free from aldehydes and ketones, having a viscosity of from about ninety-five seconds to about six hundred five seconds at 100° F. as determined by the Uni-

versal Saybolt procedure, having an acidity value of from about 0.05 mg. to about 5.0 mg. of KOH, as determined by the ASTM Standard Neutralization Test and having less than about 0.5% residual carbon.

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