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ALUMINUM HOT ROLLING PROCESSES USING AQUEOUS LUBRICANT COMPOSITIONS

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2 Claims. (Cl. 72—42)

This invention relates to aqueous lubricant compositions, and in particular, to the use of aqueous dispersions as lubricants for the hot rolling of aluminum.

Soluble oils, prepared from mineral oil bases, are currently being used in the form of about 4 percent aqueous solutions as lubricants in the hot rolling of aluminum. These oil-containing aqueous solutions have the undesirable property of allowing aluminum oxide to be transferred from the aluminum sheets to the rolls and then back to the sheets. This causes the aluminum sheets being rolled to be marked and to have a duller finish. In addition, the mineral oils cause grease streaks on the aluminum sheets. As a result, it is necessary to perform an additional operation on the aluminum sheets, removal of the aluminum oxide coating and grease streaks, which adds to the cost of the hot rolling process.

It is an object of this invention to provide an aqueous composition which is an effective lubricant for the hot rolling of aluminum.

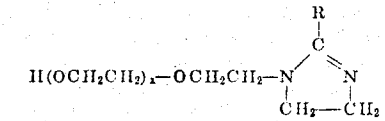
Another object is to provide an aqueous dispersion which has sufficient lubricity to avoid aluminum oxide pickup on the rolls during the hot rolling of aluminum.

A further object is to provide an aqueous lubricant composition which is easily rinsed from aluminum sheets and thereby avoid greasy streaks caused by the mineral oils currently used as lubricants.

A still further object of this invention is to provide an improved method for hot rolling aluminum.

Other objects and purposes of this invention will be apparent to those skilled in the art from the description which follows.

It has been discovered that aqueous solutions of a polyoxyethylene imidazoline represented by the formula



wherein R is an alkyl or alkenyl radical containing from 11 to 20 carbon atoms and x is a number ranging from 3 to 19, are effective lubricants for the hot rolling of aluminum. Illustrative of the polyoxyethylene imidazolines which may be used to form aqueous lubricants are those in which R is heptadecenyl and x is 8; R is heptadecyl and x is 11; R is undecyl and x is 15; etc.

The polyoxyethylene imidazolines useful in accordance with this invention are polyoxyethylene derivatives having from about 4 to about 20 oxyethylene groups per molecule. Polyoxyethylene imidazolines containing relatively small amounts of oxyethylene groups have very good lubricating properties, but as the oxyethylene content decreases, they become insoluble in water and are not readily dispersed in water. Since it is necessary that the polyoxyethylene imidazolines at least be dispersible in water in order to be useful as an aqueous lubricant, it is generally

preferred that the polyoxyethylene imidazolines contain no less than about 4 moles of oxyethylene groups per mole of imidazoline. As the oxyethylene content is increased, the polyoxyethylene imidazolines become more soluble in water but their lubricating properties are correspondingly decreased. Polyoxyethylene imidazolines which are readily soluble in water do not exhibit good lubricating properties, and for this reason, it is generally preferred that they contain no more than about 20 moles of oxyethylene groups per mole of imidazoline. For optimum performance as a lubricant for aluminum hot rolling processes, it is preferred that the oxyethylene content of the lubricant range from about 8 to about 12 moles per mole of imidazoline. In addition, the properties of a particular polyoxyethylene imidazoline lubricant can be altered by blending therewith a polyoxyethylene imidazoline having a different oxyethylene content. In this manner, the desired lubricating properties for a particular application can be achieved by blending polyoxyethylene imidazolines of differing oxyethylene content.

The aqueous lubricant compositions of this invention generally contain from about 0.1 to about 3 weight percent of polyoxyethylene imidazoline. As previously noted, polyoxyethylene imidazolines containing relatively small amounts of oxyethylene groups are more difficult to disperse in water and therefore lesser amounts of these materials may be used in the aqueous composition. Polyoxyethylene imidazolines containing relatively large amounts of oxyethylene groups are readily dispersed in water but their lubricating properties are not as effective as those containing fewer oxyethylene groups, and therefore, greater amounts of these materials may be used to obtain the desired lubricity. If less than about 0.1 weight percent of the polyoxyethylene imidazoline is present, there is little or no beneficial lubricating effect obtained. Using more than about 3 weight percent is impractical from a cost standpoint and may cause excessive lubricity.

In some instances, it may be desirable to incorporate a corrosion inhibitor in the aqueous lubricant compositions of this invention. Any of the conventional corrosion inhibitors may be used. Representative of corrosion inhibitors which may be present in the aqueous lubricants when used in aluminum hot rolling processes are sodium nitrite (about 0.05 to about 0.1 weight percent), triethanol amine (about 0.1 to about 0.5 weight percent) and morpholine (about 0.1 to about 0.5 weight percent).

The aqueous lubricant compositions of this invention are particularly useful in aluminum hot rolling processes. The equipment employed for hot rolling aluminum is called a "hot-mill." In its simplest form, the essential features are a pair of oppositely driven cylindrical rolls arranged in a suitable housing so that the roll axes are parallel to each other and in a position so that one roll is above the other. Working is accomplished by repeatedly passing a hot, aluminum ingot between the rolls. The temperature of the ingot usually ranges from about 600° F. to about 950° F. Hot-mills are seldom heated by special means, for the rolls become heated by contact with the hot aluminum ingot.

In accordance with this invention, the hot-mill rolls are lubricated with the aqueous lubricant compositions. The lubricant may be applied to each roll from a perforated pipe located above or below the roll and extending across the length of the roll. The aqueous lubricant flowing off the rolls falls into a collecting pit underneath the

mill from which it may be pumped back to the perforated pipe for further lubrication. The lubricant supply is controlled so that the rolls are covered with a substantial film over their entire surface.

It has been found that the aqueous lubricant compositions of this invention have sufficient lubricity to reduce, and in some instances to prevent, aluminum oxide pickup on the rolls. In addition, the aqueous lubricants are easily rinsed from the rolled aluminum sheets, thereby avoiding greasy streaks which are obtained when mineral oil based lubricants are used.

The objects and purposes of this invention will become more apparent from the following illustrative examples.

Example I

Introduce 1580 grams of 1-hydroxyethyl-2-heptadecenyl imidazoline reactant mixture having an HCl equivalent of about 410 and 10 grams of sodium hydroxide into an autoclave provided with a stirrer and a coil for circulating heat exchange fluid therein. Flush the autoclave with ethylene oxide gas and close. Heat the charge to about 145° C. and slowly add 3426 grams of ethylene oxide. The rate of adding the ethylene oxide and the rate of heat exchange are controlled so as to maintain the temperature at about 145° C. and the pressure between 30 and 50 pounds per square inch. After all of the ethylene oxide has been added, the reaction is continued at about 145° C. until a total reaction time of about 5 hours has elapsed. The reaction is substantially complete when the pressure drops to atmospheric. The resultant product is a liquid containing about 20 oxyethylene groups per imidazoline radical and is readily dispersible in water.

Example II

Several other polyoxyethylene derivatives of 1-hydroxyethyl-2-heptadecenyl imidazoline having various oxyethylene contents were prepared in accordance with the process set forth in Example I. The following compounds were prepared:

A. 1-polyoxyethylene (4) 2-heptadecenyl imidazoline
B. 1-polyoxyethylene (8) 2-heptadecenyl imidazoline
C. 1-polyoxyethylene (12) 2-heptadecenyl imidazoline
D. 1-polyoxyethylene (20) 2-heptadecenyl imidazoline

wherein the number in parenthesis represents the moles of oxyethylene groups per mol of polyoxyethylene imidazoline product. Aqueous solubility tests were run on several of these polyoxyethylene imidazoline products.

Compound	Room Temp. (24 hours)	200° F. (24 hours)
3% A in deionized water	Slightly dispersible.	Slightly dispersible.
3% A in 1,000 p.p.m. hard water	do	Do.
3% B in deionized water	Dispersible	Dispersible.
3% B in 1,000 p.p.m. hard water	do	Do.
3% C in deionized water	Soluble	Do.
3% C in 1,000 p.p.m. hard water	do	Do.
3% D in deionized water	do	Soluble.
3% D in 1,000 p.p.m. hard water	do	Do.

Example III

Compounds A, B, C and D of Example II were also tested in the form of 3% by weight aqueous dispersions for their lubricating properties. They were compared to a mineral oil lubricant for their performance as lubricant in a Falex Lubricant Tester.

The Falex Lubricant Tester is a well known testing device comprising a steel journal and bearing loaded by a spring gauge micrometer and driven by a ⅓ H.P., 290 r.p.m. motor. The test measures bearing load and resulting wear produced by extreme pressure forces under constant speed and temperature. A detailed description of the Falex machine method may be found in ASTM-D-2-Section V, Tech. K.

Lubricant compound:	Falex failure load (lbs.)
Mineral oil	approx. 500
A	2600
B	2600
C	2000
D	2250

The Falex test indicates that the polyoxyethylene imidazoline aqueous dispersions are effective lubricants.

Subsequent tests in a laboratory rolling mill indicated that 0.5 weight percent aqueous dispersions of the polyoxyethylene imidazolines had very good lubricating properties.

Example IV

Introduce 285 grams of 1-hydroxyethyl-2-undecyl imidazoline and 1.5 grams of sodium hydroxide into an autoclave provided with a stirrer and a coil for circulating heat exchange fluid therein. Flush the autoclave with ethylene oxide and close. Heat the charge to 145° C. and add, in increments, 396 grams of ethylene oxide. The rate of adding the ethylene oxide and the rate of heat exchange are controlled so as to maintain the temperature at about 145° C. and the pressure between 30 and 50 pounds per square inch. After all of the ethylene oxide has been added, the reaction is continued at about 145° C. until the ethylene oxide is consumed as indicated by the decrease of pressure to substantially atmospheric. The resultant product is a liquid containing about 10 oxyethylene groups per imidazoline radical and is readily dispersible in water. 1.0% by weight aqueous solutions of this product exhibit effective lubricating properties in aluminum hot rolling processes.

Example V

Introduce 386 grams of 1-hydroxyethyl-2-heptadecyl imidazoline and 1.1 grams of sodium hydroxide into an autoclave provided with a stirrer and a coil for circulating heat exchange fluid therein. A polyoxyethylene derivative is prepared as in Examples I and IV by adding 220 grams of ethylene oxide to the autoclave. The resultant product is a liquid containing about 6 oxyethylene groups per imidazoline radical and is readily dispersible in water. 0.5 weight percent aqueous solutions of this product are effective lubricants for aluminum hot rolling processes.

Example VI

Aluminum ingots were heated to about 900° F. and were rolled in a conventional two roll hot-mill. During the hot rolling process the following three materials were tested as aqueous lubricants at concentrations of 1 weight percent:

1-polyoxyethylene (8) 2-heptadecenyl imidazoline
1-polyoxyethylene (10) 2-heptadecenyl imidazoline
1-polyoxyethylene (12) 2-heptadecenyl imidazoline

All of the aqueous lubricant compositions also contained 0.05% by weight of sodium nitrite as a corrosion inhibitor.

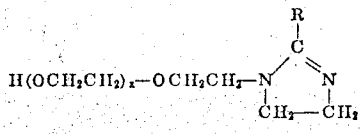
The rest results indicated that all of the aqueous lubricant compositions performed satisfactorily with the 1-polyoxyethylene (8) 2-heptadecenyl imidazoline material being particularly effective in preventing aluminum oxide pickup.

In this specification and the claims which follow, the indicated oxyethylene content of the polyoxyethylene imidazolines includes the hydroxyethyl group of the 1-hydroxyethyl substituted imidazolines.

Having completely described the compositions of this invention, what is claimed is:

1. A method of hot rolling aluminum which comprises the steps of heating an aluminum ingot to a temperature within the range of about 600° F. to about 950° F. and

then passing said ingot through the rolls of a hot-mill while contacting the surface of said ingot with an aqueous lubricant composition comprising water and from about 0.1% to about 3% by weight of a polyoxyethylene imidazoline represented by the formula.



wherein R is selected from the group consisting of alkyl and alkenyl radicals which contain from 11 to 20 carbon atoms and x is a number from 3 to 19.

2. The method of claim 1 in which the aqueous lubricant composition also contains a corrosion inhibitor.

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