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LUBRICANT FOR HOT ROLLING OF NON-FERROUS METALS

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This invention relates to improved lubricants and more particularly to aqueous base lubricants for use in hot rolling of non-ferrous metals such as aluminum and alloys thereof.

It is well known from the prior art that non-soluble oils such as straight mineral oils or soluble-oil emulsions are unsatisfactory as lubricants for hot rolling of non-ferrous metals such as aluminum. Straight mineral oils or compounded mineral oils lack the necessary required cooling properties since the temperature encountered during the hot rolling of aluminum is in the range of from about 300° F. to about 900° F. To take advantage of the lubricating qualities of oils, emulsions have been tried for this purpose, but although they are good coolants they cause staining of the worked surfaces and cause so-called "pick-up." This phenomenon is the appearance of nodules or accretions on the surfaces of the rolls. The accretions build up causing sticking and deformation which at times becomes serious enough to cause shut-down and regrounding of the rolls. In addition to loss of time and money, spoilage and waste of metal is the result of improper lubrication.

It is an object of the present invention to provide an improved lubricant for hot rolling of non-ferrous metals. It is also an object of the present invention to provide an improved aluminum hot rolling lubricant having good cooling and lubricating and bright surface finishing properties and which is resistant to staining and metal pick-up.

These and other objects are accomplished in accordance with this invention by providing a lubricant consisting essentially of a water base containing a minor, but critical amount, of from about 3% to about 10%, preferably 3% to 5% of a particular class of hydrophilic monoalkyl ether of a heteropolyoxyalkylene liquid compound, having a negative coefficient of solubility in water at an elevated temperature and from about 0.01% to about 2% of a corrosion inhibitor selected from group (1) a mixture of substantially equal amounts of an alkali metal nitrate and an alkali metal chromate or (2) the mixture of alkali metal nitrate, alkali metal phosphate and an alkylolamine. Optionally, where a bright surface finish is required, a minor amount (0.05%–0.5%) of a particular type of surface active agent preferably ionic and particularly anionic in character capable of passing the emulsion stability test described hereinbelow can be incorporated into the lubricant composition.

By a negative coefficient of solubility is meant a hydrophilic monoalkyl ether of a heteropolyoxyalkylene liquid compound which is completely (3–10%) soluble in water at temperatures up to about 40° C. and which separate out of water thereby forming two liquid phases between about 40° C. and about 90° C., preferably between 50° C. and 70° C. Polyoxyalkylene liquids having a separation temperature above 100° C. and a viscosity (SUS at 100° F.) above 1000 are unsatisfactory for the purpose of this invention because they are ineffective in preventing metal pick-up.

Specifically hydrophilic polyoxyalkylene liquids for use in the present compositions comprise the monoalkyl ether derivatives of the copolymers of ethylene oxide and 1,2-propylene oxide, the alkyl radical having from 1 to 12 carbon atoms, the ratio of ethylene oxide to 1,3-propylene oxide being from 1:1 to about 3:1 respectively. These materials can be prepared by the methods described in United States Patent 2,425,755. The hydrophilic polyalkylene liquids preferred for use in the subject compositions are those having a viscosity range in SUS at 100° F. of from about 500 to about 1000, preferably from about 600 to about 800. In the preparation of the monoethers, alcohols having from 1 to about 12 carbon atoms are used, and preferably C_{2-4} aliphatic monohydric alcohols.

Examples of such compounds are monobutyl ether of polyoxyalkylene having an ethylene oxide to 1,2-propylene oxide ratio of 1:1 and having a viscosity of 660 SUS at 100° F. (A) or a similar monoether of polyoxyalkylene derived from ethylene oxide and 1,2-propylene oxide used in the ratio of 3:1 respectively, and having a viscosity of about 1000 SUS at 100° F. (B).

The desired separation temperature of the compositions which are used in the hot rolling process of this invention, depends upon the temperature of the composition in the circulation system, in particular in the storage tank, and the temperature which the composition attains at the rolls, which in turn depends upon the nature of the metal to be rolled, the conditions under which the rolling takes place and the rate of circulation of the rolling liquid. Generally it can be said that for aluminum rolling wherein the temperature in the storage tank usually does not exceed about 40° C. and the temperature which the liquid attains at the rolls is between 80° C. and 90° C. a separation temperature of between 50° and 70° C. gives best results. When the liquid reaches this separation temperature the oily phase which is separated remains dispersed in the liquid in the form of a very fine emulsion.

The water soluble corrosion inhibitors of group (1) include the sodium, potassium and lithium nitrites and chromates of which preferred are the sodium and potassium nitrites and chromates in the ratio of about 1:4 to 4:1 and preferably 3:1, respectively. The total amount of this additive mixture ranging from about 0.1% to about 2% based on the final composition. The corrosion inhibiting mixture of group (2) include the sodium, potassium or lithium nitrites, mono- or dihydrogen sodium, potassium or lithium phosphates and an alkylolamine such as the mono- di- or triethanolamine. The additive mixture of group (2) is used in about equal amounts, the total of which ranges from about 0.1% to about 2%.

The following are illustrative of the compositions of the invention:

Composition 1:	Percent weight
Example A [1]	3.5
Triethanolamine	0.22
Sodium nitrite	0.22
$Na_2HPO_4.12H_2O$	0.22
Water	balance

Composition 2:	Percent weight
Example A [1]	4.0
Sodium nitrite	0.375
Potassium chromate	0.125
Water	balance

See footnote at end of table.

Composition 3:

Example B [2]	3.5
Triethanolamine	0.22
Sodium nitrite	0.22
$Na_2HPO_4.12H_2O$	0.22
Water	balance

Composition 4:

Example A [1]	3.5
Sodium nitrite	0.375
Potassium chromate	0.125
Water	balance

[1] Monobutyl ether of the copolymer of ethylene oxide and 1,2-propylene oxide (1:1) having a viscosity at 100° F. SUS of 660.

[2] Monobutyl ether of the copolymer of ethylene oxide and 1,2-propylene oxide (3:1) having a viscosity at 100° F. SUS of about 1000.

The following examples illustrate the advantages gained by use of compositions of the present invention:

Under actual hot aluminum rolling conditions using 10-inch diameter rolls 24 inches wide with a 4° camber mill operating at a speed of 150 ft./min. pure aluminum ingots 6 by 6 by 2.5 inches at 550° C. were reduced to about 0.25 inch thickness, using as the lubricants the compositions identified in Table I and the results were as follows:

TABLE I

Composition	Temp., ° C. of fluid leaving rolls	Reduction, percent per pass	Comments
Composition 2:			
Billet 1-3	50	15	Rolled successfully, no pick-up or discoloration.
Billet 4-6	50	18	No difficulty in rolling.
Billet 7-9	60	20	Do.
Billet 22-25	85	30	Finish acceptable.
Composition X (same as composition 2 but additive of Example A used in amount of 1.75% rather than 4% and water increased from 95.5% to 97.75%): Billet 1-11.	40	20	Severe sticking of strips.
Commercial soluble mineral oil comprising a 6% emulsion of oil-water:			
Billet 1-3	35-43	15	Persistant refusal of billet to enter rolls after first pass, one billet centered halfway and then slip occurred.
Billet 4-6	38-46	12	Do.
Billet 7-9	38-46	12	Do.
Commercial soluble oil sold under the trade name "Solvac oil emulsion":			
Billet 1-10	60-68	15	Strips became speckled and pick-up started.
Billet 11-15	63-66	18	Strips appeared patchy and speckled.
Billet 16-20	63-66	20	Increased speckling, 18%.

When a bright finish is required as in the case when decorative domestic articles of aluminum are processed, a minor amount (0.05%–0.5%) of a particular type of surface active agent (ionic and preferably anionic) can be incorporated into the lubricant compositions which agent passes the "Emulsion Stability Test" described below.

The "Emulsion Stability Test" is conducted as follows: About 0.5% of a surface active agent is added to 100 cc. of water containing a hydrophilic compound such as Example A and the solution heated while stirring to a temperature of 70° C. and allowed to stand at this temperature for 3 hours. The volume of any lower layer which may have separated is measured and its volume is a measure of the instability of the emulsion. The most convenient apparatus for this test is a graduated centrifuge tube having a top diameter of about 2½ inches and which tapers to a point at the bottom.

The surface active agents which may be used in the lubricant compositions according to the present invention are those which when used in the above-mentioned test prevent the separation of a lower layer greater than 0.1 ml. in volume and preferably those which prevent the separation of a lower layer completely. Surface active agents which prevent the separation of a lower layer in the above test when used at all concentrations between 0.05% and 0.5% by weight are particularly preferred. The surface active agents which pass the above-mentioned test include cationic and anionic surface active agents such as amine salts, quaternary ammonium salts, nitrogenous base; sulfonic esters (sulfate), sulfonic acid derivatives and phosphates, those which are particularly preferred are the anionic surface active agents such as the secondary alkyl sulfates or alkali metal or alkali earth metal salts of organic sulfonic acids, especially petroleum sulfonic acids are preferred. More especially preferred as surface active agents according to the present invention are sulfated olefins e.g. "Teepol" (secondary Na alkyl sulfate, manufactured by Shell Chemical Co. Ltd., identified in Soap and Chemical Specialties, October 1955 and described in U.S. Patent 2,152,292), sodium naphthasulfonate and calcium naphthasulfonate, although other substances for example sodium heptly sulfonate and sodium octyl sulfonate may also be used. The use of sodium naphthasulfonate or calcium naphthasulfonate as surface active agents in the lubricant composition according to the present invention is particularly attractive since these salts, whether of high molecular weight or low molecular weight, give some protection against corrosion of steel.

Examples of suitable aqueous lubricant compositions are as follows:

Composition 5:	Percent weight
Example A	4
Sodium naphthasulfonate	0.1
Sodium nitrite	0.06
Disodium hydrogen phosphate (hydrated-$12H_2O$)	0.12
Triethanolamine	0.25

Composition 6:

Example A	4
Sodium naphthasulfonate	0.1
Sodium nitrite	0.07
Disodium hydrogen phosphate (hydrated-$12H_2O$)	0.07

Excellent bright surface finish lubricants of this invention were obtained as evidenced from the results obtained when Compositions 5 and 6 were subjected to the Emulsion Stability Test and after 3 hours the volume of lower layer separation was nil. The substitution of other surface active agents for the sodium naphtha sulfonate in Compositions 5 and 6 with such surface active agents as sodium dinonyl phosphate, secondary sodium alkyl sulfate ("Teepol"), dihexyl sodium sulfosuccinate, or "Amine 220" (a gloxalidine identified in U.S. Patent 2,785,127 and manufactured by Carbide and Carbon Company) also resulted in excellent bright surface finish and the volume of lower layer separation in the emulsion test was nil. Also when any of these surface active agents are added to Compositions 1 to 4, essentially the same desired results are obtained.

Further advantages of rolling liquids of this invention are that they are non-corrosive to ferrous and non-ferrous metal surfaces, they are stable in both soft and hard water, they are resistant to phase separation during use of storage and any solid contaminates which get into the compositions can be easily removed by simple filtration. On the other hand, conventional oil or emulsion rolling lubricants are corrosive to some metal surfaces, their stability is dependent to the type of oil or water used, they have poor storage stability and special filters are generally required to remove solid contaminants.

We claim as our invention:

1. An aluminum hot rolling lubricant consisting essentially of water and from about 3% to about 10% of a hy-

drophilic mono C_{1-12} alkyl ether of a copolymer of ethylene oxides and 1,2-propylene oxide having in the ratio of 1:1 to 3:1, respectively, a separation temperature between 40° C. and 70° C. and a viscosity at 100° F. SUS of from about 500 to about 1000 and from about 0.01% to about 2% of a corrosion inhibitor selected from the group consisting of (1) a mixture of alkali metal nitrite and alkali metal chromate and (2) a mixture of alkali metal nitrite, alkali metal phosphate and an ethanolamine.

2. An aluminum hot rolling lubricant consisting essentially of water and from about 3% to about 5% of a hydrophilic mono C_{2-4} alkyl ether derivative of the copolymer of ethylene oxide and 1,2-propylene oxide in the ratio of 1:1 to 3:1 respectively, having a separation temperature between 50° C. and 70° C. and a viscosity at 100° F. SUS of about 500 to about 1000 and from about 0.01% to 2% of a mixture of sodium nitrite and sodium chromate.

3. An aluminum hot rolling lubricant consisting essentially of water and from about 3% to about 5% of a hydrophilic mono C_{2-4} alkyl ether derivative of the copolymer of ethylene oxide and 1,2-propylene oxide in the ratio of 1:1 to 3:1 respectively, having a separation temperature between 50° C. and 70° C. and a viscosity at 100° F. SUS from about 500 to about 1000 and from about 0.01% to 2% of a mixture of sodium nitrite, sodium phosphate and an ethanolamine.

4. An aluminum hot rolling lubricant consisting essentially of water and from about 3% to about 5% of a hydrophilic monobutyl ether derivative of the copolymer of ethylene oxide and 1,2-propylene oxide in the ratio of 1:1 to 3:1 respectively, having a separation temperature between 50° C. and 70° C. and a viscosity at 100° F. SUS from about 500 to about 1000 and from about 0.01% to 2% of a mixture of sodium nitrite and sodium chromate.

5. An aluminum hot rolling lubricant consisting essentially of water and from about 3% to about 5% of a hydrophilic monobutyl ether derivative of the copolymer of ethylene oxide and 1,2-propylene oxide in the ratio of 1:1 to 3:1 respectively, having a separation temperature between 50° C. to 70° C. and having a viscosity at 100° F. SUS of from about 500 to about 1000 and from about 0.01% to 2% of a mixture of sodium nitrite, sodium phosphate and an ethanolamine.

6. An aluminum hot rolling lubricant consisting essentially of about 3.5–4% monobutyl ether of the copolymer of ethylene oxide and 1,2-propylene oxide in the ratio of 1:1 respectively and having a viscosity of 660 SUS at 100° F., about 0.37% sodium nitrite, about 0.125% potassium chromate and the balance water.

7. An aluminum hot rolling lubricant consisting essentially of about 3.5–4% copolymer of ethylene oxide and 1,2-propylene oxide in the ratio of 3:1 respectively, and having a viscosity of 660 SUS at 100° F. and about 0.22% each of sodium nitrite, sodium hydrogen phosphate and the balance water.

8. The lubricant composition of claim 7 having incorporated therein from about 0.05% to about 0.5% of sodium petroleum sulfonate.

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