United States Patent Office 3,432,434
Patented Mar. 11, 1969

3,432,434

ALKYL AROMATIC HYDROCARBON EMULSION LUBRICANT FOR METAL ROLLING

Eldon L. Armstrong, Mullica Hill, and Robert H. Davis, Pitman, N.J., assignors to Mobil Oil Corporation, a corporation of New York

No Drawing. Filed May 19, 1967, Ser. No. 639,639
U.S. Cl. 252—49.5 12 Claims
Int. Cl. C10m 3/10, 3/04

ABSTRACT OF THE DISCLOSURE

Emulsions containing 5% to 99% by weight of water and 95% to 1% of an alkyl aromatic composition provide effective non-staining roll oil lubricants, especially for rolling nonferrous metals, such as aluminum alloys. The aromatic compounds include those having from 1 to 3 rings with the number of alkyl groups ranging from 1 up to the available number of substitutions on the rings, each alkyl group having 3 to 20 carbon atoms. The compounds contain a total of from 12 to 40 carbon atoms.

BACKGROUND OF THE INVENTION

This invention relates to an emulsion lubricant for metal-rolling operations, and in particular it relates to a method of cold rolling non-ferrous metals, particularly aluminum alloys, using aqueous emulsions containing aromatic lubricants.

DESCRIPTION OF THE PRIOR ART

British Patent No. 892,565 discloses method of rolling metals using aromatic hydrocarbons. French Patent No. 980,058 discloses specific alkylated aromatic hydrocarbons for use in metal-rolling. These patents deal with use of the hydrocarbons in a neat form, stating that they possess non-staining and load carrying characteristics. The load-carrying and non-staining requirements for roll oil lubricants are important in metal-rolling operations. However, of equal importance with these criteria is the cooling efficiency of roll oils. Metals exposed to extreme pressures under high temperature, particularly in the cold reduction process, may suffer undesirable changes in metallurgical characteristics. Moreover, use of oils that are unable to cool uniformly can cause variances in roll diameter and inconsistencies in the gauge of the finished piece. As a result, the operations may have to be repeated or the metals must be scrapped. Until now, no lubricant which has a high cooling efficiency and which is also non-staining has yet been found for cold-rolling operations on aluminum alloys.

SUMMARY OF THE INVENTION

It has now been found that oil-in-water or water-in-oil emulsions containing from 5% to 99% by weight of water and 95% to 1% by weight of an alkyl aromatic compound having 12 to 40 carbon atoms of the formula:

$$(Ar)—R_n$$

wherein Ar is an aromatic hydrocarbon of 1 to 3 aromatic rings, R is alkyl of 3 to 20 carbon atoms and n is 1 up to the number of available positions of Ar, preferably 1 to 2. Ar may include phenyl, diphenyl, naphthalene or anthracenyl. The R groups may be the same or different when n is greater than 1. The preferred number of alkyl carbon atoms for R is in the range of 6 to 16; thus, when n is 1, the smallest R group is preferably hexyl.

The emulsions of this invention may be prepared by adding the emulsifiers to the alkylated aromatic compound and then combining this mixture with the appropriate quantity of water using known emulsifying techniques.

Generally, simple agitation is sufficient. The water concentration ranges from 5% to 99%: 5% to about 50% for water-in-oil emulsions and 50% to about 99% for oil-in-water emulsions. The oil-in-water emulsions are excellent coolants. They retain enough lubricity to permit satisfactory rolling operations, and they are non-staining. When the organic compound is the preponderant component, the resulting water-in-oil emulsion has excellent load-carrying ability and better cooling properties than the neat or unemulsified compounds and these emulsions are relatively non-staining.

The emulsifiers used in this invention are not limited to specific classes. Most commercial emulsifiers are useful in preparing the emulsion lubricants of this invention, including cationic, anionic, and nonionic. Oil-in-water emulsions are prepared from emulsifiers having a hydrophilic-lipophilic balance (HLB) number of over 6, while water-in-oil emulsions are made from 2 to 6 HLB emulsifiers. The effect of this HLB number is discussed in more detail in U.S. Patent No. 3,213,024. Anionic emulsifiers include alkali and alkaline earth metal and amine sulfonates, phenates and phosphates as well as soaps derived from fatty acids. Nonionic emulsifiers include alkylene oxide adducts of C_3–C_{18}-alkyl phenols, and of polyols and ethers containing 2 to 12 moles of oxide. High temperature stabilizers may also be present, to maintain the emulsions during use. The nonionic stabilizers include alkylene oxide adducts of C_8–C_{30} acids, amides, and esters. Adducts of ethylene oxide, also hereinafter referred to as ETO, are of particular interest. Preferred agents are ethoxylated nonyl phenol (9 to 10 moles of ETO) and ethoxylated oleyl ether (2 moles of ETO), for oil-in-water systems and ethoxylated sorbitan monooleate (over 2 moles of ETO) for water-in-oil systems. The term "ETO" represents ethoxy groups.

The emulsions of this invention are exceptionally adapted to the cold-rolling of nonferrous metals, such as aluminum. Upon exposure to the 600° to 650° F. temperatures used in annealing aluminum to relieve cold-rolling stress, the roll oil lubricants in the past have formed objectionable residues or lacquers on the metal which made the finished metal unfit for sale. Mineral oil is susceptible to this form of breakdown. Even certain alkyl aromatic compounds in the neat form cannot withstand prolonged periods at 600° F. It has been found that many of these too can break down and leave stains. Surprisingly the emulsions of this invention are almost completely non-staining.

The preferred alkyl aromatic contains 1 or 2 6-membered rings. The alkyl side chains attached to the aromatic nucleus may contain 3 to 20, and preferably 6 to 16 carbon atoms. However, the total number of carbon atoms in the molecule should not be less than 12 and should not exceed 40. Dodecyl benzene and monononyl naphthalene are the most preferred since these substances are readily obtained in commercial amounts. Mixtures of the alkyl aromatic compounds may also be used. Moreover, the emulsions of this invention have been found to be so effective that even a minor proportion of the mineral oil can be tolerated therein. A preferred concentration of mineral oil for such compositions is in the range of from 1% to 30% by weight of the total of the oil phase.

The following examples illustrate the invention more clearly.

Example 1

Oil-in-water emulsions are prepared from the following emulsifier package: 50% by weight of ethoxylated nonyl phenol (9 to 10 moles of ETO), 40% by weight of ethoxylated oleyl ether (2 moles of ETO), and 10% by weight of cyclohexanol. This package is added to a series

of oils, including the alkyl aromatic compounds, at a concentration of 5% by weight at 120° F. The resulting "soluble oil" is combined with water in a weight ratio of 1 part soluble oil per 8 parts of water. Known techniques to form the emulsion are used in preparing each of the emulsion samples.

Example 2

Water-in-oil emulsions are prepared by adding 0.25% by weight of polyoxyethylene sorbitan monooleate and 0.25% by weight of sorbitan monooleate to a series of base oil media. The resulting oil is combined with water in a weight ratio of 4 parts of the "soluble oil" to 1 part of water.

The emulsions of Examples 1 and 2 are tested in an aluminum stain test. A series of cold-rolled aluminum plates are cleaned and dried. Over the surface is spread 0.8 ml. of the sample emulsion as a coating. The plates are placed in an electric muffle furnace, maintained at about 650° F., for 30 minutes. The plates are removed and observed for staining. Five standard plates are used as the comparison, the test samples being matched with the numbered standards. In the rating scale of 1 to 5, a 1 rating indicates no stain, 5 indicates severe stain.

The results for the oil-in-water emulsions are tabulated in Table 1. Those for the water-in-oil emulsions are tabulated in Table 2.

Table 1

Base Oil:	Stain rating
(a) Dodecyl Benzene [1]	1
(b) Dodecyl Benzene [2]	2
(c) Mononyl Naphthalene [3]	1
(d) Dinonyl Naphthalene	2
(e) Mineral Oil [4]	5
(f) Mineral Oil [5]	4

[1] Branched chain; sp. g. at 60° F./60° F. 0.8639; Bromine No. 0.11.
[2] Straight chain; sp. g. at 60° F. 0.859; 40.3% C_{12}-, 38.4% C_{11}-, 14.4% C_{10}-, 6.7% C_{13}-, 0.2% C_{14}-alkyl chains.
[3] Contains 15% to 25% by weight of dinonyl naphthalene.
[4] Paraffinic oil, 130 SUS at 100° F.
[5] 50/50 Paraffinic/Naphthenic, 44.8 SUS at 100° F.

The base oil of items *d* and *e* have also been tested as a neat oil in the stain test, and both give ratings of 5. Those results show that even certain alkyl aromatic compounds when used alone are unfit as a lubricant.

Table 2

Base Oil:	Stain rating
(g) Dodecyl benzene [1]	1
(h) Mononyl naphthalene [3]	2
(i) Mineral oil [5]	5

[1] Branched chain; sp. g. at 60° F./60°F. 0.8639; Bromine No. 0.11.
[3] Contains 15% to 25% by weight of dinonyl naphthalene.
[5] 50/50 Paraffinic/Naphthenic, 44.8 SUS at 100° F.

Example 3

An oil-in-water emulsion is produced by combining 1 part by weight of an equal-weight mixture of dodecyl benzene and monononyl naphthalene as the base fluid and 5% by weight of the emulsifier package of Example 1 with 8 parts by weight of water. The resulting emulsion is a satisfactory lubricant for cold-rolling aluminum alloys.

Example 4

An emulsion is prepared in a manner similar to the water-in-oil emulsion of Example 2. In this case the base fluid contains 80% by weight of monononyl naphthalene and 20% by weight of a paraffinic solvent-refined mineral oil. The emulsifier package and the water concentration are the same as that of Example 2. The resulting emulsion is a satisfactory lubricant for metal-rolling operations.

Several emulsions of this invention are tested in the internal thread forming test described in detail in the application Serial Number 639,665, filed on May 19, 1967, in the name of Robert H. Davis. These tests are shown in the said application to simulate stresses met during the actual metal-rolling operations.

Example 5

A number of oil-in-water emulsions are prepared by combining a mixture of 87.5 parts by weight of base medium, 10 parts by weight of pelargonic acid and 2.5 parts by weight of an ethoxylated tallow amine (2 moles ETO) with water. The weight ratio of the oil mixture to water is 1:8.

In the internal thread forming test the emulsions are used to lubricate the threading of a hole in metal without cutting the metal. The metal work piece is 7075 aluminum, the hole size is 0.228 inch. The thread former is rotated in the hole at 410 r.p.m. The measured torque is rated as an efficiency figure, as follows:

$$E=100\ A/B \text{ percent}$$

E is efficiency, A is the average torque of any standard reference oil, and B is the average torque of the sample test oil. A result of 100 or below indicates that the sample oil is equal to or worse than the reference standard. The standard used is a commercial mineral oil-in-water emulsion. The results are tabulated in Table 3.

TABLE 3

	Base Oil	Parts by Weight	E
j	Mineral Oil [1]	87.5	103
k	Dodecyl Benzene	87.5	131
l	Monononyl Naphthalene	87.5	143
m	Dodecyl Benzene	17.5	140
	Monononyl Naphthalene	12.5	
	Mineral Oil [1]	17.5	

[1] Paraffinic Oil, 35 SUS at 100° F.

It is evident from the above results that the emulsion lubricants of this invention can be successfully employed in the rolling of metals, particularly when the process includes an annealing step of about 600° to 650° F.

The scope of the invention is not limited by the specific examples presented, but may include all variations and modifications which become manifest to those skilled in the arts upon reading our disclosure and our appended claims.

We claim:

1. An emulsion lubricant suitable for the rolling of non-ferrous metals consisting essentially of about 5% to 99% by weight of water and 95% to 1% by weight of an alkyl aromatic hydrocarbon, having from 1 to 3 aromatic rings wherein the alkyl groups contain from 3 to 20 carbon atoms per group, and the total number of carbon atoms of the said alkyl aromatic hydrocarbon is from 12 to 40, and an emulsifier therefor.

2. The lubricant of claim 1, wherein the number of alkyl groups is 1 to 2.

3. The lubricant of claim 1 wherein the alkyl groups contain 6 to 16 carbon atoms per group.

4. The lubricant of claim 1, wherein the alkyl aromatic hydrocarbon is selected from the group consisting of alkyl benzene, alkyl naphthalene and mixtures thereof.

5. The lubricant of claim 1 wherein the alkyl aromatic hydrocarbon is dodecyl benzene.

6. The lubricant of claim 1 wherein the alkyl aromatic hydrocarbon is monononyl naphthalene.

7. The lubricant of claim 1, wherein the concentration of water is 5% to 50%.

8. The lubricant of claim 1, wherein the concentration of water is 50% to 99%.

9. The lubricant of claim 4, wherein the alkyl aromatic hydrocarbon is a mixture of alkyl benzene and alkyl naphthalene.

10. The lubricant of claim 1, wherein from 1% to 30% by weight of the alkyl aromatic hydrocarbon is replaced by a mineral oil.

11. The lubricant of claim 10, wherein the alkyl aro-

matic hydrocarbon is a mixture of alkyl benzene and alkyl naphthalene.

12. The method of cold-rolling aluminum comprising using as the rolling lubricant an oil-in-water emulsion containing from 50% to 90% by weight of composition of water, wherein the oil portion consists of the alkyl aromatic hydrocarbon of claim 1 and an emulsifier therefor.

References Cited

UNITED STATES PATENTS

2,447,475	8/1948	Kaberg et al.	252—312 XR
2,626,242	1/1953	Talley et al.	252—59 XR
2,826,549	3/1958	Manteuffel et al.	252—49.5 XR
3,310,489	3/1967	Davis	252—49.5

FOREIGN PATENTS

892,565 3/1962 Great Britain.

OTHER REFERENCES

Kobel, "Chemical Abstracts," vol. 44 (1950), pages 2217 and 2218.

Sachanen, "Chemical Constituents of Petroleum," Reinhold Pub. Corp., 1945, pages 228, 229, and 233 to 240.

DANIEL E. WYMAN, *Primary Examiner.*

W. H. CANNON, *Assistant Examiner.*

U.S. Cl. X.R.

252—59