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COLD METAL FORMING LUBRICANT

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ABSTRACT OF THE DISCLOSURE

Cold metal forming lubricant comprising effective amounts of:

(a) water (optional)
(b) alkali metal orthophosphate
(c) alkali metal fatty acid soap
(d) alkali metal alkaryl sulfonate.

BACKGROUND OF THE INVENTION

This invention relates to an improved lubricating composition and more particularly it relates to an improved lubricant which is useful in lubricating chemically coated metal surfaces prior to deformation and which can be used for extended periods without separation or salting out of the components. This invention also relates to a flowable to semi-solid lubricant composition concentrate possessing improved rheological properties whereby said lubricant can be readily removed from a storage container prior to use.

According to the customary techniques of cold forming metal, e.g., metal deformation or metal drawing, a chemical coating (e.g., phosphate, oxide, oxalate, sulfide or the like) is initially applied to the surface of the metal to be deformed. Prior to the actual deformation of the metal, the chemical coating on the metal surface is frequently treated with a lubricant, such as a hot, aqueous soap solution. Upon the application of pressure to the metal surface, during the deforming operation, the coating on the surface crushes to a continuous, unctuous film which has been found to be an excellent parting layer between the metal and the die during the deforming operation.

While it has been the general practice to employ lubricant composition, e.g., aqueous soap solutions containing one or more inorganic materials which act as diluents in the lubricant compositions, these compositions have been found to have numerous disadvantages including the separation or salting out of the soap and organic materials from the lubricant composition. When this occurs, the entire lubricant bath must be dumped and another is made up which gives rise to one or more severe limitations including the cost and the loss of time due to the interruption of production schedules.

One attempt to solve the stability problem involved the addition of anionic phosphate esters, non-ionic ethylene oxide condensates or amphoteric biodegradable surface active agents to the cold forming lubricant as taught in U.S. Pat. 3,372,117. However, when the surface active agents are employed in the lubricant composition concentrates, a high degree of gumming or calking of the lubricant has been found to occur. Thus, on shipping or storage, the lubricant concentrates have been found to become very hard to the point where a crowbar might necessarily have to be used to remove the concentrates from the drum or storage container.

There thus remains a need for a cold forming lubricant composition having a high degree of stability when in use and one which can be readily removed from a storage container prior to use. The present invention, quite unexpectedly, reveals that this need can be satisfied.

OBJECTS OF THE INVENTION

Specifically, it is the primary object of the invention to provide a lubricant composition for use in the cold forming of metal which can be used for extended periods of time without separation or salting out of the components.

Consistent with this primary object, it is a further object hereof to provide a flowable to semi-solid lubricant concentrate having improved rheological properties such that said lubricant can be readily and easily removed from a storage container or drum prior to use.

Still another, most important object of this invention is to provide a lubricant concentrate which can be used in the form of an aqueous solution thereby facilitating its application and use, and said composition comprising comparatively inexpensive and readily available constituents.

The invention will be better understood and objects other than those set forth above will become apparent after reading the following detailed description of preferred, yet illustrative, embodiments hereof.

SUMMARY OF THE INVENTION

The composition of this invention is a flowable to semi-solid lubricant composition concentrate or a solution thereof, comprising (A) an intimate mixture of an alkali metal orthophosphate, (B) a fatty acid soap, and (C) an anionic hydrotropic surface active agent to substantially prevent the lubricant from separating into layers and to provide such rheological properties of the composition thus permitting the lubricant to be readily removed from a storage container prior to use. This lubricant composition has been found to be especially useful in metal deforming operations when it is applied over a chemical coating, e.g., phosphate, oxide, sulfide, oxalate coating or the like, on the metal surface to be deformed.

DETAILED DESCRIPTION OF THE INVENTION

More specifically, the improved lubricant concentrate composition of the present invention is a flowable to semi-solid lubricant composition concentrate comprising (A) an intimate mixture of about 3 to 80 percent by weight of an alkali metal orthophosphate, (B) about 20 to 97 percent by weight of an alkali metal fatty acid soap containing from about 8 to 22 carbon atoms, and (C) a sufficient, but minor amount of a solid, anionic hydrotropic surface active agent to substantially prevent said lubricant from separating into layers when in use and to provide such rheological properties of said composition that the lubricant concentrate can be readily removed from a storage container prior to use.

The fatty acid soaps which may be used in the composition of the present invention are exemplified by those fatty acid soaps containing from about 8 to 22 carbon atoms and are preferably fatty acid soaps containing from about 12 to about 18 carbon atoms. Specifically preferred for use in the present invention are the sodium tallow soaps. Additionally, it is to be appreciated that in referring to the present composition containing a soap, it is intended to include both those compositions which contain the soap per se as well as compositions which contain components which react to form the soap in situ in the composition, such as compositions containing a fatty acid, a fat, or an oil and an alkali, e.g., an alkali metal hydroxide or an alkali metal carbonate. Generally, the amount of fatty acid soap which is employed is about 20 to 97 percent and preferably about 35 to 80 percent by weight of the total composition.

The alkali metal orthophosphate which may be used in the present composition is selected from the group consisting of mono-, di-, and tri-alkali metal phosphates, and mixtures thereof. It is to be appreciated that as used in the specification and claims, the term "alkali metal" is intended to refer to lithium, sodium, potassium, cesium, and rubidium. Of these, the preferred alkali metal is sodium and for this reason, primary reference hereinafter will be made to this material. This is not, however, to be regarded as a limitation of the alkali metals which may be used, as excellent results may also be obtained with other alkali metals such as potassium. Of the alkali metal orthophosphates which have been indicated hereinabove as being suitable for the present composition, the preferred materials is trisodium phosphate. Generally, from about 3 to about 80 percent and preferably from about 15 to 60 percent by weight of the alkali metal orthophosphate is present in the composition.

The solid, anionic hydrotropic surface active agent which is employed in the practice of the invention may include compounds of the formula

$$R\{X\}(SO_3M)_n$$

wherein R is an alkyl group of 3 to 12 carbon atoms; X is an aryl or diphenyl ether group; M is an alkali metal, and n is at least 1.

The alkyl group, as stated above, generally contains from 3 to 12 carbon atoms and preferably from 4 to 10 carbon atoms. Generally, the alkyl chain may be branched or an essentially straight chain with straight chain alkyl groups being preferred. The aryl group may be selected from the group consisting of benzene, naphthalene, biphenyl and diphenyl ether. The value of n in the above formula is at least 1 and preferably 1 or 2.

It would appear that other solid anionic hydrotropic surface active agents having other equivalent acid salt groups attached to the aryl nucleus or diphenyl ether group would also be suitable for the practice of the invention. Accordingly, other acid salt groups providing the same function as the $—SO_3M$ radical would also fall within the scope of this invention.

The acid salt group attached to the aryl nucleus is in the form of an alkali metal salt with M being an "alkali metal" and having the same definition as set forth above.

Typical of the solid anionic hydrotropic surface active agents that are employed in the practice of this invention include sodium sulfonate of dodecyl (50 percent straight and 50 percent branched chain) benzene, sodium sulfonate of propyl (branched chain) naphthalene, sodium sulfonate of secondary butyl naphthalene, sodium sulfonate of nonyl (branched chain) naphthalene. Best results are obtained with sodium sulfonate of butyl (straight chain) benzene, sodium sulfonate of monobutyl (straight chain) biphenyl and sodium disulfonate of dodecyl (branched chain) diphenyl ether.

As noted above, the solid anionic hydrotropic surface active agent is employed in the composition in a minor, but sufficient amount to prevent the lubricant solution from separating into layers when in use and to provide the lubricant concentrate with such rheological properties so that the lubricant can be readily removed from a storage container prior to use. This amount is generally between about 0.1 and 25 percent and preferably between 1 and 25 percent and preferably between 1 and 10 percent by weight of the total composition.

In addition to the fatty acid soap, alkali metal orthophosphate, and the solid anionic hydrotropic surface active agent, the lubricant compositions of the present invention may also contain one or more water dispersible diluent or adjuvant materials, as optional ingredients. These diluents may be incorporated in the composition in addition to or as a replacement for a part of the alkali metal orthophosphate component. Preferably, the diluent materials employed are water soluble although non-water soluble diluents which will remain dispersed in the aqueous lubricant composition are also suitable. Desirably, the diluents are present in the composition in amounts within the range of about 0.1 to 80 percent by weight of the composition, with amounts within the range of about 10 to about 50 percent by weight of the composition being preferred. These diluent materials may be either inorganic or organic in nature and include antimony oxide, antimony sulfide, arsenious oxide, arsenious sulfide, barium pyrophosphate, bismuth sulfide, boric anhydride, calcium tetraborate, calcium carbonate, cadmium pyrophosphate, cobalt sulfide, chromium fluoride, copper sulfide, ferrous sulfide, ferrous phosphate, lead borate, lead chromate, lead molybdate, lead oxide, lead phosphate, lead metasilicate, lead sulfide, manganese pyrophosphate, manganese borate, mercury sulfide, mercury chloride, molybdic oxide, nickel sulfide, molybdenum sulfide, sodium tetraborate (borax), vanadium pentoxide, zinc borate, zinc phosphate, the alakli metal silicates and particularly sodium metasilicate, calys, diatomaceous earth, fuller's earth, bentonite, kaolin, mica, sugar, starch, polyethylene glycols, dextrin, gelatin, gum arabic, bitumin, and the like. Of these, the preferred diluent materials for use in the present composition have been found to be sugar and the polyethylene glycols. Typically, the polyethylene glycols have a molecular weight from about 100 to about 10,000, with the intermediate molecular weight of from about 2,000 to 8,000, being preferred. These and other diluent materials have been found to make the present lubricating composition easier to clean from the workpiece after the deforming operation and have also been found to reduce the attack of the lubricant composition on the chemical coating, e.g., the phosphate coating, on the metal surface.

In addition to the components which have been set forth hereinabove, the lubricant composition of the present invention may also contain corrosion inhibitors, e.g., alkali metal nitrate and alkali metal nitrites. These and other corrosion inhibitors known to those skilled in the art, when used, are typically present in amounts within the range of about 0.1 to about 5 percent by weight of the composition and are preferably present in amounts within the range of about 0.1 to about 3 percent by weight of the composition. Additionally, dyes, such as Bismarck brown, and the like, and perfumes and other materials for imparting a pleasant odor to the composition, e.g., pine oil and the like, may also be incorporated in the lubricant composition in amounts sufficient to impart the desired color and/or odor to the composition.

In addition to the above adjuvants, the lubricant concentrate compositions of the present invention may also contain water, the amount depending upon the physical form which is desired for the composition. Typically, water in amounts up to about 80 percent by weight of the total composition may be used, with amounts within the range of about 15 to about 75 percent by weight of the total composition being preferred. As will be appreciated by those in the art, in determining the physical form or consistency of the lubricant composition which is desired, consideration will be given to the manner in which the composition is to be handled, packaged and transported which is usually in the form of a dry material. Accordingly, the amount of water included in the concentrate composition may vary widely, but in most instances will be added just prior to use.

In some instances, however, when water in an amount of 75 percent by weight of the lubricant concentrate composition is used, the concentration of the composition may still be sufficiently high as to be undesirable for many applications to metallic surfaces. Accordingly, in formulating a working composition for application to a metal surface, the concentrated lubricant composition as has been described hereinabove will frequently be diluted with water. Typical working compositions may contain the above described lubricant concentrate in amounts within the range of about 10 to about 400 pounds per hundred gallons of solution, and preferably in amounts within the range of about 50 to about 200 pounds per hundred gallons of solution.

The lubricant concentrate compositions of this invention, as noted above, are flowable to semi-solid materials. By "semi-solid," it is intended to refer to those compositions which are not readily flowable but which is thixotropic and has a consistency similar to molasses such that the composition can be removed from a drum or other container by means of a spatula. This term is not intended to include a composition which has a degree of hardness such that the composition can only be removed from a drum or other container with a crowbar.

The aqueous working lubricant solution as described above may be applied to the metal surfaces to be deformed in various ways, e.g., by roller application, flow coating, spraying, or by immersing the metal surface in the lubricant solution. In such applications, the lubricant temperature may vary widely, from about room temperature up to about 100 degrees centigrade. Typical temperatures for application by immersion technique are within the range of about 60 to 100 degrees centigrade with temperatures from about room temperature up to about 60 degrees centigrade are typical for roller application. In some instances, it has been found that in the use of roller applications, it may be desirable to use the lubricant composition as a concentrate, with no further dilution. In this technique, the concentrate composition may be applied to the applicator rolls with air pressure, a reciprocating piston pump, or a centrifugal pump. It is believed that the details of the various techniques whereby the present lubricant compositions may be applied are sufficiently familiar to those in the art that further description of the details of such methods are not necessary.

In forming metal articles in accordance with the process of the present invention, the lubricant compositions are applied to a chemically coated metal surface using the application techniques described above, to obtain the desired amount of lubricant on the surface. Generally, the lubricant coating is then dried and the coated surface is, thereafter, subjected to drawing, cold forming, or other deformation operations. The chemical coating on the metal surface, such as a phosphate, oxide, sulfide, oxalate coating, or the like, may be applied using various application techniques as are known in the art, such as spraying immersion, flowing, roller coating, and the like. Generally, the application of the chemical coating to the metal surface is preceded by a cleaning or pickling step and a rinse to remove the cleaning or pickling solution. Frequently, between the application of the chemical coating and the lubricant coating, the chemically coated surface is also rinsed to remove unreacted coating material. Although this latter rinse may be a water rinse, alkaline or neutralizing rinses are also frequently used. It is believed that the composition and nature of the various chemical coating materials, as well as the specific details of the processes of applying them to the metal surface and the details of various metal deforming operations are all sufficiently well known to those in the art that a further detailed description of these compositions and processes is not necessary.

It has been found that in using the lubricant compositions of the present invention, the metal deforming operations are easily and economically performed. It has been further found that with these lubricant compositions, there is little or no problem of separation or salting out of the components of the lubricant compositions so that a bath of the lubricant can be used for extended periods of time with only periodic replenishment of the lubricant which is used. Additionally, it has been found that where the chemically coated metal parts are immersed in the lubricant for extended periods of time, there is only slight attack by the lubricant on the chemically coated surface.

In order for those skilled in the art to better understand this invention and the manner in which it may be practiced, the following specific examples are set forth.

ILLUSTRATIVE EXAMPLES

Example 1

An aqueous lubricant composition was prepared containing 213 grams trisodium phosphate, 9.9 grams sodium metasilicate, 8.5 grams polyethylene glycol (M.W. 6000), 38.3 grams of high titer sodium tallow soap and 17.7 grams sodium sulfonate of monobutyl (straight chain) biphenyl (Roberts Chemicals RWA 300). Each of the ingredients were added to a one quart jar in the order shown and mixed dry. At this point, the bottle was capped and put aside until the next day. The following morning some hot water was added to the jar and the jar was heated to 190° F. in an oven. While heating the jar, the ingredients were stirred on a continuous basis. The jar was then capped and held in an oven at 190° F. and observed for stability. This composition was found to be stable for 15 days.

Example 2

The procedure of Example 1 was repeated with the exception that for sodium sulfate of monobutyl (straight chain) biphenyl there was substituted 7.9 grams sodium disulfonate of dodecyl (branched chain) diphenyl ether (Dow Chemical Dowfax 2A1). Upon subjecting the lubricant composition to a temperature of 190° F. in an oven, the composition was found to be stable for 23 days.

Example 3

A lubricant concentrate was prepared containing 112.5 grams trisodium phosphate ($TSP.12H_2O$), 5.37 grams of sodium sulfonate of butyl (straight chain) benzene (Santomerse E), 5.25 grams sodium metasilicate, 4.5 grams of polyethylene glycol (M.W. 6000), and 20.25 grams of high titer sodium tallow soap. This composition was by weighing out, in the order indicated above, the trisodium phosphate, and then the surface active agent and intimately mixing the two ingredients in a bottle. The remaining materials were then weighed and individually mixed with the materials in the bottle. When all the materials had been added, the materials were further mixed and the bottle was then capped and allowed to stand on the shelf. The product was found to be soft, free-flowing product after having been on a shelf for a period of eight weeks.

After considering the foregoing description and the immediately preceding examples, it should be apparent that the objects set forth at the outset of this specification have been successfully achieved.

Accordingly,

What is claimed is:

1. A flowable to semi-solid cold forming lubricant composition concentrate consisting essentially of an intimate mixture of about 3 to 80 percent by weight of an alkali metal orthophosphate, about 20 to 97 percent by weight of an alkali metal fatty acid soap containing about 8 to 22 carbon atoms and a sufficient but minor amount of a sulfonated compound of the formula

$$R{-}(X){-}(SO_3M)_n$$

wherein R is alkyl containing from 3 to 12 carbon atoms; X is aryl or diphenyl ether; M is an alkali metal; and *n* is at least 1, to substantially prevent said lubricant from separating into layers and to provide such rheological properties of said composition that lubricant can be readily removed from a storage container prior to use.

2. The composition of claim **1** comprising from about 0.1 to 25 percent by weight of said sulfonated compound.

3. The composition of claim **1** comprising from about 1 to 10 percent by weight of said sulfonated compound.

4. The composition of claim **1** wherein said alkyl group contains 4 to 10 carbon atoms.

5. The composition of claim **1** wherein said sulfonated compound is selected from the group of sulfonated compounds consisting of alkyl benzene, alkyl naphthalene, alkyl diphenyl ether, and alkyl biphenyl.

6. The composition of claim **1** wherein said sulfonated alkyl aryl compound is sodium sulfonate of linear alkyl benzene, said alkyl group containing about 4 carbon atoms.

7. The composition of claim **1** wherein said sulfonated alkyl aryl compound is sodium disulfonate of dodecyl diphenyl ether.

8. The composition of claim **1** wherein said sulfonated alkyl aryl compound is sodium sulfonate of monobutyl biphenyl.

9. The composition of claim **1** wherein said alkali metal orthophosphate is trisodium and said soap is sodium tallow soap.

10. The composition of claim **9** which further comprises at least one water dispersible diluent selected from the group consisting of alkali metal silicate, polyethylene glycol having a molecular weight from about 100 to 10,000, and mixtures thereof, in an amount within the range of about 0.1 to 80 percent by weight.

11. The composition of claim **10** wherein said alkali metal silicate is sodium metasilicate.

12. An aqueous lubricant composition containing the lubricant concentrate of claim **1** in an amount between about 10 to 400 pounds per hundred gallons of solution.

13. The composition of claim **12** which further comprises at least one water dispersible diluent selected from the group consisting of alkali metal silicate, polyethylene glycol having a molecular weight from about 100 to 10,000, and mixtures thereof, in an amount within the range of about 0.1 to 80 percent by weight of the concentrate composition.

14. The composition of claim **13** wherein said alkali metal orthophosphate is trisodium phosphate and said soap is sodium tallow soap.

15. A method for cold forming a metal article comprising contacting said metal with an aqueous lubricant composition containing from 10 to 400 pounls per hundred gallons of solution of the concentrate recited in Claim **1**, and thereafter colld forming said article.

16. The method of Claim **15** wherein said metal article is first treated to form a chemical coating on the surface of the article prior to contact with the lubricant composition.

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