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LUBRICANT FOR PROCESSING METALS

Joseph Harrel Shipp, Wilmington, Del., and
Osborne Coster Bacon and Charles J. Pedersen,
Penns Grove, N. J., assignors to E. I. du Pont
de Nemours & Company, Wilmington, Del., a
corporation of Delaware

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This invention relates to new compositions of matter and particularly to aqueous emulsions especially adapted for lubricating metals during processing operations, such as cutting, drawing, drilling, tapping, milling, stamping and the like.

For many years there has been a problem of improving lubricants used in cutting and drawing metals and in various other metal processing steps. In many cutting operations, such as those performed on lathes, drill presses and milling machines, it is very difficult to keep a lubricant at the cutting point due to the continual flow of metal past this point under extreme pressures. The ideal lubricant would be one which could be applied to the cutting edge before cutting was begun, and which would cling tenaciously to that edge and facilitate the sliding of the metal surfaces by the cutting edge. Without proper lubrication at the cutting edge, there is a tendency for metal to build up on the cutting tool and this impairs cutting. Likewise, in other metal cutting operations where high pressures are involved, there is a tendency for metal to metal contact between cutting tool or die and metal being processed, unless a tenacious lubricant is used. As a result, there is a welding of the two metals which eventually causes scoring or tearing out of metal, giving a rough surface to the object being processed. This problem exists in cutting, drawing, stamping and other operations.

In the cutting of soft metals, the difficulty is accentuated due to the low resistance of the metals to deformation under pressure. Thus, in tapping holes in aluminum, there is a tendency to tear out the metal and give an over size hole unless a highly efficient lubricant is used. Due to this fact, it was difficult to get close fitting threads in aluminum. It has been customary to use under-size taps in tapping aluminum and other soft metals. This necessitates two sets of taps where one set of taps would be sufficient if a satisfactory lubricant were used. In tapping hard metals to give close clearance threads, there is also some tendency for some of the harder crystals of some alloy metals to be pulled out rather than cut through. This results in an unevenly cut surface. To minimize the tearing out of these crystals, it is often necessary to resort to laborious hand tapping to obtain close clearances.

Shipp and Pedersen have discovered that aqueous emulsions of a "Lorol" residue, in which the emulsifying agent is a surface-active water-soluble non-acidic salt of an acid-ester of phosphoric acid, are extremely effective lubricants for

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metal processing operations, such as cutting, drawing, drilling, tapping, milling, stamping and the like. However, such emulsions tend to foam to an objectionable extent during handling, dilution and in use.

The emulsions of Shipp and Pedersen are disclosed in detail and are claimed in their copending application Serial No. 596,078, filed May 26, 1945. A brief description of such emulsions follows:

The "Lorol" residue is obtained by the carboxyl hydrogenation of a natural fatty oil in the presence of a hydrogenation catalyst until the major proportion, at least 70%, of the carboxyl groups have been reduced, followed by separation of the hydrogenation catalyst and distillation of the reaction mixture to remove substantially all alcohols up through octadecyl alcohol. The residue left in the still is a "Lorol" residue. It is a product of indeterminate composition and appears to contain higher alcohols, esters of higher alcohols, ethers of higher alcohols, hydrocarbons, glycerine and esters of glycerine with the ethers of the higher alcohols predominating. Frequently, it is desirable to subject this residue to a further hydrogenation and distillation so as to recover more of the valuable alcohols and to reduce the proportion of esters in the residue.

The water-soluble non-acidic salts of the acid-esters of phosphoric acid which are surface-active, that is, which have emulsifying properties, are particularly effective for emulsifying "Lorol" residues in water to produce non-corrosive, non-rusting and non-discoloring emulsions. An "acid-ester" of phosphoric acid is one in which from 1 to 2 of the hydrogens of phosphoric acid has been replaced by an esterifying group and which contains from 1 to 2 unreplaced hydrogen atoms. The esterifying group may be any organic group which imparts substantial surface activity to the compound. Suitable esterifying groups are long-chain alkyl, alkyl substituted aryl, aralkyl and the like. By "long-chain alkyl," is meant open-chain aliphatic hydrocarbon groups of 8 or more carbon atoms. Preferably, the long-chain alkyl groups will contain from 8 to 20 carbon atoms. Representative long-chain alkyl groups are octyl, decyl, dodecyl, tetradecyl, hexadecyl and cetyl. Preferably, the acid-esters will be mixtures of mono and di-esters containing about 1.5 esterifying groups for each phosphate radical. Best results have been obtained with acid-esters containing about 1.5 long-chain alkyl groups of 8 to 18 carbon atoms per phosphate radical.

The salts of the acid-esters are those in which

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the ester has been completely neutralized by a basic salt-forming substance which forms, with the ester, a surface-active water-soluble salt. Suitable basic salt-forming substances include primary, secondary and tertiary amines, particularly mono-, di- and trialkylamines and alkylolamines. Preferably, the basic salt-forming substance will be a short-chain aliphatic amine and particularly an alkylolamine, such as triethanolamine.

The concentration of the "Lorol" residue in the emulsion may be widely varied in accordance with the use to which it is to be put. Where the emulsion is to be employed as a coolant, as well as a lubricant, and applied by a circulating pump or the like, the "Lorol" residue should be present in a concentration of from about 1% to about 5% and preferably from about 2% to about 4%. Where the lubricant is to be applied to the work and tool by brushing or the like, the "Lorol" residue will be present in the emulsion in a concentration of approximately 10%. Ordinarily, the emulsion will be marketed as a concentrate to be further diluted for use. In such concentrate, the "Lorol" residue will usually be present in a concentration of from about 40% to about 55%. The concentrated emulsion may contain higher concentrations of "Lorol" residue up to about 70%, but such concentrations will usually be undesirable as they are quite viscous and are difficult to stir into water to obtain the desired diluted emulsion for use.

The proportion of the emulsifying agent in the emulsion may be widely varied and will be largely dependent upon the effectiveness thereof as an emulsifying agent. For practical purposes, sufficient emulsifying agent should be used to provide a stable emulsion. A substantial increase of the emulsifying agent over that required to provide a stable emulsion will usually be undesirable because it increases the tendency of the emulsion to foam during use. Proportions of emulsifying agent ranging from as little as 2% to as much as 50% based on the "Lorol" residue have been employed satisfactorily. With the preferred emulsifying agents, very satisfactory results have been obtained employing from about 3% to about 10% of the emulsifying agent based on the "Lorol" residue.

It is an object of the present invention to provide new and useful emulsions. Another object is to provide novel emulsions particularly adapted for lubricating metals during metal processing operations and whose tendency to foam have been largely inhibited. Still another object is to provide improved metal processing lubricants, and particularly lubricants which are stable and non-corrosive toward metals and which are substantially non-foaming. Other objects are to provide new compositions of matter and to advance the art. Still other objects will appear hereinafter.

The above and other objects may be accomplished in accordance with our invention which comprises providing an aqueous emulsion of a "Lorol" residue, in which the emulsifying agent is a surface-active water-soluble non-acetic salt of an acid-ester of phosphoric acid, to which has been added a member of the group of pine oil, white camphor oil, "Tetralin" and Hexalin" in an amount sufficient to substantially inhibit the tendency of the emulsion to foam. We have found that such emulsions are effective lubricants for metal processing operations, such as cutting, drawing, drilling, tapping, milling, stamping and

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the like and that the pine oil, white camphor oil, "Tetralin" and "Hexalin" are very effective to inhibit the tendency of the emulsions to foam. "Tetralin" is the trade name for tetrahydronaphthalene and "Hexalin" is the trade name for cyclohexanol.

Ordinarily, we employ from about 25% to about 100% of the anti-foaming agent, based on the weight of the "Lorol" residue. Usually, about 25% to about 50% of the anti-foaming agent, based on the "Lorol" residue, will be sufficient and preferred. However, larger or smaller amounts of anti-foaming agent may be employed as the amount will be largely dependent upon the concentration of effectiveness of the emulsifying agent. Increasing amounts of emulsifying agent will generally require larger amounts of the anti-foaming agent.

Representative concentrated preparations, which have been employed satisfactorily in commercial applications, had the following compositions:

	#1	#2
"Lorol" Residue.....	Parts 40	Parts 40
Pine Oil.....	12	12
Alkyl phosphate ¹	0.75	1.5
Triethanolamine.....	0.75	1.5
Water.....	46.50	45.00

¹ This is a mixture of esters of phosphoric acid containing about 1.5 alkyl groups per phosphoric acid radical, the alkyl groups being derived from a mixture of primary straight-chain aliphatic alcohols of 8 to 14 carbon atoms.

In order to more clearly illustrate our invention, the preferred modes of carrying the same into effect and advantageous results to be obtained thereby, the following examples are given.

Example 1

Forty lbs. of residue, left in the still after distilling a hydrogenated cocoanut oil, hydrogenated according to U. S. Patent 2,023,383, was mixed with 10 lbs. of pine oil and then emulsified with 50 lbs. of a 5% aqueous solution of the triethanolamine salt of a mixed dodecyl and decyl phosphate by stirring with a high speed stirrer. The phosphate was prepared from a mixture of equal parts of dodecyl and decyl alcohols and contained about 1.5 alkyl groups per phosphate radical. The resulting emulsion was diluted with 10 parts of water for 1 part of emulsion, and the diluted emulsion used as a coolant and lubricant in drawing dynamite blasting caps from aluminum stampings. These dynamite caps were extremely thin walled and yet there was no indication of tearing or scoring when the above lubricant was used. With ordinary lubricants, it had been noted that a large number of caps had torn edges and scored surfaces. It was also noted that, with the lubricant prepared according to this invention, the life of the dies was greatly increased. Similar blasting caps were drawn from gilding metal, which is a high copper content alloy, and an equal improvement was noted over the use of other lubricants. There was no corrosion of the bright surface of either the aluminum or the gilding metal, even when the lubricant was left in contact with the metal for several hours. The pine oil effectively inhibited foaming of the emulsion during use.

Example 2

A one inch rod of cold rolled steel was threaded, using the concentrated emulsion described in Example 1 as lubricant. The lubricant was

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brushed onto the metal and onto the die during hand threading. The surfaces of the cut threads were examined under a magnification of ten times. It was noted that an extremely smooth cut was obtained, when compared with a similar rod threaded with the same die, but using a sulfurized cutting oil as lubricant. Likewise, a one inch hole was tapped in a high carbon steel, using the emulsion of Example 1 as lubricant. After tapping, the metal was cut through the hole and the threads viewed under ten-power magnification. Again it was observed that a very smooth cut had been obtained.

Example 3

Twenty pounds of pine oil were added to 40 lbs. of the residue from the distillation of hydrogenated cotton seed oil. The pine oil and residue were heated to 60° C. and poured with violent stirring into 50 lbs. of water containing 4% of the salt of 2-amino 2-methyl propanol-1 and decyl phosphoric acid in which 1½ alkyl groups are present for each phosphoric acid unit. This emulsion was diluted with 20 parts of water and used as a coolant and lubricant for tapping holes in aluminum alloy crank cases. With this lubricant, very clean cut threads were obtained using standard size taps and a close fit was also obtained as shown by the "Go-No Go" gauge. A similar emulsion, except that the pine oil was omitted, foamed to an objectionable degree but the foaming was overcome by the addition of the pine oil.

Example 4

Seven and one-half pounds of a mixture of mono and di-lauryl phosphates, containing about 1.5 lauryl groups per phosphate radical, was added to 27 pounds of water. Seven and one-half pounds of triethanolamine was added and the solution heated to 60° C. Eighteen pounds of "Tetralin" was added to forty pounds of a "Lorol" residue obtained from coconut oil and this mixture heated to 60° C. The "Lorol" residue-"Tetralin" solution was then added to the aqueous solution with vigorous stirring. A creamy emulsion was obtained which could be readily diluted with water. One pound of this emulsion was diluted with fifteen pounds of water and placed in a circulating system of a pipe threading machine. This machine was used for threading various size iron pipes. Microscopic examination of the cut surfaces of the threads showed a much smoother cut than had previously been obtained with a mineral oil lubricant. The tool life of the dies was also increased over that observed with mineral oil lubricant. The "Tetralin" effectively inhibited foaming of the emulsion during use.

It will be understood that the foregoing examples are given for illustrative purposes solely and that our invention is not to be limited to the specific embodiments disclosed therein, but

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that many variations and modifications can be made without departing from the spirit or scope of our invention. For example, "Lorol" residues may be prepared from other vegetable oils and animal oils. Also, other salts of other acid-esters of phosphoric acid, which are emulsifying agents, may be substituted for those specifically mentioned.

We claim:

1. An aqueous emulsion of a distillation residue derived from a hydrogenated natural fatty oil by distilling off fractions up through octadecyl alcohol, in which the emulsifying agent is a surface-active water-soluble non-acidic salt of a long-chain alkyl acid-ester of phosphoric acid, the distillation residue being present in a concentration of from about 1% to about 70% and the emulsifying agent being present in a minor proportion sufficient to form a substantially stable emulsion, said emulsion having "Tetralin" incorporated therein in an amount sufficient to substantially inhibit foaming during use.

2. An aqueous emulsion of a distillation residue derived from a hydrogenated natural fatty oil by distilling off fractions up through octadecyl alcohol, in which the emulsifying agent is a surface-active water-soluble mixture of non-acidic triethanolamine salts of long-chain alkyl esters of phosphoric acid containing about 1.5 alkyl groups per phosphate radical, the distillation residue being present in a concentration of from about 1% to about 70% and the emulsifying agent being present in a minor proportion sufficient to form a substantially stable emulsion, said emulsion having "Tetralin" incorporated therein in an amount sufficient to substantially inhibit foaming during use.

JOSEPH HARREL SHIPP.
OSBORNE COSTER BACON.
CHARLES J. PEDERSEN.

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The following references are of record in the file of this patent:

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Webster's New International Dictionary, G. and C. Merriam, Springfield, Mass., 1941. (Copy in Div. 64.)

Certificate of Correction**Patent No. 2,420,329.****May 13, 1947.****JOSEPH HARREL SHIPP ET AL.**

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 3, line 67, for "non-acetic" read *non-acidic*; column 4, line 15, for "of effectiveness" read *and effectiveness*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of July, A. D. 1947.

[SEAL]

LESLIE FRAZER,

First Assistant Commissioner of Patents.