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(54) **METALWORKING FLUID CONCENTRATE**

(57) A metalworking fluid concentrate with improved stability and overall performance is described, comprising

(A1) 1.5 - 4.0wt% of a blend of a C_8-C_{30} alcohol with a fatty acid ester R^1CO2R^2 where R^1 is a C_8-C_{30} acid residue and R^2 is a C_1-C_{12} alcohol residue;

(A2) 1.5 - 4.0wt% wt% of a surfactant;

(A3) 0.5 - 3.0wt% of additives selected from anti-gelling agents, foam control agents, antiwear additives, extreme pressure additives, pH buffers and biocides;

(B1) 6 - 15wt% of an amine which is water-soluble at room temperature;

(B2) 2 - 5wt% of a corrosion inhibitor which is water-soluble at room temperature;

(B3) 5 - 15wt% of a compound selected from ethylene oxide or propylene oxide block copolymers, ethylene oxide or propylene oxide random copolymers, ethylene oxide or propylene oxide polymer esters and ethylene oxide ethers; and

(B4) 60-80wt% of water.

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Description

[0001] The present invention relates to a metalworking fluid, and more particularly a metalworking fluid comprising a blend of synthetic (water-based) and semi-synthetic (oil-based) components.

[0002] Metalworking fluids have many applications within industry, such as destructive metalworking (chips of metal are produced, such as in milling or grinding) and deformation metalworking (chips of metal are not produced, such as in rolling), as well as more specific applications such as wire drawing. The metalworking fluids are used to cool and lubricate during metalworking operations. Such fluids typically comprise an oil-based (oleaginous) component, an aqueous component and emulsifier. The products are typically supplied as concentrates which are diluted with water by the user. In use the continuous water phase provides cooling, whilst the oil droplets plate out on metal surfaces to form a lubricating film between the metal being worked and the tool.

[0003] Mixing otherwise immiscible aqueous and oil-based components requires the use of emulsifiers to create an emulsion. Surfactants are typically used as emulsifiers, with sufficient surfactant included to ensure that the emulsion forms completely. Ideally there should be no residual immiscible components, and the emulsion should be stable, such that the individual components do not separate out during storage or use.

[0004] Historically metalworking fluids were soluble oils, typically comprising a majority of mineral oil together with other components such as emulsifiers, corrosion inhibitors and other additives. The oil was mixed with water to form an emulsion. As performance requirements have become more demanding the proportion of additives has increased, such that the oil content has reduced to 10-50wt% (excluding water). Such products are known as "semi-synthetic" metalworking fluids. Known disadvantages of semi-synthetic fluids include limited long-term stability and also adverse reactions between anionic emulsifiers and cations in the water, which can lead to insoluble reaction products generating deposits on machines and in filters, and can also deplete the level of emulsifier, potentially leading to phase separation.

[0005] An alternative type of metalworking fluid is known as a "fully synthetic" fluid, all components of which are soluble in water. The lubrication is provided by compounds whose solubility in water is inversely proportional to temperature, such that at room temperature they are soluble in water, whereas as the temperatures typically encountered at the metalworking surface due to friction (80°C or more) they plate out to form a lubricating film on the metal surface. Examples of such compounds are polyelkylene glycols (PAGs), which are copolymers of ethylene oxide and propylene oxide.

[0006] The absence of reactive anionic species and an emulsified oil phase means that fully synthetic products do not have any sensitivity to cations, nor do they form problematic deposits with the consequent risk of phase separation. However they have their own inherent problems due to their design. PAGs are strong surfactants, and the absence of an oily residue on surfaces following evaporation of the water phase can lead to corrosion problems. Additionally, the fact that lubrication is only provided above a certain temperature (that at which the PAG is no longer fully soluble in water, known as the "cloud point") means that at the start of a metalworking operation, before friction has raised the temperature of the working surfaces sufficiently, no lubrication is provided and damage to the surfaces may occur, particularly if the worked metal is soft.

[0007] A similar problem occurs in conditions where surface temperatures are lower throughout the process, in which case lubrication may generally be insufficient. This is particularly the case in wire drawing applications, where a wire is drawn out of a die onto a capstan and differential speeds cause the wire to slip on the capstan. The slipping wire is lubricated, but because the contact pressure between the wire and the capstan is low, the temperature may not rise high enough to cause the PAG to become insoluble. Consequently lubrication is minimal, leading to a reduction in surface quality of the wire, and poor or inconsistent slipping can cause the tension in the wire to increase resulting in breakage of the wire.

[0008] In order to overcome these specific difficulties in wire drawing, it has been known to to provide an aqueous solution of a fully synthetic product and then add to this dilution a small amount of a soluble oil concentrate. This can improve the slip of the wire, but it is difficult to monitor and control the relative proportions of the active materials in the final fluid, which can be critical for successful performance.

[0009] It is an object of the invention to overcome some of the above disadvantages of both synthetic and semi-synthetic fluids, and to provide a metalworking fluid which can provide lubrication at all working surface temperatures and hence throughout the process, as well as long-term stability.

[0010] Accordingly in a first aspect the present invention provides a metalworking fluid concentrate comprising

(A1) 1.5 - 4.0wt% of a blend of a C_8-C_{30} alcohol with a fatty acid ester $R^1CO_2R^2$ where R^1 is a C_8-C_{30} acid residue and R^2 is a C_1-C_{12} alcohol residue

(A2) 1.5 - 4.0wt% wt% of a surfactant

(A3) 0.5-1.8wt% of additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides

(B1) 6 - 15wt% of an amine which is water-soluble at room temperature

(B2) 2 - 5wt% of a corrosion inhibitor which is water-soluble at room temperature

(B3) 5 - 15wt% of a compound selected from ethylene oxide or propylene oxide block copolymers, ethylene oxide or propylene oxide random copolymers, ethylene oxide or propylene oxide polymer esters and ethylene oxide ethers
(B4) 60-80wt% of water.

[0011] We have found that the composition of the invention provides excellent lubrication in a wide range of applications including wire drawing, gives low deposits during use and also has excellent long-term stability.

[0012] Throughout this specification the term "water-soluble" means that no more than 0.5wt% of a compound is left undissolved in the aqueous phase when the compound is either dissolved in water or reacts in water to form a salt which itself dissolves.

Component (A1)

[0013] Component (A) is a blend of a C_8-C_{30} alcohol with a fatty acid ester $R^1CO_2R^2$ where R^1 is a C_8-C_{30} acid residue and R^2 is a C_1-C_{12} alcohol residue.

[0014] The alcohol is preferably a C_{12}-C_{24}, more preferably a C_{14}-C_{20} alcohol, with C_{16} being particularly preferred.

[0015] In the fatty acid ester, the acid residue R^1 is preferably a C_{12}-C_{24} hydrocarbyl group, more preferably C_{14}-C_{20}, with C_{16}-C_{18} being particularly preferred. The alcohol residue R^2 is preferably a C_1-C_8 hydrocarbyl group. Examples of the alcohol of which R^2 is the residue are methanol, 2-ethylhexanol, ethanol, butanol and isotridecanol.

[0016] Amounts of component (A1) range from 1.5 to 3.7wt%, preferably from 1.8 to 3.5wt% and more preferably from 2 to 3wt%.

Component (A2)

[0017] Component (A2) is a surfactant, which means anything capable of acting as an emulsifier.

[0018] The surfactant is preferably nonionic, and may have a hydrophobic portion of C_{10}-C_{28}, preferably C_{14}-C_{24}, and more preferably C_{16}-C_{20} chain length, optionally modified with 1-20, preferably 4-16 and more preferably 6-12 units of a hydrophobic polyalkoxylate chain, plus a hydrophilic portion comprising a polyalkoxylate. Alternatively the nonionic surfactant may comprise a C_{10}-C_{28}, preferably C_{14}-C_{24} and more preferably C_{16}-C_{20} fatty acid esterified with a poly-functional alcohol.

[0019] The surfactant may alternatively be anionic, in which case it may have a hydrophobic portion of C_{10}-C_{28}, preferably C_{14}-C_{24}, and more preferably C_{16}-C_{20} chain length, optionally modified with 1-20, preferably 4-16 and more preferably 8-10 units of a hydrophobic polyalkoxylate chain, and capped with an anionic group such as carboxylate, sulfate, sulfonate, sulfosuccinate or phosphate, with carboxylate, sulfonate and phosphate being preferred, of which carboxylate and phosphate are most preferred.

[0020] A further list of possible surfactants includes C_{16} -C_{18} fatty alcohol ethoxylates - with an ethoxylation range of 0-9 moles (fatty alcohol polyglycol ethers); C_{16} -C_{18} fatty alcohol ethoxylate and propoxylate; C_6/C_8/C_{16} -C_{18} alkyl polyoxyethylene ether carboxylic acids with a 2 to 9 mole ethoxylation range; alkyl ether ethoxylate mono phosphate esters - alkyl chain C18 , with a 2 to 5 mole ethoxylation range; ethoxylated oleine with a 6/9 mole ethoxylation range; and polyethylene glycol esters of C_{16} -C_{18} fatty acids. Combinations of various surfactants may be particularly advantageous.

[0021] Other possible surfactants include alkanolamides, alkylaryl sulfonates, alkylaryl sulfonic acids, amine oxides, amide and amine soaps, block copolymers, carboxylated alcohols, carboxylic acids/fatty acids, ethoxylated alcohols, ethoxylated amines/amides, ethoxylated fatty acids, ethoxylated fatty esters and oils, ethoxylated phenols, fatty amines and esters, glycerol esters, glycol esters, imidazolines and imidazoline derivatives, lignin and lignin derivatives, maleic or succinic anhydrides, methyl esters, monoglycerides and derivatives, naphthenic acids, olefin sulfonates, phosphate esters, polyalkylene glycols, polyols, polymeric (polysaccharides, acrylic acid, acrylamide), propoxylated & ethoxylated fatty acids, alcohols or alkyl phenols, quaternary surfactants, sarcosine derivatives, soaps, sorbitan derivatives, sucrose and glucose esters and derivatives, sulfates and sulfonates of oils and fatty acids, sulfates and sulfonates ethoxylated alkylphenols, sulfates of alcohols, sulfates of ethoxylated alcohols, sulfates of fatty esters, sulfonates of dodecyl and tridecylbenzenes, sulfonates of naphthalene and alkyl naphthalene, sulfonates of petroleum, sulfosuccinamates, sulfosuccinates and derivatives, tridecyl and dodecyl benzene sulfonic acids.

[0022] Particularly preferred classes of nonionic surfactants are fatty alcohol alkoxylates, polyethylene glycol esters, sorbitan esters and sorbitan ester alkoxylates.

[0023] Particularly preferred classes of anionic surfactants are alkyl ether carboxylates, sulfosuccinates, sulphonates, alkyl phosphate esters and alkyl ether phosphate esters.

[0024] Combinations of surfactants may also be particularly advantageous.

[0025] Amounts of component (A2) range from 1.5 to 3.7wt%, preferably from 1.8 to 3.5wt% and more preferably from 2 to 3wt%.

Component (A3)

[0026] Types of additives include glycols and glycol ethers to prevent gelling, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides.

[0027] Biocides include, but are not limited to, formaldehyde releasing agents including ortho-formal, hexahydratriazine and derivatives, methylene bis morpholene, oxazoladine and derivatives, isothiazolinones and derivatives and iodo propyl butyl carbamate-fungicide.

[0028] Extreme pressure additives include, but are not limited to, chlorinated and sulfurized fatty acids and esters, polysulfides, organophosphates, and neutralized phosphate esters.

[0029] Examples of foam control agents include, but are not limited to, methyl silicone oil, fluorosilicone oil, polyacrylate and the like.

[0030] The total amount of all components (A3) ranges from 0.5 to 1.8wt%, preferably from 0.6 to 1.5wt% and more preferably from 0.7 to 1.4wt%.

Component (B1)

[0031] Component (B1) is an amine which is soluble in water at room temperature. Examples include aminomethylpropanol (AMP-95), 3-amino-4-octanol, diglycolamine (DGA), monoethanolamine (MEA), monoisopropanolamine (MIPA), butylethanolamine (NBEA), dicylclohexylamine (DCHA), diethanolamine (DEA), butyldiethanolamine (NBDEA), triethanolamine (TEA), and methylpentamethylenediamine.

[0032] Amounts of component (B1) range from 6 to 15wt%, preferably from 6.5 to 10wt% and more preferably from 7 to 8wt%. Alternative preferred ranges are from 9 to 12wt%, preferably from 10 to 12wt%.

Component (B2)

[0033] Corrosion inhibitors are chemical compounds which, when added at low concentrations, inhibit the corrosion of metals and alloys. They generally function by either forming a passivation layer on the metal, or by inhibiting either the oxidation or reduction part of the redox corrosion system (anodic and cathodic inhibitors), or by scavenging dissolved oxygen. Different metals typically require different corrosion inhibitors. Examples of corrosion inhibitors include alkylphosphonic acids, alkali and alkanolamine salts of carboxylic acids, undecandioic/dodecandioic acid and its salts, C_4-C_{22} carboxylic acids and their salts, tolytriazole and its salts, benzotriazole and its salts, imidazoline and its salts, alkanolamines and amides, sulfonates, alkali and alkanolamine salts of naphthenic acids, phosphate ester amine salts, alkali nitrites, alkali carbonates, carboxylic acid derivatives, alkylsulfonamide carboxylic acids, arylsulfonamide carboxylic acids, fatty sarkosides, phenoxy derivatives and sodium molybdate.

[0034] A further list of possible corrosion inhibitors which can be used includes polycarboxylic acid compounds, polymeric phosphoric acid compounds and benzotriazole. but are not limited to amine/alkali salts of short chain carboxylic mono acids, di acids and tri acids, short chain acidic phosphate esters, including alkoxylated esters, semi-succinate half esters, amide-carboxylic acid salts, fatty amides, and amine and alkali sulphonates or their derivatives. Inhibitors for yellow metals include benzotriazole or its derivatives and tolutriazole or its derivatives. Suitable esters include, but are not limited to TMP (trimethylol propane) mono, di and tri esters of C_8 - C_{18} fatty acids, glycol esters of predominantly olely fatty acids, methyl or isopropyl esters of predominantly olely fatty acids or triglycerides, natural triglycerides, such as rapeseed, and modified natural oils such as blown rapeseed.

[0035] Preferred cast iron corrosion inhibitors include undecandioic/dodecandioic acid and its salts. Preferred yellow metal corrosion inhibitors include tolytriazole sodium salts. Preferred aluminum corrosion inhibitors include octanephosphonic acid and citric acid monohydrate.

[0036] Amounts of component (B2) range from 2 to 5wt%, preferably from 2.1 to 4.5wt% including ranges from 2.2 to 2.8wt% and from 4.0 to 4.5wt%, with the higher range being for applications involving copper. The amounts and types of corrosion inhibitor required for different metals are well understood by those skilled in the art.

Component (B3)

[0037] Component (B3) is a compound having a solubility in water which varies inversely with temperature. As stated above it is selected from ethylene oxide or propylene oxide block copolymers, ethylene oxide or propylene oxide random copolymers, ethylene oxide or propylene oxide polymer esters and ethylene oxide ethers. Examples of such compounds are the reaction products of alcohols and alkylene oxides commonly known as polyalkylene glycols (PAGs). Polyalkylene glycols are well known as lubricants in many applications including metalworking fluids due to their high thermal and oxidative stability, excellent lubricity and high film strength/load capacity, as well as good anti-wear properties and shear stability.

[0038] PAGs are random or block copolymers containing ethylene oxide (EO) and propylene oxide (PO) units. The cloud point, defined as the temperature at which the PAG in a 1% aqueous solution comes out of solution, is dependent primarily on the EO content, which can range from 10% to 80%, and is typically between 20% and 75%. The cloud point may vary from 20°C to 90°C, with values in the range 40°C to 90°C being preferred. The exact PAG used may depend on the cloud point required, which in turn depends on the intended final application of the concentrate.

[0039] Amounts of component (B3) range from 5 to 15wt%, preferably from 6 to 14wt% and more preferably from 7 to 13wt%.

Component (B4)

[0040] Component (B4) is water, and is present in an amount of 60-80wt%, preferably 69-78wt%, more preferably 70-77wt%. Alternative prefered ranges are 60-72wt%, preferably 62-70wt%.

[0041] Each of the above components of the concentrate (A1)-(A3) and (B 1)-(B3) may comprise either a single compound or more than one compound.

[0042] A preferred metalworking fluid concentrate formulation comprises

(A1) 1.5 - 3.7wt% of a blend of a C_{12}-C_{24}, preferably a C_{14}-C_{20} alcohol with a fatty acid ester $R^1CO_2R^2$ where R^1 is a C_{12}-C_{24}, preferably C_{14}-C_{20} hydrocarbyl acid residue and R^2 is a C_1-C_8 alcohol residue, preferably a residue of methanol, 2-ethylhexanol, ethanol, butanol or isotridecanol;
(A2) 1.5 - 3.7wt% wt% of a surfactant which is either

(i) nonionic, being a hydrophobic C_{10}-C_{28} portion optionally modified with 1-20 units of a hydrophobic polyalkoxylate chain or alternatively a C_{10}-C_{28} fatty acid esterified with a polyfunctional alcohol, or
(ii) anionic, being a hydrophobic C_{10}-C_{28} portion optionally modified with 1-20 units of a hydrophobic polyalkoxylate chain and capped with an anionic group;

(A3) 0.5 - 3.0wt% of additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides;
(B1) 6 - 15wt% of an amine which is water-soluble at room temperature selected from aminomethylpropanol (AMP-95), 3-amino-4-octanol, diglycolamine (DGA), monoethanolamine (MEA), monoisopropanolamine (MIPA), butylethanolamine (NBEA), dicylclohexylamine (DCHA), diethanolamine (DEA), butyldiethanolamine (NBDEA), triethanolamine (TEA), and methylpentamethylenediamine;
(B2) 2 - 5wt% of a water-soluble corrosion inhibitor;
(B3) 5 - 15wt% of a polyalkylene glycols (PAG) having an ethylene oxide content of 20-75% and a cloud point between 20°C and 90°C;
(B4) 60 - 80wt% of water.

[0043] Formulations which are particularly suited for metalworking operations at relatively high temperatures, such as those involving ferrous metals, preferably contain amounts of the various components listed above as follows:

(A1) 1.8 to 3.7wt%, preferably from 2 to 3wt%, more preferably from 2.6 to 3.0wt%;
(A2) 1.8 to 3.7wt%, preferably from 2 to 3wt%, more preferably from 2.6 to 3.0wt%;
(A3) 0.6 to 1.5wt%, preferably from 0.7 to 1.4wt%, more preferably from 0.7 to 1.0wt%;
(B1) 6.5 to 10wt%, preferably from 7 to 8wt%;
(B2) 2.1 to 2.9wt%, preferably from 2.2 to 2.8wt%, more preferably from 2.3 to 2.6wt%;
(B3) 6 to 14wt%, preferably from 7 to 13wt%, more preferably from 8 to 10wt%;
(B4) 69-78wt%, preferably 70-77wt, more preferably from 72 to 76wt%.

[0044] A particularly preferred formulation suited for metalworking operations at relatively high temperatures is a metalworking fluid concentrate comprising

(A1) 2.6 to 3.0wt% of a mixture of G16 guerbet alcohol and methyl oleate/methyl palmitate;
(A2) 2.6 to 3.0wt% of a mixture of oleth-9-carboxyate and either a C_{16}-C_{18} phosphate ester or oxirane, 2-methyl, polymer with oxirane, hexadecyl ether (CAS 9087-53-0);
(A3) 0.7 to 1.0wt% of additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides;
(B1) 7 to 8wt% of triethanolamine;
(B2) 2.3 to 2.6wt% of a polycarboxylic acid;

(B3) 8 to 10wt% of a polyalkylene glycol (PAG) having an ethylene oxide content of 40-75% and a cloud point of 60-85°C;
(B4) 72 to 76wt% water.

[0045] Formulations which are particularly suited for metalworking operations at lower temperatures, such as those involving non-ferrous ("yellow") metals or wire drawing operations, typically contain lower amounts of water, because the lower operating temperature means that the PAG reaches its cloud point more slowly and hence additional lubricant components are required. If the worked metal is copper, such as in some wire drawing, such formulations also require higher amounts of corrosion inhibitors due to the presence of corrosive copper ions. Preferred formulations for such operations contain amounts of the various components listed above as follows:

(A1) 1.8 to 3.7wt%, preferably from 2.5 to 3.7wt%, more preferably from 3.5 to 3.7wt%;
(A2) 1.8 to 3.7wt%, preferably from 2.5 to 3.7wt%, more preferably from 3.5 to 3.7wt%;
(A3) 1.5 to 3.0wt%, preferably from 1.8 to 2.6wt%, more preferably from 2.0 to 2.4wt%;
(B1) 8 to 15wt%, preferably from 9 to 14wt%, more preferably from 10 to 12wt%;
(B2) 22.1 to 4.5wt%, preferably from either 2.2 to 2.8wt% or 4.0 to 4.5wt%; more preferably from 2.3 to 2.6wt% or 4.0 to 4.5wt%, with the higher range preferred for use with copper;
(B3) 6 to 14wt%, preferably from 7 to 13wt%, more preferably from 8 to 10wt%;
(B4) 60-72wt%, preferably 62-70wt%, more preferably from 63 to 68wt%.

[0046] A particularly preferred formulation for lower temperature operation is a metalworking fluid concentrate comprising

(A1) 3.5 to 3.7wt% of a mixture of G16 guerbet alcohol and methyl oleate/methyl palmitate;
(A2) 3.5 to 3.7wt% of a mixture of oleth-9-carboxyate and either a C_{16}-C_{18} phosphate ester or oxirane, 2-methyl, polymer with oxirane, hexadecyl ether (CAS 9087-53-0);
(A3) 2.0 to 2.4wt% of additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides;
(B1) 10-12wt% of triethanolamine;
(B2) 2.3 to 2.6wt% or 4.0 to 4.5wt%of a polycarboxylic acid and/or benzotriazole;
(B3) 8 to 10wt% of a polyalkylene glycol (PAG) having an ethylene oxide content of 40-75% and a cloud point of 40-60°C;
(B4) 63 to 68wt% water.

[0047] The metalworking fluid concentrate is preferably formulated by mixing components (A1)-(A3) and (B1-B4) as two separate formulations or phases (A) and (B), which are then combined to form the final formulation. For example components (B1) and (B2) may be dissolved in water (B4), and the PAG (B3) dissolved in the resulting solution. Preblended components (A1)-(A3) may then be added. Components (A1)-(A3) may be regarded as oleaginous components, and (B1)-(B4) as aqueous components similar to a fully synthetic metalworking fluid.

[0048] A key feature of the present invention is that the oleaginous phase (A) and the aqueous phase (B) are capable of forming a stable emulsion when mixed together. The precise amounts of component (A2) can be adjusted in order to optimise the long-term stability.

[0049] For use the metalworking fluid concentrate is diluted with water in a known manner, either prior to or during use. Accordingly a further aspect of the invention provides a metalworking fluid comprising 3-20wt% of the above metalworking fluid concentrate and 80-97wt% of water. Preferably the concentrate comprises 10-15wt% of the metalworking fluid.

[0050] The present invention will now be described by way of example only, with reference to illustrative embodiments.

EXAMPLE 1

[0051] A drawing oil concentrate was formulated by forming an oleaginous phase (A) comprising components (A1)-(A3) and an aqueous phase (B) comprising components (B1)-(B4). The two phases were then mixed together to form an emulsion having the composition shown in Table 1:

TABLE 1

Component	Compound	wt%
A1	G16 Guerbet alcohol	1.8

(continued)

Component	Compound	wt%
A1	CE-1875 (methyl oleate/methyl palmitate)	0.9
A2	Oleth-9-carboxyate	0.9
A2	Oxirane, 2-methyl, polymer with oxirane, hexadecyl ether (CAS 9087-53-0)	1.8
A3	Foamban® 1840	0.1
A3	Ethyl diglycol ether	0.75
B1	Triethanolamine 90%	14.44
B2	Polycarboxylic acid 50%	4.0
B2	Benzotriazole	0.4
B3	PAG W270 (75% EO, cloud point 85°C)	9.0
B4	Water	65.91

[0052] To evaluate its stability, the emulsion was diluted in both deionized water and also water containing 500ppm Ca salts to a concentration of 10%. In both cases the result was a bright, semi-translucent and stable emulsion.

[0053] The performance of this formulation was compared with two commercially available non-ferrous wire drawing oils, one a soluble drawing oil and the other a fully synthetic drawing oil, using a Reichert wear tester, which determines overall lubrication by measuring the weight loss of the bearing pin, and also determines the time taken to establish a lubricating film by measuring the time taken for noise drop off. All formulations were used as a 10% dilution in water. The results are shown in Table 2 below:

TABLE 2

	Noise drop-off time (secs)	% weight loss of bearing pin
Example 1	17.5	14.9
Commercial soluble drawing oil	78.5	53.4
Commercial fully synthetic drawing oil	21.5	26.5

[0054] It can be seen that Example 1 provides lubrication slightly more rapidly than the fully synthetic oil, and much more rapidly than a soluble oil. Overall lubrication was also significantly better than both commercial oils.

EXAMPLE 2

[0055] Example 2 is a general purpose metal-cutting fluid designed for use with both ferrous and non-ferrous metals. It was formulated in the same way as Example 1, and has the composition shown in Table 3:

TABLE 3

Component	Compound	wt%
A1	G16 Guerbet alcohol	1.8
A1	CE-1875 (methyl oleate/methyl palmitate)	0.9
A2	Oleth-9-carboxyate	0.1
A2	C_{16}-C_{18} phosphate ester	2.7
A3	Foamban® 1840	0.3
A3	20% bisisothiazolinone in glycol (biocide)	1.2
A3	Ethyl diglycol ether	0.75
B1	Triethanolamine 90%	7.8

(continued)

Component	Compound	wt%
B2	Polycarboxylic acid 50%	2.5
B3	Pluronic PE6400 (PO/EO block, -40% PEG)	9.0
B4	Water	72.95

[0056] The stability of this formulation was found to be similar to that of Example 1. The performance of this formulation was compared with two commercially available metalworking fluid concentrates, one a soluble oil and the other a semi-synthetic cutting fluid, using a Reichert wear tester as in Example 1. All formulations were used as a 10% dilution in water. The results are shown in Table 4 below:

TABLE 4

	Noise drop-off time (secs)	% weight loss of bearing pin
Example 2	21.5	14.9
Commercial soluble cutting oil	100	81.7
Commercial semi-synthetic cutting oil	100	77.4

[0057] It can be seen that Example 2 provides lubrication much more rapidly than both commercial oils, and overall lubrication was also significantly better than both commercial oils.

EXAMPLE 3

[0058] Example 3 is a metal-cutting fluid designed for use with non-ferrous metals, which are typically softer and therefore generate less heat. As a result the temperature of the working surface rises to the cloud point of component B3 more slowly, thereby requiring a higher degree of lubrication from the oleaginous phase. Consequently the amount of oleaginous phase is higher and the amount of water lower in this Example. Such formulations may also require a higher level of corrosion inhibitor due to the presence of corrosive copper ions from the worked metal. Example 3 was formulated in the same way as Example 1, and has the composition shown in Table 5:

TABLE 5

Component	Compound	wt%
A1	G16 Guerbet alcohol	2.42
A1	CE-1875 (methyl oleate/methyl palmitate)	1.21
A2	Oleth-9-carboxyate	1.21
A2	Oxirane, 2-methyl, polymer with oxirane, hexadecyl ether (CAS 9087-53-0)	2.42
A3	Foamban® 1840	0.13
A3	20% bisisothiazolinone in glycol (biocide)	1.2
A3	Ethyl diglycol ether	1.01
B1	Triethanolamine 90%	11.9
B2	Citric acid monohydrate	0.5
B2	Polycarboxylic acid 50%	2.5
B3	Pluronic RPE1740 (EO/PO block. -40% PEG)	9.0
B4	Water	66.5

[0059] The stability of this formulation was found to be similar to that of Example 1. The performance of this formulation was compared with two commercially available metalworking fluid concentrates, one a non-ferrous cutting fluid and the other a semi-synthetic cutting fluid, using a Reichert wear tester as in Example 1. All formulations were used as a 10%

dilution in water. The results are shown in Table 6 below:

TABLE 6

	Noise drop-off time (secs)	% weight loss of bearing pin
Example 3	11	9.0
Commercial soluble cutting fluid	100	98.3
Commercial semi-synthetic cutting fluid	100	77.4

[0060] It can be seen that Example 3 provides lubrication much more rapidly than both commercial oils, and overall lubrication was also significantly better than both commercial oils.

Claims

1. A metalworking fluid concentrate comprising

(A1) 1.5 - 4.0wt% of a blend of a C_8-C_{30} alcohol with a fatty acid ester $R^1CO_2R^2$ where R^1 is a C_8-C_{30} acid residue and R^2 is a C_1-C_{12} alcohol residue;
(A2) 1.5 - 4.0wt% wt% of a surfactant;
(A3) 0.5 - 3.0wt% of additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides;
(B1) 6 - 15wt% of an amine which is water-soluble at room temperature;
(B2) 2 - 5wt% of a corrosion inhibitor which is water-soluble at room temperature;
(B3) 5 - 15wt% of a compound selected from ethylene oxide or propylene oxide block copolymers, ethylene oxide or propylene oxide random copolymers, ethylene oxide or propylene oxide polymer esters and ethylene oxide ethers; and
(B4) 60-80wt% of water.

2. Metalworking fluid concentrate according to claim 1, comprising

(A1) 1.5 - 3.7wt% of a blend of a C_{12}-C_{24}, preferably a C_{14}-C_{20} alcohol with a fatty acid ester $R^1CO_2R^2$ where R^1 is a C_{12}-C_{24}, preferably C_{14}-C_{20} hydrocarbyl acid residue and R^2 is a C_1-C_8 alcohol residue, preferably a residue of methanol, 2-ethylhexanol, ethanol, butanol or isotridecanol;
(A2) 1.5 - 3.7wt% wt% of a surfactant which is either

(iii) nonionic, being a hydrophobic C_{10}-C_{28} portion optionally modified with 1-20 units of a hydrophobic polyalkoxylate chain or alternatively a C_{10}-C_{28} fatty acid esterified with a polyfunctional alcohol, or
(iv) anionic, being a hydrophobic C_{10}-C_{28} portion optionally modified with 1-20 units of a hydrophobic polyalkoxylate chain and capped with an anionic group;

(A3) 0.5 - 3.0wt% of additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides;
(B1) 6 - 15wt% of an amine which is water-soluble at room temperature selected from aminomethylpropanol (AMP-95), 3-amino-4-octanol, diglycolamine (DGA), monoethanolamine (MEA), monoisopropanolamine (MIPA), butylethanolamine (NBEA), dicylclohexylamine (DCHA), diethanolamine (DEA), butyldiethanolamine (NBDEA), triethanolamine (TEA), and methylpentamethylenediamine;
(B2) 2 - 5wt% of a water-soluble corrosion inhibitor;
(B3) 5 - 15wt% of a polyalkylene glycols (PAG) having an ethylene oxide content of 20-75% and a cloud point between 20°C and 90°C;
(B4) 60 - 80wt% of water.

3. Metalworking fluid concentrate according to claim 2 wherein component (A1) comprises guerbet alcohol plus methyl oleate and/or methyl palmitate.

4. Metalworking fluid concentrate according to any preceding claim wherein component (A2) is selected from fatty

alcohol alkoxylates, polyethylene glycol esters, sorbitan esters, sorbitan ester alkoxylates, alkyl ether carboxylates, sulfosuccinates, sulphonates, alkyl phosphate esters and alkyl ether phosphate esters.

5. Metalworking fluid concentrate according to any preceding claim wherein for component (A3),

any anti-gel agents present comprise glycols or glycol ethers;
any biocides present comprise formaldehyde releasing agents, hexahydratriazine or derivatives, methylene bis morpholene, oxazoladine or derivatives, isothiazolinones or derivatives or iodo propyl butyl carbamate-fungicide;
any extreme pressure additives present comprise chlorinated and sulfurized fatty acids or esters, polysulfides, organophosphates, or neutralized phosphate esters;
any foam control agents present comprise methyl silicone oil, fluorosilicone oil or polyacrylate.

6. Metalworking fluid concentrate according to any preceding claim wherein component (B1) is triethanolamine (TEA).

7. Metalworking fluid concentrate according to any preceding claim wherein component (B2) is selected from alkylphosphonic acids, alkali and alkanolamine salts of carboxylic acids, undecandioic/dodecandioic acid and its salts, C_4-C_{22} carboxylic acids and their salts, tolytriazole and its salts, benzotriazole and its salts, imidazoline and its salts, alkanolamines and amides, sulfonates, alkali and alkanolamine salts of naphthenic acids, phosphate ester amine salts, alkali nitrites, alkali carbonates, carboxylic acid derivatives, alkylsulfonamide carboxylic acids, arylsulfonamide carboxylic acids, fatty sarkosides, phenoxy derivatives and sodium molybdate.

8. Metalworking fluid concentrate according to any preceding claim wherein component (B3) is a polyalkylene glycol (PAG) having an ethylene oxide content of 20-75% and a cloud point between 40°C and 75°C.

9. Metalworking fluid concentrate according to any preceding claim, wherein the components are present in amounts:

(A1) 1.8 to 3.7wt%, preferably from 2 to 3wt%;
(A2) 1.8 to 3.7wt%, preferably from 2 to 3wt%;
(A3) 0.6 to 1.5wt%, preferably from 0.7 to 1.4wt%;
(B1) 6.5 to 10wt%, preferably from 7 to 8wt%;
(B2) 2.1 to 2.9wt%, preferably from 2.2 to 2.8wt%;
(B3) 6 to 14wt%, preferably from 7 to 13wt%;
(B4) 69-78wt%, preferably 70-77wt%.

10. Metalworking fluid concentrate according to claim 9, wherein the components are present in amounts:

(A1) 2.6 to 3.0wt%;
(A2) 2.6 to 3.0wt%;
(A3) 0.7 to 1.0wt%;
(B1) 7 to 8wt%;
(B2) 2.3 to 2.6wt%;
(B3) 8 to 10wt%;
(B4) 72-76wt%.

11. Metalworking fluid concentrate according to claim 10, wherein the components are:

(A1) a mixture of G16 guerbet alcohol and methyl oleate/methyl palmitate;
(A2) a mixture of oleth-9-carboxyate and either a C_{16}-C_{18} phosphate ester or oxirane, 2-methyl, polymer with oxirane, hexadecyl ether (CAS 9087-53-0);
(A3) additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides;
(B1) triethanolamine;
(B2) a polycarboxylic acid;
(B3) a polyalkylene glycol (PAG) having an ethylene oxide content of 40-75% and a cloud point of 60-85°C;
(B4) water.

12. Metalworking fluid concentrate according to any of claims 1 to 8, wherein the components are present in amounts:

(A1) 1.8 to 3.7wt%, preferably from 2.5 to 3.7wt%;
(A2) 1.8 to 3.7wt%, preferably from 2.5 to 3.7wt%;
(A3) 1.5 to 3.0wt%, preferably from 1.8 to 2.6wt%;
(B1) 8 to 15wt%, preferably from 9 to 12wt%;
(B2) 2.1 to 4.5wt%, preferably from either 2.2 to 2.8wt% or 4.0 to 4.5wt%;
(B3) 6 to 14wt%, preferably from 7 to 13wt%;
(B4) 60-72wt%, preferably 62-70wt%.

13. Metalworking fluid concentrate according to claim 12, wherein the components are present in amounts:

(A1) 3.5 to 3.7wt%;
(A2) 3.5 to 3.7wt%;
(A3) 2.0 to 2.4wt%;
(B1) 10 to 12wt%;
(B2) 2.3 to 2.6wt% or 4.0 to 4.5wt%;
(B3) 8 to 10wt%;
(B4) 63 to 68wt%.

14. Metalworking fluid concentrate according to claim 13, wherein the components are:

(A1) a mixture of G16 guerbet alcohol and methyl oleate/methyl palmitate;
(A2) a mixture of oleth-9-carboxyate and either a C_{16}-C_{18} phosphate ester or oxirane, 2-methyl, polymer with oxirane, hexadecyl ether (CAS 9087-53-0);
(A3) additives selected from anti-gelling agents, foam control agents, anti-wear additives, extreme pressure additives, pH buffers and biocides;
(B1) triethanolamine;
(B2) a polycarboxylic acid and/or benzotriazole;
(B3) a polyalkylene glycol (PAG) having an ethylene oxide content of 40-75% and a cloud point of 40-60°C;
(B4) water.

15. Metalworking fluid comprising 3-20wt%, preferably 10-15wt%, of a metalworking fluid concentrate as defined in any preceding claim and 80-97wt% of water.

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 8960

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X	WO 2022/099300 A1 (ARDAGH METAL BEVERAGE USA INC [US]) 12 May 2022 (2022-05-12) * paragraphs [0002], [0013] - [0015], [0097] * * paragraphs [0037], [0038], [0040], [0041], [0042], [0045], [0048], [0049] * * paragraphs [0051], [0078]; claims 1-32; examples; tables 1-4 *	1-15	INV. C10M173/02 C10M173/00 C10N20/00 C10N30/06 C10N30/12 C10N30/00 C10N40/20 C10N40/22 C10N40/24 C10N50/00
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Munich	20 October 2023	Bork, Ana-Maria

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