

WATER-SOLUBLE OIL COMPOSITION FOR METALWORKING

BACKGROUND

1. Technical Field

[0001] The present invention relates to a water-soluble oil composition for metalworking. More specifically, the invention relates to an oil composition that is used for metal cutting, grinding, plastic working, precision polishing, and the like and has anticorrosion and antirust effect on metal surfaces.

2. Description of the Background

[0002] As an oil composition for metalworking such as cutting and grinding, oily compositions have been conventionally used, but from the viewpoint of reduction in fire risk, improvement in workability, or the like, water-soluble oil compositions have recently been widely used. The water-soluble oil composition is a mixture comprising a lubricant, an oily agent, an antiwear agent, an extreme-pressure additive, an antirust agent, a surfactant, and other components. In particular, in order to maintain the antirust effect and the pH of an oil composition, alkanolamines such as monoethanolamine, diethanolamine, and triethanolamine are added.

[0003] International Publication WO2014/129499 discloses a water-based metalworking oil agent comprising two alkanolamines having particular structures. JP-A-2002-338988 discloses a water-soluble cutting grinding oil agent for alloy, and the agent comprises a dibasic acid, a mineral oil and/or an oil and fat, an alkali metal compound and/or an amine, and a surfactant.

BRIEF SUMMARY

[0004] Monoisopropanolamine (MIPA) exemplified as the alkanolamine contained in the metalworking oil agent according to the above document is an alkaline substance, forms an amine salt together with a fatty acid to exhibit interfacial activity, and thus is often used as an alkanolamine component in metalworking oil agents. As a metalworking oil agent containing MIPA is continuously used, aging degradation is caused to result in reduction in the pH, unfortunately. A metalworking oil agent is typically used cyclically, and is continuously used while a fresh metalworking oil agent is added, but addition of a fresh metalworking oil agent fails to increase the pH or fails to increase the concentration of MIPA in some cases. This is thought to be because exposure of a metalworking oil agent to frictional heat generated between a tool and a material to be processed during metalworking causes two MIPA molecules contained in the metalworking oil agent to undergo intermolecular cyclodehydration (intermolecular dehydration cyclization reaction), then this reaction yields dimethyl pyrazine, and MIPA gradually decreases. The present invention is therefore intended to provide a water-soluble oil composition for metalworking. The oil composition contains an alkanolamine but is unlikely to cause reduction in the pH or reduction in the concentration.

[0005] A water-soluble oil composition for metalworking in an aspect of the present invention comprises a primary alkanolamine having substituents to inhibit intermolecular cyclodehydration.

[0006] The water-soluble oil composition for metalworking of the present invention can be continuously, stably used without deterioration over a long time while the formation of pyrazines due to increase in the temperature during metalworking is suppressed, the concentration of an alkanolamine component is not reduced, or the pH of

the oil composition is not reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0007] FIG. 1 is GC-MS spectra of oil compositions (product A containing 2-amino-2-methyl-1-propanol (AMP)) before use, after use for 5 months, after use for 5 months, after use for 11 months, and after use for 8 months.

FIG. 2 is GC-MS spectra of oil compositions (product B containing monoisopropanolamine (MIPA)) before use and after use for 1 month.

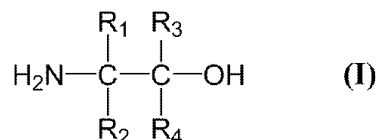
DETAILED DESCRIPTION

[0008] Embodiments of the present invention will now be described. An embodiment of the present invention is a water-soluble oil composition for metalworking, and the composition comprises a primary alkanolamine having substituents to inhibit intermolecular cyclodehydration. In the present embodiment, the oil composition is a mixture comprising oil components. A typical oil composition contains a synthetic oil such as polyalkylene glycol as a lubricant as well as a natural oil such as a mineral oil and further contains other components including an oily agent, an antiwear agent, an extreme-pressure additive, an antirust agent, an antiseptic agent, and a surfactant. Water-soluble means being easily dissolved in water and having high affinity for water. The water-soluble oil composition can be diluted with water to be used and is in the form of an emulsion, a transparent aqueous solution, or a translucent soluble aqueous solution. The metalworking means metal cutting, grinding, plastic working, rolling, or the like. The water-soluble oil composition for metalworking is intended to maintain the lubricity of a metal surface, to cool a metal surface, and to prevent a metal surface from rusting during

such metalworking. The intermolecular cyclodehydration in the present embodiment will be described later.

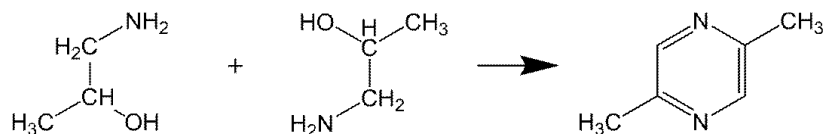
[0009] In an embodiment, the primary alkanolamine is represented by formula (I):

[Chemical Formula 1]



(where R₁, R₂, R₃, and R₄ are hydrogen atoms, identical or different alkyl groups having 1 to 6 carbon atoms, or identical or different cycloalkyl groups having 3 to 6 carbon atoms, provided that at least R₁ and R₂ are each independently an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms, or at least R₃ and R₄ are each independently an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms). In formula (I), at least one of the carbon adjacent to the amino group (-NH₂) and the carbon adjacent to the hydroxy group (-OH) has two alkyl groups. As described above, a conventional metalworking oil agent contains monoisopropanolamine (MIPA) as an alkanolamine. MIPA may react under contact with a metal in a high temperature condition during metalworking to generate dimethylpyrazine as shown below.

[Chemical formula 2]



A reaction in which two molecules of a primary alkanolamine undergo intermolecular dehydration to form a ring as above is to be called intermolecular cyclodehydration in the

present description. When a metalworking oil agent is used for a long time, the above intermolecular cyclodehydration is caused to generate dimethylpyrazine, thus MIPA gradually decreases, and accordingly the metalworking oil agent has a lower pH, in some cases.

[0010] R₁, R₂, R₃, and R₄ of the primary alkanolamine of formula (I) used in the present embodiment are hydrogens, identical or different alkyl groups having 1 to 6 carbon atoms, or identical or different cycloalkyl groups having 3 to 6 carbon atoms. The alkyl group having 1 to 6 carbon atoms may be a linear alkyl group or a branched alkyl group. The cycloalkyl group having 3 to 6 carbon atoms is a cyclic alkyl group such as a cyclopropyl group, a cyclobutyl group, a cyclopentyl group, and a cyclohexyl group. In addition, the substituents R₁, R₂, R₃, and R₄ satisfy the following requirement: at least R₁ and R₂ are each independently an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms; or at least R₃ and R₄ are each independently an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms. The substituents R₁ and R₂ and/or the substituents R₃ and R₄ thus hinder two alkanolamine molecules from undergoing intermolecular cyclodehydration. The oil composition in the embodiment is unlikely to generate pyrazines even when used for a long time, thus the concentration of an alkanolamine is unlikely to decrease, and accordingly the pH is also unlikely to decrease. In the description, the pyrazines means pyrazine and pyrazines having substituents. A suitable group for the substituents R₁, R₂, R₃, and R₄ is an alkyl group having 1 to 6 carbon atoms, preferably an alkyl group having 1 to 3 carbon atoms, or a cycloalkyl group having 3 to 6 carbon atoms. It is thought that as the carbon number of an alkyl group or a cycloalkyl group increases, steric hindrance between two alkanolamine molecules increases, and intermolecular cyclodehydration can

be more effectively inhibited. However, if the carbon number of an alkyl group or a cycloalkyl group increases excessively, such an alkanolamine itself has lower water-solubility and thus cannot be used as a component in the water-soluble oil composition of the present embodiment. Hence, the substituents R₁, R₂, R₃, and R₄ are particularly preferably alkyl groups having 1 to 3 carbon atoms. To maintain the water-solubility of an alkanolamine and to inhibit the formation reaction of pyrazines, especially preferred groups for the substituents R₁, R₂, R₃, and R₄ are alkyl groups having 1 or 2 carbon atoms, that is, a methyl group and an ethyl group.

[0011] In an embodiment, examples of the primary alkanolamine of formula (I) include 2-amino-2-methyl-1-propanol, 1-amino-2-methyl-2-propanol, 3-amino-3-methyl-2-butanol, 3-amino-2-methyl-2-butanol, 3-amino-2,3-dimethyl-2-butanol, 2-amino-2-ethyl-1-propanol, and 1-amino-2-ethyl-2-propanol.

[0012] In an embodiment, the primary alkanolamine is added in order to impart antirust and anticorrosion properties against a metal surface to the water-soluble oil composition for metalworking. For the purpose, the primary alkanolamine can be added at a proportion of 1 to 20%, preferably 2 to 15%, based on the weight of a water-soluble oil composition for metalworking. Primary alkanolamines can be used singly or as a mixture of two or more of them. When two or more primary alkanolamines are mixed and used, the total weight of the mixed primary alkanolamines is preferably 1 to 20% based on the weight of a water-soluble oil composition for metalworking.

[0013] In an embodiment, the water-soluble oil composition for metalworking can contain, in addition to the above primary alkanolamine, water and additives such as an mineral oil, an animal or vegetable oil, a hydrocarbon synthetic oil, a fatty acid, a fatty acid condensate, a fatty acid ester, an organic amine, a surfactant, an antiwear agent, an

extreme-pressure additive, an antirust agent, an antiseptic agent, and an antifoaming agent.

[0014] The mineral oil is a mixture of hydrocarbon compounds derived from petroleum, natural gas, or the like. For example, a paraffin oil or a naphthene oil can be used. The mineral oil is used as a base oil of the water-soluble oil composition for metalworking. Two or more of the above mineral oils can be appropriately used in combination as needed.

[0015] As the animal or vegetable oil, vegetable oils such as castor oil, rapeseed oil, palm oil, soybean oil, and olive oil and animal oils such as beef tallow, mutton tallow, lard, and fish oil can be used. The animal or vegetable oil is used as a base oil of the water-soluble oil composition for metalworking. Two or more of the above animal or vegetable oils can be appropriately used in combination as needed.

[0016] As the hydrocarbon synthetic oil, synthetic hydrocarbon oils typified by α -polyolefin and polybutene, ether synthetic oils typified by alkyl diphenyl ether and polypropylene glycol, silicon oils, and fluorine oils can be used, for example. Two or more of the above hydrocarbon synthetic oils can be appropriately used in combination as needed.

[0017] The fatty acid is a carboxylic acid of a long-chain hydrocarbon. The fatty acid condensate is an intermolecular dehydration condensate of fatty acids, and the fatty acid ester is an ester compound of a fatty acid and an alcohol. The fatty acid, the fatty acid condensate, and the fatty acid ester are added as an antirust agent and a lubricant for the water-soluble oil composition for metalworking. Examples of the fatty acid suitably used in the water-soluble oil composition for metalworking include butyric acid, valeric acid, caprylic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, and arachidic acid, and condensates thereof can be used as the fatty acid condensate. Examples of the fatty

acid ester suitably used in the water-soluble oil composition for metalworking include methyl laurate, methyl stearate, methyl oleate, castor oil fatty acid methyl ester, butyl palmitate, octyl stearate, isopropyl myristate, and trimethylolpropane caprylate. Two or more of the above fatty acids, fatty acid condensates, and fatty acid esters can be appropriately used in combination depending on purpose or intended functions.

[0018] The organic amine is added in order to impart antirust and anticorrosion properties against a metal surface to the water-soluble oil composition for metalworking, as with the primary alkanolamine. Examples of the amine suitably used in the water-soluble oil composition for metalworking include alkylamines having 1 to 5 carbon atoms such as ethylamine and propylamine, cycloalkylamines having 5 to 20 carbon atoms such as morpholine and cyclohexylamine, secondary alkanolamines such as diethanolamine, and tertiary alkanolamines such as triethanolamine. Two or more of the organic amines can be appropriately used in combination depending on purpose or intended functions.

[0019] The surfactant is added in order to maintain the water-soluble oil composition for metalworking as a stable composition. As the surfactant, any of cationic surfactants, anionic surfactants, nonionic surfactants, and amphoteric surfactants can be used. Preferred examples of the cationic surfactant include quaternary ammonium salts. Preferred examples of the anionic surfactant include alkyl group-containing sulfonate salts, alkyl group-containing sulfonate esters, alkyl group-containing phosphate salts, alkyl group-containing phosphate esters, organic fatty acids, and organic fatty acid derivatives, and specifically, alkyl group-containing sulfonate salts, organic fatty acids, and organic fatty acid derivatives are preferred. Preferred examples of the nonionic surfactant include alkyl alcohol-ethylene oxide adducts, terminal alkyl ethers of alkyl alcohol-ethylene oxide adducts, organic fatty acid-ethylene oxide adducts, hydroxy fatty

acid-ethylene oxide adducts, Pluronic surfactants, Tetronic surfactants, and sugar ester-ethylene oxide adducts. Preferred examples of the amphoteric surfactant include alkyl betaines. Two or more of the above surfactants can be appropriately used in combination depending on purpose or intended functions.

[0020] The antiwear agent is added in order to prevent friction, abrasion, and burning between two metal faces. Preferred examples of the antiwear agent include phosphate esters (such as tricresyl phosphate and lauryl acid phosphate), phosphite esters (such as tributyl phosphite and dilauryl phosphite), thiophosphate salts (such as zinc dialkyldithiophosphate and zinc diallyldithiophosphate), phosphate ester amine salts, and zinc dialkyldithiocarbamates. Two or more of the above antiwear agents can be appropriately used in combination as needed.

[0021] The extreme-pressure additive is added in order to prevent friction, abrasion, and burning between two metal faces. Examples of the extreme-pressure additive include sulfurized oils and fats (such as sulfurized sperm oil), sulfurized esters (such as sulfurized fatty esters), sulfides (such as dibenzyl disulfide, alkyl polysulfide, olefin polysulfide, and xanthic sulfide), chlorine compounds (such as chlorinated paraffin and methyl trichlorostearate), lead naphthenate, amine alkylthiophosphate, and chloroalkyl xanthate. Two or more of the above extreme-pressure additives can be appropriately used in combination as needed.

[0022] The antirust agent is added in order to suppress rust formation on a metal surface. Usable examples of the antirust agent include calcium sulfonate, calcium phenate, calcium salicylate, magnesium sulfonate, magnesium phenate, magnesium salicylate, barium sulfonate, barium phenate, barium salicylate, glycerol monooleate, glycerol monolaurate, glycerol monostearate, sorbitan monooleate, sorbitan monolaurate,

and sorbitan monostearate. Two or more of the above antirust agents can be appropriately used in combination as needed.

[0023] The antiseptic agent is added in order to prevent microorganisms from growing especially in the water-soluble oil composition. Usable examples of the antiseptic agent include thiazole antiseptic agents such as 2-methyl-4-isothiazolin-3-one, 1,2-benzisothiazolin-3-one, and 5-chloro-2-methyl-4-isothiazolin-3-one, iodine antiseptic agents such as 3-iodo-2-propargylbutyl carbamate, phenol antiseptic agents such as o-phenylphenol, p-chloro-m-cresol, and 3-methyl-4-chloro-phenol, pyridine antiseptic agents such as sodium 2-pyridinethiol-1-oxide, triazine antiseptic agents such as hexahydro-1,3,5-tris(2-hydroxyethyl)-S-triazine and hexahydro-1,3,5-triethyl-S-triazine, bromine antiseptic agents such as 1,2-dibromo-2,4-dicyanobutane and 2-bromo-2-nitropropane, inorganic antiseptic agents such as water-soluble glass-silver and zeolite-copper, poly{oxyethylene(dimethylimino)ethylene(dimethylimino)ethylene} dichloride, 5-methyloxazolidine, 4-(2-nitrobutyl)morpholine, tris(hydroxymethyl)nitromethane, 4,4'-(2-ethyl-2-nitrotrimethylene)dimorpholine, and boric acid. Two or more of the above antiseptic agents can be appropriately used in combination as needed.

[0024] The antifoaming agent is added in order to prevent foaming by a surfactant contained in the oil composition. Examples of the antifoaming agent include silicone antifoaming agents, polyols, and organic antifoaming agents such as higher alcohols. Two or more of the above antifoaming agents can be appropriately used in combination as needed.

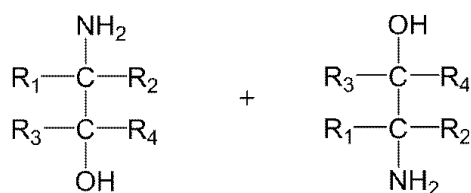
[0025] In an embodiment, the water-soluble oil composition for metalworking may appropriately contain, in addition to these components, nonferrous metal anticorrosives, organic acids, alcohols, chelating agents, coloring agents, flavoring agents, and the like

depending on purpose.

[0026] In an embodiment, the water-soluble oil composition for metalworking can be produced by mixing these components at an appropriate ratio. Each component can be added at a ratio known by a person skilled in the art in accordance with a conventionally used metalworking oil agent. In an embodiment, each component in the water-soluble oil composition for metalworking is so added as not to inhibit each of the effect of suppressing intermolecular cyclodehydration of the primary alkanolamine, the effect of suppressing pyrazine formation, and the effect of suppressing reduction in pH of the oil composition.

[0027] The oil composition containing a primary alkanolamine in an embodiment is characterized in that the formation of pyrazines by intermolecular cyclodehydration of the primary alkanolamine is suppressed. In the description, the formation of pyrazines by intermolecular cyclodehydration of a primary alkanolamine means that the amino group of a primary alkanolamine molecule and the hydroxy group of another primary alkanolamine molecule undergo intermolecular dehydration, thus the two alkanolamines are so condensed as to form a ring structure, and a pyrazine is formed. The pyrazines mean pyrazine and pyrazines having substituents. Even when two molecules of a primary alkanolamine used in an embodiment come close to each other, the substituents R_1 and R_2 and/or the substituents R_3 and R_4 hinder the two molecules from undergoing intermolecular cyclodehydration because at least the substituents R_1 and R_2 are each an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms, or at least the substituents R_3 and R_4 are each an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms.

[Chemical Formula 3]



Accordingly, even when the oil composition in an embodiment is used for metalworking over a long time, the formation of pyrazines is suppressed.

[0028] The oil composition containing a primary alkanolamine in an embodiment is characterized in that reduction in the concentration of the primary alkanolamine due to use thereof is suppressed. In the description, the reduction in the concentration of a primary alkanolamine means that a primary alkanolamine is changed into a compound different from the primary alkanolamine, and the concentration of the primary alkanolamine itself is reduced. When the oil composition in an embodiment is used for metalworking over a long time, the composition is exposed to harsh conditions such as high temperature and high shear conditions, and a primary alkanolamine undergoes decomposition or other reactions, or two primary alkanolamine molecules are condensed to each other, like intermolecular cyclodehydration of monoisopropanolamine (MIPA) as described above, in some cases. The primary alkanolamine used in the oil composition of the present embodiment is characterized in that at least the substituents R_1 and R_2 are each an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms, or at least the substituents R_3 and R_4 are each an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms, and thus such condensation reaction is unlikely to be caused. Hence, in the oil composition in an embodiment, reduction in the concentration of the primary alkanolamine due to use thereof is suppressed.

Examples

[0029] (1) Studies of components in oil compositions before and after use 1

An oil composition containing, as an alkanolamine, 2-amino-2-methyl-1-propanol (AMP) as a primary alkanolamine and a conventionally used oil composition containing monoisopropanolamine (MIPA) were each used for metalworking for a long time, and whether components thereof were changed before use and after use was examined.

[0030] (1-1) Example 1

An oil composition containing AMP at 3.6% as an alkanolamine (product A, Neos Company Ltd.) was used for metalworking for 5 to 11 months. The oil compositions before use and after use were each subjected to GC-MS measurement, and components thereof were analyzed. The GC-MS measurement equipment was JMS-Q1050GV (JEOL Ltd.), the column used for the measurement was CP-Volamine (Agilent Technologies), and the diluent solvent was ion-exchanged water or methanol. The dilution was performed at any degree depending on a measurement sample. The GC-MS measurement conditions are shown in Table 1.

[0031] [Table 1]

GC-MS measurement conditions

GC conditions	column	CP-Volamine (for amine measurement)
	column temperature	40°C to 250°C
	injection port temperature	250°C
	injection method	autosampler
	injection volume/split ratio	1 μ L/50

MS conditions	start mass/end mass	10.00/500.00
	start time/end time	00:02:00/00:25:00
	ionization current	50 μ A
	ionization energy	70 eV
	detector voltage	-1,100 Volt
	ion source temperature	230°C

[0032] FIG. 1 shows GC-MS spectra of the oil composition (fresh liquid) before use and oil compositions after use for 5 months, after use for 5 months, after use for 11 months, and after use for 8 months. In FIG. 1, No.1 is a GC-MS spectrum of the fresh liquid of product A; No.2 is a GC-MS spectrum of product A after use for about 5 months in company S; No.3 is a GC-MS spectrum of product A after use for about 5 months in company NS; No.4 is a GC-MS spectrum of product A after use for about 11 months in company N; and No.5 is a GC-MS spectrum of product A after use for about 8 months in company D.

[0033] (1-2) Comparative Example 1

An oil composition containing MIPA at 2.0% as an alkanolamine (product B, Neos Company Ltd.) was used for metalworking for 1 month. The oil compositions before use and after use were each subjected to GC-MS measurement under substantially the same conditions as in Example 1, and components thereof were analyzed. FIG. 2 shows GC-MS spectra of the oil composition (fresh liquid) before use and the oil composition after use for 1 month. In FIG. 2, No.1 is a GC-MS spectra of a fresh liquid of product B; and No.2 is a GC-MS spectra of product B after use for about 1 month in company M.

Components in the oil compositions used in Example 1 and Comparative

Example 1 are shown in Table 2.

[0034] [Table 2]

Oil composition

Example 1, Example 2	Comparative Example 1, Comparative Example 2	Example 2	Comparative Example 2
product A	product B	product C	product D
AMP 3.6%	MTPA 2.0%	AMP 1.8%	MTPA 3.0%
TEA 2.0%	TEA 2.0%	CH-020 2.0%	TEA 4.0%
organic amines 1-10%	organic amines 1-10%	organic amines 1-10%	organic amines 1-10%
organic acids less than 1%	organic acids less than 1%	organic acids less than 1%	organic acids less than 1%
fatty acids 5-15%	fatty acids 5-15%	fatty acids 5-15%	fatty acids 5-15%
Fatty acid condensates 5-15%	fatty acid condensates 5-15%	fatty acid condensates 5-15%	fatty acid condensates 5-15%
fatty acid esters less than 15%	fatty acid esters less than 15%	fatty acid esters less than 15%	fatty acid esters less than 15%
mineral oil 30-70%	mineral oil 30-70%	mineral oil 30-70%	mineral oil 30-70%
surfactant 1-15%	surfactant 1-15%	surfactant 1-15%	surfactant 1-15%

antirust agent less than 3%	antirust agent less than 3%	antirust agent less than 3%	antirust agent less than 3%
antiseptic agent less than 3%	antiseptic agent less than 3%	antiseptic agent less than 3%	antiseptic agent less than 3%
alcohols less than 3%	alcohols less than 3%	alcohols less than 3%	alcohols less than 3%
antifoaming agent less than 1%	antifoaming agent less than 1%	antifoaming agent less than 1%	antifoaming agent less than 1%
water 1-15%	water 1-15%	water 1-15%	water 1-15%

[0035] In FIG. 1 (Example 1), no change in components were observed between the oil compositions before and after use. In contrast, the spectrum of the oil composition after use in FIG. 2 (Comparative Example 1) showed a peak (peak around 16 minutes in spectrum No.2 in FIG. 2) that was not observed in the fresh liquid and was assigned to a new component. The component in the peak was identified as 2,5-dimethylpyrazine by mass analysis (MS).

[0036] The oil composition of the present invention does not generate pyrazines, which are generated from alkanolamines by intermolecular cyclodehydration, even when the oil composition is used at high temperature for a long time. This suggests that the concentration of an alkanolamine is unlikely to be reduced and the pH of an oil composition is unlikely to be reduced. In contrast, when the oil composition in Comparative Example is used at high temperature over a long time, the alkanolamine (MIPA) undergoes intermolecular cyclodehydration to generate a pyrazine, thus the alkanolamine gradually decreases, and the pH of the oil composition is reduced, in some

cases.

[0037] (2) Studies of components in oil compositions before and after use 2

An oil composition containing, as an alkanolamine, 2-amino-2-methyl-1-propanol (AMP) as a primary alkanolamine and an oil composition containing monoisopropanolamine (MIPA) were each used for metalworking for a long time, and whether components thereof were changed before use and after use was examined.

[0038] (2-1) Example 2

Product A (Neos Company Ltd., AMP: 3.6%, TEA: 2.0%) and product C (Neos Company Ltd., AMP: 1.8%, CH-020: 2.0%), which were each an oil composition containing at least two of AMP as a primary alkanolamine, triethanolamine (TEA) as a tertiary alkanolamine, and N,N-bis(2-hydroxyethyl)-N-cyclohexylamine (CH-020) as a tertiary alkanolamine, were used for metalworking for 1 to 5 months. The oil compositions before use and after use were each subjected to capillary electrophoresis (CE). The CE measurement equipment was G1600A (Agilent Technologies), the column used for the measurement was G1600-61232 (Agilent Technologies, 50 μ mI.D. $\times$ 56 cm), and the diluent solvent was ion-exchanged water. The dilution was performed at any degree depending on a measurement sample. The CE measurement conditions are shown in Table 3.

[0039] [Table 3]

CE measurement conditions

Column	G1600-61232
Buffer	Cation Buffer for CE, pH 3.2, manufactured by Agilent Technologies
Injection	pressure method, 50 mbar, 4 seconds

Polarity	positive
Applied voltage	30 kV
Measurement temperature	25°C
Measurement time	8 minutes
Light source wavelength	signal wavelength = 310/20 nm reference wavelength = 215/10 nm

[0040] Table 4 shows the ratios of AMP concentrations to tertiary alkanolamine concentrations calculated from CE measurement of the oil compositions (fresh liquids) before use and oil compositions after use for 1 to 6 months.

[0041] [Table 4]

CE measurement result (oil composition containing AMP), Example 2

Product containing AMP			Amine concentration ratio		
Product name	user	period of use	AMP	TEA	CH-020
Product A (fresh liquid) (dilution degree: 125 times)	-	-	1.84	1.00	-
Product A (dilution degree: 10 times)	company K	about 2 months	1.73	1.00	-
Product A (dilution degree: 10 times)	company Y	about 5 months	1.82	1.00	-
Product A (dilution degree: 10 times)	company D	about 6 months	1.81	1.00	-
Product C (fresh liquid)	-	-	0.92	-	1.00

(dilution degree: 100 times)					
Product C (dilution degree: 10 times)	company H	about 1 month	0.91	-	1.00
Product C (dilution degree: 10 times)	company A	about 4 months	0.90	-	1.00
Product C (dilution degree: 10 times)	company D	about 5 months	0.92	-	1.00

[0042] (2-2) Comparative Example 2

Product D (Neos Company Ltd., MIPA: 3.0%, TEA: 4.0%) and product B (Neos Company Ltd., MIPA: 2.0%, TEA: 2.0%)), which were each an oil composition containing at least two of MIPA as a primary alkanolamine, triethanolamine (TEA) as a tertiary alkanolamine, and N,N-bis(2-hydroxyethyl)-N-cyclohexylamine (CH-020) as a tertiary amine, were used for metalworking for 1 to 3 months. The oil compositions before use and after use were each subjected to CE measurement in substantially the same conditions as in Example 2. Table 5 shows the ratios of MIPA concentrations to tertiary alkanolamine concentrations calculated from CE measurement of the oil compositions (fresh liquids) before use and oil compositions after use for 1 to 6 months.

Components of the oil compositions used in Example 2 and Comparative Example 2 are shown in Table 2.

[0043] [Table 5]

CE measurement result (oil composition containing MIPA), Comparative Example 2

Product containing MIPA			Amine concentration ratio	
Product name	user	period of use	MIPA	TEA

Product D (fresh liquid) (dilution degree: 200 times)	-	-	0.70	1.00
Product D (dilution degree: 10 times)	company S, machine 1	about 1 month	0.17	1.00
Product D (dilution degree: 10 times)	company S, machine 2	about 1 month	0.23	1.00
Product D (dilution degree: 10 times)	company M	about 2 months	0.13	1.00
Product B (fresh liquid) (dilution degree: 100 times)	-	-	0.96	1.00
Product B (dilution degree: 10 times)	company F	about 1 month	0.65	1.00
Product B (dilution degree: 10 times)	company NS	about 2 months	0.30	1.00
Product B (dilution degree: 10 times)	company NT	about 3 months	0.25	1.00

[0044] Even when the oil composition containing AMP of the present invention was used for a long time, the AMP concentration was scarcely changed. Even when the oil compositions of the present invention were used for a long time, the concentrations of other amines (TEA, CH-020) were scarcely changed, and thus the pH of each oil composition is supposed not to be reduced. In contrast, when the oil compositions containing MIPA in Comparative Examples were used for a long time, the MIPA concentration was revealed to be reduced. The pH of the oil composition is supposed to be accordingly reduced.

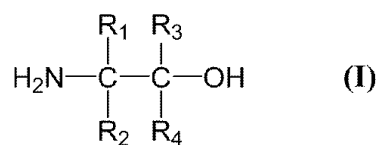
WHAT IS CLAIMED IS:

1. A water-soluble oil composition for metalworking, the composition comprising:

a primary alkanolamine having substituents to inhibit intermolecular cyclodehydration.

2. The water-soluble oil composition for metalworking according to claim 1, wherein the primary alkanolamine is represented by formula (I):

[Chemical Formula 1]



(where R₁, R₂, R₃, and R₄ are hydrogen atoms, identical or different alkyl groups having 1 to 6 carbon atoms, or identical or different cycloalkyl groups having 3 to 6 carbon atoms, provided that at least R₁ and R₂ are each independently an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms, or at least R₃ and R₄ are each independently an alkyl group having 1 to 6 carbon atoms or a cycloalkyl group having 3 to 6 carbon atoms).

3. The water-soluble oil composition for metalworking according to claim 1 or 2, wherein pyrazines formation by intermolecular cyclodehydration of the primary alkanolamine associated with use of the water-soluble oil composition for metalworking is suppressed.

4. The water-soluble oil composition for metalworking according to any one of claims 1 to 3, wherein reduction in concentration of the primary alkanolamine associated with use

of the water-soluble oil composition for metalworking is suppressed.