

DESCRIPTION

Title of Invention

WATER-SOLUBLE CUTTING FLUID STOCK SOLUTION
COMPOSITION, CUTTING FLUID COMPOSITION, AND
5 CUTTING METHOD

Technical Field

[0001] The present invention relates to a stock solution composition for
a water-soluble cutting fluid, a water-soluble cutting fluid composition,
and a cutting method, and specifically relates to a water-soluble cutting
10 fluid composition suitable for cutting a material to be processed
comprising aluminum or alloys thereof, copper or alloys thereof, or
steel, a stock solution composition which can provide a water-soluble
cutting fluid composition thereof by dilution with water, and a cutting
method in which the aforementioned water-soluble cutting fluid
15 composition is used.

Background Art

[0002] When steel or nonferrous materials are subjected to cutting such
as turning, planing, boring, and milling, a cutting fluid is used. The
purpose of using a cutting fluid is to reduce friction between a tool and a
20 material to be processed or swarf, to remove swarf, to prevent formation
of a built-up edge, to prevent heat generation, to provide cooling, and
the like, and thereby, extension of the tool life and the machining
accuracy have been attempted.

[0003] Generally, cutting fluids are largely classified as water-insoluble
25 cutting fluids, the main purpose of which is lubricating action, and
water-soluble cutting fluids, the main purpose of which is cooling

action. A conventional water-soluble cutting fluid is prepared by blending a surfactant, such as a polyoxyethylene monoalkyl ether, a polyoxyethylene monoalkyl phenyl ether, a fatty acid salt, and a sulfonate; an oily agent, such as a partial ester of a fatty acid salt and a polyhydric alcohol; an extreme pressure agent, such as a polyoxyethylene phosphoric acid ester; and a corrosion inhibitor, such as an amine, a phosphate, a molybdate, a tungstate, a borate, and a nitrite to water (for example, see Patent Literature 1).

[0004] A water-soluble cutting fluid to be used is diluted with water usually by a factor of about 5 to about 50. As can be seen from this, the performance required for water-soluble cutting fluids is cooling properties or processability exploiting the cooling properties. Insufficient cooling properties may cause heat to not be removed during processing, with the material to be cut thus melting and adhering to the tool, thereby resulting in processing defects. Alternatively, in order to use the water-soluble cutting fluid stably, emulsification stability and decay resistance are also regarded as important. Insufficient emulsification stability may cause the fluid to separate into water and oil content, making it not only impossible to achieve the performance as designed, but also resulting in abrasion powder of cut metal aggregating to adhere to the materials. When this happens, removal in the post step is required, and thus, the productivity will be reduced. Decay resistance is also important performance: in a water-soluble cutting fluid containing much water, bacteria and molds are prone to proliferate, and if decay occurs, the performance will be decreased, or its odor will significantly deteriorate working environments.

Citation List

Patent Literature

[0005] Patent Literature 1: JP H08-239683

Summary of Invention

5 Technical Problem

[0006] An object of the present invention is to provide a water-soluble cutting fluid composition which is excellent in emulsification stability, decay resistance, and processability and is suitable for cutting a material to be processed comprising aluminum or alloys thereof, copper or alloys thereof, or steel, a stock solution composition which is diluted with water to be able to provide a water-soluble cutting fluid composition thereof, and a cutting method in which the aforementioned water-soluble cutting fluid composition is used.

Solution to Problem

15 [0007] To solve the problem described above, the present invention provides a stock solution composition for a water-soluble cutting fluid described in the following [1] to [3], a cutting fluid composition described in the following [4], and a cutting method described in the following [5].

20 [1] A stock solution composition for a water-soluble cutting fluid comprising not less than 0.3% by mass and not more than 7.0% by mass of at least one amine compound selected from aromatic tertiary amines and heterocyclic tertiary amines, not less than 0.1% by mass and not more than 5.0% by mass of water, and not less than 70% by mass and
25 not more than 98% by mass of an mineral oil on the basis of the total amount of the stock solution composition.

[2] The stock solution composition according to [1], wherein the aromatic component in the mineral oil is not less than 10% by mass.

[3] The stock solution composition according to [1] or [2], wherein the heterocyclic tertiary amine is dimorpholine or N-ethylmorpholine.

5 [4] A water-soluble cutting fluid composition prepared by diluting the stock solution composition according to any one of [1] to [3] with water by a factor of not less than 5 and not more than 50.

[5] A cutting method for cutting a material to be cut comprising at least one metal selected from aluminum and alloys thereof, copper and alloys thereof, and steel by using the water-soluble cutting fluid composition according to [4].

10

Advantageous Effects of Invention

[0008] According to the present invention, a water-soluble cutting fluid composition which is excellent in emulsification stability, decay resistance, and processability and is suitable for cutting a material to be processed comprising aluminum or alloys thereof, copper or alloys thereof, or steel, a stock solution composition which is diluted with water to be able to provide a water-soluble cutting fluid composition thereof, and a cutting method in which the aforementioned water-soluble cutting fluid composition is used are provided.

15

20

Description of Embodiments

[0009] Hereinbelow, preferred embodiments of the present invention will be described in detail.

[0010] [First embodiment: water-soluble cutting fluid stock solution composition]

25

The water-soluble cutting fluid composition according to the

first embodiment of the present invention (hereinbelow, also simply referred to as the "stock solution composition") comprises not less than 0.3% by mass and not more than 7.0% by mass of at least one amine compound selected from aromatic tertiary amines and heterocyclic tertiary amines, not less than 0.1% by mass and not more than 5.0% by mass of water, and not less than 70% by mass and not more than 98% by mass of an mineral oil on the basis of the total amount of the stock solution composition.

[0011] Examples of the aromatic tertiary amines include triphenylamine, tri(methylphenyl)amine, tri(ethylphenyl)amine, tri(propylphenyl)amine, tri(butylphenyl)amine, tri(phenoxyphenyl)amine, tri(benzylphenyl)amine, diphenylmethylaniline, diphenylethylaniline, diphenylpropylaniline, diphenylbutylaniline, diphenylhexylaniline, diphenylcyclohexylaniline, N,N'-dimethylaniline, N,N'-diethylaniline, N,N'-dipropylaniline, N,N'-dibutylaniline, N,N'-dihexylaniline, N,N'-dicyclohexylaniline, (methylphenyl)dimethylamine, (ethylphenyl)dimethylamine, (propylphenyl)dimethylamine, (butylphenyl)dimethylamine, bis(methylphenyl)methylamine, bis(ethylphenyl)methylamine, bis(propylphenyl)methylamine, bis(butylphenyl)methylamine, N,N'-di(hydroxyethyl)aniline, N,N'-di(hydroxypropyl)aniline, N,N'-di(hydroxybutyl)aniline, and diisopropanol-p-toluidine. Among them, from the viewpoint of emulsification stability and decay resistance, tri(methylphenyl)amine, tri(ethylphenyl)amine, and tri(propylphenyl)amine are preferred.

[0012] Specific examples of the heterocyclic tertiary amines include

pyridine compounds such as picolines, isoquinoline, and quinolines, imidazole compounds, pyrazole compounds, morpholine compounds, piperazine compounds, and piperidine compounds.

[0013] Additionally, examples of the pyridine compound include N,N'-dimethyl-4-aminopyridine, bipyridine, and 2,6-lutidine. Among them, from the viewpoint of emulsification stability and decay resistance, N,N'-dimethyl-4-aminopyridine is preferred.

[0014] Additionally, examples of the imidazole compound include 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-cyanoethyl-2-ethyl-4-imidazole, 1-cyanoethyl-2-undecylimidazole, 1-cyanoethyl-2-methylimidazolium trimellitate, 1-cyanoethyl-2-undecylimidazolium trimellitate, 1-benzyl-2-phenylimidazole, 1-(2-hydroxyethyl)imidazole, 1-benzyl-2-formylimidazole, 1-benzyl-imidazole, and 1-allylimidazole.

Among them, from the viewpoint of emulsification stability and decay resistance, 1-benzyl-2-methylimidazole and 1-benzyl-2-phenylimidazole are preferred.

[0015] Examples of the pyrazole compound include pyrazole and 1,4-dimethylpyrazole. Among them, from the viewpoint of emulsification stability and decay resistance, pyrazole is preferred.

[0016] Examples of the morpholine compound include morpholine, dimorpholine, 4-(2-hydroxyethyl)morpholine, N-ethylmorpholine, N-methylmorpholine, and 2,2'-dimorpholine diethylether. Among them, from the viewpoint of emulsification stability and decay resistance, dimorpholine, 4-(2-hydroxyethyl)morpholine, and N-ethylmorpholine are preferred.

[0017] Examples of the piperazine compound include 1-(2-hydroxyethyl)piperazine and N,N'-dimethylpiperazine. Among them, from the viewpoint of emulsification stability and decay resistance, N,N'-dimethylpiperazine is preferred.

5 [0018] Examples of the piperidine compound include N-(2-hydroxyethyl)piperidine, N-ethylpiperidine, N-propylpiperidine, N-butylpiperidine, N-hexylpiperidine, N-cyclohexylpiperidine, and N-octylpiperidine. Among them, from the viewpoint of emulsification stability and decay resistance, N-(2-hydroxyethyl)piperidine,
10 N-propylpiperidine, and N-butylpiperidine are preferred.

[0019] In the present embodiment, only one of either the aromatic tertiary amines or the heterocyclic tertiary amines may be used, or one or two or more of the aromatic tertiary amines and one or two or more of the heterocyclic tertiary amines may be used in combination. From
15 the viewpoint of emulsification stability and decay resistance, the heterocyclic tertiary amines are more preferred, and among the heterocyclic tertiary amines, dimorpholine, 4-(2-hydroxyethyl)morpholine, and N-ethylmorpholine, which are morpholine compounds, are preferred, and dimorpholine and
20 N-ethylmorpholine are particularly preferred.

[0020] The content of the aromatic tertiary amines and/or the heterocyclic tertiary amines is not less than 0.3% by mass on the basis of the total amount of the stock solution compound. A content of not less than 0.5% by mass is preferred, not less than 1.0% by mass is more
25 preferred, not less than 1.5% by mass is still more preferred, and not less than 2.0% by mass is most preferred. If the content is less than the

aforementioned lower limit, a sufficient effect may not be achieved with respect to emulsification stability and decay resistance. Additionally, the content is not more than 7.0% by mass on the basis of the total amount of the stock solution compound. A content of not more than 6.5% by mass is preferred, not more than 6.0% by mass is more preferred, not more than 5.0% by mass is still more preferred, and not more than 4.5% by mass is most preferred. If the content exceeds the aforementioned upper limit, an effect corresponding to the addition tends not to be achieved, and also, there may be a risk of inhibiting the processability.

[0021] The stock solution composition according to the present embodiment comprises not less than 0.1% by mass and not more than 5.0% by mass of water on the basis of the total amount of the stock solution composition. The stock solution composition is diluted with water in its use, but it is possible to obtain good emulsification stability by blending an appropriate amount of water into the stock solution in advance.

[0022] As the water, it is possible to use optional ones such as industrial water, tap water, ion exchange water, distilled water, water treated with activated carbon or a common domestic water purifier, and water having absorbed moisture from the atmosphere.

[0023] The content of water is not less 0.1% by mass and not more than 5.0% by mass on the basis of the total amount of the stock solution composition. The lower limit of the content of water is not less than 0.1% by mass with respect to emulsification stability, not less than 0.5% by mass is preferred, and not less than 1.0% by mass is most preferred.

Additionally, the upper limit of the content is not more than 5.0% by mass also with respect to emulsification stability, not more than 4.0% by mass is more preferred, and not more than 3.0% by mass is most preferred.

5 [0024] The method for blending water is not particularly limited, but examples include (1) a method in which water is added and dissolved into the stock solution in the same manner as usual additives; (2) a method in which a surfactant and water are mixed in advance, and the mixed solution is blended into a base oil; (3) a method in which water is
10 forcibly blended and dispersed by using a stirring device such as a homogenizer; (4) a method in which steam is blown into a base oil to thereby forcibly blend and disperse water; and (5) a method in which the moisture in the atmosphere is allowed to be naturally absorbed.

[0025] The stock solution composition according to the present
15 embodiment comprises not less than 70% by mass and not more than 98% by mass of a mineral oil on the basis of the total amount of the stock solution composition. The mineral oil is used as the base oil.

[0026] Examples of the mineral oil include mineral oils used as a base material for kerosene, light oil, spindle oil, machine oil, turbine oil,
20 cylinder oil, and liquid paraffin oil. More specific examples include paraffin-base or naphthene-base mineral oil obtained by subjecting a lubricant oil fraction obtained by atmospheric distillation or vacuum distillation of a paraffin-base crude oil, an intermediate base crude oil, or a naphthene-base crude oil to any one of or any suitable combination
25 of two or more of refining means selected from solvent deasphalting, solvent extraction, hydrocracking, solvent dewaxing, catalytic

dewaxing, hydrorefining, sulfuric acid treatment, and clay treatment.

[0027] The content of mineral oil is not less than 70% by mass on the basis of the total amount of the stock solution composition, preferably not less than 75% by mass, and more preferably not less than 80% by mass.

Meanwhile, the content of mineral oil is not more than 98% by mass on the basis of the total amount of the stock solution composition, not more than 93% by mass is preferred, and not more than 90% by mass is most preferred.

If the content of the mineral oil is within the aforementioned range, it is possible to achieve excellent emulsification stability.

[0028] The viscosity of the mineral oil is not particularly limited, but in terms of the kinematic viscosity at 40°C, not less than 2 mm²/sec is preferred, not less than 5 mm²/sec is more preferred, and not less than 10 mm²/sec is most preferred. If the viscosity is less than the aforementioned lower limit, there may be a risk of reduction in the processability.

Meanwhile, in terms of the viscosity of the mineral oil, not more than 150 mm²/sec is preferred, not more than 100 mm²/sec is more preferred, and not more than 80 mm²/sec is most preferred. If the viscosity exceeds the aforementioned upper limit, there may be a risk of impairing the emulsification stability.

[0029] The composition of the mineral oil is not particularly limited, but the composition of the base oil, which occupies most of the composition, greatly affects the processability and emulsification stability of the cutting fluid. In this sense, it is preferred that the

aromatic content of the mineral oil to be used as a base oil be not less than 10% by mass, it is more preferred that the aromatic content be not less than 15% by mass, and it is most preferred that the aromatic content be not less than 20% by mass. The aromatic content of the mineral oil is usually not more than 40% by mass. In the present invention, the "aromatic content" refers to a value determined by applying a fluorescent indicator adsorption method according to the JIS K2536, "Petroleum products - Testing method of hydrocarbons types".

[0030] It should be noted that the stock solution composition according to the present embodiment may be one comprising only a mineral oil as the base oil, or may be one comprising a mixed base oil of a mineral oil and a synthetic oil provided that the content of the mineral oil is not less than 70% by mass on the basis of the total amount of the stock solution composition.

[0031] The stock solution composition according to the present embodiment may be one comprising at least one amine compound selected from aromatic tertiary amines and heterocyclic tertiary amines, water, and a mineral oil, and known additives usually blended in the past water-soluble cutting fluid can be added as required.

[0032] For example, when comprising a water-soluble metal corrosion inhibitor, the stock solution composition according to the present embodiment is effective for improving the anti-corrosion function of the fluid composition. Examples of the water-soluble metal corrosion inhibitor include sodium salt or potassium salt of an inorganic acid such as boric acid, tungsten acid, molybdenum acid, phosphoric acid, carbonic acid, sulfuric acid, silicic acid, nitric acid, and nitrous acid;

triazoles such as benzotriazole, methyl benzotriazole, tolyltriazole, and hydrocarbyl triazole, and salt thereof; thiazoles such as mercapto-benzothiazole, and salt thereof; aliphatic alkanolamides; imidazolines; and oxazolines.

5 [0033] In the case where the stock solution composition according to the present embodiment comprises the aforementioned additives, the content (in the case where two or more additives are comprised, their total content) is usually selected in the range of not more than 20% by mass on the basis of the total amount of the stock solution composition.

10 [0034] [Second embodiment: water-soluble cutting fluid composition]

A water-soluble cutting fluid composition according to the second embodiment of the present invention is prepared by diluting a stock solution composition for a water-soluble cutting fluid comprising not less than 0.3% by mass and not more than 7.0% by mass of at least one amine compound selected from aromatic tertiary amines and heterocyclic tertiary amines, not less than 0.1% by mass and not more than 5.0% by mass of water, and not less than 70% by mass and not more than 98% by mass of a mineral oil on the basis of the stock solution composition with water by a factor of not less than 5 and not more than 50. It should be noted that the stock solution composition in the present embodiment is similar to the stock solution composition according to the aforementioned first embodiment, and overlapping description will be omitted here.

20 [0035] As the water used for diluting the stock solution composition, it is possible to use optional ones such as industrial water, tap water, ion exchange water, distilled water, water treated with activated carbon or a

common domestic water purifier, and water having absorbed moisture from the atmosphere. The type of the water used for diluting the stock solution composition may be the same as or different from the type of the water contained in the stock solution composition.

5 [0036] The dilution ratio is a factor of not less than 5, preferably a factor of not less than 7, and more preferably a factor of not less than 10 in the volume ratio to the stock solution composition, from the viewpoint of cooling properties. Additionally, the dilution ratio is a factor of not more than 50, preferably a factor of not more than 40, and
10 more preferably a factor of not more than 30 in the volume ratio to the stock solution composition, from the viewpoint of processability. If the dilution ratio is a factor of less than 5, failures in the processability and the stability of the emulsion may occur due to a significant increase in the fluid viscosity, the reverse phase of the emulsion, etc.
15 Additionally, if the factor exceeds 50, the concentration of each active component will be insufficient, and there may be a case where sufficient processing performance cannot be achieved.

[0037] [Third embodiment: cutting method]

A cutting method according to the third embodiment of the
20 present invention comprises a step of cutting a material to be cut comprising at least one metal selected from aluminum and alloys thereof, copper and alloys thereof, and steel by using a water-soluble cutting fluid composition prepared by diluting a stock solution composition for a water-soluble cutting fluid comprising not less than
25 0.3% by mass and not more than 7.0% by mass of at least one amine compound selected from aromatic tertiary amines and heterocyclic

tertiary amines, not less than 0.1% by mass and not more than 5.0% by mass of water, and not less than 70% by mass and not more than 98% by mass of a mineral oil on the basis of the total amount of the stock solution composition with water by a factor of not less than 5 and not more than 50. It should be noted that the stock solution composition and the water-soluble cutting fluid composition in the present embodiment are similar to the stock solution for the water-soluble cutting fluid according to the aforementioned first embodiment and the water-soluble cutting fluid composition according to the aforementioned second embodiment, respectively, and overlapping description will be omitted here.

[0038] In the cutting method according to the present embodiment, the aforementioned water-soluble cutting fluid composition excellent in emulsification stability, decay resistance, and processability is used, and thus the method is useful as a method for cutting a material to be cut comprising at least one metal selected from aluminum and alloys thereof, copper and alloys thereof, and steel.

Example

[0039] Hereinbelow, the present invention will be described more specifically based on Examples and Comparative Examples, but the present invention is not limited in any way by the Examples below.

[0040] [Examples 1 to 27 and Comparative Examples 1 to 10]

In Examples 1 to 27 and Comparative Examples 1 to 10, amine compounds A1 to A10, mineral oils B1 to B8, other additives C1 to C5, each shown below, and water (U.S. hardness 64) were used to prepare water-soluble cutting fluid stock solution compositions having the

composition shown in Tables 1 to 4.

[0041] <Amine compounds>

A1: tri(methylphenyl)amine

A2: N,N'-dimethyl-4-aminopyridine

5 A3: 1-benzyl-2-phenylimidazole

A4: pyrazole

A5: dimorpholine

A6: 4-(2-hydroxyethyl)morpholine

A7: N-ethylmorpholine

10 A8: N,N'-dimethylpiperazine

A9: N-(2-hydroxyethyl)piperidine

A10: triethanolamine

[0042] <Mineral oil>

15 B1: mineral oil (kinematic viscosity at 40°C 24 mm²/sec, aromatic content 12% by mass)

B2: mineral oil (kinematic viscosity at 40°C 22 mm²/sec, aromatic content 22% by mass)

B3: mineral oil (kinematic viscosity at 40°C 93 mm²/sec, aromatic content 14% by mass)

20 B4: mineral oil (kinematic viscosity at 40°C 3.4 mm²/sec, aromatic content 12% by mass)

B5: mineral oil (kinematic viscosity at 40°C 144 mm²/sec, aromatic content 14% by mass)

25 B6: mineral oil (kinematic viscosity at 40°C 27 mm²/sec, aromatic content 6.7% by mass)

B7: mineral oil (kinematic viscosity at 40°C 1.2 mm²/sec, aromatic

content 13% by mass)

B8: mineral oil (kinematic viscosity at 40°C 162 mm²/sec, aromatic content 14% by mass)

[0043] <Other additives>

5 C1: sodium sulphonate

C2: potassium oleate

C3: polyethylene glycol (average degree of polymerization 12)

C4: oleic acid monoester of polyethylene glycol (average degree of polymerization 4.5)

10 C5: silicone oil

[0044] Then, the stock solution compositions of Examples 1 to 27 and Comparative Examples 1 to 10 were used to be diluted with water, and the following evaluation tests were conducted. It should be noted that the dilution ratio was a factor of 5 (20%) in Examples 1 to 26 and
15 Comparative Examples 1 to 10 and a factor of 50 (2%) in Example 27 (both ratios were volume ratios. The numerical values in the parentheses mean the content of the stock solution composition on the basis of the total amount of the cutting fluid composition.).

[0045] <Emulsification stability evaluation>

20 Evaluation was conducted according to JIS K2241: Emulsification stability test. However, tap water (U.S. hardness 64) was used as the water for dilution. Also, the dilution ratio was a factor of 10 (stock solution concentration 10%), and the total of the oil layer and the cream layer was evaluated 24 hours after emulsification. It
25 should be noted that, in Example 27, the dilution ratio was a factor of 50 (2%) (volume ratio, the numerical values in the parentheses mean the

content of the stock solution composition on the basis of the total amount of the cutting fluid composition.), and evaluation was conducted in the same manner. Evaluation criteria in the present test are as follows. The results obtained are shown in Tables 1 to 4.

- 5 A: The total of the oil layer and the cream layer is less than 1 mL.
B: The total of the oil layer and the cream layer is not less than 1 mL and less than 2 mL.
B: The total of the oil layer and the cream layer is not less than 1 mL and less than 2 mL.
10 C: The total of the oil layer and the cream layer is not less than 2 mL and less than 3 mL.
D: The total of the oil layer and the cream layer is not less than 3 mL and less than 4 mL.
E: The total of the oil layer and the cream layer is not less than 4 mL and less than 5 mL.
15 F: The total of the oil layer and the cream layer is not less than 5 mL.

[0046] <Decay resistance evaluation>

Tap water (U.S. hardness 64) was used to dilute the stock solution composition by a factor of 20 to prepare a fluid composition.
20 Then, to 300 mL of the fluid composition, 15 g of bacterial strain (fluid used by a customer and decayed, the total number of bacteria of not less than 10^7 /mL) was added and stirred at 30°C and 60 revolutions/minute. After seven days, the total number of bacteria in the fluid was determined with San-ai Biochecker TTC manufactured by SAN-AI OIL
25 CO., LTD. The same test was conducted on UNISOLUBLE EM-L (diluted by a factor of 20) manufactured by JX Nippon Oil & Energy

Corporation as a reference oil, and the total numbers of bacteria were compared. It should be noted that, in Example 27, evaluation was conducted in the same manner on a fluid composition prepared by diluting the stock solution composition by a factor of 50 (2%) (volume ratio, the numerical values in the parentheses mean the content of the stock solution composition on the basis of the total amount of the cutting fluid composition.). Evaluation criteria in the present test are as follows. The results obtained are shown in Tables 1 to 4.

A: The total number of bacteria is less than the reference oil.

B: The total number of bacteria is equivalent to the reference oil.

C: The total number of bacteria is more than the reference oil.

[0047] <Processability evaluation>

Evaluation was conducted by determining the tapping energy efficiency (TEE) from a tapping evaluation test with a rolled tap.

The material evaluated was aluminum (AC8A).

B-NRT B M8 (pitch 1.25) manufactured by OSG Corporation was used as the tool to conduct processing evaluation on the lower hole of 7.4 mm at a number of revolutions of 360 revolutions/minute and a feed rate of 9 m/minute.

It should be noted that reference oil used was UNISOLUBLE EM-L (diluted by a factor of 20) manufactured by JX Nippon Oil & Energy Corporation, and both the reference oil and the oil to be evaluated were diluted with tap water by a factor of 20.

The tapping energy efficiency is a value obtained by dividing the tapping energy of the reference oil (torque integration on processing) by the tapping energy of the oil to be evaluated, and defined

by the following formula:

(Tapping energy efficiency, %) = (Tapping energy of the reference oil / Tapping energy of the test oil) $\times$ 100. In terms of a fluid composition of which tapping energy efficiency exceeds 100, its processability is better than the reference oil. Evaluation criteria in the present test are as follows. The results obtained are shown in Tables 1 to 4.

A: The tapping energy efficiency is not less than 110.

B: The tapping energy efficiency is less than 110 and not more than 105.

C: The tapping energy efficiency is less than 105 and not more than 95.

D: The tapping energy efficiency is less than 95.

[0048] [Table 1]

(1/2)

			Example				
			1	2	3	4	5
Composition (% by mass)	Amine compound	A1			3		
		A2				3	
		A3					3
		A4					
		A5	3	3			
		A6					
		A7					
		A8					
		A9					
		A10					
	Mineral oil	B1	95	86	86	86	86
		B2					
		B3					
		B4					
		B5					
		B6					
		B7					
		B8					
	Other additive	C1		4	4	4	4
		C2		4	4	4	4
		C3		0.5	0.5	0.5	0.5
		C4		0.4	0.4	0.4	0.4
		C5		0.1	0.1	0.1	0.1
	Water		2	2	2	2	2
Evaluation	Emulsification stability		D	C	D	D	D
	Decay resistance		B	A	B	B	B
	Processability		C	B	C	C	C

(2/2)

			Example				
			6	7	8	9	10
Composition (% by mass)	Amine compound	A1					
		A2					
		A3					
		A4	3				
		A5					
		A6		3			
		A7			3		
		A8				3	
		A9					3
		A10					
	Mineral oil	B1	86	86	86	86	86
		B2					
		B3					
		B4					
		B5					
		B6					
		B7					
		B8					
	Other additive	C1	4	4	4	4	4
		C2	4	4	4	4	4
		C3	0.5	0.5	0.5	0.5	0.5
		C4	0.4	0.4	0.4	0.4	0.4
		C5	0.1	0.1	0.1	0.1	0.1
	Water		2	2	2	2	2
Evaluation	Emulsification stability		D	C	C	D	D
	Decay resistance		B	A	B	B	B
	Processability		C	C	A	C	C

[0049] [Table 2]

(1/2)

			Example				
			11	12	13	14	15
Composition (% by mass)	Amine compound	A1					
		A2					
		A3					
		A4					
		A5	3	3	3	3	3
		A6					
		A7					
		A8					
		A9					
		A10					
	Mineral oil	B1					
		B2	86				
		B3		86			
		B4			86		
		B5				86	
		B6					86
		B7					
		B8					
	Other additive	C1	4	4	4	4	4
		C2	4	4	4	4	4
		C3	0.5	0.5	0.5	0.5	0.5
		C4	0.4	0.4	0.4	0.4	0.4
		C5	0.1	0.1	0.1	0.1	0.1
	Water		2	2	2	2	2
Evaluation	Emulsification stability		A	C	C	C	D
	Decay resistance		A	A	A	A	A
	Processability		A	B	C	A	C

(2/2)

			Example				
			16	17	18	19	20
Composition (% by mass)	Amine compound	A1					
		A2					
		A3					
		A4					
		A5	3	3	1	0.3	5
		A6					
		A7					
		A8					
		A9					
		A10					
	Mineral oil	B1			88	88.7	84
		B2					
		B3					
		B4					
		B5					
		B6					
		B7	86				
		B8		86			
	Other additive	C1	4	4	4	4	4
		C2	4	4	4	4	4
		C3	0.5	0.5	0.5	0.5	0.5
		C4	0.4	0.4	0.4	0.4	0.4
		C5	0.1	0.1	0.1	0.1	0.1
	Water		2	2	2	2	2
Evaluation	Emulsification stability		C	D	C	D	B
	Decay resistance		A	A	A	B	A
	Processability		C	B	B	B	B

[0050] [Table 3]

			Example						
			21	22	23	24	25	26	27
Composition (% by mass)	Amine compound	A1							
		A2							
		A3							
		A4							
		A5	7	3	3	1	7	3	3
		A6							
		A7							
		A8							
		A9							
		A10							
	Mineral oil	B1	82	87.9	83	95	74	86	86
		B2							
		B3							
		B4							
		B5							
		B6							
		B7							
		B8							
	Other additive	C1	4	4	4	1	5.9	4	4
		C2	4	4	4	1	5	4	4
		C3	0.5	0.5	0.5	0.5	1	0.5	0.5
		C4	0.4	0.4	0.4	0.4	2	0.4	0.4
		C5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Water		2	0.1	5	1	5	2	2
Evaluation	Emulsification stability		A	D	C	C	C	C	C
	Decay resistance		A	A	A	A	A	A	B
	Processability		B	B	B	B	B	A	B

[0051] [Table 4]

(1/2)

			Comparative Example				
			1	2	3	4	5
Composition (% by mass)	Amine compound	A1					
		A2					
		A3					
		A4					
		A5		46	3		0.1
		A6					
		A7					
		A8					
		A9					
		A10				3	
	Mineral oil	B1	89		88	86	88.9
		B2					
		B3					
		B4					
		B5					
		B6					
		B7					
		B8					
	Other additive	C1	4	4	4	4	4
		C2	4	4	4	4	4
		C3	0.5	0.5	0.5	0.5	0.5
		C4	0.4	0.4	0.4	0.4	0.4
		C5	0.1	0.1	0.1	0.1	0.1
	Water		2	45		2	2
Evaluation	Emulsification stability		F	B	E	E	E
	Decay resistance		C	B	A	C	C
	Processability		C	D	B	C	D

(2/2)

			Comparative Example				
			6	7	8	9	10
Composition (% by mass)	Amine compound	A1					
		A2					
		A3					
		A4					
		A5	9	2	2	21	0.3
		A6					
		A7					
		A8					
		A9					
		A10					
	Mineral oil	B1	80	88.95	82	65	99
		B2					
		B3					
		B4					
		B5					
		B6					
		B7					
		B8					
	Other additive	C1	4	4	4	4	0.2
		C2	4	4	4	4	0.2
		C3	0.5	0.5	0.5	0.5	0.1
		C4	0.4	0.4	0.4	0.4	0.05
		C5	0.1	0.1	0.1	0.1	0.05
	Water		2	0.05	7	5	0.1
Evaluation	Emulsification stability		C	E	E	B	F
	Decay resistance		A	A	A	B	C
	Processability		D	B	B	D	D

Industrial Applicability

[0052] The stock solution composition, the cutting fluid composition, and the cutting method exert an excellent effect with respect to emulsification stability, decay resistance, and processability and are highly useful in cutting a material to be cut comprising at least one metal selected from aluminum and alloys thereof, copper and alloys thereof, and steel.

CLAIMS

1. A stock solution composition for a water-soluble cutting fluid comprising:

5 not less than 0.3% by mass and not more than 7.0% by mass of at least one amine compound selected from aromatic tertiary amines and heterocyclic tertiary amines;

not less than 0.1% by mass and not more than 5.0% by mass of water; and

10 not less than 70% by mass and not more than 98% by mass of a mineral oil;

on the basis of the total amount of the stock solution composition.

2. The stock solution composition according to claim 1, wherein an aromatic content in the mineral oil is not less than 10% by mass.

15 3. The stock solution composition according to claim 1 or 2, wherein the heterocyclic tertiary amine is dimorpholine or N-ethylmorpholine.

4. A water-soluble cutting fluid composition prepared by diluting the stock solution composition according to any one of claims 1 to 3 with water by a factor of not less than 5 and not more than 50 (volume ratio).

20 5. A cutting method for cutting a material to be cut comprising at least one metal selected from aluminum and alloys thereof, copper and alloys thereof, and steel by using the water-soluble cutting fluid composition according to claim 4.