(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 098 289 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
30.11.2016 Bulletin 2016/48

(21) Application number: **14878563.7**

(22) Date of filing: **17.12.2014**

(51) Int Cl.:
C10M 169/04 *(2006.01)* ***C10M 105/38*** *(2006.01)*
C10M 125/06 *(2006.01)* ***C10M 135/06*** *(2006.01)*
C10N 20/00 *(2006.01)* ***C10N 20/02*** *(2006.01)*
C10N 30/00 *(2006.01)* ***C10N 30/06*** *(2006.01)*
C10N 40/20 *(2006.01)* ***C10N 40/22*** *(2006.01)*

(86) International application number:
PCT/JP2014/083373

(87) International publication number:
WO 2015/107828 (23.07.2015 Gazette 2015/29)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **20.01.2014 JP 2014007733**

(71) Applicant: **Idemitsu Kosan Co., Ltd**
Tokyo 100-8321 (JP)

(72) Inventor: **KITAMURA Tomohiko**
Ichihara-shi
Chiba 299-0107 (JP)

(74) Representative: **Vossius & Partner**
Patentanwälte Rechtsanwälte mbB
Siebertstrasse 3
81675 München (DE)

(54) METALWORKING OIL COMPOSITION

(57) A metalworking oil composition contains: a component (A) that is an ester of a polyhydric alcohol and a fatty acid; and a component (B) that is elemental sulfur, in which the metalworking oil composition has a kinematic viscosity at 40 degrees C in a range from 5 mm^2/s to 70 mm^2/s and a flash point of 200 degrees C or more. The metalworking oil composition of the invention is suitably usable particularly in a field of a high-speed cutting work

EP 3 098 289 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a metalworking oil composition.

BACKGROUND ART

[0002] A metalworking oil composition provided by blending various additives to a base oil such as a mineral oil and a synthetic oil is widely usable. The metalworking oil composition is required to have a high flash point in addition to high workability and wear resistance. For instance, a metalworking oil composition containing a base oil, an ester oil, a hydrocarbon oil, and an extreme pressure agent of 0.005 to 20 mass% based on a total amount of the composition, in which the metalworking oil composition has a kinematic viscosity at 40 degrees C of 37 mm^2/s or less and a flash point of 250 degrees or more, has been proposed (Patent Literature 1).

CITATION LIST

PATENT LITERATURE(S)

[0003] Patent Literature 1: JP-A-2008-163115

SUMMARY OF THE INVENTION

PROBLEM(S) TO BE SOLVED BY THE INVENTION

[0004] The metalworking field also includes a working field (e.g., a cutting work) in which a working speed is required to be increased in order to improve productivity.

[0005] However, the metalworking oil composition disclosed in Patent Literature 1 generates a mass of oily smoke during a high-speed cutting work although having a high flash point.

[0006] An object of the invention is to provide a metalworking oil composition having a high workability and an excellent wear resistance and being capable of restraining generation of oily smoke.

MEANS FOR SOLVING THE PROBLEM(S)

[0007] In order to solve the above problem(s), the invention provides the following metalworking oil composition:

(1) A metalworking oil composition contains: a component (A) that is an ester of a polyhydric alcohol and a fatty acid; and a component (B) that is elemental sulfur, in which the metalworking oil composition has a kinematic viscosity at 40 degrees C in a range from 5 mm^2/s to 70 mm^2/s and a flash point of 200 degrees C or more.

[0008] According to the above aspect of the invention, a metalworking oil composition having a high workability and an excellent wear resistance and being capable of restraining generation of oily smoke can be provided. For this reason, the metalworking oil composition according to the above aspect of the invention is suitably usable particularly in a field of a high-speed cutting work.

DESCRIPTION OF EMBODIMENT(S)

[0009] A metalworking oil composition of an exemplary embodiment of the invention (hereinafter, also referred to as "the present composition") contains: a component (A) that is an ester of a polyhydric alcohol and a fatty acid; and a component (B) that is elemental sulfur, in which the metalworking oil composition has a kinematic viscosity at 40 degrees C in a range from 5 mm^2/s to 70 mm^2/s and a flash point of 200 degrees C or more.

[0010] The present composition will be described in detail below.

Component (A)

[0011] A component (A) of the present composition is an ester of a polyhydric alcohol and a fatty acid.

[0012] Herein, the polyhydric alcohol is preferably di- to deca-hydric alcohol, more preferably di- to hexa-hydric alcohol, further preferably di- to penta-hydric alcohol. Examples of the polyhydric alcohol include ethylene glycol, diethylene

glycol, propylene glycol, dipropylene glycol, butylene glycol, neopentyl glycol, glycerin, trimethylolethane, trimethylolpropane, pentaerythritol, and sorbitol. Two or more of the above polyhydric alcohol may be used in combination.

[0013] Among the above polyhydric alcohol, it is preferable to use at least one of trimethylolpropane, pentaerythritol, neopentyl glycol, and glycerin in terms of thermal stability and antioxidation stability.

[0014] A fatty acid forming the component (A) is not particularly limited, but a fatty acid having 6 to 26 carbon atoms is preferable. Examples of the fatty acid include heptadecanoic acid, octanoic acid, nonadecanoic acid, stearic acid, arachidic acid, behenic acid, isostearic acid, elaidic acid, oleic acid, linolic acid, and linolenic acid. Among the above fatty acid, a fatty acid having 8 to 18 carbon atoms is more preferably used.

[0015] When the above fatty acid has 6 or more carbon atoms, the flash point of the present composition is not lowered. When the above fatty acid has 26 or less carbon atoms, a viscosity of the present composition is not so high and an amount of the present composition to be taken away by adhering on a to-be-worked object is economically small.

[0016] The fatty acid ester of the polyhydric alcohol (i.e., the component (A)) is obtainable by a dehydration reaction of the polyhydric alcohol and the fatty acid, but transesterification reaction may be used instead of the dehydration reaction of the polyhydric alcohol and the fatty acid.

[0017] The component (A) preferably has a kinematic viscosity at 40 degrees C in a range from 4 mm^2/s to 69mm^2/s, more preferably from 8 mm^2/s to 60 mm^2/s, further preferably from 12 mm^2/s to 50 mm^2/s. When the component (A) has the kinematic viscosity at 40 degrees C of 4 mm^2/s or more, a sufficient lubricity is maintainable during metalworking, the flash point is controllable to be high, and generation of oily smoke and mist is restrainable. When the component (A) has the kinematic viscosity at 40 degrees C of 69 mm^2/s or less, a consumption amount (loss amount) of the present composition during the metalworking can be decreased.

[0018] A content of the component (A) is preferably 10 mass% or more, more preferably 40 mass% or more, further preferably 80 mass% or more. When the content of the component (A) is equal to or more than the lower limit, a friction coefficient of the present composition is decreased, thereby securing a sufficient workability of the present composition.

[0019] Herein, the flash point of the component (A) is preferably 200 degrees C or more, more preferably 250 degrees C or more. When the component (A) has the flash point of 200 degrees C or more, the flash point of the present composition is easily made at 200 degrees C or more.

Component (B)

[0020] A component (B) of the present composition is elemental sulfur. When the present composition contains the elemental sulfur, the present composition is improvable in the workability without lowering the flash point (i.e., without increasing generation amount of oily smoke). Herein, the improvement in the workability means to restrain a tool from being worn, to improve a working accuracy, and to reduce a cutting resistance in a cutting work.

[0021] The elemental sulfur may be used in any forms such as agglomerate, powders and melt liquid. A so-called powdery sulfur is preferable because of exhibiting an excellent handleability and an efficient solubility to the component (A).

[0022] A content of the component (B) is not particularly limited, but is preferably in a range from 0.05 mass% to 1 mass% based on the total amount of the composition, more preferably from 0.1 mass% to 0.7 mass%, further preferably from 0.15 mass% to 0.6 mass%, most preferably from 0.2 mass% to 0.5 mass%.

[0023] When the content of the component (B) is 0.05 mass% or more, a friction coefficient is sufficiently reducible, wear resistance is also improvable, and generation of oily smoke is effectively restrainable. Moreover, when the content of the component (B) is 1 mass% or less, generation of oily smoke is sufficiently restrainable while securing solubility of the component (B) to the component (A).

Present Composition

[0024] The above components (A) and (B) are requisite components of the present composition. When the present composition has the kinematic viscosity at 40 degrees C of 5 mm^2/s to 70 mm^2/s, the present composition exhibits a high workability and can restrain generation of oily smoke in a high-speed work. Particularly, the present composition is more effective during a high-speed cutting work of 100 m/min or more where oily smoke is liable to be generated.

[0025] When the present composition has the kinematic viscosity at 40 degrees C of 5 mm^2/s or more, the workability is excellent, generation of mist is restrainable, and further, the flash point is controllable to be sufficiently high. When the present composition has the kinematic viscosity at 40 degrees C of 70 mm^2/s or less, the consumption amount (loss amount) of the present composition during the metalworking can be decreased. For this reason, the present composition preferably has the kinematic viscosity at 40 degrees C in a range from 10 mm^2/s to 60mm^2/s, more preferably from 15 mm^2/s to 50 mm^2/s.

[0026] When the flash point of the present composition is 200 degrees C or more, there is less risk to catch fire during the metalworking. Accordingly, for instance, in a factory and the like, equipment required in accordance with the Fire

Defense Law is reducible. The flash point of the present composition is preferably 250 degrees C or more.

[0027] A kinematic friction coefficient of the present composition is preferably in a range from 0.05 to 0.2. When the present composition having the kinematic friction coefficient of 0.05 or more is applied to the cutting work, a tool easily catches a target material, thereby improving workability. At the kinematic friction coefficient of 0.2 or less, a friction force between the tool and the target material can be decreased, thereby keeping a sufficient workability. It should be noted that the kinematic friction coefficient herein refers to one measured in a later-described reciprocating friction test.

[0028] When the present composition having the kinematic friction coefficient in a small range is used for metalworking, the present composition can exhibit a high workability and prolong a lifetime of the tool. Particularly, the present composition is suitably usable for the cutting work.

Component (C)

[0029] The components (A) and (B) are requisite for the present composition. However, it is preferable that the present composition further contains a sulfurized fat and oil as a component (C). When the present composition contains the sulfurized fat and oil, the friction coefficient is further reducible and the wear resistance is also further improvable. Moreover, generation of oily smoke is restrainable.

[0030] Herein, the sulfurized fat and oil means one obtainable by reacting sulfur or a sulfur-containing compound with a fat and oil (e.g., lard oil, whale oil, vegetable oil and fish oil). Examples of the sulfurized fat and oil include sulfurized lard, sulfurized rape seed oil, sulfurized castor oil, sulfurized soybean oil and sulfurized rice bran oil.

[0031] The component (C) preferably has a kinematic viscosity at 40 degrees C in a range from 100 mm^2/s to 2000 mm^2/s, more preferably from 200 mm^2/s to 1800 mm^2/s, further preferably from 300 mm^2/s to 1500 mm^2/s.

[0032] When the component (C) has the kinematic viscosity at 40 degrees C of 100 mm^2/s or more, the friction coefficient of the present composition can be effectively decreased to improve the workability. When the component (C) has the kinematic viscosity at 40 degrees C of 2000 mm^2/s or less, the consumption amount (loss amount) of the present composition during the metalworking can be decreased. Particularly, in the cutting work, an amount of the present composition to be taken away by cut pieces is reducible and load applied to a pump is decreased.

[0033] A flash point of the component (C) is preferably 200 degrees C or more, more preferably 250 degrees C or more. When the component (C) has the flash point of 200 degrees C or more, the flash point of the present composition is easily made at 200 degrees C or more.

[0034] A content of the component (C) is preferably in a range from 0.5 mass% to 30 mass% based on the total amount of the composition, more preferably from 1 mass% to 20 mass%, further preferably from 2 mass% to 15 mass%. When the content of the component (C) is 0.5 mass% or more, the wear resistance of the present composition is improved and the friction coefficient thereof is also decreased to contribute to improvement in the workability. When the content of the component (C) is 30 mass% or less, the viscosity of the present composition is restrainable and the consumption amount (loss amount) of the present composition during the metalworking can be decreased. Particularly, in the cutting work, the amount of the present composition to be taken away by cut pieces is reducible and load applied to the pump is decreased.

[0035] In the present composition, a blending mass ratio (C)/(B) of the component (C) to the component (B) is preferably in a range from 2 to 75, more preferably from 4 to 50, further preferably from 7 to 30.

[0036] When the ratio (C)/(B) is 2 or more, the wear resistance of the present composition is sufficiently improvable. When the ratio (C)/(B) is 75 or less, the extreme pressure performance of the present composition is sufficiently improvable. In other words, when the ratio (C)/(B) falls within the above range, both of the wear resistance and the extreme pressure performance of the present composition are achievable, and consequently, the workability of the present composition is effectively improvable and generation of oily smoke are effectively restrainable.

[0037] The present composition can contain various base oils and additives as long as the advantageous effects of the invention are not impaired.

[0038] Herein, in the invention, the composition provided by blending the components (A) and (B) means not only a "composition containing the components (A) and (B)" but also a "composition containing a modified substance of at least one of the components (A) and (B) in place of the at least one of the components (A) and (B), and a "composition containing a reaction product obtained by reacting the component (A) with the component (B)." The same explanation is applied to the present composition containing the component (C) and various base oils and additives.

[0039] The base oil is not particularly limited, but includes a mineral oil and a synthetic oil. The mineral oil is exemplified by various mineral oils. Examples of the mineral oil are oil fraction obtained by atmospherically distilling paraffin-based crude oil, intermediate-based crude oil or naphthene-based crude oil or by vacuum-distilling residual oil formed by atmospheric distilling, and purified oil obtained by refining the oil fraction in accordance with an ordinary method. Examples of the purified oil are solvent-refined oil, hydrogenated refined oil, dewaxing-processed oil, and white clay-processed oil.

[0040] Examples of the synthetic oil include ester, poly-α-olefin, olefin copolymer alkylbenzene, alkyl naphthalene, polyoxyalkylene glycol, and polyphenyl ether.

[0041] Among the above, example of the ester include octyl palmitate, 2-ethylhexyl palmitate, octyl stearate, and 2-ethylhexyl oleate. Examples of the poly-α-olefin include polybutene, 1-octene oligomer, and 1-decene oligomer. The olefin copolymer is exemplified by ethylene-propylene copolymer.

[0042] Among the above synthetic oil, the ester is suitably used in terms of a low viscosity and a high flash point.

[0043] In the present composition, the mineral oil may be provided by a single one or a plurality of the above substances. The synthetic oil may be provided by a single one or a plurality of the above substances. Further, at least one of the synthetic oil and at least one of the synthetic oil may be used in combination.

[0044] However, when the above various base oils are blended, the present composition needs to have the kinematic viscosity at 40 degrees C of 5 mm^2/s to 70 mm^2/s and the flash point of 200 degrees C or more.

[0045] Examples of the additive blendable to the present composition include an extreme pressure agent, oiliness agent, antioxidant, rust inhibitor, metal deactivator and antifoaming agent. The additive may be provided by a single one or a plurality of the above agents.

[0046] Examples of the extreme pressure agent include a sulfur-based extreme pressure agent, a phosphorus-based extreme pressure agent, an extreme pressure agent containing sulfur and metal, and an extreme pressure agent containing phosphorus and metal. The extreme pressure agent may be provided by a single one or a plurality of the above agents. The extreme pressure agent may be any extreme pressure agent, as long as the extreme pressure agent contains sulfur atoms or phosphorus atoms in its molecule and the extreme pressure agent can provide load bearing effects and wear resistance. Examples of the extreme pressure agent containing sulfur in its molecule includes sulfurized fatty acid, ester sulfide, olefin sulfide, dihydrocarbyl polysulfide, a thiadiazole compound, an alkylthiocarbamoyl compound, a triazine compound, a thioterpene compound, and a dialkylthiodipropionate compound. In view of blending effects, the extreme pressure agent is blended at a content of approximately 0.05 mass% to 0.5 mass% based on the total amount of the composition.

[0047] Examples of the oiliness agent include: aliphatic alcohol; a fatty acid compound such as fatty acid and fatty acid metal salt; an ester compound such as polyol ester, sorbitan ester and glyceride; and an amine compound such as aliphatic amine. The fatty acid is exemplified by oleic acid and lauric acid.

[0048] In view of blending effects, a content of the oiliness agent is approximately from 0.1 mass% to 30 mass% based on the total amount of the composition, preferably approximately from 0.5 mass% to 10 mass%.

[0049] As the antioxidant, an amine antioxidant, phenolic antioxidant and sulfur antioxidant are usable. The antioxidant may be provided by a single one or a plurality of the above antioxidants.

[0050] Examples of the amine antioxidant include: a monoalkyldiphenylamine compound such as monooctyldiphenylamine and monononyldiphenylamine; a dialkyldiphenylamine compound such as 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine, and 4,4'-dinonyldiphenylamine; a polyalkyldiphenylamine compound such as tetrabutyldiphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine, and tetranonyldiphenylamine; and a naphthylamine compound such as α-naphthylamine, phenyl-α-naphthylamine, butylphenyl-α-naphthylamine, pentylphenyl-α-naphthylamine, hexylphenyl-α-naphthylamine, heptylphenyl-α-naphthylamine, octylphenyl-α-naphthylamine, and nonylphenyl-α-naphthylamine.

[0051] Examples of the phenolic antioxidant include: a monophenolic compound such as 2,6-di-tert-butyl-4-methylphenol and 2,6-di-tert-butyl-4-ethylphenol; and a diphenolic compound such as 4,4'-methylenebis(2,6-di-tert-butylphenol) and 2,2'-methylenebis(4-ethyl-6-tert-butylphenol).

[0052] Examples of the sulfur antioxidant include: a thioterpene compound such as 2,6-di-tert-butyl-4-(4,6-bis(octylthio)-1,3,5-triazine-2-yl amino)phenol and a reactant of phosphorus pentasulfide and pinene; and a dialkylthio dipropionate such as dilauryl thiodipropionate and distearyl thiodipropionate.

[0053] In view of blending effects, a content of the antioxidant is approximately from 0.01 mass% to 10 mass% based on the total amount of the composition, preferably approximately from 0.03 mass% to 5 mass%.

[0054] Examples of the rust inhibitor include metal sulfonate and succinate In view of blending effects, a content of the rust inhibitor is approximately from 0.01 mass% to 10 mass% based on the total amount of the composition, preferably approximately from 0.05 mass% to 5 mass%.

[0055] The metal deactivator is exemplified by benzotriazole and thiadiazole. In view of blending effects, a content of the metal deactivator is approximately from 0.01 mass% to 10 mass% based on the total amount of the composition, preferably approximately from 0.01 mass% to 1 mass%.

[0056] Examples of the antifoaming agent include methyl silicone oil, fluorosilicone oil, and polyacrylate. In view of blending effects, a content of the antifoaming agent is approximately from 0.0005 mass% to 0.01 mass% based on the total amount of the composition.

Examples

Examples 1 to 6, Comparatives 1 to 5

[0057] Metalworking oil compositions were prepared according to blending compositions shown in Table 1 to provide sample oils for evaluation. Each of used components are shown in detail below.

Table 1

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative 1	Comparative 2	Comparative 3	Comparative 4	Comparative 5
Blending Composition (mass%)	Ester 1	48.5	48.7	-	-	-	-	-	-	-	-	-
	Ester 2	45.1	45.1	-	-	-	-	-	-	-	-	-
	Ester 3	-	-	30.0	25.0	25.0	25.0	-	25.0	25.0	-	-
	Mineral oil 1	-	-	63.6	73.6	71.6	63.6	99.0	74.0	69.0	-	-
	Mineral oil 2	-	-	-	-	-	-	-	-	-	99.0	93.6
	Elemental sulfur	0.4	0.2	0.4	0.4	0.4	0.4	-	-	-	-	0.4
	Sulfurized fat and oil	5.0	5.0	5.0	-	2.0	10.0	-	-	-	-	5.0
	Polysulfide	-	-	-	-	-	-	-	-	5.0	-	-
	Overbased Ca sulfonate	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sulfurized fat and oil/Elemental sulfur (mass ratio)		12.5	12.5	12.5	0.0	5.0	25.0	-	-	-	-	12.5
Properties	Flash point (°C)	300	302	258	260	260	256	258	260	198	178	180
	Kinematic viscosity @ 40°C (mm^2/s)	46.7	46.7	37.7	33.7	35.5	45.9	45.8	33.9	33.8	10.1	12.8
Evaluation Results	Level of generation of oily smoke	A	A	A	A	A	A	A	A	B	C	C
	Weld load (N)	7845<	7845<	7845<	7845<	7845<	7845<	1236	1236	7845<	1236	7845<
	Friction coefficient	0.12	0.12	0.14	0.18	0.15	0.13	0.27	0.20	0.18	0.27	0.19

Component (A)

[0058]

Ester 1: pentaerythritol tetraester having a kinematic viscosity at 40 degrees C of 33.5 mm^2/s and a flash point of 280 degrees C
Ester 2: trimethylol propane triester having a kinematic viscosity at 40 degrees C of 49.5 mm^2/s and a flash point of 320 degrees C
Ester 3: trimethylol propane triester having a kinematic viscosity at 40 degrees C of 16.1 mm^2/s and a flash point of 264 degrees C

Mineral Oil

[0059]

Mineral Oil 1: paraffinic mineral oil having a kinematic viscosity at 40 degrees C of 45.1 mm^2/s and a flash point of 266 degrees C
Mineral Oil 2: paraffinic mineral oil having a kinematic viscosity at 40 degrees C of 9.92 mm^2/s and a flash point of 176 degrees C

Component (B)

[0060] Elemental Sulfur: powdery sulfur manufactured by Hosoi Chemical Industry Co., Ltd.

Component (C)

[0061] Sulfurized Oil and Fat: having a kinematic viscosity at 40 degrees C of 705.8 mm^2/s, a flash point of 250 degrees C and a sulfur content of 7 mass%

Other Components

[0062]

Polysulfide: DAILUBE GS-440L manufactured by Dainippon Ink and Chemicals
Overbased Ca Sulfonate: OLOA247E manufactured by Chevron Japan Limited.

Evaluation Method

[0063] A kinematic viscosity at 40 degrees C (in accordance with JIS K 2283) and a flash point (COC method in accordance with JIS K 2265) of each of the sample oils were measured. The sample oils were subjected to an oily smoke generation test, a weld test and a reciprocating friction test under conditions described below. Results are shown in Table 1.

(1) Oily Smoke Generation Test

[0064] 0.2 mL of each of the sample oils was dropped on a steel plate (SPCC-SD) heated at 185 degrees C. A 300-mL glass beaker was placed upside down on the steel plate. After the elapse of one minute, a generation amount of oily smoke was visually observed through a wall of the beaker and a level of the generation of the oily smoke was evaluated based on the following standard.

A: Almost no generation of the oily smoke was observed.
B: A slight generation of the oily smoke was observed.
C: A heavy generation of the oily smoke was observed.

(2) Weld Test

[0065] A weld load (WL: unit N) was measured by Shell four-ball test (in accordance with ASTM D 2783).

(3) Reciprocating Friction Test

[0066]

Tester: F-2100 manufactured by ORIENTEC Co., LTD.
Ball: 3/16 inch SUJ2
Test Plate: SPCC-SD
Sliding Speed: 20 mm/s
Sliding Distance: 2 cm
Load: 3 kgf (29.4N)
Test Temperature: 25 degrees C
Evaluation Item: a friction coefficient at the 30^{th} sliding

Evaluation Results

[0067] It can be understood from the results shown in Table 1 that all of the sample oils in Examples 1 to 6 (i.e., the metalworking oil composition of the invention) generate less oily smoke, bear extremely high weld load to exhibit an excellent wear resistance, and have a low friction coefficient to exhibit an excellent workability. Moreover, it can also be understood that the sample oils containing the component (C) in Examples 1 to 3, 5 and 6 have a fiction coefficient lower than that in Example 4 to exhibit more excellent workability.

[0068] In contrast, since the sample oils of Comparatives 1 to 5 do not contain at least one of predetermined components of the invention, the sample oils of Comparatives 1 to 5 can neither restrain the generation of the oily smoke nor provide excellent wear resistance and workability.

INDUSTRIAL APPLICABILITY

[0069] A metalworking oil composition of the invention is suitably usable in a metalworking such as cutting and grinding.

Claims

1. A metalworking oil composition comprising:

   a component (A) that is an ester of a polyhydric alcohol and a fatty acid; and
   a component (B) that is elemental sulfur, wherein
   the metalworking oil composition has a kinematic viscosity at 40 degrees C in a range from 5 mm^2/s to 70 mm^2/s and a flash point of 200 degrees C or more.

2. The metalworking oil composition according to claim 1, wherein
   the polyhydric alcohol in the component (A) is at least one of neopentylglycol, glycerin, pentaerythritol and trimethylol propane.

3. The metalworking oil composition according to claim 1 or 2, wherein the component (A) has a kinematic viscosity at 40 degrees C in a range from 4 mm^2/s to 69 mm^2/s.

4. The metalworking oil composition according to any one of claims 1 to 3, wherein
   a content of the component (B) is in range from 0.05 mass% to 1 mass% based on a total amount of the composition.

5. The metalworking oil composition according to any one of claims 1 to 4, further comprising:

   a component (C) that is a sulfurized oil and fat.

6. The metalworking oil composition according to claim 5, wherein
   a content of the component (C) is in range from 0.5 mass% to 30 mass% based on the total amount of the composition.

7. The metalworking oil composition according to claim 5 or 6, wherein a blending mass ratio (C)/(B) of the component (C) to the component (B) is in a range from 2 to 75.

8. The metalworking oil composition according to any one of claims 5 to 7, wherein the component (C) has a kinematic viscosity at 40 degrees C in a range from 100 mm^2/s to 2000 mm^2/s.

9. The metalworking oil composition according to any one of claims 1 to 8, wherein the metalworking oil composition is a cutting oil composition.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/083373

A. CLASSIFICATION OF SUBJECT MATTER
C10M169/04(2006.01)i, *C10M105/38*(2006.01)n, *C10M125/06*(2006.01)n, *C10M135/06*(2006.01)n, *C10N20/00*(2006.01)n, *C10N20/02*(2006.01)n, *C10N30/00*(2006.01)n, *C10N30/06*(2006.01)n, *C10N40/20*(2006.01)n, *C10N40/22*(2006.01)n
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C10M169/04, C10M105/38, C10M125/06, C10M135/06, C10N20/00, C10N20/02, C10N30/00, C10N30/06, C10N40/20, C10N40/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2009-197183 A (Idemitsu Kosan Co., Ltd.), 03 September 2009 (03.09.2009), claims 1 to 5; paragraphs [0009], [0010], [0018]; examples 1 to 5 (Family: none)	1-9
A	DeoAdd MSX 18 -- Technical Datasheet, 2006.01. 26	8
A	WO 1995/32267 A1 (Idemitsu Kosan Co., Ltd.), 30 November 1995 (30.11.1995), claims 1 to 8; examples 1 to 15 & US 5726130 A & EP 763590 A1 & CN 1149312 A	1-9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 March 2015 (11.03.15)	24 March 2015 (24.03.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/083373

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-209325 A (Idemitsu Kosan Co., Ltd.), 17 September 2009 (17.09.2009), claims 1 to 5; examples 1 to 13 & WO 2009/110452 A1 & CN 101965393 A	1-9
A	JP 2008-163115 A (Nippon Oil Corp.), 17 July 2008 (17.07.2008), claims 1 to 3; examples 1 to 20 (Family: none)	1-9

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2008163115 A **[0003]**