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(54) GREASE COMPOSITION FOR CONSTANT-VELOCITY JOINT

(57) The present invention provides a grease composition for constant-velocity joints comprising (a) a base oil, (b) a diurea thickener, (c) molybdenum dithiocarbamate, (d) molybdenum dithiophosphate, (e) overbased calcium sulfonate, and (f) neutral zinc sulfonate. The composition of the present invention is excellent in durability at high temperature and vibration suppression.

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Description

Technical Field

[0001] The present invention relates to a grease composition for constant-velocity joints.

Background Art

[0002] Regarding automobiles, front-wheel-drive (FF) vehicles are widely used from the viewpoints of weight reduction for vehicle environmental measures (CO_2 reduction) and securing of a living space, and constant-velocity joints (CVJ), which are essential for power transmission in FF vehicles, are widely used.

[0003] Among CVJ type joints, a plunging type constant-velocity joint rotates at angle, and internal parts of the joint perform complicated rolling and sliding motions. During these motions, the friction of the internal parts generates sliding resistance in the axial direction, and the sliding resistance, if large, may cause vibration and noise.

[0004] Along with a recent increase in the power output of automobile engines, a lubrication condition inside the constant-velocity joint has shifted to a high surface pressure condition. As the surface pressure as the lubrication condition becomes higher, wear tends to occur more easily inside the constant-velocity joint, which may cause problems such as deterioration of durability (anti-flaking property) and increase in vibration.

[0005] In addition, such constant-velocity joints are also required to ensure the durability at high temperature.

[0006] As greases with excellent vibration suppression performance, there have been proposed a grease for constant-velocity joints (see Patent Literature 1) obtained by using a urea grease in combination with additives of molybdenum dithiocarbamate and molybdenum dithiophosphate or in combination with these organomolybdenum compounds mixed with zinc dithiophosphate; and a grease composition for constant-velocity joints comprising a base oil, a urea thickener, molybdenum dithiocarbamate, calcium sulfonate, and thiophosphate (see Patent Literature 2). In addition, in order to meet the recent demand for even more quietness, there have been also proposed a grease composition for constant-velocity joints comprising: a grease composed of a base oil and a urea compound thickener; and a mixture of molybdenum dialkyldithiocarbamate, at least one of molybdenum dialkyldithiophosphate and molybdenum diaryldithiophosphate, and ashless dithiocarbamate or zinc dithiocarbamate (see Patent Literature 3), and a grease composition for constant-velocity joints comprising a base oil, a diurea thickener, molybdenum dialkyldithiocarbamate sulfide, zinc sulfonate, a sulfur-phosphorus extreme pressure agent, and vegetable fat and oil (see Patent Literature 4).

[0007] As a grease prepared also in consideration of durability, there has been proposed a composition for constant-velocity joints comprising a base oil, a thickener, montan wax, zinc sulfonate, and molybdenum dialkyldithiocarbamate sulfide (see Patent Literature 5).

[0008] Thus, the grease compositions for constant-velocity joints in the related art have demonstrated excellent performance in vibration suppression, and their durability at room temperature has also been studied. On the other hand, however, it cannot be said that the problem of durability at high temperature has been sufficiently studied.

Citation List

Patent Literatures

[0009]

Patent Literature 1: Japanese Examined Patent Application Publication No. H05-79280
Patent Literature 2: Japanese Patent Application Publication No. H11-172276
Patent Literature 3: Japanese Patent Application Publication No. 2009-235416
Patent Literature 4: Japanese Patent Application Publication No. 2011-37950
Patent Literature 5: International Publication No. WO2014/0954797

Summary of Invention

Problem to be solved by the invention

[0010] Therefore, the present invention has an object to provide a grease composition excellent in durability even at high temperature and vibration suppression performance.

Means for solution of the problem

[0011]

1. A grease composition for constant-velocity joints comprising:

(a) a base oil;
(b) a diurea thickener;
(c) molybdenum dithiocarbamate;
(d) molybdenum dithiophosphate;
(e) overbased calcium sulfonate; and
(f) neutral zinc sulfonate.

2. The grease composition according to claim 1, wherein a content of the component (f) is 0.1 to 10% by mass based on the total mass of the composition.

3. The grease composition according to claim 1 or 2, wherein a content of the component (f) is 0.5 to 5% by mass based on the total mass of the composition.

4. The grease composition according to any one of claims 1 to 3, wherein a content of the component (f) is 0.8 to 3% by mass based on the total mass of the composition.

5. The grease composition according to any one of claims 1 to 4, wherein a content of the component (e) is 0.1 to 10% by mass based on the total mass of the composition.

6. The grease composition according to any one of claims 1 to 5, wherein a content of the component (e) is 0.2 to 5% by mass based on the total mass of the composition.

7. The grease composition according to any one of claims 1 to 6, wherein a content of the component (e) is 1.2 to 3.5% by mass based on the total mass of the composition.

8. The grease composition according to any one of claims 1 to 7, wherein the component (b) is an aliphatic diurea thickener.

9. A constant-velocity joint in which the grease composition according to any one of claims 1 to 8 is enclosed.

Advantageous Effects of Invention

[0012] According to the present invention, it is possible to provide a grease composition excellent in durability even at high temperature and also excellent in vibration suppression.

Description of Embodiments

(a) Base Oil

[0013] A base oil usable in the composition of the present invention is not particularly limited and a mineral oil and/or a synthetic oil may be used. The synthetic oils include: synthetic hydrocarbon oils such as poly-α-olefin; phenyl ether oils such as pentaphenyl ether, tetraphenyl ether, monoalkyltetraphenyl ether, dialkyltetraphenyl ether, and alkyldiphenyl ether oils; alkylbenzene oils; ester oils such as monoester oils, diester oils, polyol ester oils, and aromatic ester oils; polyglycol oils; silicone oils; fluorine oils; ionic liquids, and the like.

[0014] As the base oil in the present invention, a mineral oil is preferably used from the viewpoint of cost. A base oil may be used in which a mineral oil as a main component is mixed with a synthetic oil.

[0015] In the case where the base oil in the present invention is a mixture oil of a mineral oil and a synthetic oil, the content of the mineral oil based on the total mass of the base oil is preferably 50 to 100% by mass, more preferably 70 to 100% by mass, and further preferably 90 to 100% by mass.

[0016] The kinematic viscosity at 100°C of the base oil in the present invention is preferably 5 to 30 mm^2/s and more preferably 7 to 20 mm^2/s. When the kinematic viscosity is less than 5 mm^2/s, the durability tends to be insufficient because no oil film is formed in a constant-velocity joint. When the kinematic viscosity exceeds 30 mm^2/s, the durability

tends to decrease due to heat generation in the CVJ.

[0017] From the viewpoint of the fluidity, the content of the base oil based on the total mass of the composition is preferably 50 to 100% by mass, more preferably 70 to 100% by mass, and further preferably 80 to 100% by mass.

(b) Diurea Thickener

[0018] The diurea thickener usable in the present invention is expressed by the following formula (1).

$$R^1\text{-NHCONH-}R^2\text{-NHCONH-}R^3 \quad (1)$$

[0019] In the formula, R^2 is a divalent aromatic hydrocarbon group having 6 to 15 carbon atoms. As R^2, tolylene diisocyanate or diphenylmethane diisocyanate are preferable and diphenylmethane diisocyanate is more preferable. R^1 and R^3, which may be the same as or different from each other, are each a linear or branched alkyl group having 6 to 30 carbon atoms, an aryl group having 6 or 7 carbon atoms, or a cyclohexyl group.

[0020] As the diurea compound in the formula (1), an aliphatic diurea compound in which both of R^1 and R^3 are alkyl groups having 6 to 30 carbon atoms. The aliphatic diurea compound may be obtained through a reaction of diisocyanate and aliphatic monoamine.

[0021] In addition, as the diurea compound in the formula (1), an alicyclic aliphatic diurea compound in which one of R^1 and R^3 is an alkyl group having 6 to 30 carbon atoms and the other one is a cyclohexyl group is preferable. Since the alicyclic aliphatic diurea compound can be obtained through a reaction of diisocyanate with alicyclic monoamine and aliphatic monoamine, the alicyclic aliphatic diurea compound in fact is not only an alicyclic aliphatic diurea compound but also a mixture comprising an aliphatic diurea compound and an alicyclic diurea compound.

[0022] In the case where any one of R^1 and R^3 is a cyclohexyl group, the other one is preferably a linear alkyl group having 8 or 18 carbon atoms. In this compound, a ratio of the cyclohexyl group to the total of the cyclohexyl group and the alkyl group is preferably 70 to 100 mol% and more preferably 80 to 100 mol% from the viewpoint of fluidity.

[0023] As the thickener in the present invention, an aliphatic diurea compound is preferable from the viewpoint of durability.

[0024] In particular, preferred is a diurea compound in the formula (1) in which both of R^1 and R^3 are alkyl groups having 8 to 30 carbon atoms and R^2 is diphenylmethane diisocyanate.

[0025] Above all, preferred is a diurea compound in the formula (1) in which both of R^1 and R^3 are linear alkyl groups having 8 or 18 carbon atoms and R2 is diphenylmethane diisocyanate.

[0026] The consistency of the grease composition of the present invention is preferably 250 to 400, more preferably 280 to 370, and further preferably 310 to 340. In the present specification, the term "consistency" refers to a 60-stoke worked penetration. The consistency may be measured in accordance with JIS K2220 7.

[0027] The content of the thickener based on the total mass of the composition is preferably 10% by mass or less, more preferably 5 to 10% by mass, and further preferably 6 to 7% by mass such that the consistency of the grease composition can be set within the above range.

(c) Molybdenum Dithiocarbamate (MoDTC)

[0028] The molybdenum dithiocarbamate usable in the present invention is a general term for organometallic load bearing additives whose metal group is molybdenum, and is generally widely used as an extreme pressure additive. A preferred example of the molybdenum dithiocarbamate can be expressed by the following formula (2).

$$[R^4R^5N\text{-CS-S}]_2\text{-}Mo_2O_mS_n \quad (2)$$

[0029] In the formula, R^4 and R^5, which may be the same as or different from each other, are each independently a liner or branched alkyl group having 1 to 24 carbon atoms or preferably 3 to 18 carbon atoms, m is 0 to 3, n is 4 to 1, and m + n = 4.

[0030] The molybdenum dithiocarbamate includes oil-soluble molybdenum dithiocarbamate (that is, liquid at room temperature (about 25°C)) and oil-insoluble molybdenum dithiocarbamate (that is, solid at room temperature). As the molybdenum dithiocarbamate in the present invention, any of them may be used, but a combination of an oil-soluble molybdenum dithiocarbamate and an oil-insoluble molybdenum dithiocarbamate is preferable because the resultant composition is excellent in durability and heat generation suppression and vibration suppression in the CSJ.

[0031] In the grease composition of the present invention, the content of the component (b) based on the total mass of the composition is preferably 0.1 to 10% by mass, more preferably 0.5 to 5% by mass, and further preferably 1 to 3% by mass from the viewpoint of vibration suppression. In the case where the composition contains an oil-soluble molybdenum dithiocarbamate and an oil-insoluble molybdenum dithiocarbamate, it is preferable to use them in a mass ratio

of the oil-soluble molybdenum dithiocarbamate to the oil-insoluble molybdenum dithiocarbamate of preferably 4:6 to 10:0 and more preferably 6:4 to 8:2 because the resultant composition is excellent in vibration suppression.

(d) Molybdenum Dithiophosphate (MoDTP)

[0032] A preferred example of the molybdenum dithiophosphate used in the present invention is expressed by the following formula (3).

$$[(R^6O)(R^7O)PS\text{-}S]_2Mo_2O_mS_n$$

(In the formula, R^6 and R^7 are each independently an alkyl group having 1 to 24 carbon atoms or an aryl group having 6 to 30 carbon atoms, m is 0 to 3, n is 4 to 1, and m + n = 4.)

[0033] In the grease composition of the present invention, the content of the component (d) based on the total mass of the composition is preferably 0.1% by mass or more, more preferably 0.1 to 5% by mass, and further preferably 0.2 to 2% by mass from the viewpoint of durability.

(e) Overbased Calcium Sulfonate

[0034] The overbased calcium sulfonate used in the present invention is a calcium sulfonate having a base number of 200 mgKOH/g or more. The base number is preferably 300 mgKOH/g or more and more preferably 300 to 500 mgKOH/g from the viewpoint of durability. In the present invention, the base number is a value measured in accordance with JIS K 2501.

[0035] As the component (e), a calcium salt of a sulfonic acid having a lipophilic organic group can be used. Such organic sulfonic acids include: petroleum sulfonic acids obtained by sulfonation of aromatic hydrocarbon components in lubricating oil fractions; synthetic sulfonic acids such as dinonylnaphthalene sulfonic acid and heavy alkylbenzene sulfonic acid; and the like. As the component (e), calcium sulfonates overbased with calcium carbonate are preferable. Above all, an alkyl aromatic calcium sulfonate containing calcium carbonate is preferable.

[0036] The content of the component (e) in the grease composition of the present invention based on the total mass of the composition is preferably 0.1 to 10% by mass, more preferably 0.2 to 5% by mass, and further preferably 1.2 to 3.5% by mass from the viewpoint of durability.

(f) Neutral Zinc Sulfonate

[0037] The neutral zinc sulfonate used in the present invention has a base number of 10 mgKOH/g or less.

[0038] The sulfonic acid constituting the zinc sulfonate is the same as described for the component (e).

[0039] As the neutral zinc sulfonate, zinc dinonylnaphthalene sulfonate is preferable.

[0040] The content of the neutral zinc sulfonate in the grease composition of the present invention based on the total mass of the composition is preferably 0.1 to 10% by mass, more preferably 0.5 to 5% by mass, and further preferably 0.8 to 3% by mass from the viewpoint of durability.

[0041] The total content of the components (e) and (f) based on the total mass of the composition is preferably 0.5 to 5% by mass and more preferably 1 to 3% by mass because excellent heat resistance can be obtained.

[0042] The mass ratio of the component (e) to the component (f) is preferably (e):(f) = 9:1 to 1:9 because excellent durability can be obtained. The mass ratio is more preferably (e):(f) = 8:2 to 3:7 and further preferably (e):(f) = 7:3 to 4:6. In particular, it is preferable that the total content of the components (e) and (f) based on the total mass of the composition be 1 to 3% by mass and the mass ratio of the component (e) to the component (f) be (e):(f) = 7:3 to 4:6, because excellent durability and heat resistance can be obtained.

[0043] The grease composition of the present invention may comprise additives, which are commonly used in greases, as needed. The content of these additives based on the total mass of the grease composition is usually 0.1 to 5% by mass and preferably 0.5 to 3% by mass.

[0044] Examples of these additives include: antioxidants such as amine-based, phenol-based, quinoline-based, sulfur-based, and zinc dithiophosphate antioxidants; rust preventives such as zinc-based, carboxylic acid-based, carboxylate-based (especially dibasic salts of sodium sebacate, sodium azelate, sodium suberate, and the like), and amine-based rust preventives; anti-wear agents such as sulfurized oil and fat, sulfurized olefin, phosphate ester, phosphite ester, and acid phosphate amine salt; oiliness agents such as fatty acid, fatty acid ester, and phosphate ester; and solid lubricants such as graphite, polytetrafluoroethylene (PTFE), and zinc oxide.

[0045] From the viewpoint of heat resistance, the grease composition preferably comprises an antioxidant.

[0046] As the antioxidant, an amine-based antioxidant is preferable and alkyl diphenylamine is more preferable. The content of the antioxidant based on the total mass of the composition is preferably 0.1% by mass or more, more preferably

0.1 to 2% by mass, and further preferably 0.2 to 1% by mass.

[0047] The composition of the present invention preferably comprises only:

(a) a base oil;
(b) a diurea thickener;
(c) molybdenum dithiocarbamate;
(d) molybdenum dithiophosphate;
(e) overbased calcium sulfonate;
(f) neutral zinc sulfonate; and
(g) an antioxidant.

[0048] The contents of the components in the above composition based on the total mass of the composition preferably are: (a) 80 to 100% by mass, (b) 6 to 7% by mass, (c) 1 to 3% by mass, (d) 0.2 to 2% by mass, (e) 0.5 to 3% by mass, (f) 0.8 to 3% by mass, and (g) 0.2 to 1% by mass.

[0049] Alternatively, the composition of the present invention preferably comprises:

(a) a base oil;
(b) an aliphatic diurea thickener;
(c) molybdenum dithiocarbamate;
(d) molybdenum dithiophosphate;
(e) overbased calcium sulfonate containing calcium carbonate and having a base number of 300 mgKOH/g or more;
(f) neutral zinc sulfonate; and
(g) an amine-based antioxidant.

[0050] The contents of the components in the above composition based on the total mass of the composition preferably are: (a) 80 to 100% by mass, (b) 6 to 7% by mass, (c) 1 to 3% by mass, (d) 0.2 to 2% by mass, (e) 0.5 to 3% by mass, (f) 0.8 to 3% by mass, and (g) 0.2 to 1% by mass.

[0051] Instead, the composition of the present invention preferably comprises:

(a) a base oil;
(b) an aliphatic diurea thickener in the above formula (1) in which R^1 and R^3 are both linear alkyl groups having 8 carbon atoms and R^2 is diphenylmethane diisocyanate;
(c) a mixture of oil-soluble molybdenum dithiocarbamate and oil-insoluble molybdenum dithiocarbamate;
(d) molybdenum dithiophosphate;
(e) alkyl aromatic calcium sulfonate containing calcium carbonate and having a base number of 300 to 500 mgKOH/g;
(f) zinc dinonylnaphthalene sulfonate having a base number of 10 mgKOH/g or less; and
(g) alkyl diphenylamine.

[0052] The contents of the components in the above composition based on the total mass of the composition preferably are: (a) 80 to 100% by mass, (b) 6 to 7% by mass, (c) 1 to 3% by mass, (d) 0.2 to 2% by mass, (e) 0.5 to 3% by mass, (f) 0.8 to 3% by mass, and (g) 0.2 to 1% by mass.

[0053] The grease composition of the present invention is applicable to constant-velocity joints. In particular, it is preferable to apply the grease composition to plunging type constant-velocity joints, especially tripod type constant-velocity joints, and double offset type constant-velocity joints, especially inboard side constant-velocity joints, because the grease composition is excellent in durability and vibration suppression.

[Examples]

[1] Production of Grease Compositions in Examples 1 to 7 and Comparative Examples 1 to 4

[0054] In a base oil, 1 mol of 4',4-diphenylmethane diisocyanate and 2 mol of octylamine were reacted, followed by heating and cooling. Thereafter, additives were blended in the ratio specified in Table 1 or 2, and the resultant mixture was kneaded in a three-roll mill to produce a grease composition with a worked penetration of 315. The numerical values in Tables 1 and 2 specify % by mass based on the total mass of the grease composition, unless otherwise specified.

[2] Production of Grease Composition in Comparative Example 5

[0055] A grease composition in Comparative Example 5 was prepared in accordance with the description of Example

C4 in Japanese Patent No. 6470851.

[0056] The components used to prepare the grease compositions are as follows.

<Base Oil>

[0057]

- Mineral oil (kinematic viscosity at 100°C: 12.4 mm^2/s)
- Mineral oil + Synthetic oil: poly-α-olefin (kinematic viscosity at 100°C: 12.0 mm^2/s) <Additives>
- MoDTC (oil-insoluble): molybdenum dithiocarbamate (ADEKA SAKURA-LUBE 600, manufactured by Adeka Corporation)
- MoDTC (oil-insoluble): molybdenum dithiocarbamate (Molyvan A, manufactured by Vanderbilt, used in Comparative Example 5)
- MoDTC (oil soluble): molybdenum dithiocarbamate (ADEKA SAKURA-LUBE 525, manufactured by Adeka Corporation)
- MoDTP: Molybdenum dithiophosphate (ADEKA SAKURA-LUBE 300, manufactured by Adeka Corporation)
- MoDTP: Molybdenum dithiophosphate (Molyvan L, manufactured by Vanderbilt, used in Comparative Example 5)
- Ca sulfonate (overbased): calcium salt of alkyl aromatic sulfonic acid (LUBRIZOL 5283C, manufactured by The Lubrizol Corporation, base number 375 mgKOH/g)
- Zn sulfonate (neutral): zinc dinonylnaphthalene sulfonate (NA-SUL ZS, manufactured by KING INDUSTRIES, base number 5 mgKOH/g)
- Antioxidant

[2] Evaluation of Durability

(1) SRV Test (High Load)

[Test Conditions]

[0058]

Test speed: 11.9 mm/s (frequency: 3.3 Hz, stroke: 1.8 mm)
Test temperature: 90°C
Load: 5.5 GPa
Specimen: Ball (diameter 17.5 mm, SUJ-2)/plate (SUJ-2, surface roughness Rz 0.5 μm)

[Evaluation criteria]

[0059]

◎ (Pass): Friction coefficient of 0.08 or less
○ (Pass): Friction coefficient of more than 0.08 to 0.10 or less
△ (Pass): Friction coefficient of more than 0.10 to 0.12 or less
× (Failure): Occurrence of seizure or friction coefficient of more than 0.12

(2) SRV Test (Low Load)

[Test conditions]

[0060]

Test speed: 2.0 mm/s (frequency: 3.3 Hz, stroke: 0.3 mm)
Test temperature: 95°C
Load: 2.1 GPa
Specimen: Ball (diameter 17.5 mm, SUJ-2)/plate (SUJ-2, surface roughness Rz 5 μm)

[Evaluation Criteria]

[0061]

○ (Pass): Friction coefficient of 0.10 or less
△ (Pass): Friction coefficient of more than 0.10 to 0.14 or less
× (Failure): Occurrence of seizure or friction coefficient of more than 0.14

[2] Evaluation of Vibration Suppression

(1) TE77 test

[0062] A TE77 tester is a vibration friction wear tester under sliding conditions. It has been reported that there is a relationship between vibration caused by a constant-velocity joint as a vibration source and the friction coefficient measured with the TE77 tester under vibration conditions (Japanese Patent Application Publication No. 2010-065194). Therefore, the vibration suppression in a constant-velocity joint was evaluated by using the TE77 tester.

[Test Conditions]

[0063]

Test speed: 16 mm/s (frequency: 10 Hz, stroke: 0.8 mm)
Test temperature: 40°C
Load: 1.2 GPa
Specimen: Ball (17.5 mm diameter, SUJ-2)/Plate (SCM)

[Evaluation criteria]

[0064]

○ (Pass): Friction coefficient of 0.07 or less
△ (Pass): Friction coefficient of more than 0.07 to 0.10 or less
× (Failure): Friction coefficient of more than 0.10

[Comprehensive Evaluation]

[0065]

○ (Pass): The grease composition passed in all of the above test results.
× (Failure): The grease composition failed in one or more of the above test results.

[0066] The results are shown in Tables 1 and 2.

[Table 1]

			Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7
(b) Thickener	Aliphatic Diurea		6.0	6.0	6.0	6.0	6.0	6.0	6.0
(a) Base Oil	Mineral Oil		Balance	Balance	Balance	Balance	Balance	Balance	Balance
	Kinematic Viscosity (mm^2/s @100°C)		12.4	12.4	12.4	12.4	12.4	12.4	12.4
Additives	(c) MoDTC	Oil-Insoluble	0.8	0.8	0.8	0.8	0.8	0.8	-
		Oil-Soluble	1.8	1.8	1.8	1.8	1.8	1.8	2.3
	(d) MoDTP		0.5	0.5	0.5	0.5	0.5	0.5	0.5
	(e) Ca Sulfonate	Overbased	1.6	3.2	1.1	0.9	1.6	0.2	1.6
	(f) Zn Sulfonate	Neutral	1.0	2.8	1.0	0.8	0.6	1.0	1.0
	Antioxidant		0.5	0.5	0.5	0.5	0.5	0.5	0.5
Comprehensive Evaluation			○	○	○	○	○	○	○
Durability	SRV Test @High Load		◎	◎	◎	○	○	◎	○
	SRV Test @Low Load		○	○	○	○	△	△	○
Vibration Suppression	TE77 Test		○	○	△	△	△	△	○

[Table 2]

			Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5
(b) Thickener	Aliphatic Diurea		6.0	6.0	6.0	6.0	-
	Li-OHSt		-	-	-	-	6.0
(a) Base Oil	Mineral Oil		Balance	Balance	Balance	Balance	Balance
	Synthetic Oil		-	-	-	-	
	Kinematic Viscosity (mm^2/s @100°C)		12.4	12.4	12.4	12.4	12.0
Additives	(c) MoDTC	Oil-Insoluble	0.8	0.8	-	0.8	1.5
		Oil-Soluble	1.8	1.8	-	1.8	-
	(d) MoDTP		0.5	0.5	0.5	-	0.5
	(e) Ca Sulfonate	Overbased	-	1.1	1.6	1.6	-
	(f) Zn Sulfonate	Neutral	1.0	-	1.0	1.0	3.0
	Antioxidant		0.5	0.5	0.5	0.5	0.3
Comprehensive Evaluation			×	×	×	×	×
Durability	SRV Test @High Load		×	△	×	×	×
	SRV Test @Low Load		△	×	△	○	×
Vibration Suppression	TE77 Test		△	×	△	△	×

Claims

1. A grease composition for constant-velocity joints comprising:

(a) a base oil;
(b) a diurea thickener;
(c) molybdenum dithiocarbamate;
(d) molybdenum dithiophosphate;
(e) overbased calcium sulfonate; and
(f) neutral zinc sulfonate.

2. The grease composition according to claim 1, wherein a content of the component (f) is 0.1 to 10% by mass based on the total mass of the composition.

3. The grease composition according to claim 1 or 2, wherein a content of the component (f) is 0.5 to 5% by mass based on the total mass of the composition.

4. The grease composition according to any one of claims 1 to 3, wherein a content of the component (f) is 0.8 to 3% by mass based on the total mass of the composition.

5. The grease composition according to any one of claims 1 to 4, wherein a content of the component (e) is 0.1 to 10% by mass based on the total mass of the composition.

6. The grease composition according to any one of claims 1 to 5, wherein a content of the component (e) is 0.2 to 5%

by mass based on the total mass of the composition.

7. The grease composition according to any one of claims 1 to 6, wherein a content of the component (e) is 1.2 to 3.5% by mass based on the total mass of the composition.

8. The grease composition according to any one of claims 1 to 7, wherein the component (b) is an aliphatic diurea thickener.

9. A constant-velocity joint in which the grease composition according to any one of claims 1 to 8 is enclosed.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/044030

A. CLASSIFICATION OF SUBJECT MATTER
C10M 141/02(2006.01)i; C10M 141/08(2006.01)i; C10M 141/10(2006.01)i; C10M 141/12(2006.01)i; C10M 169/06(2006.01)i; C10N 30/00(2006.01)n; C10N 40/02(2006.01)n; C10N 50/10(2006.01)n
FI: C10M141/08; C10M141/02; C10M141/10; C10M141/12; C10M169/06; C10N30:00 Z; C10N40:02; C10N50: 10
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)
C10M141/02; C10M141/08; C10M141/10; C10M141/12; C10M169/06; C10N30/00; C10N40/02; C10N50/10
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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.
Y	JP 2007-302761 A (SHOWA SHELL SEKIYU KK.) 22 November 2007 (2007-11-22) paragraphs [0004], [0017], [0022]-[0024], [0026], table 1, examples 1-5	1-9
Y	JP 2004-108403 A (KOYO SEIKO CO., LTD.) 08 April 2004 (2004-04-08) paragraphs [0018]-[0019], [0035], [0060], examples	1-9
Y	WO 2006/049280 A1 (THK CO., LTD.) 11 May 2006 (2006-05-11) paragraphs [0027]-[0028], [0031], examples	1-9
Y	JP 2017-115104 A (KYODO YUSHI CO., LTD.) 29 June 2017 (2017-06-29) paragraph [0009]	1-9

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

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"&" document member of the same patent family

Date of the actual completion of the international search 04 February 2021 (04.02.2021)	Date of mailing of the international search report 16 February 2021 (16.02.2021)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/044030

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WO 2006/049280 A1	11 May 2006	US 2007/0265177 A1 paragraphs [0036]-[0037], [0040], examples	
JP 2017-115104 A	29 Jun. 2017	US 2017/0183603 A1 paragraphs [0033]-[0036]	

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REFERENCES CITED IN THE DESCRIPTION

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- JP 6470851 B **[0055]**
- JP 2010065194 A **[0062]**