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(71) Applicant (for all designated States except US): **SHELL INTERNATIONAL RESEARCH MAATSCHAPPIJ B.V.** [NL/NL]; Carel van Bylandtlaan 30, NL-2596 HR The Hague (NL).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **TANAKA, Keiji** [JP/JP]; 4052-2 Nakatsu, Aikawa-Cyo, Aikou-Gun, Kana-gawa 243-0303 (JP).

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(54) Title: UREA GREASE COMPOSITION

(57) Abstract: A urea grease composition comprising any one of the following components (1), (2) and (3) in a mineral oil or a synthetic oil or a mixture thereof: (1) a mixture of compound (a) and compound (b) comprising from 20 to 80 mol% of compound (a) relative to the total of compound (a) and compound (b); (2) a mixture of compound (c) and the mixture of (1); (3) the compound (c), the compounds (a), (b) and (c) being represented by the following formulas (a), (b) and (c), respectively: (a) R¹NHCONHR²NHCONHR¹, (b) R³NHCONHR²NHCONHR³, and (c) R¹NHCONHR²NHCONHR³ wherein R² represents a diphenylmethane group; R¹ represents an alkyl group having 8 carbon atoms; and R³ represents a hydrocarbon group having 14 to 20 carbon atoms whose content of unsaturated components is 20 mol% or more.



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UREA GREASE COMPOSITION

Field of the Invention

This invention relates to an improvement in urea grease compositions, and in particular relates to those that are suitable for use at lubrication points where rolling or sliding occurs and where one side is composed of a metal and the other side is composed of a material other than a metal.

Background of the Invention

In recent years, the use of polymer materials such as resins and rubbers for parts not only in the automobile industry but also in various kinds of industrial machines has become noteworthy, these being parts of materials other than metals for various reasons such as lighter weights, cost reductions, less friction, wear resistance, quietness or recycling. But many new issues have arisen as the constituent elements of the parts have diversified, and various technical improvements are being undertaken.

For example, there are lubrication points such as the sliding parts of movable elements in electric door mirrors of cars or telescopic steering columns, various sliding parts such as the rack guides of R & P steering, the sliding parts of drive transmission gears, actuators and air cylinders in steering gear, linear guides or ball screw retainers of machine tools or bearing retainers, the sliding parts of crane booms, and also resin gear parts in acoustical equipment such as radio cassette players, video tape recorders and CD players, the resin gear parts in office automation equipment such as printers, photocopiers and fax machines, and the sliding

parts of various kinds of electrical switches, which function through contact between polymer materials other than metallic materials such as resin and resin or resin and metal or rubber and metal.

5 In the prior art, in the field of lubrication, because virtually all the constituents of machines have been of metallic materials, there has been a long and broad history of research on friction and wear of pairs of metals such as iron, aluminium, alloys thereof, brass
10 and bronze, and the prior art is replete with profound experience and knowledge.

 For example, it is well known that extreme pressure agents and anti-wear agents which contain elements such as phosphorus and sulphur are effective against friction
15 and wear for pairs of metals, and that these additives form a skin by positively giving rise to a chemical reaction with the surface of the metals, thereby exhibiting functions such as reducing friction and wear and preventing seizing. This prior art has been widely
20 applied in engine oils and gear oils as well as in high performance industrial lubricating oils and greases.

 However, notwithstanding the fact that the history of lubrication technology for different materials, such as resin pairs, resins and metals or rubbers and metals
25 has been short, the use of these has, as mentioned above, been expanding and diversifying in recent years, but the situation at present is such that no art has yet been offered that completely satisfies the various requirements regarding their lubricating greases.

30 For example, if the techniques using the phosphorus or sulphur based additives which are effective against friction and wear of metal pairs are applied to the lubrication points of, for example, resin and metal or

rubber and metal, virtually no effect in reducing friction such as is obtained for metal pairs is obtained. On the contrary, cases where the friction and anti-wear performance may deteriorate and life of the machines parts may be shortened are by no means rare.

This is considered to be because, compared with metals, the surface activity of polymer materials such as resins is very weak, so that there is virtually no reaction with organic based additives such as phosphorus or sulphur based additives on the sliding surfaces, and given that adsorption is also weak, the effect on friction and wear is poor, and so the action of reducing friction is weak. Also, if they are used in environments where temperatures inevitably rise, the active phosphorus and sulphur in these additives may permeate inside the resin parts, which may give rise to perverse actions such as the occurrence of cracks or brittleness, or even the promotion of friction and wear.

In order to mitigate friction between different materials such as resin pairs or resin and metal, a technique has been proposed (Japanese Laid-open Patent 2006-89575) whereby it is possible satisfactorily to reduce friction between lubrication elements by incorporating a lubricating oil base oil, a thickener, polytetrafluoroethylene particles and boron nitride particles. Also, a technique has been disclosed (Japanese Laid-open Patent 63-309591 (1988)) whereby compositions comprised of base oils such as polyoxyalkylenes or ether derivatives thereof and lithium soap-based thickeners together with alkenyl succinic acid-based rust inhibitors have no detrimental effect on the materials of these rubber parts and yet have excellent lubrication characteristics in respect of metals and improve

corrosion resistance. Further improvements are anticipated.

This invention is intended to improve urea grease compositions, in particular so that at lubrication points where rolling or sliding occurs and where members are of differing materials, such as resin and resin, resin and metal or rubber and metal, such that at least one member is constituted of a material other than a metal, friction is mitigated and improved lubricity is obtained.

Having previously carried out research and investigations at the physical chemistry level into grease lubrication behaviour of greases in polymer materials other than metals, the inventor has arrived at this invention after discovering that, by virtue of the viscoelasticity and extreme properties possessed by the specified urea-based thickener which forms a grease, it may be considered that, at the boundary between opposing materials such as resin and resin, or resin and metal or rubber and metal, the physical elastic film inherent in this grease forms to a satisfactory degree and interacts with the very weak electrical force occurring on the surface of the opposing polymer materials, so that it is possible more reliably to form and maintain a lubricating film containing a grease, thus obtaining a reduction in friction and good lubricity.

Summary of the Invention

According to the present invention there is provided a urea grease composition comprising any one of the following components (1), (2) and (3) in a mineral oil or a synthetic oil or a mixture thereof:

- (1) a mixture of compound (a) and compound (b) comprising from 20 to 80 mol% of compound (a) relative to the total of compound (a) and compound (b);

(2) a mixture of compound (c) and the mixture of (1);
(3) the compound (c),
the compounds (a), (b) and (c) being represented by the
following formulae (a), (b) and (c), respectively:

- 5 (a) $R^1NHCONHR^2NHCONHR^1$,
(b) $R^3NHCONHR^2NHCONHR^3$, and
(c) $R^1NHCONHR^2NHCONHR^3$

wherein R^2 represents a diphenylmethane group; R^1
represents an alkyl group having 8 carbon atoms; and R^3
10 represents a hydrocarbon group having 14 to 20 carbon
atoms whose content of unsaturated components is 20 mol%
or more.

These urea thickeners (1), (2) and (3) may be used
in an amount of approximately 2 to 30% by mass relative
15 to a mineral oil, synthetic oil or mixture of such oils.
If these urea grease compositions are used at lubrication
points where rolling or sliding occurs in machine parts
where one member is composed of a metal and the other
member is composed of a material other than a metal, a
20 greater effect can be exhibited, and further if they are
used in machine parts where the material other than a
metal is composed of a polymer material such as a resin
or a rubber, the effect is considerable.

According to this invention, it is possible to use
25 over a wide range a grease composition by which friction
is further reduced and good lubricity is obtained at
lubrication points where rolling or sliding occurs
between members where at least one of the opposing
members is composed of a polymer material such as a
30 resin.

Detailed Description of the Invention

The urea compounds which are the thickeners in this
invention are described by the following General Formulae



wherein R^2 denotes a diphenylmethane group, R^1 an alkyl group of 8 carbon atoms and R^3 a hydrocarbon group of 14 to 20 carbon atoms, including those where the unsaturated component is 20 mol% or more. In cases where the number of carbon atoms in the aforementioned R^1 is other than 8, and in cases where the number of carbon atoms in R^3 is outside the range of 14 to 20, it is difficult to exhibit the grease's structural viscosity to a suitable degree, and in cases where the amount of the unsaturated component present in the hydrocarbon group R^3 of 14 to 20 carbon atoms is less than 20 mol%, the polar properties of the urea thickener will become weak and it may be considered that the electrochemical action which interacts with the very weak electrical forces occurring on the surface with the polymer material will not work effectively, so that the effect of reducing friction is slight.

Urea grease thickener (1) uses a mixture of the aforementioned compounds (a) and (b). The amount of compound (a) is in the range of from 20 to 80 mol% relative to the sum of compound (a) and compound (b). In this case, if the proportions of the aforementioned compounds (a) and (b) exceed the range 80 : 20 to 20 : 80 mol%, the dropping point will fall and heat-resisting properties may be insufficient, so that the effect of reducing friction may not be apparent.

Instances of further mixing the aforementioned compound (c) with the aforementioned urea thickener (1) may be used as urea thickener (2).

Also, it is possible to use the aforementioned compound (c) alone as urea thickener (3).

Any of the aforementioned urea thickeners (1), (2) and (3) may be made into urea grease compositions by incorporating them in a base oil being a mineral oil, a synthetic oil or a mixture thereof.

It is preferable that the amount of such urea thickener in the base oil is in the range of from 2 to 30% by mass relative to the total amount of the composition. If the amount of urea thickener is less than 2% by mass, the thickening effect will be small, and the grease will become too soft and the flow resistance will increase, and there will be concern that it will leak. If the amount exceeds 30% by mass, the grease will become too hard, the flow resistance will increase and the friction torque may rise, and given that the intervention properties will also decrease, sufficient lubrication effect may not be achieved. The cost will also rise.

The base oil in this invention is one which may ordinarily be used as the base oil of a lubricating oil or as the base oil of a grease, and there are no special restrictions. As examples mention may be made of mineral oils, synthetic oils, animal and plant oils, and mixtures thereof.

In particular it is possible to use, singly or as mixtures, base oils which belong to Group I, Group II, Group III, Group IV and so on of the API (American Petroleum Institute) base oil categories.

Group I base oils include, for example, paraffinic mineral oils obtained by a suitable combination of refining processes such as solvent refining, hydrotreating, and dewaxing in respect of lubricating oil

fractions obtained by atmospheric distillation of crude oil.

Group II base oils include, for example, paraffinic mineral oils obtained by a suitable combination of refining processes such as hydrotreating and dewaxing in respect of lubricating oil fractions obtained by atmospheric distillation of crude oil. Group II base oils refined by hydrotreating methods such as the Gulf Company method have a total sulphur content of less than 10 ppm and an aromatic content of not more than 5% and so are suitable for use in this invention.

Group III base oils and Group II+ base oils include paraffinic mineral oils manufactured by a high degree of hydrotreating in respect of lubricating oil fractions obtained by atmospheric distillation of crude oil, base oils refined by the Isodewax process which dewaxes and substitutes the wax produced by the dewaxing process with isoparaffins, and base oils refined by the Mobil wax isomerisation process. These too are suitable for use in this invention.

Specific examples of synthetic oils include polyolefins, polyoxyalkylene glycols such as polyethylene glycol or polypropylene glycol, esters such as di-2-ethylhexyl sebacate or di-2-ethylhexyl adipate, polyol esters such as trimethylolpropane esters or pentaerythritol esters, perfluoroalkyl ethers, silicone oils, polyphenyl ethers, and so on.

The aforementioned polyolefins include polymers of various olefins or hydrides thereof. Any olefin may be used, and as examples mention may be made of ethylene, propylene, butene and α -olefins with five or more carbon atoms. In the manufacture of polyolefins, one of the aforementioned olefins may be used singly or two or more

may be used in combination. Particularly suitable are the polyolefins called poly- α -olefins (PAO). These are base oils of Group IV.

5 GTLs (gas to liquid oils) synthesised by the Fischer-Tropsch method of converting natural gas to liquid fuel have a very low sulphur content and aromatic content compared with mineral oil base oils refined from crude oil and have a very high paraffin constituent ratio, and so have excellent oxidative stability, and
10 because they also have extremely small evaporation losses, they are suitable as base oils for this invention.

Also, as typical examples of animal and plant oils mention may be made of castor oil and rapeseed oil.

15 The various kinds of oil mentioned above may be used as base oils either alone or as mixtures, but the aforementioned instances are mere examples and the invention is not limited by these.

Also, for the additives of the urea grease
20 composition of this invention, it is possible further to add as appropriate other additives such as anti-oxidants, rust inhibitors, oiliness agents, extreme pressure agents, anti-wear agents, solid lubricants, metal deactivators, polymers and so on.

25 Examples of anti-oxidants include 2,6-di-*t*-butyl-4-methylphenol, 2,6-di-*t*-butylparacresol, P,P'-dioctyldiphenylamine, N-phenyl- α -naphthylamine, and phenothiazines.

30 Rust inhibitors include paraffin oxide, carboxylic acid metal salts, sulphonic acid metal salts, carboxylic acid esters, sulphonic acid esters, salicylic acid esters, succinic acid esters, sorbitan esters and various amine salts.

Oiliness agents, extreme pressure agents and anti-wear agents include for example sulphurised zinc dialkyldithiophosphates, sulphurised zinc diaryldithiophosphates, sulphurised zinc dialkyldithiocarbamates, sulphurised zinc diaryldithiocarbamates, sulphurised molybdenum dialkyldithiophosphates, sulphurised molybdenum diaryldithiophosphates, sulphurised molybdenum dialkyldithiocarbamates, sulphurised molybdenum diaryldithiocarbamates, organomolybdenum complexes, sulphurised olefins, triphenylphosphates, triphenylphosphorothionates, tricresylphosphates, other phosphate esters, sulphurised oils and fats, and various fatty acids.

Solid lubricants include, for example, molybdenum disulphide, graphite, boron nitride, melamine cyanurate, PTFE (polytetrafluoroethylene), tungsten disulphide, mica and graphite fluoride.

Metal deactivators include N,N'-disalicylidene-1,2-diaminopropane, benzotriazoles, benzoimidazoles, benzothiazoles, and thiadiazoles, and so on.

As examples of polymers mention may be made of polybutenes, polyisobutenes, polyisobutylenes, polyisoprenes and polymethacrylates.

The additional additives mentioned above are all given as examples and they are in no way limited to these.

In this invention, it is possible to reduce friction and obtain good lubricity at lubrication points where rolling or sliding appears between opposing members where at least one is constituted of materials other than metals such as polymer materials such as resins. Consequently, the opposing member where one side is a

material other than a metal can be iron, copper, aluminium or other metal and alloys thereof as well as polymer materials such as resins, rubbers and glasses, or non-polar materials such as ceramics, and these can be widely used with no special restrictions.

Also, it is possible to use any ordinary plastics or engineering plastics for the aforementioned resin materials, and as examples mention may be made of polyamides, polyacetals, polycarbonates, polyethylene terephthalates, polybutylene terephthalates, polybutylene naphthalates, polyphenylene ethers, polyphenylene sulphides, fluorinated resins, polyacrylates, polyamidimides, polyether imides, polyether ether ketones, polysulphones, polyether sulphones, polyimides, polystyrenes, polyethylenes, polypropylenes, phenol resins, AS resins, ABS resins, AES resins, AAS resins, ACS resins, MBS resins, polyvinyl chloride resins, epoxy resins, diallyl phthalate resins, polyester resins, methacryl resins, and ABS/polycarbonate alloys, and the rubbers include acrylic rubbers, acrylonitrile butadiene rubbers, isoprene rubbers, urethane rubbers, ethylene-propylene rubbers, epichlorohydrin rubbers, chloroprene rubbers, silicone rubbers, styrene-butadiene rubbers, butadiene rubbers, fluorine rubbers and polyisobutylene, but they are not limited to these.

The invention is further explained in detail below by means of examples and comparative examples, but the invention is in no way limited by these examples.

Examples

The abbreviations for the raw material constituents of the thickeners and the lubricating base oils used in the examples and comparative examples are as follows.

1. The diisocyanate raw material of the urea thickener was diphenylmethane-4,4'-diisocyanate (MDI) (molecular weight 250.26).

2. The amine raw materials of the urea thickener were as follows.

Amine A: Industrial octylamine of average molecular weight 128.7 with saturated hydrocarbon groups of 8 carbons as the main constituent (not less than 90%).

Amine B: Industrial dodecylamine of average molecular weight 184.6 with saturated hydrocarbon groups of 12 carbons as the main constituent (not less than 90%).

Amine C: Industrial stearylamine of average molecular weight 258.7 with saturated hydrocarbon groups of 18 carbons as the main constituent (not less than 90%).

Amine D: Industrial beef tallow amine of average molecular weight 255.7 with a mixture of unsaturated and saturated hydrocarbon groups of 14 to 18 carbons (unsaturated/saturated : approx. 43/57).

Amine E: Industrial oleylamine of average molecular weight 255.0 with unsaturated hydrocarbon groups of 18 carbons as the main constituent (not less than 70%).

3. Base oils

Base oil A: a mineral oil with kinetic viscosity at 40°C of 101.1 mm²/s.

Base oil B: a poly- α -olefin oil with kinetic viscosity at 40°C of 31.2 mm²/s.

Base oil C: a highly refined oil with kinetic viscosity at 40°C of 47.08 mm²/s, kinetic viscosity at 100°C of 8.04 mm²/s, viscosity index of 146, %CA of less than 1, %CN of 11.9, and %CP of not less than 85.

Examples 1 to 10

Using the proportions shown in Tables 1 to 4, the full amount of the MDI and half the amount of the base oil (single base oil or a mixture) were put in a grease kettle, and heated to approximately 50°C. Once the MDI had dissolved, the requisite amount of amine A (octylamine) was gradually added as a dispersion in a quarter of the base oil, and strong agitation was effected. After about 10 minutes, amine E (oleylamine) dissolved and dispersed in the other quarter of the base oil was added and agitation was continued.

The temperature of the contents of the grease kettle rose by virtue of the reaction of the diisocyanate and amines, but it was heated to 170°C and kept at this temperature for approximately 30 minutes to allow the reaction to complete. After cooling to room temperature, the urea grease compositions were obtained through treatment in a three-roll mill.

Example 11

Using the proportions shown in Table 3, the full amount of the MDI and half the amount of the base oil A were put in a grease kettle, and heated to approximately 50°C. Once the MDI had dissolved, the requisite amount of amine A (octylamine) was gradually added as a dispersion in a quarter of base oil A, and strong agitation was effected. After about 10 minutes, a mixed solution of amine C (stearylamine) and amine E (oleylamine) dissolved and dispersed in the other quarter of base oil A was added and agitation was continued.

The temperature of the contents of the grease kettle rose by virtue of the reaction of the diisocyanate and amines, but it was heated to 170°C and kept at this temperature for approximately 30 minutes to allow the

reaction to complete. After cooling to room temperature, the urea grease compositions were obtained through treatment in a three-roll mill.

Example 12

5 Using the proportions shown in Table 3, the full amount of the MDI and half the amount of the base oil A were put in a grease kettle, and heated to approximately 50°C. Once the MDI had dissolved, the requisite amount of amine A (octylamine) was gradually added as a dispersion
10 in a quarter of base oil A, and strong agitation was effected. After about 10 minutes, amine D (beef tallow amine) dissolved and dispersed in the other quarter of base oil A was added and agitation was continued.

 The temperature of the contents of the grease kettle
15 rose by virtue of the reaction of the diisocyanate and amines, but it was heated to 170°C and kept at this temperature for approximately 30 minutes to allow the reaction to complete. After cooling to room temperature, the urea grease compositions were obtained through
20 treatment in a three-roll mill.

Comparative Examples 1 to 5

 The various urea grease compositions were obtained by the same method as for the aforementioned examples, by reacting MDI and various amines, in the proportions shown
25 in Table 4, in a base oil (a single base oil or a mixture).

 The following measurements and experiments were carried out in order to compare the characteristics and performance of the examples and comparative examples.

30 1. Penetration: Measured in accordance with JIS K2220-7.

 2. Dropping point: Measured in accordance with JIS K2220-8.

3. Kinetic viscosity of base oil: Measured in accordance with JIS K2283.

4. Friction tests: Bowden type friction tests were carried out. In other words, the friction coefficient between a resin (test material 1b) and a paired material other than a resin (test material 1a) was measured under the following test conditions using a Bowden friction test rig.

(1) Test material 1a: Material - steel S45C and copper alloy ALBC2.

Dimensions - pin shape of outside diameter 5.0 mm and length 24 mm, the pin tip being a semi-spheroid of $r = 2.5$ mm, and the contact surface was machined to a flat area of approximately 1.0 mm diameter.

(2) Test material 1b: Material - polyamide resin (66 Nylon/Amilan made by Toray Ltd.) and polyacetal resin (Delrin 500P made by Dupont Ltd.)

Dimensions - plate of length 200 mm, width 52 mm.

(3) Temperature: 25°C

(4) Sliding rate: 1.0 mm/s

(5) Load: 870 g

(6) Surface pressure of contact surfaces: 10 MPa

A Bowden friction test was carried out on all the examples and on all the comparative examples for a polyamide resin and steel pairing, and tests were carried out selectively for a polyacetal resin and copper alloy pairing.

Results

The results are as shown in Tables 1 to 4.

Discussion

The urea grease compositions of Examples 1 to 8 and 10 to 12 all displayed the grease characteristics of a semi-solid and the penetration displayed moderate hardness values in the range from 212 to 258, while the dropping point was also of a satisfactory nature at not less than 250°C. Also, in the case of Example 9, although there was little thickener, the penetration, at 368, was in the range of the number 0 of the NLGI penetration grades (softness numbers for penetration) and whilst the dropping point was somewhat lower at 221°C, it was still a satisfactory grease of semi-solid state. Further, in the case of Examples 1 to 12, the friction coefficients between a polyamide resin and steel in the Bowden friction test were in the range of from 0.051 to 0.068, and the friction coefficients between a polyacetal resin and copper alloy were uniformly low at 0.050 to 0.066, so that it was evident in particular that a satisfactory lubrication performance was displayed between various resins and materials other than resins such as alloys and steel.

On the other hand, the grease compositions of Comparative Examples 1 to 5 all displayed the grease characteristics of a semi-solid, and the penetration displayed hardness values in the range of from 254 to 321, while the dropping point was also of a satisfactory nature at 241°C or not less than 250°C, but the friction coefficients between a polyamide resin and steel in the Bowden friction test were in the range of from 0.087 to 0.124, and the friction coefficients between a polyacetal resin and copper alloy were uniformly high at 0.097 to 0.131, so that it was evident that they were all inferior to the examples according to the present invention as

regards the lubrication state between various resins and materials other than resins such as alloys or steel, and that no effect in improving lubrication performance was obtained.

- 5 From these results it can be seen that the urea grease composition of this invention exhibits satisfactory lubrication performance by suitable disposition of the terminal groups of the urea thickener and without the use of special additives.

Table 1

Example	1	2	3	4
(1) Urea compound (mass %)				
MDI	5.42	4.94	4.94	4.94
Amine A C8	4.58	3.04	3.04	3.04
Amine B C12	-	-	-	-
Amine C C18	-	-	-	-
Amine D C14-18, C14'-18'	-	-	-	-
Amine E C16'-18'	2.00	4.02	4.02	4.02
Amount of thickener (mass %)	12.0	12.0	12.0	12.0
Ratio of urea compounds (a), (b), (c) (mass %)	(a)/ (b)= 75/25	(a)/ (b)= 50/50	(a)/ (b)= 50/50	(a)/ (b)= 50/50
Unsaturated component of R ² in general formulae (mol%)	85.5	85.5	85.5	85.5
(2) Base oil (mass %)				
Base oil A	88.0	88.0	-	-
Base oil B	-	-	88.0	-
Base oil C	-	-	-	88.0
Total	100.00	100.00	100.00	100.00
Penetration	248	243	258	255
Dropping point	>250	>250	>250	>250
Kinetic viscosity of base oil (40°C, mm ² /sec)	101.1	101.1	31.24	47.08
Bowden friction test				
(1) Polyamide resin-steel	0.067	0.066	0.062	0.063
(2) Polyacetal resin-copper alloy	0.066	0.064	-	0.063

Table 2

Example	5	6	7	8
(1) Urea compound (mass %)				
MDI	4.45	4.75	4.85	4.85
Amine A C8	1.53	2.46	2.75	2.75
Amine B C12	-	-	-	-
Amine C C18	-	-	-	-
Amine D C14-18, C14'-18'	-	-	-	-
Amine E C16'-18'	6.02	4.79	4.40	4.40
Amount of thickener (mass %)	12.0	12.0	12.0	12.0
Ratio of urea compounds (a), (b), (c) (mass %)	(a) / (b) = 25/75	(c) = 10 0	(a) / (b) / (c) = 25/25/ 50	(a) / (b) / (c) = 25/25/ 50
Unsaturated component of R ² in general formulae (mol%)	85.5	85.5	85.5	85.5
(2) Base oil (mass %)				
Base oil A	88.0	88.0	88.0	30.0
Base oil B	-	-	-	30.0
Base oil C	-	-	-	28.0
Total	100.00	100.00	100.00	100.00
Penetration	244	230	236	251
Dropping point	>250	>250	>250	>250
Kinetic viscosity of base oil (40°C, mm ² /sec)	101.1	101.1	101.1	51.6
Bowden friction test				
(1) Polyamide resin-steel	0.059	0.051	0.055	0.056
(2) Polyacetal resin- copper alloy	-	0.050	0.054	-

Table 3

Example	9	10	11	12
(1) Urea compound (mass %)				
MDI	2.06	7.20	4.92	4.93
Amine A C8	1.27	4.45	3.04	3.04
Amine B C12	-	-	-	-
Amine C C18	-	-	2.63	-
Amine D C14-18, C14'-18'	-	-	-	4.03
Amine E C16'-18'	1.67	5.85	1.41	-
Amount of thickener (mass %)	5.0	17.5	12.0	12.0
Ratio of urea compounds (a), (b), (c) (mass %)	(a) / (b) = 50/50	(a) / (b) = 50/50	(a) / (b) = 50/50	(a) / (b) = 50/50
Unsaturated component of R ² in general formulae (mol%)	85.5	85.5	29.5	42.5
(2) Base oil (mass %)				
Base oil A	50.0	-	88.0	88.0
Base oil B	45.0	42.5	-	-
Base oil C	-	40.0	-	-
Total	100.00	100.00	100.00	100.00
Penetration	368	212	257	255
Dropping point	221	>250	>250	>250
Kinetic viscosity of base oil (40°C, mm ² /sec)	55.25	38.44	101.1	101.1
Bowden friction test				
(1) Polyamide resin-steel	0.059	0.061	0.068	0.063
(2) Polyacetal resin- copper alloy	-	0.063	-	-

Table 4

Comparative Example	1	2	3	4	5
(1) Urea compound (mass %)					
MDI	5.92	5.38	4.92	4.92	4.40
Amine A C8	6.08	3.04	3.04	3.04	-
Amine B C12	-	3.58	-	-	3.58
Amine C C18	-	-	4.04	-	-
Amine D C14-18, C14'-18'	-	-	-	1.01	-
Amine E C16'-18'	-	-	-	3.03	4.02
Amount of thickener (mass %)	12.0	12.0	12.0	12.0	12.0
Ratio of urea compounds (a), (b), (c) (mass %)	-	-	-	-	-
Unsaturated component of R ² in general formulae (mol%)	0	0	0	10.7	85.5
(2) Base oil (mass %)					
Base oil A	88.0	45.0	88.0	88.0	45.0
Base oil B	-	43.0	-	-	-
Base oil C	-	-	-	-	43.0
Total	100.00	100.00	100.00	100.00	100.00
Penetration	277	316	256	254	321
Dropping point	>250	>250	>250	>250	241
Kinetic viscosity of base oil (40°C, mm ² /sec)	101.1	54.28	101.1	101.1	68.09
Bowden friction test					
(1) Polyamide resin-steel	0.124	0.122	0.091	0.087	0.101
(2) Polyacetal resin-copper alloy	0.119	0.131	-	-	0.097

C L A I M S

1. A urea grease composition comprising any one of the following components (1), (2) and (3) in a mineral oil or a synthetic oil or a mixture thereof:

(1) a mixture of compound (a) and compound (b)

5 comprising from 20 to 80 mol% of compound (a) relative to the total of compound (a) and compound (b);

(2) a mixture of compound (c) and the mixture of (1);

(3) the compound (c),

10 the compounds (a), (b) and (c) being represented by the following formulae (a), (b) and (c), respectively:

(a) $R^1NHCONHR^2NHCONHR^1$,

(b) $R^3NHCONHR^2NHCONHR^3$, and

(c) $R^1NHCONHR^2NHCONHR^3$

15 wherein R^2 represents a diphenylmethane group; R^1 represents an alkyl group having 8 carbon atoms; and R^3 represents a hydrocarbon group having 14 to 20 carbon atoms whose content of unsaturated components is 20 mol% or more.

20 2. A urea grease composition according to claim 1, wherein any one of the components (1), (2) and (3) is present in the composition at a level in the range of from 2 to 30 % by mass relative to the total composition.

25 3. A urea grease composition according to claim 1 or 2, which is used at a lubricating point where rolling or sliding occurs, wherein one side of the lubricating point is composed of a metal and the other side of the lubricating point is composed of a material other than a metal.

4. A urea grease composition according to claim 1 or 2,
which is used at a lubricating point where rolling or
sliding occurs, wherein one side of the lubricating point
is composed of a material other than a metal and the
5 other side of the lubricating point is also composed of a
material other than a metal.

5. A urea grease composition according to claim 3 or 4,
where the material other than a metal of the lubricating
point is a polymer material such as a resin or a rubber.

10 6. A urea grease composition according to any of Claims
1 to 5 wherein the composition comprises one or more
additives.

7. Use of a urea grease composition according to any of
Claims 1 to 6 for reducing friction.

15 8. Use of a urea grease composition according to any of
Claims 1 to 6 for improving lubricity.

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2009/067263

A. CLASSIFICATION OF SUBJECT MATTER

INV. C10M115/08 C10M169/02

ADD. C10N30/06 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)

C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPO-Internal, COMPENDEX, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2004/053032 A1 (SHELL INT RESEARCH [NL]) 24 June 2004 (2004-06-24) page 9, line 4 - page 11, line 30 claims; examples	1-8
X	EP 1 889 897 A1 (JTEKT CORP [JP]) 20 February 2008 (2008-02-20) paragraph [0009] paragraph [0016] claims; examples	1-8

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"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

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Date of the actual completion of the international search

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Elflein, Eleonore

INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 1 602 710 A1 (NSK LTD [JP]; NSK STEERING SYS CO LTD [JP]) 7 December 2005 (2005-12-07) paragraph [0002] paragraph [0005] paragraph [0014] - paragraph [0021] figure 13; examples paragraph [0068] - paragraph [0071] claims -----	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2009/067263

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