The invention relates to a food-grade high-temperature lubricant, more particularly a high-temperature oil and a high-temperature grease, comprising the following components:

a) at least one oil selected from a trimellitic ester or a mixture of different trimellitic esters, alkylation aromatics, preferably an aliphatically substituted naphthalene, or estolides;

b) a hydrogenated or fully hydrogenated polystyrene or a mixture of hydrogenated or fully hydrogenated polystyrene; and

c) additives individually or in combination.

In the case of the high-temperature grease, a thickener is added.
Figure 1

25% polymer content

- Residue dissolubility after complete aging 250°C/72 h
- Residue dissolubility after complete aging 220°C/120 h
HIGH TEMPERATURE LUBRICANT FOR THE FOOD INDUSTRY

[0001] The invention relates to a high-temperature lubricant, more particularly a high-temperature oil based on an aromatic ester, such as a trimellitic ester and mixtures of different trimellitic esters, heteroaromatics, estolides, and a fully hydrogenated or hydrogenated polyisobutylene or a mixture thereof. The high-temperature lubricant may, furthermore, be a high-temperature grease, if a thickener is added to the components stated above. The invention further relates to the use of these high-temperature lubricants for lubricating equipment used in the processing of foods.

[0002] In addition to the lubricating activity, the lubricants are required to fulfill a great many other functions: they must cool, reduce friction, wear, and force transmission, protect against corrosion, and at the same time exhibit a sealing effect.

[0003] Conventional lubricants are unsuitable for high-temperature applications because at high temperatures they are destroyed, through oxidation reactions and/or thermal decomposition reactions and polymerizations, for example, and their lubricating properties are severely restricted. In the case of decomposition reactions, the lubricant is split into volatile components of low molecular mass. Evaporation of these components causes unwanted changes in viscosity, loss of oil, and excessive vapor formation. The result of this is a loss in the lubricating activity. Polymerization as well causes the lubricants to lose their lubricating activity, owing to the formation of insoluble polymerization products.

[0004] Removing these contaminants increases maintenance efforts and produces chemical wastes which have to be disposed of, which is costly and inconvenient. On account of the increased cleaning and maintenance efforts, downtimes are increased. Overall, the use of unsuitable lubricants in high-temperature applications results in higher costs, since the equipment is fouled and there is a greater demand for lubricants. Furthermore, product quality is lowered.

[0005] Base oils used for high-temperature applications are often synthetic esters, since these esters possess very good oxidative, hydrolytic, and thermal stability.

[0006] In order to meet the diverse requirements in high-temperature applications, the lubricants are required to exhibit qualities including high stability, low coefficients of friction, and high wear resistances. In order to be able to ensure uniform lubrication even at high temperatures, there must be a liquid lubricating film maintained between metal parts throughout the processing operation. At the maximum processing temperature, therefore, the lubricant must undergo little evaporation, form little residue, and form cracking residues to as small an extent as possible.

[0007] High processing temperatures often occur in the context of use in food processing, as when cooking, baking, boiling, roasting, stewing, sterilizing, frying, and steaming. Diverse forms of equipment are employed in these operations. The lubrication of this equipment requires lubricants that are resistant to high temperature.

[0008] The base oils for lubricating equipment for the processing of foods are subject to particular requirements in relation to their environmental compatibility and toxicity. Fundamentally, a food-grade lubricant ought to have H1 suitability if the lubricant can come into contact, directly or indirectly, with foods, beverages, and confections. The preferred areas of application in the food industry include chains in baking ovens, and other high-temperature applications, and also ancillary transport means, more particularly trolleys and their bearings.

[0009] These lubricants are subject to statutory provisions, such as certification according to NSF/H1 or NSF/H2.

[0010] The grading “H1” is to be met by lubricants which are in “incidental food contact”, meaning that they are in occasional, technically unavoidable contact with foods. Intended or lasting contact, however, must be ruled out even in the case where “H1” lubricants are used. An “H2” classification can be achieved by lubricants which are not toxic and not carcinogenic. With the use of “H2” lubricants, nevertheless, any contact with the food must be ruled out.

[0011] A disadvantage of the known food-grade lubricants which are used in the high-temperature sector is that they often lack satisfactory technical performance. Hence, while the food-grade lubricants used to date do possess good oxidation resistance and an acceptable pour point, their residue behavior after full evaporation does not conform to the exacting requirements required in high-temperature applications. The cracking residues which develop form deposits which, after a certain time, have to be removed again. In general, the operation of the plant must be stopped and the residue must be detached or the components must be replaced. There is therefore a demand for a high-temperature lubricant with which the evaporation of individual base oil constituents of the oil is greatly reduced and for which the lubricating activity is not lost at a constantly relatively high temperature over a long time period.

[0012] The object of the present invention is to provide a high-temperature oil and a high-temperature grease that meet the standards of an NSF/H1 lubricant and, furthermore, have satisfactory tribological properties. In particular, the lubricant is to exhibit good lubricating activity at high temperature over a long time period. Furthermore, the cracking residues formed are not to exhibit “varnishing”, but are instead to be redissoluble by means of fresh oil. Furthermore, the high-temperature lubricant is to have good stability to hydrolysis, be resistant to corrosion and to wear, and to possess good oxidation resistance and low-temperature behavior adapted to the requirements.

[0013] This object is achieved in accordance with the invention by means of a food-grade, high-temperature oil comprising the following components:

a) 93.9 to 45 wt % of at least one oil selected from the group consisting of a mixture of trimellitic acid tri(iso-C10) esters (1) and trimellitic acid tri(iso-C15) esters (2), the mixing ratio of (1) to (2) being 99:1 to 1:99, alkylaromatics, preferably aliphatically substituted naphthalene, estolides;

b) 6 to 45 wt % of a polymer, specifically a hydrogenated or fully hydrogenated polyisobutylene or a mixture of hydrogenated or fully hydrogenated polyisobutylene;

c) 0.1 to 5 wt % of additives, individually or in combination, selected from the group consisting of anticorrosion additives, antioxidants, antiwear additives, UV stabilizers, inorganic or organic solid lubricants.

[0014] The food-grade high-temperature grease of the invention comprises the following components:

a) 91.9 to 30 wt % of at least one oil selected from the group consisting of a mixture of trimellitic acid tri(iso-C10) esters (1) and trimellitic acid tri(iso-C15) esters (2), the mixing ratio of (1) to (2) being 99:1 to 1:99, alkylaromatics, preferably aliphatically substituted naphthalene, estolides;
b) 6 to 45 wt % of a polymer, selected from the group consisting of a hydrogenated or fully hydrogenated polyisobutylene or a mixture of hydrogenated or fully hydrogenated polyisobutylene;

[0015] c) 0.1 to 5 wt % of additives, individually or in combination, selected from the group consisting of anticorrosion additives, antioxidant, antwear additives, UV stabilizers, inorganic or organic solid lubricants, and

[0016] d) 2 to 20 wt % of thickener.

[0017] Surprisingly it has been found that the high-temperature oil of the invention and the high-temperature grease of the invention are not only suitable for IT classification but also display outstanding functionality. Hence the high-temperature oil or high-temperature grease of the invention exhibits high thermal stability in combination with long lifetime and good lubricating properties.

[0018] The high-temperature oil of the invention and the high-temperature grease of the invention comprise, as an ester compound, a trimellitic ester of a mixture of different trimellitic esters, the alcohol group of the ester being a linear or branched alkyl group having 8 to 16 carbon atoms. Depending on the choice of the aromatic ester it is possible to adapt the properties of the lubricant, for example the viscosity, the viscosity/temperature behavior, the oxidation resistance, and residue characteristics.

[0019] According to one particularly preferred embodiment of the invention, the aromatic ester comprises a sterically hindered alcohol as alcohol component, preferably an alcohol having 8 to 16 carbon atoms, more particularly 10 to 13 carbon atoms, more particularly trimellitic acid tri(iso-C₆H₄) esters (1) and trimellitic acid tri(iso-C₆H₄) esters (2). The mixing ratio of (1) to (2) is 99:1 to 1:99; with particular preference, the mixing ratio (1):(2) is 87:12.

[0020] The high-temperature oil or grease of the invention may comprise a second oil which comprises an aromatic. An aromatic for the purposes of the invention is a monocyclic, bicyclic or tricyclic ring system having four to fifteen carbon atoms, the monocyclic ring system being aromatic, or at least one of the rings in a bicyclic or tricyclic ring system being aromatic. Preference is given to using a bicyclic ring system, having preferably 10 carbon atoms.

[0021] The aromatic is preferably substituted by one or more aliphatic substituents. With particular preference the aromatic is substituted by one to four aliphatic substituents and more particularly by two or three aliphatic substituents.

[0022] An alkyl group in accordance with the invention is a saturated aliphatic hydrocarbon group having 1 to 30, preferably 3 to 20, more preferably 4 to 17, and more particularly 6 to 15 carbon atoms. An alkyl group may be linear or branched and is optionally substituted by one or more of the substituents stated above.

[0023] Practical experiments have shown that mixtures of differently substituted naphthalenes, i.e. mixtures of naphthalenes which have a different degree of substitution and different aliphatic substituents, are particularly suitable. By varying the mixture composition it is possible in this case for the properties, such as the viscosity, for example, of the high-temperature lubricant to be adjusted in a particularly simple way. Aliphatically substituted naphthalenes, furthermore, are notable for outstanding dissolution properties and high thermooxidative stability.

[0024] The viscosity, measured at 40° C., of the aliphatically substituted naphthalene is preferably 50 to 600 mm²/s, more preferably 30 to 300 mm²/s.

[0025] Furthermore, estolides can also be used as component a). Preferred viscosities measured at 40° C., are between 30 and 500 mm²/sec. Particularly preferred are viscosities from 30 to 140 mm²/sec.

[0026] By estolides are meant ester compounds which are prepared with acidic or enzymatic catalysts from fatty acids, preferably oleic acid, or dicarboxylic acids. In this reaction, the acid function attacks the double bond of an adjacent fatty acid molecule, to form an ester compound of higher molecular mass. The terminal acid group is then conventionally esterified with an alcohol, preferably 2-ethylhexanol, and the remaining double bonds are subsequently hydrogenated or esterified with carboxylic acid-acetic acid for example. Other alcohols such as isooamyl alcohol or Guerbet alcohols, for example, are likewise conceivable for the esterification of the terminal acid group.

[0027] Further estolides may also be synthesized via a condensation of hydroxy carboxylic acids, examples being derivatives of oleic acid or of stearic acid. The chain lengths of the hydroxy carboxylic acids or unsaturated acids used may range from C₆ to C₄₆. The acids may contain further functional groups, e.g., amines, ethers, sulfur-containing groups. Also conceivable, furthermore, is esterification with alpha-olefins or bifurcenes.

[0028] The high-temperature oil or grease of the invention further comprises a polyisobutylene. Through appropriate selection of the polyisobutylene, especially with regard to degree of hydrogenation and molecular weight, it is possible to influence the properties of the oil and grease of the invention in a desired way—for example, its kinematic viscosity. The polyisobutylene may be used in hydrogenated or fully hydrogenated form, and a mixture of hydrogenated and fully hydrogenated polyisobutylene may also be used. Preference is given to using fully hydrogenated polyisobutylene. The polyisobutylene is present in an amount of 6 to 45 wt % in the composition, with preferably 10 to 45 wt % and more particularly 15 to 45 wt % being used.

[0029] According to a further preferred embodiment, the polyisobutylene has a number-average molecular weight of 115 to 10 000 g/mol, preferably of 160 to 5000 g/mol.

[0030] The high-temperature oil or grease of the invention further comprises from 0.1 to 5 wt % of additives, which are used individually or in combination and are selected from the group consisting of anticorrosion additives, antioxidants, antwear additives, UV stabilizers, inorganic or organic solid lubricants.

[0031] The high-temperature grease of the invention further comprises a thickener. The thickener in the high-temperature grease of the invention in the lubricant composition is either a reaction product of a diisocyanate, preferably 2,4-diisocyanatotoluene, 2,6-diisocyanatotoluene, 4,4’-diisocyanatodiphenylmethane, 2,4’-diisocyanatophenylmethane, 4,4’-diisocyanatobiphenyl, 4,4’-diisocyanato-3,3’-dimethylphenyl, 4,4’-diisocyanato-3,3’-dimethylphenylmethane, which may be used individually or in combination, with an amine of the general formula R₂–N–R’, or with a diamine of the general formula R₂–N–R–NR’, where R is an aryl, alkyl or alkylene radical having 2 to 22 carbon atoms and R’ identically or differently is a hydrocarbon or an alkyl, alkylene or aryl radical, or with mixtures of amines and diamines, or is selected from Al complex soaps, simple metal soaps of the elements of the first and second main groups of the Periodic
Table, metal complex soaps of the elements of the first and second main groups of the Periodic Table, bentonites, sulfonates, silicates, Aerosil, polyimides or PTFE, or a mixture of the aforesaid thickeners.

In order to comply with the statutory provisions governing the use of lubricants for lubricating equipment for the processing of foods, it is useful for the additives employed to have a H1 classification.

The addition of antioxidants may reduce or even prevent oxidation of the oil or grease of the invention, especially in the course of its use. In the event of oxidation, unwanted free radicals may form and, consequently, decomposition reactions may occur to an increased extent in the high-temperature lubricant. The addition of antioxidants stabilizes the high-temperature oil or grease.

Antioxidants particularly suitable in accordance with the invention are the following food-grade compounds: Diaromatic amines, phenolic resins, thiophenolic resins, phosphites, butylated hydroxytoluene, butylated hydroxyanisole, phenyl-alpha-naphthylamine, phenyl-beta-naphthylamine, octylated/butylated diphenylamine, di-alpha-tocopherol, di-tert-butylphenyl, benzenepropanoic acid and mixtures of these components.

Commercially available food-grade additives are:

IRGANOX® 1010 (benzenepropanoic acid, 3,5-bis(1,1-dimethyl)-4-hydroxy-2,2-bis[3-[3,5-bis(1,1-dimethyl)-4-hydroxyphenyl]-1-oxoproxy][methyl]-1,3-propanediyl] ester);
IRGANOX® L06 (alkylated phenyl-alpha-naphthylamine or N-phenyl-(1,1,3,3-tetramethylbutyl)-1-naphthalencarboxylic acid;)
IRGANOX® L01 (dioctylated diphenylamine);
IRGANOX® L57 (mixture of alkylated diphenylamines);
IRGANOX® L06;
IRGANOX® L115;
IRGANOX® L150 (mixture of aminic and phenolic antioxidants with high molecular weight);
IRGANOX® L64 (mixture of mono- and dialkyl-buty/ocetyl-diphenylamine);
IRGANOX® 1035; (mixture consisting of thiadiethylene bis(3,5-di-tert-butyl-4-hydroxydiphenylmethane);
IRGANOX® 1010;
IRGANOX® L101 (mixture consisting of tetraakis [methylene-3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate][methane];
IRGANOX® L109 (benzenepropanoic acid, 3,5-bis(1,1-dimethyl)-4-hydroxy-1,6-hexanediyl ester);
IRGANOX® L57;
IRGANOX® L109;
IRGALUBE® TPT;
IRGALUBE® 101 (liquid DL-alpha-tocopherol, 2H-1-benzopyran-6-ol, 3,4-dihydro-2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl); IRGAFO® 168 (mixture containing tris(2,4-di-tert-butylphenyl) phosphate);
ADDITIN® RC7130 (N-phenyl-1-naphthylamine);
Na-LUBE® A0142 (liquid, diphenylamine-based antioxidant);
VANLUBE® N61 (mixture of octylated and butylated diphenylamine or benzeneamine, N-phenyl, reaction product of 2,4-trimethylpentane and 2-methylpropane);
VANLUBE® PCX (mixture containing 1-hydroxy-4-methyl-2,6-di-tert-butylbenzene; hexamethylene bis(3,5-di-tert-butyl-4-hydroxydiphenylmethane); Irgafos® 168; reaction product of N-phenylbenzeneamine with 2,4,4-trimethylpentene; tridiethylene bis(3,5-di-tert-butyl-4-hydroxydiphenylmethane); bis(4,1,3,5-trimethylhexadecyl)phenylamine; 3,5-bis(1,1-dimethyl)ethyl4-hydroxy ester; thiocarbamide 2,1-ethanediyl ester).

The high-temperature oil or grease may, furthermore, comprise anticorrosion additives, metal deactivators or ion complexing agents. These include triazoles, imidazolines, N-methylglycine (sarcosine), benzo triazole derivatives, NN-bis(2-ethylhexyl)-ar-methyl-1H-benzotriazole-1-methanamine; methyl-N(1-oxo-9-octadecyl)glycine, a mixture of phosphoric acid and mono- and dioisocarbonyl esters reacted with (C12,14)-alkylamines, mixture of phosphoric acid and mono- and disiocarbonyl esters reacted with terti alkylamine and primary (C12,14)-amines, dodecanic acid, triphenyl phosphorothionate, and amine phosphates. Commercially available additives are the following:

IRGAMET® 39, IRGACOR® DSS G, Amine O; SARKOSY® O (Ciba), COBRA® 122, CUVAN® 303, VANLUBE® 9123, CI-426, CI-426EP, CI-429, and CI-498.

Further conceivable antiwear additives are amines, amine phosphites, phosphites, triphosphites, phosphorothionates, and mixtures of these components. The commercially available antiwear additives include IRGALUBE® TPPT, IRGALUBE® 250, IRGALUBE® 349, IRGALUBE® 211 and ADDITIN® RC7160 Liq 3960, FIRC-SHUN® FG 1505 and FG 1506, NA-LUBE® KR-015FG, LUBECOND®, FLUORO® FG, SYNOX® 40D, ACHESON® FGA 1820 and ACHESON® FGA 1810.

The oil or grease may further comprise solid lubricants with food suitability such as PTFE, BN, Na pyrophosphate, Zn oxide, Mg oxide, Zn pyrophosphate, Na thiosulfate, Mg carbonate, Ca carbonate, Ca stearate, Zn sulfide, or a mixture thereof.

Practical experiments have shown that the high-temperature oil or grease of the invention exhibits no decomposition phenomena or negligible decomposition phenomena up to a temperature of 250°C. This means that less than 10% of the lubricant undergoes decomposition.

As a further food-grade base oil, the high-temperature oil or grease of the invention may comprise an oil preferably selected from the group consisting of mineral oil, aliphatic carboxylic and dicarboxylic esters, fatty acid triglycerides, and/or poly-alpha-olefins.

In one particular embodiment, the high-temperature oil or grease of the invention comprises an estolide, the main constituents of the estolide preferably being obtained by chemical or enzymatic processes on the basis of natural oils from the group of sunflower oil, rapeseed oil, castor oil, linseed oil, corn oil, safflower oil, soybean oil, linseed oil, groundnut oil, "I.equerelle" oil, palm oil, olive oil, or mixtures of the aforesaid oils.
In comparison to comparative examples 1 to 3, examples to 10 below show the outstanding properties of the food-grade high-temperature oil of the invention in relation to dissolubility when different components a) are used as oil.

EXAMPLES 8 TO 10

Composition of the oils (all figures are in wt %)

<table>
<thead>
<tr>
<th></th>
<th>Inventive example 8</th>
<th>Comparative example 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimellitate 1</td>
<td>70.0</td>
<td>52.65</td>
</tr>
<tr>
<td>Trimellitate 2</td>
<td>0.7</td>
<td>44.0</td>
</tr>
<tr>
<td>Hydrogenated PIB</td>
<td>25.95</td>
<td>6.0</td>
</tr>
<tr>
<td>Alkylated naphthalene</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Phenolic antioxidant</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Anticorrosive agent</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Dissolubility</td>
<td>very good (4)</td>
<td>poor (1)</td>
</tr>
</tbody>
</table>

Production of a High-Temperature Oil of the Invention for the Food Industry

Two trimellitic esters are charged to a stirred vessel. At 100°C, with stirring, the polyisobutylene and optionally a further oil are added. The mixture is subsequently stirred for 1 hour in order to give a homogeneous mixture. The antioxidant agents and the antioxidant are added to the vessel with stirring at 60°C. After about 1 hour, the completed oil can be dispensed into the intended containers.

Composition of the High-Temperature Oils

Table 1 shows the compositions of the high-temperature oils and the redissolubility of the oil residue after complete evaporation of the oil, as a function of the amount of polyisobutylene added.

<table>
<thead>
<tr>
<th></th>
<th>Ex. 1</th>
<th>Ex. 2</th>
<th>Ex. 3</th>
<th>Ex. 4</th>
<th>Ex. 5</th>
<th>Ex. 6</th>
<th>Ex. 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully hydrogenated polyisobutylene</td>
<td>24.41</td>
<td>22.0</td>
<td>19.53</td>
<td>17.1</td>
<td>14.63</td>
<td>12.2</td>
<td>9.76</td>
</tr>
<tr>
<td>C10 branched trimellitic ester (1)</td>
<td>71.52</td>
<td>73.91</td>
<td>76.35</td>
<td>78.76</td>
<td>81.2</td>
<td>83.61</td>
<td>86.02</td>
</tr>
<tr>
<td>C11 branched trimellitic ester (2)</td>
<td>0.72</td>
<td>0.74</td>
<td>0.77</td>
<td>0.79</td>
<td>0.82</td>
<td>0.84</td>
<td>0.87</td>
</tr>
<tr>
<td>Viscosity 40°C, mm²/s</td>
<td>426.8</td>
<td>375.5</td>
<td>328.7</td>
<td>292.7</td>
<td>259</td>
<td>228.8</td>
<td>202.8</td>
</tr>
<tr>
<td>Dissolubility of residue after 72 h/250°C, (varnish)</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

4 = residue very dissoluble after full evaporation
3 = residue readily dissoluble after full evaporation
2 = residue partially dissoluble after full evaporation
1 = residue not dissoluble after full evaporation

All figures are in % by weight. The balance to 100 wt % is made up by the addition of antioxidant, especially amine and/or phenolic antioxidants, anticorrosion additives, antiwear additives EP/AW, metal deactivators.

These results show that up to a kinematic viscosity at 40°C of 292.7 mm²/s, it is possible for residues formed after full evaporation to be redissolved using fresh oil. The composition according to example 1 shows the best properties in terms of viscosity and redissolubility.
Table 5 provides an exemplary description below of the food-grade high-temperature greases of the invention.

<table>
<thead>
<tr>
<th>Table 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. 11</td>
</tr>
<tr>
<td>Trimeellitate 1</td>
</tr>
<tr>
<td>Trimeellitate 2</td>
</tr>
<tr>
<td>Estolide 1</td>
</tr>
<tr>
<td>Estolide 2</td>
</tr>
<tr>
<td>Alkylated naphthalene</td>
</tr>
<tr>
<td>Fully hydrogenated PIB</td>
</tr>
<tr>
<td>Antioxidant</td>
</tr>
<tr>
<td>Thickener</td>
</tr>
</tbody>
</table>

[0055] To determine the redissolubility, the samples were conditioned at 250°C for 72 hours. The residue was redissolved using the respective base oil of the grease specimen. In all examples the redissolubility was good.

[0056] The thickeners used in examples 11 to 16 are complex Li (Ex. 11 and 12), complex Al (Ex. 13), bentonite (Ex. 14), simple Ca (Ex. 15), simple Li (Ex. 16), and urea (Ex. 17).

[0057] Furthermore, the redissolubility of the oil residue after full evaporation at two different temperatures (220°C / 120 h) and (250°C / 72 h) was investigated as a function of the mixing ratio of the two trimeellitate esters (1) and (2). The concentration of the fully hydrogenated PIB was kept constant at 25 wt%. It was found, surprisingly, that for both temperatures the redissolubility is dependent on the mixing ratio of the two trimeellitate esters. At a mixing ratio of 0.02, i.e. with a high fraction of the iso-C₁₃ trimeellitate ester over the iso-C₁₀ ester, the residue is not redissolvable with fresh oil, but the dissolubility increases significantly as the amount of iso-C₁₀ trimeellitate ester goes up, as is evident from FIG. 1. A saturation point is reached at a mixing ratio of 1:1. The values are also shown in table 6.

<table>
<thead>
<tr>
<th>Table 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
</tr>
<tr>
<td>iso-C₁₀/iso-C₁₃</td>
</tr>
<tr>
<td>iso-C₁₀/iso-C₁₃</td>
</tr>
<tr>
<td>0.02</td>
</tr>
<tr>
<td>0.33</td>
</tr>
<tr>
<td>1.00</td>
</tr>
</tbody>
</table>

[0058] It was possible to show, accordingly, that the dissolubility of the residues is dependent not only on the degree of hydrogenation of the polyisobutylene but also on the mixing ratio of the two esters. Both esters must be used in combination in order to ensure the H1 capacity of the high-temperature oil. The mixing ratios are freely selectable, with the preferred ranges beginning from a 1:1 mixture. The particularly preferred ratio is 87.12 (iso-C₁₀/iso-C₁₃). [0059] The above-described food-grade high-temperature oils and high-temperature greases can also be used for lubricating equipment subject to limitations similar to those relating to the requirements imposed on the lubricants. Included here are the cosmetic and pharmaceutical industries and also the animal feed industry.

[0060] With regard to the food industry, the high-temperature lubricants of the invention can be used for the lubrication of equipment in food processing, as hydraulic oils for the food industry, for transport chains and control chains in the food industry, and also for devices for the processing of cereal, flour, and animal feed, and also for baking ovens.

[0061] For certain applications, use in the form of a spray is advantageous.

1. A food-grade high-temperature oil comprising the following components:
   a) 93.9 to 45 wt % of at least one oil selected from the group consisting of a mixture of trimellitic acid tri(iso-C₁₃) esters (1) and trimellitic acid tri(iso-C₁₃) esters (2), the mixing ratio of (1) to (2) being 99:1 to 1:99, alkyloalkanes, estolides;
   b) 6 to 45 wt % of a polymer, selected from the group consisting of a hydrogenated or fully hydrogenated polyisobutylene or a mixture of hydrogenated or fully hydrogenated polyisobutylene;
   c) 0.1 to 5 wt % of additives, individually or in combination, selected from the group consisting of anticorrosion additives, antioxidants, antiairwear additives, UV stabilizers, inorganic or organic solid lubricants.

2. A food-grade high-temperature grease comprising the following components:
   a) 91.9 to 30 wt % of at least one oil selected from the group consisting of a mixture of trimellitic acid tri(iso-C₁₃) esters (1) and trimellitic acid tri(iso-C₁₃) esters (2), the mixing ratio of (1) to (2) being 99:1 to 1:99, alkyloalkanes, estolides;
   b) 6 to 45 wt % of a polymer, selected from the group consisting of a hydrogenated or fully hydrogenated polyisobutylene or a mixture of hydrogenated or fully hydrogenated polyisobutylene;
   c) 0.1 to 5 wt % of additives, individually or in combination, selected from the group consisting of anticorrosion additives, antioxidants, antiairwear additives, UV stabilizers, inorganic or organic solid lubricants, and
   d) 2 to 20 wt % of thickener.
3. The high-temperature oil or grease as claimed in claim 1, wherein the alkylaromatic compound is an aliphatically substituted naphthalene.

4. The high-temperature oil or grease as claimed in claim 1, wherein component a) comprises as a further food-grade oil a compound selected from the group consisting of mineral oil, aliphatic carboxylic and dicarboxylic esters, fatty acid triglycerides, and poly-alpha-olefins.

5. The high-temperature grease as claimed in claim 2, wherein component d) is selected from the group consisting of urea, Al complex soaps, simple metal soaps of the elements of the first and second main groups of the Periodic Table, metal complex soaps of the elements of the first and second main groups of the Periodic Table, bentonites, sulfonates, silicates, Aerosil, polyimides, PTFE or a mixture of the aforesaid thickeners.

6. The use of the high-temperature oil and/or high-temperature grease as claimed in claim 1 for the lubrication of equipment in food processing, as a hydraulic oil in the food industry, for transport chains and control chains, for devices for the processing of cereal, flour, and animal feed, and also in baking ovens.

7. The use of the high-temperature oil as claimed in claim 1 as oil in the form of a spray.

8. The high-temperature oil or grease as claimed in claim 2, wherein the alkylaromatic compound is an aliphatically substituted naphthalene.

9. The high-temperature oil or grease as claimed in claim 2, wherein component a) comprises as a further food-grade oil a compound selected from the group consisting of mineral oil, aliphatic carboxylic and dicarboxylic esters, fatty acid triglycerides, and poly-alpha-olefins.

10. The use of the high-temperature oil and/or high-temperature grease as claimed in claim 2 for the lubrication of equipment in food processing, as a hydraulic oil in the food industry, for transport chains and control chains, for devices for the processing of cereal, flour, and animal feed, and also in baking ovens.

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