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

(11) EP 2 248 878 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.11.2010 Bulletin 2010/45

(51) Int Cl.:
C10M 141/08 *(2006.01)* *C10N 10/12* *(2006.01)*
C10N 40/25 *(2006.01)*

(21) Application number: **09159279.0**

(22) Date of filing: **01.05.2009**

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

(71) Applicant: **Shell Internationale Research Maatschappij B.V.**
2596 HR Den Haag (NL)

(72) Inventors:
- **Cocco, Claudia**
  21107 Hamburg (DE)
- **Ojeda Garcia Jose Luis**
  21107 Hamburg (DE)

(74) Representative: **Matthezing, Robert Maarten**
Shell International B.V.
Intellectual Property Services
P.O. Box 384
2501 CJ The Hague (NL)

(54) Lubricating composition

(57) The present invention provides a lubricating composition comprising:
- a base oil;
- a molybdenum-containing compound; and
- a fatty acid amide.

Furthermore, the present invention provides the use of the lubricating composition, in particular in a gas engine, in order to improve friction reduction properties (in particular according to the SRV test of DIN 51834-1).

EP 2 248 878 A1

Description

[0001] The present invention relates to a lubricating composition, in particular for use as a gas engine oil.

[0002] In recent years the specifications for finished lubricants have required the lubricant formulators to develop lubricants having, among others, improved friction reducing properties with the purpose of meeting energy saving (or "fuel economy") trends.

[0003] As an example, US 2007/0265176 discloses to this end the use of a lubricating oil composition comprising a major amount of a base oil having a viscosity index greater than 80, a kinematic viscosity at 100°C of from 2 to 50 mm^2/s, containing 90 wt.% or more saturates, having less than 5 ppm sulphur and wherein the base oil is derived from a waxy feed, and a minor amount of: (a) a polyol ester of an aliphatic carboxylic acid having 12 to 24 carbon atoms; and (b) an oil soluble or oil dispersible molybdenum compound.

[0004] Furthermore, US 2008/0015127 discloses the use of a lubricating composition comprising a base oil, a friction modifier and a dispersant wherein the lubricating composition comprises less than 325 ppm boron.

[0005] US 6 562 765 discloses an engine oil comprising a base oil and at least 450 ppm molybdenum of a friction modifier composition containing a specific oxymolybdenum complex and a specific molybdenum dithiocarbamate.

[0006] It is an object of the present invention to improve the friction reduction properties of lubricating compositions, especially for use in a gas engine.

[0007] It is another object of the present invention to provide alternative lubricating compositions for use in a gas engine.

[0008] One or more of the above or other objects can be obtained by the present invention by providing a lubricating composition comprising:

- a base oil;
- a molybdenum-containing compound; and
- a fatty acid amides.

[0009] It has now surprisingly been found according to the present invention that the lubricating compositions according to the present invention may exhibit improved friction reduction properties.

[0010] There are no particular limitations regarding the base oil used in lubricating composition according to the present invention, and various conventional mineral oils, synthetic oils as well as naturally derived esters such as vegetable oils may be conveniently used.

[0011] The base oil used in the present invention may conveniently comprise mixtures of one or more mineral oils and/or one or more synthetic oils; thus, according to the present invention, the term "base oil" may refer to a mixture containing more than one base oil. Mineral oils include liquid petroleum oils and solvent-treated or acid-treated mineral lubricating oil of the paraffinic, naphthenic, or mixed paraffinic/naphthenic type which may be further refined by hydrofinishing processes and/or dewaxing.

[0012] Suitable base oils for use in the lubricating oil composition of the present invention are Group I-III mineral base oils, Group IV poly-alpha olefins (PAOs), Group I-III Fischer-Tropsch derived base oils and mixtures thereof.

[0013] By "Group I", "Group II", "Group III" and "Group IV" base oils in the present invention are meant lubricating oil base oils according to the definitions of American Petroleum Institute (API) for category III and IV. These API categories are defined in API Publication 1509, 15th Edition, Appendix E, April 2002.

[0014] Fischer-Tropsch derived base oils are known in the art. By the term "Fischer-Tropsch derived" is meant that a base oil is, or is derived from, a synthesis product of a Fischer-Tropsch process. A Fischer-Tropsch derived base oil may also be referred to as a GTL (Gas-To-Liquids) base oil. Suitable Fischer-Tropsch derived base oils that may be conveniently used as the base oil in the lubricating composition of the present invention are those as for example disclosed in EP 0 776 959, EP 0 668 342, WO 97/21788, WO 00/15736, WO 00/14188, WO 00/14187, WO 00/14183, WO 00/14179, WO 00/08115, WO 99/41332, EP 1 029 029, WO 01/18156 and WO 01/57166.

[0015] Synthetic oils include hydrocarbon oils such as olefin oligomers (including polyalphaolefin base oils; PAOs), dibasic acid esters, polyol esters, polyalkylene glycols (PAGs), alkyl naphthalenes and dewaxed waxy isomerates. Synthetic hydrocarbon base oils sold by the Shell Group under the designation "Shell XHVI" (trade mark) may be conveniently used.

[0016] Poly-alpha olefin base oils (PAOs) and their manufacture are well known in the art. Preferred poly-alpha olefin base oils that may be used in the lubricating compositions of the present invention may be derived from linear C_2 to C_{32}, preferably C_6 to C_{16}, alpha olefins. Particularly preferred feedstocks for said poly-alpha olefins are 1-octene, 1-decene, 1-dodecene and 1-tetradecene.

[0017] The total amount of base oil incorporated in the lubricating composition of the present invention is preferably present in an amount in the range of from 60 to 99 wt.%, more preferably in an amount in the range of from 65 to 98 wt.% and most preferably in an amount in the range of from 70 to 95 wt.%, with respect to the total weight of the lubricating composition.

[0018] There are no particular limitations regarding the molybdenum-containing compound used in lubricating composition according to the present invention and various conventional molybdenum-containing compounds may be conveniently used.

[0019] Preferably, the molybdenum-containing compound is a sulphur-containing molybdenum-containing compound such as a compound selected from the group consisting of a molybdenum dithiocarbamate (MoDTC), molybdenum dithiophosphate, molybdenum dithiophosphinate, molybdenum xanthate, molybdenum thioxanthate, molybdenum sulfide and mixtures thereof. The molybdenum-containing compound may also be a di- or trinuclear molybdenum compound. Most preferably, the molybdenum compound is a molybdenum dithiocarbamate compound. Preferably the lubricating composition according to the present invention comprises at least 0.40 wt.%, more preferably at least 0.45 wt.%, even more preferably at least 0.50 wt.% of the molybdenum-containing compound, based on the total weight of the lubricating composition. Typically, the lubricating composition comprises at most 1.5 wt.%, more typically at most 1.0 wt.%, of the molybdenum-containing compound, based on the total weight of the lubricating composition.

[0020] There are no particular limitations regarding the fatty acid amide as used in lubricating composition according to the present invention and various conventional saturated or unsaturated fatty acid amides such as oleamide, stearamide, behenamide, docosamide, erucamide may be conveniently used. Preferably the fatty acid amide contains from 12 to 26 carbon atoms, more preferably from 16 to 24 carbon atoms, most preferably from 18 to 22 carbon atoms. Especially preferred are the unsaturated fatty acid amides, preferably containing 18 to 22 carbon atoms such as oleamide (C_{18}), arachidonamide (C_{20}) and erucamide (C_{22}). It is even more preferred that the fatty acid amides are monounsaturated fatty acid amides, preferably containing 18 to 22 carbon atoms such as oleamide and erucamide.

[0021] The amount of the fatty acid amide in the compositions of the invention is typically from 0.01 wt.% to 2.0 wt.%, preferably from 0.05 wt.% to 1.5 wt.% and more preferably from 0.1 to 1.0 wt.%, based on the total weight of the lubricating composition.

[0022] According to a preferred embodiment according to the present invention, the lubricating composition further comprises a polyol ester. There are no particular limitations regarding the polyol esters as used in lubricating composition according to the present invention and various conventional polyol esters may be conveniently used.

[0023] Preferably, the polyol ester according to the present invention is a polyol ester of an aliphatic carboxylic acid having 12 to 24 carbon atoms, more preferably 14 to 20 carbon atoms, most preferably 16 to 18 carbon atoms. The polyol moiety of the polyol ester may include polyols such as diols, triols and the like such as ethylene glycol, propylene glycol, glycerol, sorbitol, etc.

[0024] Examples of the carboxylic acid moiety of the polyol ester include octadecanoic acid, oleic acid, hexadecanoic acid, dodecanoic acid, tetradecanoic acid and iso-forms thereof (i.e. having branched carbon chains). Preferably the carboxylic acid moiety of the polyol ester is a fatty acid.

[0025] The polyol esters used in the present invention may be mixtures of mono-, di- and trimesters, but preferably are predominantly the monoesters.

[0026] It is even more preferred that the polyol ester is a polyol monoester of an iso-fatty acid (i.e. a branched fatty acid) such as glycerol mono-isostearate, which is commercially readily available. Other polyol esters such as the oleic acid monoester of glycerol may be conveniently used as well.

[0027] The amount of the polyol ester in the compositions of the invention is typically from 0.01 wt.% to 2.0 wt.%, preferably from 0.2 wt.% to 1.2 wt.% and more preferably from 0.4 to 0.8 wt.%, based on the total weight of the lubricant composition.

[0028] The lubricating composition according to the present invention may further comprise one or more other additives such as anti-oxidants, anti-wear additives, dispersants, detergents, overbased detergents, extreme pressure additives, other friction modifiers, viscosity modifiers, pour point depressants, metal passivators, corrosion inhibitors, demulsifiers, anti-foam agents, seal compatibility agents and additive diluent base oils, etc.

[0029] As the person skilled in the art is familiar with the above and other additives, these are not further discussed here in detail. Specific examples of such additives are described in for example Kirk-Othmer Encyclopedia of Chemical Technology, third edition, volume 14, pages 477-526.

[0030] The lubricating compositions of the present invention may be conveniently prepared by admixing the one or more additives with the base oil(s).

[0031] The above-mentioned additives are typically present in an amount in the range of from 0.01 to 35.0 wt.%, based on the total weight of the lubricating composition, preferably in an amount in the range of from 0.05 to 25.0 wt.%, more preferably from 1.0 to 20.0 wt.%, based on the total weight of the lubricating composition.

[0032] According to a preferred embodiment of the present invention, the lubricating composition has a sulphated ash content (according to ASTM D 874) of at most 1.2 wt.%, preferably at most 0.90 wt%, more preferably at most 0.50 wt.%.

[0033] Further it is preferred that the composition has a total base number (TBN) value (according to ASTM D 2896) of between 4.0 and 12.0 mg KOH/g.

[0034] Moreover, the lubricating composition according to the present invention preferably has a calcium content (according to ASTM D 4951) of at most 0.25 wt.%.

[0035] Typically, the kinematic viscosity 100°C (according to ASTM D 445) of the composition according to the present invention is between 9.3 and 26.1 cSt, preferably above 9.3 and below 16.3 cSt.

[0036] In another aspect, the present invention provides the use of a lubricating composition according to the present invention, in particular in a gas engine, in order to improve the friction reduction properties (in particular according to the SRV test of DIN 51834-1).

[0037] The lubricating compositions according to the present invention are useful for lubricating apparatus generally, but in particular for use as engine oils for internal combustion engines. These engine oils include passenger car engines, diesel engines, marine diesel engines, gas engines, two- and four-cycle engines, etc., and in particular gas engines.

[0038] The present invention is described below with reference to the following Examples, which are not intended to limit the scope of the present invention in any way.

Examples

Lubricating Oil Compositions

[0039] Various lubricating compositions for use in a gas engine were formulated.

[0040] Table 1 indicates the composition and properties of the fully formulated gas engine oil formulations that were tested; the amounts of the components are given in wt.%, based on the total weight of the fully formulated formulations.

[0041] All tested gas engine oil formulations were formulated as SAE 40 formulations meeting the so-called SAE J300 Specifications (as revised in May 2004; SAE stands for Society of Automotive Engineers).

[0042] All the tested gas engine oil formulations contained a combination of a base oil, an additive package and - if present - a total amount of 1.5 wt.% of one or more friction modifiers, based on the total weight of the composition.

[0043] The additive packages contained a combination of additives including anti-oxidants, zinc-based anti-wear additives, an ashless dispersant, overbased and ashless detergents, a pour point depressant, a corrosion inhibitor and a metal passivator.

[0044] "Additive package 1" and "Additive package 2" were so-called Low Ash additive packages, i.e. resulting in a total Sulfated Ash content of 0.50 wt.%; "Additi-cre package 1" provided a TBN of about 4.5 mg KOH/g (according to ASTM D 2896), whereas "Additive package 2" provided a TBN of about 9.0 mg KOH/g.

[0045] "Additive package 3" was a so-called Medium Ash additive package, i.e. resulting in a total Sulfated Ash content of 0.90 wt.%.

[0046] "Base oil 1" was a commercially available Group II base oil having a kinematic viscosity at 100°C (ASTM D445) of approx. 12.4 cSt (mm^2s^{-1}). Base oil 1 is commercially available from e.g. Chevron Products Company (San Ramon, CA, United States) (under the trade designation "Chevron 600 R").

[0047] "Base oil 2" was a Fischer-Tropsch derived base oil ("GTL 8") having a kinematic viscosity at 100°C (ASTM D445) of approx. 8 cSt (mm^2s^{-1}). This GTL base oil may be conveniently manufactured similar to the process as described in e.g. WO 02/070631, the teaching of which is hereby incorporated by reference.

[0048] "Base oil 3" was a commercially available Group I base oil having a kinematic viscosity at 100°C (ASTM D445) of approx. 11.2 cSt (mm^2s^{-1}). Base oil 3 is commercially available from e.g. Shell Chemicals under the trade designation "Catenex".

[0049] "Friction modifier 1" (hereafter "FM 1") was a molybdenum-containing dithiocarbamate compound. FM 1 is commercially available from e.g. Infineum International Ltd (Abingdon, United Kingdom) under the trade designation "Infineum C9455".

[0050] "Friction modifier 2" (hereafter "FM 2") was a fatty acid amide, more specifically an oleamide. FM 2 is commercially available from e.g. Croda Oleochemicals (Hull, United Kingdom) under the trade designation "Crodamide O".

[0051] "Friction modifier 3" (hereafter "FM 3") was a polyol ester, more specifically a glycerol mono-isostearate (i.e. a glycerol monoester of an iso-fatty acid). FM 3 is commercially available from e.g. Croda International Plc (Snaith, United Kingdom) under the trade designation "Prisorine 2040".

[0052] "Friction modifier 4" (hereafter "FM 4") was a polyol ester, more specifically a glycerol mono-octadecanoate. FM 4 is commercially available from e.g. Croda International Plc (Snaith, United Kingdom) under the trade designation "Perfad 3336".

[0053] The compositions of Examples 1-5 and Comparative Examples 1-5 were obtained by mixing the base oils with the additive package and friction modifier(s) using conventional lubricant blending procedures.

Table 1

Component [we.%]	Example 1	Example 2	Example 3	Example 4	Example 5	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5
Base oil 1 (Group II)	89.50	89.50	-	-	89.50	91.00	89.50	89.50	89.50	89.50
Base oil 2 (GTL 8)	-	-	89.50	-	-	-	-	-	-	-
Base oil 3 (Group I)	-	-	-	86.70	-	-	-	-	-	-
Additive package 1	9.00	-	-	-	9.00	9.00	9.00	9.00	9.00	9.00
Additive package 2	-	9.00	9.00	-	-	-	-	-	-	-
Additive package 3	-	-	-	11.80	-	-	-	-	-	-
FM 1 (Mo-compound)	0.60	0.60	0.60	0.60	0.60	-	0.75	0.75	-	-
FM 2 (Fatty acid amide; i.c. oleamide)	0.30	0.15	0.15	0.15	0.30	-	-	-	0.75	1.50
FM 3 (polyol ester; i.c. glycerol mono-isostearate)	0.60	0.75	0.75	0.75	-	-	0.75	-	0.75	-
FM 4 (polyol ester; i.c. glycerol mono-octadecanoate)	-	-	-	-	0.60	-	-	0.75	-	-
TOTAL	100	100	100	100	100	100	100	100	100	100

Properties of the formulated lubricating composition										
Component [wt.%]	Example 1	Example 2	Example 3	Example 4	Example 5	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5
Sulfated ash content[1] [wt.%]	0.50	0.48	0.48	0.90	0.50	0.49	0.50	0.50	0.50	0.50
TBN value[2] [mg KOH/g]	4.56	9.00	9.00	8.76	4.54	4.56	4.56	4.56	4.53	4.44
Kinematic viscosity at 100°C[3] [cSt]	13.55	13.52	13.70	13.75	13.42	13.71	13.46	13.48	13.57	13.45
Kinematic viscosity at 40°C[3] [cSt]	126.7	126.6	97.0	133.5	124.8	128.0	125.2	125.7	127.0	124.9
Ca content[4] [wt.%]	0.14	0.13	0.13	0.25	0.14	0.14	0.14	0.14	0.14	0.14
Zn content[4] [wt.%]	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

[1]According to ASTM D 874
[2]According to ASTM D 2896
[3]According to ASTM D 445
[4]Acoording to ASTM D 4951

Friction Reduction Properties

[0054] In order to demonstrate the friction reduction properties of the present invention, measurements were performed according to the SRV-test of DIN 51834-1, whilst following the ASTM D 6425 prescriptions with respect to test machine and materials. In the test, the following test conditions were used:

- Load: 50 N
- Temperature: 150°C
- Reciprocating Frequency: 50 Hz
- Stroke length: 1 mm
- Time: 90 minutes.

[0055] The measured friction reduction properties are indicated in Table 2 below. The "normalised friction coefficient" refers to the relative value when compared to the value of Comparative Example 1; the lower this normalised friction coefficient is, the more friction reduction occurs.

Table 2

	Example 1	Example 2	Example 3	Example 4	Example 5	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5
Friction coefficient	0.051	0.066	0.06	0.047	0.075	0.157	0.087	0.11	0.129	0.111
Normalised friction coefficient	32.48	42.04	38.22	29.94	47.77	100	55.41	70.06	82.17	70.70
Friction reduction [%]	67.52	57.96	61.78	70.06	52.23	0	44.59	29.94	17.83	29.30

Discussion

[0056] As can be learned from Table 2, the friction reduction values for the compositions according to the present invention were significantly improved when compared with Comparative Example 1 (containing no friction modifier) and Comparative Example 2 and 3 (containing the same amount of friction modifier but no fatty acid amide such as an oleamide). This is a clear indication of desirable friction reduction properties for the compositions according to the present invention.

[0057] Also, friction reduction values for the Examples according to the present invention were also significantly improved when compared with Comparative Example 4 (containing the same fatty acid amide and polyol ester but no molybdenum compound) and Comparative Example 5 (containing only a fatty acid amide).

[0058] Also, as can be learned from Tables 1 and 2, the present invention surprisingly allows formulating suitable gas engine oil compositions having a low sulphated ash content and both low (Examples 1 and 5) or high (Examples 2-4) TBN-values. In this respect it is noted that usually the performance of a friction modifier combination varies with the specific formulation used; however, the combination according to the present invention appears to perform consistently good.

[0059] From the comparison between Example 1 and Example 5 (differing only in the polyol ester) it can be learned that according to the present invention there is a preference for a polyol ester of a branched fatty acid (glycerol mono-isostearate) above a polyol ester of an unbranched fatty acid (glycerol mono-octadecanoate).

Claims

1. A lubricating composition comprising:

- a base oil;
- a molybdenum-containing compound; and
- a fatty acid amide.

2. Lubricating composition according to claim 1, wherein the molybdenum-containing compound is a sulphur-containing molybdenum-containing compound.

3. Lubricating composition according to claim 2, wherein the molybdenum-containing compound is a dithiocarbamate compound.

4. Lubricating composition according to any of claims 1 to 3 wherein the composition comprises at least 0.40 wt.%, more preferably at least 0.45 wt.%, even more preferably at least 0.50 wt.% of the molybdenum-containing compound.

5. Lubricating composition according to any of claims 1 to 4, wherein the fatty acid amide contains from 12 to 26 carbon atoms, preferably from 16 to 24 carbon atoms, more preferably from 18 to 22 carbon atoms.

6. Lubricating composition according to any of claims 1 to 5, further comprising a polyol ester.

7. Lubricating composition according to claim 6, wherein the polyol ester is a polyol ester of an aliphatic carboxylic acid containing from 12 to 24 carbon atoms.

8. Lubricating composition according to claim 6 or 7, wherein the polyol ester is a polyol monoester of an iso-fatty acid, preferably containing from 14 to 20 carbon atoms, more preferably from 16 to 18 carbon atoms.

9. Use of a lubricating composition according to any of claims 1 to 8, in particular in a gas engine, in order to improve friction reduction properties (in particular according to the SRV test of DIN 51834-1).

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 15 9279

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
E	EP 2 080 798 A (IDEMITSU KOSAN CO [JP]) 22 July 2009 (2009-07-22) * paragraphs [0025] - [0034], [0078] - [0082]; claims 1-3; table 1 *	1-9	INV. C10M141/08
X	-& WO 2008/050681 A (IDEMITSU KOSAN CO [JP]; KAMANO HIDEKI [JP]) 2 May 2008 (2008-05-02)	1-9	ADD. C10N10/12 C10N40/25
X	US 5 356 547 A (ARAI KATSUYA [JP] ET AL) 18 October 1994 (1994-10-18) * claims 1-5; table 1 *	1,2,5	
X	WO 96/37581 A (EXXON RESEARCH ENGINEERING CO [US]; TOKASHIKI MICHIHIDE [JP]; TOMIZAWA) 28 November 1996 (1996-11-28) * page 9, paragraph 3 - page 11; claims 1-5; examples 1,2; tables 1,2 *	1-9	

TECHNICAL FIELDS SEARCHED (IPC)

C10M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 October 2009	Glod, Guy

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
.....
& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 15 9279

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

07-10-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2080798 A	22-07-2009	CN 101528900 A	09-09-2009
		JP 2008106199 A	08-05-2008
		WO 2008050681 A1	02-05-2008
		KR 20090069173 A	29-06-2009
WO 2008050681 A	02-05-2008	CN 101528900 A	09-09-2009
		EP 2080798 A1	22-07-2009
		JP 2008106199 A	08-05-2008
		KR 20090069173 A	29-06-2009
US 5356547 A	18-10-1994	JP 5186787 A	27-07-1993
WO 9637581 A	28-11-1996	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- US 20070265176 A **[0003]**
- US 20080015127 A **[0004]**
- US 6562765 B **[0005]**
- EP 0776959 A **[0014]**
- EP 0668342 A **[0014]**
- WO 9721788 A **[0014]**
- WO 0015736 A **[0014]**
- WO 0014188 A **[0014]**
- WO 0014187 A **[0014]**
- WO 0014183 A **[0014]**
- WO 0014179 A **[0014]**
- WO 0008115 A **[0014]**
- WO 9941332 A **[0014]**
- EP 1029029 A **[0014]**
- WO 0118156 A **[0014]**
- WO 0157166 A **[0014]**
- WO 02070631 A **[0047]**

Non-patent literature cited in the description

- API Publication 1509, 15th Edition, Appendix E. April 2002 **[0013]**
- Kirk-Othmer Encyclopedia of Chemical Technology. vol. 14, 477-526 **[0029]**