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(54) **LUBRICANT COMPOSITION FOR ROTARY GAS COMPRESSOR AND ROTARY GAS COMPRESSOR FILLED WITH THE SAME**

(57) A lubricating oil composition for a rotary gas compressor has a kinematic viscosity of 5 mm^2/s or less at 100 degrees C, a flash point of 200 degrees C or more and 5 volume % distillation temperature of 350 degrees C or more. The lubricating oil composition contains at least either one of a phosphorous extreme pressure agent and an antioxidant.

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Description

Technical Field

[0001] The present invention relates to a lubricating oil composition for a rotary gas compressor and a rotary gas compressor filled with the same.

Background Art

[0002] A rotary gas compressor, which generates less vibration than a reciprocating gas compressor, is operated with a massive amount of a lubricating oil being injected, so that a temperature of discharged gas can be lowered. Among the rotary gas compressor, an oil-cooling screw compressor, which is a positive displacement type, has features of a rotary type as well as features of the positive displacement type. Owing to the features such as high efficiency, compact size and long-period continuous operation, the oil-cooling screw compressor has been widely used in the industry (for example, Patent Documents 1 and 2). A lubricating oil having a high kinematic viscosity of more than 5 mm^2/s at 100 degrees C is typically used for such compressor.

[0003]

Patent Document 1: JP-A-09-151870
Patent Document 2: JP-A-11-013661

Disclosure of the Invention

Problems to Be Solved by the Invention

[0004] Since such a typical rotary gas compressor (oil-cooling screw compressor) as disclosed in Patent Documents 1 and 2 has used the lubricating oil of high viscosity as described above, a driving power becomes excessive when the rotary gas compressor is operated. Resultantly, a sufficient performance for energy-saving has not been obtainable. Accordingly, an object of the invention is to provide a lubricating oil composition for a rotary gas compressor and a rotary gas compressor filled with the same, the lubricating oil composition having a sufficient lubricity performance as well as excellent capability of energy-saving and reducing a lubricating oil consumption.

Means for Solving the Problems

[0005] As a result of a dedicated studies for solving the problem, the inventors have found that a lubricating oil composition is particularly excellently applicable to a rotary gas compressor when a kinematic viscosity, a flash point and a distillation temperature of the lubricating oil composition are within a particular range, and then the invention have been achieved.

[0006] The invention provides a lubricating oil composition for a rotary gas compressor and a rotary gas compressor filled with the same as described below:

(1) a lubricating oil composition for a rotary gas compressor having a kinematic viscosity of 5 mm^2/s or less at 100 degrees C; a flash point of 200 degrees C or more; and 5 volume % distillation temperature of 350 degrees C or more;
(2) the lubricating oil composition for the rotary gas compressor as described in (1), in which a kinematic viscosity at 40 degrees C is 28 mm^2/s or less;
(3) the lubricating oil composition for the rotary gas compressor as described in (1) or (2), in which at least either one of a phosphorous extreme pressure agent and an antioxidant is contained;
(4) the lubricating oil composition for the rotary gas compressor as described in (3), in which the phosphorous extreme pressure agent is at least either one of an orthophosphoric ester and an amine salt of a phosphate ester;
(5) the lubricating oil composition for the rotary gas compressor as described in (3) or (4), in which the antioxidant is at least either one of an amine compound, a phosphorous compound, a sulfur compound and a phosphorous/sulfur containing compound; and
(6) A rotary compressor filled with the lubricating oil composition for the rotary gas compressor as described in any one of (1) to (5).

[0007] When the lubricating oil composition for the rotary gas compressor according to the above aspect of the invention is filled in the rotary gas compressor and the rotary gas compressor is operated, a sufficient lubricity performance is maintainable, while an energy-saving effect is excellent owing to a low kinematic viscosity. Further, owing to a low

evaporativity of the lubricating oil composition, an evaporation loss is small even when the rotary gas compressor is operated for long hours. The lubricating oil composition for the rotary gas compressor according to the above aspect of the invention is considerably effective particularly when being filled in an oil-cooling crew compressor.

Best Mode for Carrying Out the Invention

[0008] Embodiments of the invention will be described in detail below. A lubricating oil composition for a rotary gas compressor according to an aspect of the invention (referred to as "the composition" hereinafter) contains a lubricating base oil and an additive, the composition having a kinematic viscosity of 5 mm^2/s or less at 100 degrees C, a flash point of 200 degrees C or more and 5 volume % distillation temperature of 350 degrees C or more.
The lubricant base oil is not particularly limitative, but any oil typically used as a lubricant base oil can be used irrespective of a mineral oil or a synthetic oil.
Preferably, examples of the mineral oil may include paraffinic and naphthenic base oils which can be obtained by subjecting a lubricating oil fraction produced by atmospheric- and vacuum-distillation of a crude oil, to any suitable combination of refining processes selected from solvent-deasphalting, solvent-extracting, hydrocracking, solvent-dewaxing, catalytic-dewaxing, hydrorefining, sulfuric acid treatment and clay treatment.

[0009] Preferably, examples of the synthetic oil may include: a poly-α-olefin (1-octene oligomer, 1-decene oligomer and the like), a polybutene, an isoparaffin, an olefin copolymer (an ethylene-propylene copolymer and the like), an alkylbenzene, an alkyl naphthalene, monoester (butyl stearate and the like), a dibasic acid ester (ditridecyl glutarate, di-2-ethylhexyladipate, diisodecyladipate, ditridecyladipate, di-2-ethylhexlsebacate and the like), a tribasic acid ester (trimerit acid ester and the like), a polyol ester (trimethylol propane caplyrate, trimethylol propane pelargonate, pentaerythritol 2-ethylhexanoate, pentaerythritol pelargonate, and the like), a polyoxyalkylene glycol, a dialkyl diphenyl ether, an alkyl diphenyl sulfide, a polyphenyl ether, silicone oil (dimethyl silicone and the like) and a perfluoropolyether.

[0010] These mineral oils and synthetic oils may be singularly used, or two or more base oils selected from these oils may be mixed at any rate in use.
The base oil of any viscosity may be used for the composition. However, in consideration of lubricity, cooling performance and friction loss at agitation, it is desirable to use the base oil with a kinematic viscosity of 1 to 10,000 mm^2/s at 40 degrees C, preferably 5 to 100 mm^2/s, more preferably 10 to 68 mm^2/s. The base oil for the composition may be preferably selected from API (American Petroleum Institute) classification groups II to IV.

[0011] It is preferable that the lubricating oil composition for the rotary gas compressor according to the aspect of the invention contains at least either one of a phosphorous extreme pressure agent and an antioxidant.
The phosphorous extreme pressure agent is preferably orthophosphoric esters, phosphite esters, acidic phosphate esters, acidic phosphite esters or an amine salt thereof.
The orthophosphoric ester may be exemplified by a triaryl phosphate, a trialkyl phosphate, a trialkyl aryl phosphate, a triaryl alkyl phosphate and a trialkenyl phosphate, examples of which may include: a triphenyl phosphate, a tricresyl phosphate, a benzyl diphenyl phosphate, an ethyl diphenyl phosphate, a tributyl phosphate, an ethyl dibutyl phosphate, a cresyl diphenyl phosphate, a dicresyl phenyl phosphate, an ethylphenyl diphenyl phosphate, a diethylphenyl phenyl phosphate, a propylphenyl diphenyl phosphate, a dipropylphenyl phenyl phosphate, a triethylphenyl phosphate, a tripropylphenyl phosphate, a butylphenyl diphenyl phosphate, a dibutylphenyl phenyl phosphate, a tributylphenyl phosphate, a trihexyl phosphate, a trinormal octyl phosphate, a tri(2-ethylhexyl) phosphate, a tridecyl phosphate, a trilauryl phosphate, a trimyristyl phosphate, a tripalmityl phosphate, a tristearyl phosphate, a trioleyl phosphate and the like.

[0012] Examples of the phosphite ester may include: a triethyl phosphite, a tributyl phosphite, a triphenyl phosphite, a tricresyl phosphite, a tri(nonylphenyl)phosphite, a tri(2-ethylhexyl)phosphite, a tridecyl phosphite, a trilauryl phosphite , a triisooctyl phosphite, a diphenylisodecyl phosphite, a tristearyl phosphite, a trioleyl phosphite and the like.
Examples of the acidic phosphate ester may include: a 2-ethylhexyl acid phosphate, a dinormal octyl acid phosphate, an ethyl acid phosphate, a butyl acid phosphate, an oleyl acid phosphate, a tetracosyl acid phosphate, an isodecyl acid phosphate, a lauryl acid phosphate, a tridecyl acid phosphate, a stearyl acid phosphate, an isostearyl acid phosphate and the like.

[0013] Examples of the acidic phosphite ester may include: a diethyl hydrogen phosphite, a dibutyl hydrogen phosphite, a dilauryl hydrogen phosphite, a dioleyl hydrogen phosphite, a distearyl hydrogen phosphite, a diphenyl hydrogen phosphite and the like. Examples of amines to form the amine salt of the above compounds may include: a mono-substituted amine, a di-substituted amine or a tri-substituted amine represented by the following formula (1). The alkyl group or the alkenyl group having 3 to 30 carbon atoms represented by R in the formula (1) may be linear, branched or cyclic.

$$RnNH3\text{-}n \qquad (1)$$

In the formula: R represents an alkyl group or an alkenyl group having 3 to 30 carbon atoms, preferably 4 to 18 carbon atoms, an aryl group or an arylalkyl group having 6 to 30 carbon atoms, preferably 6 to 15 carbon atoms, or a hydroxyalkyl

group having 2 to 30 carbon atoms, preferably 2 to 18 carbon atoms; and n represents 1, 2 or 3. When plural units ofR are contained, the plural units ofR may be mutually the same or different.

[0014] Examples of the mono-substituted amine may include: a butyl amine, a pentyl amine, a hexyl amine, a cyclohexyl amine, an octyl amine, a lauryl amine, a stearyl amine, an oleyl amine, a benzyl amine and the like. Examples of the di-substituted amine may include: a dibutyl amine, a dipentyl amine, a dihexyl amine, a dicyclohexyl amine, a dioctyl amine, a dilauryl amine, a distearyl amine, an dioleyl amine, a dibenzyl amine, a stearyl monoethanol amine, a decyl monoethanol amine, a hexyl monopropanol amine, a benzyl monoethanol amine, a phenyl monoethanol amine, tolyl monopropanol and the like. Examples of the tri-substituted amine may include: a tributyl amine, a tripentyl amine, a trihexyl amine, a tricyclohexyl amine, a trioctyl amine, a trilauryl amine, a tristearyl amine, a trioleyl amine, a tribenzyl amine, a dioleyl monoethanol amine, a dilauryl monopropanol amine, a dioctyl monoethanol amine, a dihexyl monopropanol amine, a dibutyl monopropanol amine, an oleyl diethanol amine, a stearyl dipropanol amine, a lauryl diethanol amine, an octyl dipropanol amine, a butyl diethanol amine, a benzyl diethanol amine, a phenyl diethanol amine, a tolyl dipropanol amine, a xylyl diethanol amine, a triethanol amine, a tripropanol amine, a tertiary dodecyl amine and the like.

Among the phosphorous extreme pressure agents, tricresyl phosphate and a diethyl hydrogen phosphite tertiary dodecyl amine salt are preferable in perspective of heat resistance.

In view of blending effects and an economical aspect, a content of the extreme pressure agent is typically approximately 0.01 to 30 mass% of the total amount of the lubricating oil composition, preferably 0.01 to 10 mass%.

[0015] Antioxidants typically used for a lubricating oil such as an amine compound, a phosphorous compound, a sulfur compound, a phosphorous/sulfur containing compound and a phenol compound can be used as the antioxidant. Examples of the amine compound may include: a monoalkyldiphenylamine compound such as monooctyldiphenylamine and monononyldiphenylamine; a dialkyl diphenylamine compound such as 4,4'-dibutyldiphenylamine, 4,4'-dipentyldiphenylamine, 4,4'-dihexyldiphenylamine, 4,4'-diheptyldiphenylamine, 4,4'-dioctyldiphenylamine and 4,4'-dinonyldiphenylamine; a polyalkyldiphenylamine compound such as tetrabutyldiphenylamine, tetrahexyldiphenylamine, tetraoctyldiphenylamine and tetranonyldiphenylamine; and a naphthylamine compound such as α-naphthylamine, phenyl-α-naphthylamine, butylphenyl-α-naphthylamine, pentylphenyl-α-naphthylamine, hexylphenyl-a-naphthylamine, heptylphenyl-a-naphthylamine, octylphenyl-α-naphthylamine, nonylphenyl-α-naphthylamine, decylphenyl-α-naphthylamine, dodecylphenyl-α-naphthylamine and the like.

[0016] Examples of the phosphorous compound, sulfur compound and phosphorous/sulfur containing compound may include: the phosphorous compound such as diethyl[[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]methyl]phosphonate, zinc dialkyldithiophosphate such as zinc di-2-ethylhexyldithiophosphate, 2,6-di-tert-butyl-4-(4,6-bis(octylthio)-1,3,5-triazine-2-ylamino)phenol, a thioterpene compound such as a reactant of phosphorous pentasulfide and pinene, dialkyl thiodipropionate such as dilauryl thiodipropionate and distearyl thiodipropionate.

Examples of the phenol compound may include: alkyl phenols such as 2,6-di-tert-butyl-4-methylphenol and bisphenols such as methylene-4,4-bis(2,6-di-tert-butyl-4-methylphenol).

Among the antioxidants, diethyl[[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]methyl]phosphonate is preferable in perspective of heat resistance.

A content of the antioxidant is typically approximately 0.01 to 10 mass% of the total amount of the lubricating oil composition, preferably 0.03 to 5 mass%.

[0017] The composition, which is preferably formed of the above-described base oil and various additives, has a kinematic viscosity (according to JIS (Japanese Industrial Standard) K 2283) of 5 mm^2/s or less at 100 degrees C, preferably 4.95 mm^2/s or less, more preferably 4.5 mm^2/s or less. When the kinematic viscosity at 100 degrees C exceeds 5 mm^2/s, the driving power of the rotary gas compressor is excessive.

A flash point of the composition (according to C.O.C, JIS K 2265) is 200 degrees C or more, preferably 210 degrees C or more, more preferably 220 degrees C or more. When the flash point is less than 200 degrees C, there is an increasing danger of flashing in operation of the rotary gas compressor filled with the composition.

5 volume % distillation temperature of the composition (according to JIS K 2254) is 350 degrees C or more, preferably 370 degrees C or more, more preferably 390 degrees C or more. In case where 5 volume % distillation temperature is less than 350 degrees C, lubricating oil consumption unpreferably increases when the rotary gas compressor is operated for long hours.

The rotary gas compressor filled with the above composition as a lubricating oil consumes less the lubricating oil and maintains a sufficient lubricity, thereby exhibiting an excellent energy-saving effect. Particularly, when the composition is filled in an oil-cooling screw compressor, the composition exhibits considerably excellent cooling performance and heat resistance.

The kinematic viscosity of the composition at 40 degrees C is preferably 28 mm^2/s or less, more preferably 25 mm^2/s or less, more preferably 23 mm^2/s or less. When the kinematic viscosity at 40 degrees C exceeds 28 mm^2/s, the driving power of the rotary gas compressor is excessive.

[0018] The lubricating oil composition for the rotary gas compressor according to the aspect of the invention may be further added with an oiliness agent, a rust inhibitor, a detergent dispersant, a metal deactivator and an antifoaming

agent as needed.

The oiliness agent may be exemplified by an aliphatic alcohol, a fatty acid compound such as a fatty acid and a fatty acid metal salt, an ester compound such as a polyol ester, a sorbitan ester and a glyceride and an amine compound such as an aliphatic amine. The ester compound is preferable among these compounds since the ester compound can provide both heat resistance and lubricity.

In view of blending effects, a content of the oiliness agent is typically approximately 0.1 to 30 mass% of the total amount of the lubricating oil composition, preferably 0.5 to 10 mass%.

[0019] The rust inhibitor may be exemplified by a metal sulfonate, aliphatic amines, an organic phosphite ester, an organic phosphate ester, an organic metal sulfonate, an organic metal phosphate, an alkenyl succinic acid ester, a multivalent alcohol ester and the like. In view of blending effects, a content of the rust inhibitor is typically approximately 0.01 to 10 mass% of the total amount of the lubricating oil composition, preferably 0.05 to 5 mass%.

[0020] The detergent dispersant may be exemplified by a metal sulfonate, a metal salicylate, a metal phenate, a metal phosphonate and succinimide. A metallic detergent dispersant is preferable among these in perspective of detergent dispersivity and demulsification performance.

In view of blending effects, a content of the detergent dispersant is typically approximately 0.1 to 30 mass% of the total amount of the lubricating oil composition, preferably 0.5 to 10 mass%.

[0021] The metal deactivator may be exemplified by benzotriazoles and thiadiazoles. In view of blending effects, a content of the metal deactivator is typically approximately 0.01 to 10 mass% of the total amount of the lubricating oil composition, preferably 0.01 to 1 mass%.

The antifoaming agent may be exemplified by methyl silicone oil, fluorosilicone oil and polyacrylates. In view of blending effects, a content of the antifoaming agent is typically approximately 0.0005 to 0.01 mass% of the total amount of the lubricating oil composition.

Examples

[0022] The invention will be further described in detail below with reference to Examples and Comparatives, which by no means limit scope of the invention.

[Examples 1 to 6 and Comparatives 1 and 2]

[0023] Additives were added to predetermined base oils (API classification groups I to IV) to prepare lubricating oil compositions having respective properties. Maximum loading capacity, wear resistance, evaporation amounts and actual power consumption were evaluated. A method of examining properties of the lubricating oil compositions and a method for evaluating respective properties are shown below. Results are shown in Table 1.

(1) Properties of Lubricating Oil Composition

[0024] A method of examining each property (standard) is shown below.

(1.1) Kinematic Viscosity (100 degrees C, 40 degrees C): according to JIS K 2283
(1.2) Viscosity Index: according to JIS K 2283
(1.3) Density (at 15 degrees C): according to JIS K 2249
(1.4) Flash Point (C.O.C): according to JIS K 2265
(1.5) Distillation Property (5 volume % distillation temperature, 10 volume % distillation temperature): according to JIS K 2254 (Distillation was conducted at reduced pressure of 133MPa and an obtained value was converted to a value at atmospheric pressure.)

(2) Evaluation Items and Evaluation Method

[0025]

(2.1) Maximum Loading Capacity Test (Shell EP Test)
A test was conducted at a rotational speed of 1,800 rpm and at room temperature according to ASTM D2783. A load wear index (LWI) was obtained from a last non-seisure load (LNL) and a weld load (WL). The larger this value is, the better a load resistance is.
(2.2) Wear Resistance Test (Shell Wear Test)
A test was conducted under conditions of a load of 392N, a rotational speed of 1,200 rpm, an oil temperature of 80 degrees C and a testing time of 60 minutes according to ASTM D2783. An average wear track diameter was

calculated by averaging wear track diameters of three half-inch balls.

(2.3) Film Residue Test

In a vessel based on JIS K 2540, a sample of 1g was filled. Air was flowed into the vessel under an atmosphere at a constant temperature of 150 degrees C with a flowing volume of 10 L/h for 6 hours. After the test, a mass of the sample (evaporation residue) was measured. An amount of the evaporation residue relative to the original amount of the sample was expressed by mass percentage.

(2.4) Actual Power Consumption

A commercially available oil-cooling screw compressor (motor output: 22kW, oil quantity: 10L, intake gas: air, intake pressure: atmospheric pressure, intake temperature: 25 degrees C) was used as a rotary gas compressor to measure effective power consumption of the compressor motor when continuously operated for three hours at an average oil temperature of 80 degrees C. The measurement was conducted by a clamp-on-sensor type power meter that is commercially available.

The measurement was conducted in two operation modes as follows.

Operation Mode I: discharge pressure of 0.65 MPa
Operation Mode II: discharge pressure of 0.24 MPa

[0026]

[Table 1]

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative 1	Comparative 2
base oil (mass%)	API GII (100 neutral)	remnant			remnant	remnant	remnant		
	API GIII (100 neutral)		remnant						
	API GIV (100 neutral)			remnant					
	API GII (150 neutral)						65	remnant	
	API GI (100 neutral)								remmant
additives (mass%)	dioctyldiphenylamine	2	2	2	2	2	2	2	2
	octylphenyl-α-naphthylamirte	1	1	1	1	1	1	1	1
	phosphorous containing antioxidant *1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	ester oiliness agent *2	-	-	-	-	10	-	-	-
	tricresyl phosphate	-	-	-	0.4	-	-	-	-
	amine salt of phosphate ester	-	-	-	0.02	-	-	-	-
	other additives *3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
properties	kinematic viscosity (100 °C) (mm^2/s)	4.284	4.230	3.900	4.291	4.300	4.931	5.346	4.208
	kinematic viscosity (40 °C) (mm^2/s)	20.44	19.57	17.50	20.51	20.30	26.58	30.98	20.54
	viscosity index	116	122	120	116	120	110	105	108
	density (15 °C)(g/cm^3)	0.8428	0.8338	0.8190	0.8431	0.8482	0.8558	0.8630	0.8577
	flash point (COC) (°C)	212	230	222	212	215	218	222	210
	distillation property - 5 volume % distillation temperature (° C)	375	398	417	376	377	375	374	346
	distillation property - 10 volume % distillation temperature (° C)	388	406	422	388	390	390	393	351

(continued)

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative 1	Comparative 2
evaluation	Shell EP LWI (N)	165	171	164	301	307	163	164	170
	Shell wear (mm)	0.58	0.59	0.56	0.31	0.33	0.59	0.57	0.55
	film residue (mass%)	89.9	92.0	95.5	90.2	93.4	88.6	87.1	75.5
	actual power consumption-operation mode I (kWh)	67.731	67.647	67.136	67.741	67.756	68.730	69.280	67.613
	actual power consumption - operation mode II (kWh)	28.320	28.255	27.820	28.330	28.341	29.161	29.631	29.225
*1 diethyl[[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]methyl]phosphonate *2 trimethylol propane trialkyl ester (in which an alkyl group is a mixture of C8 and C10) *3 a package of a metallic detergent dispersant, metallic rust inhibitor and antifoaming agent									

[Evaluation Results]

[0027] As shown in Table 1, the results of Examples 1 to 6 using the composition exhibited excellent lubricity performance as a lubricating oil as well as excellent energy-saving effect and consumed less lubricating oil. In contrast, in Comparative 1, a kinematic viscosity at 100 degrees C is high and power consumption of a rotary gas compressor is large. Moreover, a consumption of a lubricating oil is rather large irrespective of the high kinematic viscosity at 100 degrees C. In Comparative 2, a consumption of a lubricating oil becomes excessive due to a low 5 volume % distillation temperature, thereby making it difficult to operate a rotary gas compressor for long hours.

Industrial Applicability

[0028] The present invention is preferably applicable as a lubricating oil for a rotary gas compressor.

Claims

1. A lubricating oil composition for a rotary gas compressor, comprising:

a kinematic viscosity of 5 mm^2/s or less at 100 degrees C;
a flash point of 200 degrees C or more; and
5 volume % distillation temperature of 350 degrees C or more.

2. The lubricating oil composition for the rotary gas compressor according to claim 1, wherein a kinematic viscosity at 40 degrees C is 28 mm^2/s or less.

3. The lubricating oil composition for the rotary gas compressor according to claim 1 or 2, wherein at least either one of a phosphorous extreme pressure agent and an antioxidant is contained.

4. The lubricating oil composition for the rotary gas compressor according to claim 3, wherein the phosphorous extreme pressure agent is at least either one of an orthophosphoric ester and an amine salt of a phosphate ester.

5. The lubricating oil composition for the rotary gas compressor according to claim 3 or 4, wherein the antioxidant is at least one of an amine compound, a phosphorous compound, a sulfur compound and a phosphorous/sulfur containing compound.

6. A rotary compressor filled with the lubricating oil composition for the rotary gas compressor according to any one of claims 1 to 5.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/074685

A. CLASSIFICATION OF SUBJECT MATTER
C10M171/02(2006.01)i, *C10M137/04*(2006.01)i, *C10M137/08*(2006.01)i, *C10M169/04*(2006.01)i, *C10N20/00*(2006.01)n, *C10N20/02*(2006.01)n, *C10N40/30*(2006.01)n
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C10M171/02, C10M137/04, C10M137/08, C10M169/04, C10N20/00, C10N20/02, C10N40/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008
Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2005-213447 A (Idemitsu Kosan Co., Ltd.), 11 August, 2005 (11.08.05), Claims; Par. Nos. [0001], [0002], [0006], [0008]; examples (Family: none)	1-6
Y	JP 2005-154760 A (Idemitsu Kosan Co., Ltd.), 16 June, 2005 (16.06.05), Claims; Par. Nos. [0005], [0007], [0009], [0011], [0015], [0019], [0021], [0023]; examples (Family: none)	1-6
Y	JP 2005-155461 A (Sanyo Electric Co., Ltd.), 16 June, 2005 (16.06.05), Claims; examples; drawings (Family: none)	1-6

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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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
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 February, 2008 (21.02.08)	04 March, 2008 (04.03.08)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/074685

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 7-126673 A (Matsushita Refrigeration Co.), 16 May, 1995 (16.05.95), Claims; drawings (Family: none)	1-6
Y	WO 98/58042 A1 (Nippon Oil Co., Ltd.), 23 December, 1998 (23.12.98), Claims; page 12, lines 2 to 7; examples & EP 1018538 A1	1-6

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 9151870 A **[0003]**
- JP 11013661 A **[0003]**