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(54) **LUBRICATING OIL COMPOSITION**

(57) A lubricating oil composition contains: a first base oil with a kinematic viscosity at 100 degrees C in a range from 1.5 mm²/s to 3.5 mm²/s; a second base oil with a kinematic viscosity at 100 degrees C in a range more than 3.5 mm²/s but not more than 100 mm²/s;

polymethacrylate with a mass average molecular weight in a range from 1×10^4 to 4×10^4 ; and a sulfur compound. The lubricating oil composition has a kinematic viscosity at 100 degrees C in a range from 5 mm²/s to 6 mm²/s and a viscosity index of 200 or more.

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Description

TECHNICAL FIELD

[0001] The present invention relates to a lubricating oil composition suitable for an automatic transmission.

BACKGROUND ART

[0002] A commercially available typical lubricating oil for an automatic transmission usually has a kinematic viscosity at 100 degrees C in a range from 7.0 mm²/s to 9.0 mm²/s. However, in order to enhance a fuel-saving performance of a lubricating oil for an automatic transmission, it is effective to reduce the stirring resistance of the lubricating oil, which requires lowering the viscosity of the lubricating oil. In connection with the above, there has been disclosed an automatic transmission oil with a kinematic viscosity at 100 degrees C in a range from 5.0 to 6.0 mm²/s (see Patent Literature 1). Further, there has been disclosed a lubricating oil composition for a transmission that contains a specific lubricating base oil added with a specific polymethacrylate-based additive and has a kinematic viscosity at 100 degrees C in a range from 3.0 mm²/s to 8 mm²/s (see Patent Literature 2).

CITATION LIST

PATENT LITERATURES

[0003]

Patent Literature 1 JP-A-2004-169025

Patent Literature 2 JP-A-2006-117852

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004] A low-viscosity lubricating oil, however, is less capable of forming an oil film when heated to a high temperature, which results in a reduced durability of transmission components (seizure resistance of gears). Further, a low-viscosity lubricating oil is likely to leak in a hydraulic oil controller of a transmission. Such oil leakage may lead to failure in transmission shift. In view of the above, in order to balance fuel-saving performance with component durability, it is important to ensure a high-temperature viscosity while keeping a low-temperature viscosity at a low level for a long duration of time. In the transmission oils as disclosed in Patent Literatures 1 and 2, fuel-saving performance and component durability are not sufficiently balanced.

[0005] An object of invention is to provide a lubricating oil composition excellent in fuel-saving performance, shear stability and component durability.

MEANS FOR SOLVING THE PROBLEMS

[0006] In order to solve the above problems, the following lubricating oil composition is provided according to an aspect of the invention.

(1) A lubricating oil composition contains: a first base oil with a kinematic viscosity at 100 degrees C in a range from 1.5 mm²/s to 3.5 mm²/s; a second base oil with a kinematic viscosity at 100 degrees C in a range more than 3.5 mm²/s but not more than 100 mm²/s; polymethacrylate with a mass average molecular weight in a range from 1×10^4 to 4×10^4 ; and a sulfur compound. The lubricating oil composition has a kinematic viscosity at 100 degrees C in a range from 5 mm²/s to 6 mm²/s and a viscosity index of 200 or more.

(2) In the lubricating oil composition, when a blending amount (mass%) of the first base oil based on a total composition amount is represented by A and a blending amount (mass%) of the second base oil with the reference to the total composition amount is represented by B, the blending amount A and the blending amount B satisfy the following formula [1].

$$0.6 \leq A / (A+B) < 1 \dots [1]$$

(3) In the lubricating oil composition, the blending amount B of the second base oil is 10 mass% or more.

(4) In the lubricating oil composition, a blending amount of the polymethacrylate is in a range from 1 mass% to 16 mass% based on the total composition amount.

(5) In the lubricating oil composition, a blending amount of the sulfur compound is 0.03 mass% or more based on the total composition amount.

(6) In the lubricating oil composition, the sulfur compound comprises sulfur in an amount of 20 mass% or more based on the sulfur compound.

(7) The lubricating oil composition is further blended with at least one of a detergent dispersant, an antiwear agent, a friction modifier, a rust inhibitor, a metal deactivator, an antifoaming agent and an antioxidant.

(8) A lubricating oil composition for an automatic transmission is the lubricating oil composition.

[0007] According to the aspect of the invention, it is possible to provide a lubricating oil composition excellent in fuel-saving performance, shear stability and component durability. Such a lubricating oil composition according to the aspect of the invention is suitably usable for an automatic transmission.

DESCRIPTION OF EMBODIMENTS

[0008] A lubricating oil composition according to an exemplary embodiment of the invention (hereinafter also simply referred to as "the present composition") is prepared by blending: a first base oil with a kinematic viscosity at 100 degrees C in a range from 1.5 mm²/s to 3.5 mm²/s; a second base oil with a kinematic viscosity at 100 degrees C in a range more than 3.5 mm²/s but not more than 100 mm²/s; polymethacrylate with a mass average molecular weight in a range from 1×10^4 to 4×10^4 ; and a sulfur compound. The lubricating oil composition has a predetermined kinematic viscosity at 100 degrees C and a predetermined viscosity index. Detailed description will be made below.

First Base Oil 1

[0009] The first base oil in the present composition has a kinematic viscosity at 100 degrees C in a range from 1.5 mm²/s to 3.5 mm²/s, preferably in a range from 1.5 mm²/s to 2.5 mm²/s. When the kinematic viscosity at 100 degrees C is less than 1.5 mm²/s, seizure resistance is likely to be lowered irrespective of whether or not a viscosity of the second base oil is in a predetermined range (described later). In contrast, when the kinematic viscosity at 100 degrees C is more than 3.5 mm²/s, the fuel-saving performance is poor irrespective of whether or not the viscosity of the second base oil is in the predetermined range (described later).

[0010] Such a base oil may be a mineral oil, a synthetic oil or a mixture thereof as long as the viscosity at 100 degrees C falls within the above range.

[0011] The mineral oil is subject to no particular limitation but may be any appropriate one selected from among mineral oils usable as a base oil for a typical lubricating oil for an automobile transmission. For instance, the mineral oil may be a paraffin-based mineral oil, an intermediate-based mineral oil or a naphthene-based mineral oil.

[0012] The synthetic oil is also subject to no particular limitation but may be polybutene, polyolefin, polyol ester, dibasic acid ester, phosphate, polyphenyl ether, polyglycol, alkylbenzene or alkylnaphthalene. Examples of the polyolefin are an alpha-olefin homopolymer and an alpha-olefin copolymer.

Second Base Oil 2

[0013] The second base oil in the present composition has a kinematic viscosity at 100 degrees C in a range more than 3.5 mm²/s but not more than 100 mm²/s, preferably in a range from 4 mm²/s to 8 mm²/s. When the kinematic viscosity at 100 degrees C is not more than 3.5 mm²/s, seizure resistance is likely to be lowered irrespective of whether or not the viscosity of the first base oil is in the above predetermined range. In contrast, when the kinematic viscosity at 100 degrees C is more than 100 mm²/s, the fuel-saving performance is poor irrespective of whether or not the viscosity of the first base oil is in the above predetermined range.

[0014] As the second base oil, the same oils as the mineral oils and the synthetic oils usable as the first base oil are usable as long as the second base oil has a viscosity in the above range.

[0015] When a blending amount (mass%) of the first base oil based on a total composition amount is represented by A and a blending amount (mass%) of the second base oil based on the total composition amount is represented by B, the blending amount A and the blending amount B preferably satisfy the following formula [1].

$$0.6 \leq A / (A+B) < 1 \dots [1]$$

[0016] When $A / (A+B)$ is 0.6 or more, fuel-saving performance is sufficiently exhibited. Accordingly, $A / (A+B)$ is preferably 0.65 or more. It should be noted that component durability cannot be sufficiently exhibited when the second base oil is not blended.

[0017] The blending amount B of the second base oil is preferably 5 mass% or more based on the total composition amount, more preferably 10 mass% or more. When the blending amount of the second base oil is 5 mass% or more, the durability of bearings and gear components is improved.

Polymethacrylate

[0018] The polymethacrylate in the present composition serves as a viscosity index improver and thus should have a mass average molecular weight in a range from 1×10^4 to 4×10^4 . When the mass average molecular weight of the polymethacrylate is less than 1×10^4 , the polymethacrylate cannot sufficiently serve as a viscosity index improver. In contrast, when the mass average molecular weight of the polymethacrylate is more than 4×10^4 , the shear stability is poor.

[0019] Examples of the polymethacrylate are a non-dispersed polymethacrylate and a dispersed polymethacrylate. The non-dispersed polymethacrylate and the dispersed polymethacrylate may be used alone or in combination. A blending amount of the polymethacrylate is preferably in a range from 1 mass% to 16 mass% based on the total composition amount, more preferably in a range from 7 mass% to 13 mass%. When the blending amount of the polymethacrylate is 1 mass% or more, the polymethacrylate is sufficiently effective for improving the viscosity index. When the blending amount is 16 mass% or less, the fuel-saving performance is improved.

Sulfur Compound

[0020] The sulfur compound in the present composition contributes to the durability of a component such as a gear. The sulfur content of the sulfur compound is preferably 20 mass% or more based on the sulfur compound in terms of improvement in durability.

[0021] For instance, a thiadiazole compound is favorably usable as the sulfur compound.

[0022] Preferable examples of the thiadiazole compound are a 2,5-bis(n-hexyldithio)-1,3,4-thiadiazole, 2,5-bis(n-octyldithio)-1,3,4-thiadiazole, 2,5-bis(n-nonyldithio)-1,3,4-thiadiazole, 2,5-bis[(1,1,3,3-tetramethylbutyl)dithio]-1,3,4-thiadiazole, 3,5-bis(n-hexyldithio)-1,2,4-thiadiazole, 3,6-bis(n-octyldithio)-1,2,4-thiadiazole, 3,5-bis(n-nonyldithio)-1,2,4-thiadiazole, 3,5-bis[(1,1,3,3-tetramethylbutyl)dithio]-1,2,4-thiadiazole, 4,5-bis(n-octyldithio)-1,2,3-thiadiazole, 4,5-bis(n-nonyldithio)-1,2,3-thiadiazole and 4,5-bis[(1,1,3,3-tetramethylbutyl)dithio]-1,2,3-thiadiazole.

[0023] As the sulfur compound in the present composition, a mono/diolefin sulfide, dihydrocarbyl mono/disulfide, dithiocarbamate compound, ester compound with a disulfide structure, and the like are also favorably usable in addition to the thiadiazole compound.

[0024] A favorable blending amount of the sulfur compound is 0.03 mass% or more based on the total composition amount, preferably 0.05 mass% or more. It should be noted that the blending amount is preferably not more than 0.5 mass% in terms of oxidation stability.

Composition

[0025] The present composition is prepared by blending the above base oils with an additive and has a kinematic viscosity at 100 degrees C in a range from 5mm²/s to 6 mm²/s. When the kinematic viscosity at 100 degrees C is less than 5 mm²/s, the component durability is poor. In contrast, when the kinematic viscosity at 100 degrees C is more than 6 mm²/s, the fuel-saving performance is poor.

[0026] The present composition has a viscosity index of 200 or more. Therefore, a decrease in a high-temperature viscosity of the present composition can be reduced, so that the present composition is excellent in component durability.

[0027] The present composition, which is prepared by blending the predetermined mixed base oil as described above with the predetermined additive, keeps an initial viscosity even when heated to a high temperature. Further, the viscosity of the component is kept at an appropriate level even after long-duration shearing, so that the present composition can exhibit fuel-saving performance and component durability. In other words, the present composition does not cause problems such as deterioration of the component durability (e.g., seizure of a gear) resulting from a decrease in the high-temperature viscosity and leakage of a hydraulic pressure in a hydraulic pressure controller. Therefore, the present composition is suitably usable as a lubricating oil especially for an automatic transmission.

[0028] The present composition may be blended with a variety of additives as listed below as long as the effects of the invention can be exhibited. Specific examples of additives are a detergent dispersant, an antiwear agent, a friction modifier and an antioxidant.

[0029] As the detergent dispersant, an ashless dispersant and a metallic dispersant are usable.

[0030] Examples of the ashless dispersant are a succinimide compound, boron imide compound, Mannich dispersant

and acid amide compound. One of these examples may be used alone or, alternatively, two or more thereof may be used in combination. A blending amount of the ashless dispersant is subject to no particular limitation but is preferably in a range from 0.1 mass% to 20 mass% based on the total composition amount.

[0031] Examples of the metallic dispersant are alkali metal sulfonate, alkali metal phenate, alkali metal salicylate, alkali metal naphthenate, alkaline earth metal sulfonate, alkaline earth metal phenate, alkaline earth metal salicylate and alkaline earth metal naphthenate. One of these examples may be used alone or, alternatively, two or more thereof may be used in combination. A blending amount of the metallic dispersant is subject to no particular limitation but is preferably in a range from 0.1 mass% to 10 mass% based on the total composition amount.

[0032] The antiwear agent is exemplified by a sulfur-based compound or a phosphorus-based compound. Examples of the sulfur-based compound are olefin sulfide, sulfurized fat and oil, ester sulfide, thiocarbonates, dithiocarbamates and polysulfides. Examples of the phosphorus-based compound are phosphites, phosphates, phosphonates, and amine salts or metal salts of these esters. One of these examples may be used alone or, alternatively, two or more thereof may be used in combination. A blending amount of the antiwear agent is preferably in a range from 0.1 mass% to 20 mass% based on the total composition amount.

[0033] The friction modifier is exemplified by fatty acid ester, fatty acid amide, fatty acid, aliphatic alcohol, aliphatic amine or aliphatic ether. Specifically, a substance having at least one alkyl group or alkenyl group having 6 to 30 carbon atoms in a molecule is usable. For instance, oleic acid and oleylamine are favorably usable. One of these examples may be used alone or, alternatively, two or more thereof may be used in combination. A blending amount of the friction modifier is preferably in a range from 0.01 mass% to 2 mass% based on the total composition amount, more preferably in a range from 0.01 mass% to 1 mass%.

[0034] Examples of the antioxidant are amine antioxidants such as alkylated diphenylamine, phenyl-alpha-naphthylamine and alkylated-alpha-naphthylamine and phenol antioxidants such as 2,6-di-t-butyl-4-methylphenol and 4,4-methylenebis(2,6-di-t-butylphenol). A blending amount of the antioxidant is preferably in a range from 0.05 mass% to 25 mass% based on the total composition amount.

[0035] Examples

[0036] Next, the exemplary embodiment of the invention will be further described in detail with reference to Examples, which by no means limit the invention.

Examples 1 to 5 and Comparative Examples 1 to 5

[0037] Sample oils were prepared according to compositions shown below and were measured in kinematic viscosity (40 degrees C and 100 degrees C), viscosity index, shear stability and gear durability by a method as described below.

Kinematic Viscosity

[0038] Measurement was conducted in accordance with JIS K2283.

Viscosity Index

[0039] Measurement was conducted in accordance with JIS K2283.

Shear Stability

[0040] A KRL shearing test was conducted in accordance with DIN52350-6.

[0041] Specifically, a kinematic viscosity at 100 degrees C was measured with a KRL shear tester after the elapse of 96 hours since shearing was started. A practical target value was 4.8 mm²/s or more.

Gear Durability

[0042] An FZG gear test was conducted in accordance with ASTM D5182-97.

[0043] Specifically, a load stage was gradually set higher and higher under such conditions that a gear speed along a pitch circle was 8.3 m/s and the temperature of a hydraulic oil was 90 degrees C to find out a level of the load stage at the time when scuffing with a width of 20 mm or more was caused.

Table 1

	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5
Base Oil 1 (mass%)	58.00	58.00	58.00	50.00	-	47.00	58.00	-	61.80	62.30
	-	-	-	-	73.00	-	-	-	-	-
Base Oil 2 (mass%)	-	-	-	28.00	-	-	-	86.50	-	-
	20.00	19.80	19.55	-	5.00	32.00	20.05	-	22.40	22.90
Additives (mass%)	10.50	10.50	10.50	10.50	10.50	9.50	10.50	2.00	-	-
	-	-	-	-	-	-	-	-	4.30	-
	-	-	-	-	-	-	-	-	-	3.30
	0.05	0.25	0.50	0.05	0.05	0.05	-	0.05	0.05	0.05
	11.45	11.45	11.45	11.45	11.45	11.45	11.45	11.45	11.45	11.45
Total										
A/(A+B) in Formula [1]										
Properties	40°C Kinematic Viscosity (mm ² /s)									
	100°C Kinematic Viscosity (mm ² /s)									
	Viscosity Index									
Evaluation Results	KRL Shearing Test (100°C kinematic viscosity after elapse of 96 hours: mm ² /s)									
	FZG Gear Test (Load Stage)									

[0044]

- 1) Mineral oil 1: kinematic viscosity at 100 degrees C: 2.2 mm²/s, viscosity index: 109
- 2) Mineral oil 2: kinematic viscosity at 100 degrees C: 2.8 mm²/s, viscosity index: 109
- 3) Mineral oil 3: kinematic viscosity at 100 degrees C: 4.1 mm²/s, viscosity index: 126
- 4) Mineral oil 4: kinematic viscosity at 100 degrees C: 6.5 mm²/s, viscosity index: 130
- 5) PMA1: polymethacrylate with a mass average molecular weight of 3×10^4
- 6) PMA2: polymethacrylate with a mass average molecular weight of 5×10^4
- 7) PMA3: polymethacrylate with a mass average molecular weight of 1.2×10^5
- 8) Sulfur compound: a thiadiazole-based additive
- 9) Other additives: an additive package for a transmission (i.e., a package including a detergent dispersant, an antiwear agent, a friction modifier and an antioxidant).

Evaluation Results

[0045] As shown in Table 1, the sample oils of Examples 1 to 5 each have a low viscosity and a high viscosity index and are excellent in shear stability and gear durability. In view of the above, it is understandable that the lubricating oil composition according to the exemplary embodiment exhibits excellent performance especially when used for an automatic transmission.

[0046] In contrast, none of the sample oils of Comparative Examples 1 to 5, which fail to fulfill all the requirements according to the exemplary embodiment, is favorable in terms of all of low viscosity, high viscosity index, shear stability and gear durability.

Claims**1. A lubricating oil composition comprising:**

a first base oil with a kinematic viscosity at 100 degrees C in a range from 1.5 mm²/s to 3.5 mm²/s;
 a second base oil with a kinematic viscosity at 100 degrees C in a range more than 3.5 mm²/s but not more than 100 mm²/s;
 polymethacrylate with a mass average molecular weight in a range from 1×10^4 to 4×10^4 ; and
 a sulfur compound, the lubricating oil composition having a kinematic viscosity at 100 degrees C in a range from 5 mm²/s to 6 mm²/s and a viscosity index of 200 or more.

2. The lubricating oil composition according to claim 1, wherein when a blending amount (mass%) of the first base oil based on a total composition amount is represented by A and a blending amount (mass%) of the second base oil with the reference to the total composition amount is represented by B, the blending amount A and the blending amount B satisfy a formula [1] below,

$$0.6 \leq A / (A+B) < 1 \dots [1]$$

3. The lubricating oil composition according to claim 1 or 2, wherein the blending amount B of the second base oil is 10 mass% or more.

4. The lubricating oil composition according to any one of claims 1 to 3, wherein a blending amount of the polymethacrylate is in a range from 1 mass% to 16 mass% based on the total composition amount.

5. The lubricating oil composition according to any one of claims 1 to 4, wherein a blending amount of the sulfur compound is 0.03 mass% or more based on the total composition amount.

6. The lubricating oil composition according to any one of claims 1 to 5, wherein the sulfur compound comprises sulfur in an amount of 20 mass% or more based on the sulfur compound.

7. The lubricating oil composition according to any one of claims 1 to 6, further comprising at least one of a detergent dispersant, an antiwear agent, a friction modifier, a rust inhibitor, a metal deactivator, an antifoaming agent and an

antioxidant.

8. A lubricating oil composition for an automatic transmission, comprising the lubricating oil composition according to any one of claims 1 to 7.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/080893

A. CLASSIFICATION OF SUBJECT MATTER

C10M169/04(2006.01)i, C10M101/02(2006.01)i, C10M135/36(2006.01)i,
C10M145/14(2006.01)i, C10N20/00(2006.01)n, C10N20/02(2006.01)n, C10N20/04
(2006.01)n, C10N30/00(2006.01)n, C10N40/04(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)

C10M169/04, C10M101/02, C10M135/36, C10M145/14, C10N20/00, C10N20/02,
C10N20/04, C10N30/00, C10N40/04

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 1996-2013
Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013

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.
X	JP 2009-249496 A (Nippon Oil Corp.), 29 October 2009 (29.10.2009), claims 1 to 5; paragraphs [0057] to [0059]; examples 1 to 4 & US 2011/0034358 A1 & EP 2261309 A1 & WO 2009/125551 A1	1-8
A	JP 2003-82377 A (Nippon Oil Corp.), 19 March 2003 (19.03.2003), claims 1 to 6; paragraphs [0042] to [0086]; examples 1 to 14 & US 2004/0171500 A1 & EP 1428866 A1	1-8

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

☐ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search
12 February, 2013 (12.02.13)

Date of mailing of the international search report
19 February, 2013 (19.02.13)

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004169025 A [0003]
- JP 2006117852 A [0003]