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(54) **LUBRICATING OIL COMPOSITION FOR TWO-WHEELED MOTOR VEHICLES**

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ABSTRACT

A lubricating oil composition for two-wheeled motor vehicles including a base oil and a metal phenate and having a coefficient of friction measured of less than 0.0900. The lubricating oil composition in which a performance required for lubricating oil for engines is satisfied, and a good shift feeling is achieved while a high coefficient of friction is kept in a wet clutch.

(30) **Foreign Application Priority Data**

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LUBRICATING OIL COMPOSITION FOR TWO-WHEELED MOTOR VEHICLES

TECHNICAL FIELD

[0001] The present invention relates to a lubricating oil composition for two-wheeled motor vehicles.

BACKGROUND ART

[0002] A system for lubricating using a common oil solution as a lubricating oil for engines and a lubricating oil for power transmission of two-wheeled motor vehicles or the like needs to have a performance required for a lubricating oil for engines and a performance as the lubricating oil for power transmission.

[0003] Specifically, various characteristics, such as wear resistance, detergency, heat resistance, oxidation stability, less oil consumption, and low frictional loss, are required for the lubricating oil for engines. On the other hand, in two-wheeled motor vehicles equipped with a manual transmission, parts such as a shift drum, a shift fork, and a shifter gear in a gear box operates under user's manual operation of a clutch lever and a shift pedal during running, and the gear changes. The friction characteristics of the parts vary depending on a lubricating oil used, and this may change the sense felt by the user (shift feeling).

[0004] PTL 1 discloses a lubricating oil composition containing an imide compound, a metal-based detergent, and zinc dithiophosphate as a lubricating oil composition that is excellent in a performance required for an engine system and an increase in coefficient of friction for a wet clutch.

CITATION LIST

Patent Literature

[0005] PTL 1: JP2019-206644A

SUMMARY OF INVENTION

Technical Problem

[0006] However, although the lubricating oil composition described in PTL 1 has a high coefficient of friction from the viewpoint of clutch friction characteristics, a low coefficient of friction needs to be achieved under a particular condition in addition to the high coefficient of friction from the viewpoint of a shift feeling, and a further improvement is desired.

[0007] For example, in an upshift, a user disengages the clutch with the clutch lever, and then operates the shift pedal to rotate the shift drum in the gear box, and with the rotation of the shift drum, the shifter gear is shifted with the shift fork to mesh with the dog teeth. The user finally releases the clutch lever to fasten the clutch, and thus the upshift is completed. In this series of procedures, especially when the user operates the shift pedal, the user feels a sense of roughness due to sliding of the parts in the gear box, which is a poor shift feeling, or the user does not feel such a sense and obtains a sense of smooth sliding, which is a good shift feeling.

[0008] The present invention has been made in view of the aforementioned problems, and an object of the present invention is to provide a lubricating oil composition for two-wheeled motor vehicles that satisfies the performance

required for a lubricating oil for engines and achieves a good shift feeling while a high coefficient of friction is kept in a wet clutch.

Solution to Problem

[0009] The present inventors have found that the object can be achieved by a lubricating oil composition for two-wheeled motor vehicles that contains a base oil and a metal phenate and in which the coefficient of friction measured with a MTM tester is in a specific range, and completed the present invention.

[0010] Specifically, the present invention provides the following items [1] to [3].

[0011] [1] A lubricating oil composition for two-wheeled motor vehicles containing a base oil (A) and a metal phenate (B), the lubricating oil composition having a coefficient of friction measured with a MTM tester under a condition described below of less than 0.0900.

[0012] Test piece: a disk of a standard test piece (AISI 52100) and a ball ($\frac{3}{4}$ inches) of the same material

[0013] Operation time: 2 hours

[0014] Load: 30 N

[0015] Oil temperature: 80° C.

[0016] Speed: 100 mm/s

[0017] Slip-to-roll ratio (SRR): 50%

[0018] [2] A method for lubricating an engine and a transmission of a two-wheeled motor vehicle using the lubricating oil composition for two-wheeled motor vehicles according to the item [1].

[0019] [3] A method for producing a lubricating oil composition for two-wheeled motor vehicles including: mixing a base oil (A) and a metal phenate (B), wherein a coefficient of friction measured with a MTM tester under a condition described below of the lubricating oil composition for two-wheeled motor vehicles is less than 0.0900.

[0020] Test piece: a disk of a standard test piece (AISI 52100) and a ball ($\frac{3}{4}$ inches) of the same material

[0021] Operation time: 2 hours

[0022] Load: 30 N

[0023] Oil temperature: 80° C.

[0024] Speed: 100 mm/s

[0025] Slip-to-roll ratio (SRR): 50%

Advantageous Effects of Invention

[0026] The present invention can provide a lubricating oil composition for two-wheeled motor vehicles that satisfies a performance required for a lubricating oil for engines and achieves a good shift feeling while a high coefficient of friction is kept in a wet clutch.

DESCRIPTION OF EMBODIMENTS

[0027] In this description, the lower limit values and the upper limit values described in stages for the preferred numerical ranges (for example, the range of the content) can be independently combined. For example, the expression of “preferably 10 to 90, more preferably 30 to 60” can mean “10 to 60” by combining “the preferable lower limit value (10)” and “the more preferable upper limit value (60)”. Similarly, in this description, values with the expressions of

“or more”, “or less”, “less than”, and “more than” regarding the recitation of numerical range can be optionally combined.

[0028] In this description, the content of calcium atom means a value measured in accordance with JPI-5S-38-03.

[Lubricating Oil Composition for Two-Wheeled Motor Vehicles]

[0029] A lubricating oil composition for two-wheeled motor vehicles of the present embodiment contains a base oil (A) and a metal phenate (B), and the coefficient of friction measured with a MTM tester under the following condition is less than 0.0900.

[0030] Test piece: a disk of a standard test piece (AISI 52100) and a ball (¾ inches) of the same material

[0031] Operation time: 2 hours

[0032] Load: 30 N

[0033] Oil temperature: 80° C.

[0034] Speed: 100 mm/s

[0035] Slip-to-roll ratio (SRR): 50%

[0036] Each component contained in the lubricating oil composition for two-wheeled motor vehicles of the present embodiment will be described below.

<Base Oil (A)>

[0037] The base oil (A) contained in the lubricating oil composition for two-wheeled motor vehicles of the present embodiment needs to be a base oil containing one or more selected from a mineral oil and a synthetic oil.

[0038] Examples of the mineral oil include atmospheric pressure residual oils obtained by atmospheric distillation of crude oils such as a paraffinic crude oil, an intermediate base crude oil, and a naphthenic crude oil; distillate oils obtained by vacuum distillation of the atmospheric pressure residual oils; and mineral oils obtained by subjecting the distillate oils to one or more of refining treatments such as solvent de-asphalting, solvent extraction, hydrocracking, solvent dewaxing, catalytic dewaxing, and hydrogenation refining.

[0039] Examples of the synthetic oil include poly- α -olefins such as an α -olefin homopolymer and an α -olefin copolymer (e.g., α -olefin copolymers having 8 to 14 carbon atoms such as an ethylene- α -olefin copolymer); isoparaffins; various esters such as a polyol ester and a dibasic acid ester; various ethers such as polyphenyl ether; polyalkylene glycols; alkylbenzenes; alkyl-naphthalenes; and GTL base oils obtained by isomerization of wax (GTL wax (GasToLiquid-WAX)) produced from natural gas by the Fischer-Tropsch process or the like.

[0040] As the base oil used in the present embodiment, base oils classified into Groups II and III in API (The American Petroleum Institute) base oil category are preferred, and base oils classified into Group III are more preferred.

[0041] As the base oil (A), the mineral oil may be used alone or a plurality of kinds of the mineral oils may be used in combination, or the synthetic oil may be used alone or a plurality of kinds of the synthetic oils may be used in combination. Alternatively, one or more kinds of the mineral oils and one or more kinds of the synthetic oils may be used in combination.

[0042] The kinematic viscosity and viscosity index of the base oil (A) are not particularly limited, and from the viewpoint of enhancing the wear resistance of the lubricat-

ing oil composition, the kinematic viscosity and the viscosity index are preferably in the following ranges.

[0043] The kinematic viscosity at 100° C. of the base oil (A) is preferably 4.0 mm²/s or more, more preferably 4.5 mm²/s or more, and even more preferably 5.0 mm²/s or more, and preferably 20.0 mm²/s or less, more preferably 15.0 mm²/s or less, and even more preferably 11.0 mm²/s or less. The upper limit value and the lower limit value can be optionally combined, and specifically, the kinematic viscosity is preferably 4.0 to 20.0 mm²/s, more preferably 4.5 to 15.0 mm²/s, and even more preferably 5.0 to 11.0 mm²/s.

[0044] The viscosity index of the base oil (A) is preferably 80 or more, more preferably 90 or more, even more preferably 100 or more, and even more preferably 105 or more.

[0045] In this description, the kinematic viscosity and the viscosity index mean values measured or determined in accordance with JIS K 2283:2000.

[0046] When the base oil (A) is a mixed base oil containing two or more kinds of base oils, the kinematic viscosity and viscosity index of the mixed base oil need only to be in the aforementioned ranges.

[0047] In the lubricating oil composition of the present embodiment, the content of the base oil (A) is not particularly limited, and from the viewpoint of enhancing the wear resistance, it is preferably 60 to 99% by mass, more preferably 70 to 98% by mass, even more preferably 80 to 97% by mass, and particularly preferably 85 to 95% by mass, based on the whole amount (100% by mass) of the lubricating oil composition.

<Metal Phenate (B)>

[0048] The lubricating oil composition of the present embodiment contains the metal phenate (B), and therefore a shift feeling can be enhanced.

[0049] From the viewpoint of improving detergency, a metal atom contained in the metal phenate (B) is preferably a metal atom selected from an alkali metal atom and an alkaline earth metal atom, more preferably a sodium atom, a calcium atom, a magnesium atom, or a barium atom, even more preferably a calcium atom or a magnesium atom, and even more preferably a calcium atom. That is, the metal phenate (B) is preferably calcium phenate.

[0050] The content of calcium phenate in the metal phenate (B) is preferably 70 to 100% by mass, more preferably 80 to 100% by mass, even more preferably 90 to 100% by mass, and even more preferably 95 to 100% by mass, relative to the total amount (100% by mass) of the metal phenate (B) contained in the lubricating oil composition.

[0051] The metal phenate (B) used in the present embodiment is preferably a metal phenate containing a sulfur atom. The content of the sulfur atom in the metal phenate (B) is preferably 1.00 to 8.00% by mass, more preferably 2.00 to 6.00% by mass, even more preferably 2.30 to 5.00% by mass, and even more preferably 2.50 to 4.00% by mass. When the content of the sulfur atom in the metal phenate (B) is in the aforementioned range, the amount of a polar group in the molecular structure is large, and the lubricating oil is prone to adsorption to a metal. Therefore, the coefficient of friction measured in a MTM test is presumed to reduce.

[0052] The metal phenate (B) may be any of a neutral salt, a basic salt, an overbased salt, or a mixture thereof, and the overbased salt is particularly preferred.

[0053] When the metal phenate (B) is a neutral salt, the base number of the neutral salt is preferably 0 to 30

mgKOH/g, more preferably 0 to 25 mgKOH/g, and even more preferably 0 to 20 mgKOH/g.

[0054] When the metal phenate (B) is a basic salt or an overbased salt, the base number of the basic salt or the overbased salt is preferably 100 to 600 mgKOH/g, more preferably 120 to 550 mgKOH/g, even more preferably 160 to 500 mgKOH/g, and even more preferably 200 to 450 mgKOH/g.

[0055] In the description, the “base number” means a base number according to a perchloric acid method that is measured in accordance with 7 of “Petroleum products and lubricants-Determination of neutralization number” of JIS K2501.

[0056] In the lubricating oil composition for two-wheeled motor vehicles of the present embodiment, the content of the metal phenate (B) in terms of metal atoms is not particularly limited, and from the viewpoint of enhancing the shift feeling, it is preferably 1,100 to 4,000 ppm by mass, more preferably 1,100 to 3,000 ppm by mass, even more preferably 1,100 to 2,000 ppm by mass, and even more preferably 1,200 to 1,500 ppm by mass, based on the whole amount of the lubricating oil composition.

[0057] In the lubricating oil composition for two-wheeled motor vehicles of the present embodiment, the content of the metal phenate (B) is preferably adjusted such that the content in terms of metal atoms is in the aforementioned range. Specifically, from the viewpoint of enhancing the shift feeling, it is preferably 1.10% by mass or more, more preferably 1.20% by mass or more, even more preferably 1.25% by mass or more, and particularly preferably 1.30% by mass or more, and preferably 2.00% by mass or less, more preferably 1.80% by mass or less, even more preferably 1.70% by mass or less, even more preferably 1.60% by mass or less, and particularly preferably 1.50% by mass or less, based on the whole amount (100% by mass) of the lubricating oil composition for two-wheeled motor vehicles. The upper limit values and the lower limit values can be optionally combined, and specifically, the content of the metal phenate (B) is preferably 1.10 to 2.00% by mass, more preferably 1.20 to 1.80% by mass, even more preferably 1.25 to 1.70% by mass, even more preferably 1.30 to 1.60% by mass, and particularly preferably 1.30 to 1.50% by mass.

<Additional Metal-Based Detergent (C)>

[0058] The lubricating oil composition for two-wheeled motor vehicles of the present embodiment may further contain an additional metal-based detergent (C).

[0059] From the viewpoint of improving detergency, a metal atom contained in the additional metal-based detergent (C) is preferably a metal atom selected from an alkali metal atom and an alkaline earth metal atom, more preferably a sodium atom, a calcium atom, a magnesium atom, or a barium atom, even more preferably a calcium atom or a magnesium atom, and even more preferably a calcium atom. The additional metal-based detergent (C) is preferably a metal sulfonate or a metal salicylate, and more preferably a metal sulfonate. That is, the additional metal-based detergent (C) is preferably calcium sulfonate.

[0060] The content of calcium sulfonate in the additional metal-based detergent (C) is preferably 70 to 100% by mass, more preferably 80 to 100% by mass, even more preferably 90 to 100% by mass, and even more preferably 95 to 100%

by mass, relative to the total amount (100% by mass) of the additional metal-based detergent (C) contained in the lubricating oil composition.

[0061] The additional metal-based detergent (C) may be any of a neutral salt, a basic salt, an overbased salt, or a mixture thereof.

[0062] When the additional metal-based detergent (C) is a neutral salt, the base number of the neutral salt is preferably 0 to 30 mgKOH/g, more preferably 0 to 25 mgKOH/g, and even more preferably 0 to 20 mgKOH/g.

[0063] When the additional metal-based detergent (C) is a basic salt or an overbased salt, the base number of the basic salt or the overbased salt is preferably 100 to 600 mgKOH/g, more preferably 120 to 550 mgKOH/g, even more preferably 160 to 500 mgKOH/g, and even more preferably 200 to 450 mgKOH/g.

[0064] In the description, the “base number” means a base number according to a perchloric acid method that is measured in accordance with 7 of “Petroleum products and lubricants-Determination of neutralization number” of JIS K2501.

[0065] In the lubricating oil composition for two-wheeled motor vehicles of the present embodiment, the content of the additional metal-based detergent (C) in terms of metal atoms is not particularly limited, and from the viewpoint of enhancing the high-temperature detergency, it is preferably 200 to 8,000 ppm by mass, more preferably 400 to 5,000 ppm by mass, even more preferably 600 to 3,500 ppm by mass, and even more preferably 700 to 2,500 ppm by mass, based on the whole amount of the lubricating oil composition.

[0066] In the lubricating oil composition for two-wheeled motor vehicles of the present embodiment, the content of the additional metal-based detergent (C) is preferably adjusted such that the content in terms of metal atoms is in the aforementioned range. Specifically, from the viewpoint of enhancing the shift feeling, it is preferably 0.10% by mass or more, more preferably 0.30% by mass or more, even more preferably 0.50% by mass or more, and particularly preferably 0.60% by mass or more, and preferably 3.00% by mass or less, more preferably 2.50% by mass or less, even more preferably 2.00% by mass or less, even more preferably 1.40% by mass or less, and particularly preferably 1.00% by mass or less, based on the whole amount (100% by mass) of the lubricating oil composition for two-wheeled motor vehicles. The upper limit values and the lower limit values can be optionally combined, and specifically, the content of the additional metal-based detergent (C) is preferably 0.10 to 3.00% by mass, more preferably 0.30 to 2.50% by mass, even more preferably 0.50 to 2.00% by mass, even more preferably 0.60 to 1.40% by mass, and particularly preferably 0.60 to 1.00% by mass.

<Viscosity Index Improver (D)>

[0067] The lubricating oil composition for two-wheeled motor vehicles of the present embodiment may further contain a viscosity index improver (D).

[0068] Examples of the viscosity index improver (D) include polymers such as a non-dispersant-type poly(meth)acrylate, a dispersant-type poly(meth)acrylate, a star polymer, a comb polymer, an olefinic copolymer (e.g., an ethylene-propylene copolymer), a dispersant-type olefinic copolymer, and a styrene-based copolymer (e.g., a styrene-diene copolymer and a styrene-isoprene copolymer). Among

these, a non-dispersant-type poly(meth)acrylate, a dispersant-type poly(meth)acrylate, and a star polymer are preferred, and a star polymer is the most preferred.

[0069] One kind of the polymer may be used alone, or two or more kinds thereof may be used in combination.

[0070] The weight-average molecular weight (Mw) of the viscosity index improver (D) is preferably 10,000 to 1,500,000, preferably 200,000 to 1,200,000, and more preferably 300,000 to 1,000,000, and it is appropriately determined depending on the kind of the polymer.

[0071] The molecular weight distribution (Mw/Mn) of the viscosity index improver (D) is preferably 8.0 or less, more preferably 5.0 or less, even more preferably 3.0 or less, and even more preferably 1.9 or less, and typically 1.01 or more.

[0072] In the description, the weight-average molecular weight (Mw) and number-average molecular weight (Mn) of each component are values measured by gel permeation chromatography (GPC) in terms of standard polystyrene.

[0073] The star polymer need only to be a polymer having a structure in which 3 or more linear macromolecules are bonded at one position.

[0074] Examples of the linear macromolecules constituting the star polymer include a copolymer of a vinyl aromatic monomer and a conjugated diene monomer, and a hydrogenated product thereof.

[0075] Examples of the vinyl aromatic monomer include styrene, styrene substituted by an alkyl having 8 to 16 carbon atoms, styrene substituted by an alkoxy having 8 to 16 carbon atoms, vinyl naphthalene, and vinyl naphthalene substituted by an alkyl having 8 to 16 carbon atoms.

[0076] Examples of the conjugated diene monomer include conjugated dienes having 4 to 12 carbon atoms, specifically, 1,3-butadiene, isoprene, piperylene, 4-methylpenta-1,3-diene, 3,4-dimethyl-1,3-hexadiene, and 4,5-diethyl-1,3-octadiene.

[0077] In the lubricating oil composition for two-wheeled motor vehicles of the present embodiment, the content of the viscosity index improver (D) in terms of resin content is preferably 0.01 to 10% by mass, more preferably 0.05 to 5.0% by mass, even more preferably 0.10 to 2.0% by mass, and even more preferably 0.20 to 1.0% by mass, based on the whole amount (100% by mass) of the lubricating oil composition.

<Additional Additive for Lubricating Oil>

[0078] The lubricating oil composition for two-wheeled motor vehicles of the present embodiment may contain an additional additive for lubricating oil other than the aforementioned components as long as the effects of the present invention are not impaired.

[0079] Examples of the additional additive for lubricating oil include an anti-wear agent, an ash-free dispersant, an antioxidant, a pour point depressant, a metal-based friction modifier, a rust inhibitor, a metal deactivator, a demulsifier, and an anti-foaming agent.

[0080] One kind of the additive for lubricating oil may be used alone, or two or more kinds thereof may be used in combination.

[0081] Examples of the anti-wear agent include zinc-containing compounds such as zinc dialkyldithiophosphate (ZnDTP) and zinc phosphate; sulfur-containing compounds such as disulfides, olefin sulfides, sulfurized oils and fats, sulfurized esters, thiocarbonates, thiocarbamates, and polysulfides; phosphorus-containing compounds such as phos-

phite esters, phosphate esters, phosphonate esters, and amine salts or metal salts thereof; and sulfur and phosphorus-containing anti-wear agents such as thiophosphite esters, thiophosphate esters, thiophosphonate esters, and amine salts or metal salts thereof.

[0082] Among these, zinc dialkyldithiophosphate (ZnDTP) is preferred.

[0083] Examples of the ash-free dispersant include one or more kinds of compounds selected from the group consisting of succinic acid monoimides such as alkenyl succinic acid monoimide and alkyl succinic acid monoimide; boron modified products of succinic acid monoimides; succinic acid bisimides such as alkenyl succinic acid bisimide and alkyl succinic acid bisimide; and boron modified products of succinic acid bisimides.

[0084] Among these, one or more selected from the group consisting of succinic acid monoimides (boron-free modified products) and succinic acid bisimides (boron-free modified products) are preferred, and succinic acid bisimides (boron-free modified products) are more preferred.

[0085] Examples of the antioxidant include an amine-based antioxidant, a phenol-based antioxidant, a molybdenum-based antioxidant, a sulfur-based antioxidant, and a phosphorus-based antioxidant. Among these, one or more selected from the amine-based antioxidant and the phenol-based antioxidant are preferred.

[0086] Examples of the pour point depressant include an ethylene-vinyl acetate copolymer, a condensate of chlorinated paraffin and naphthalene, a condensate of chlorinated paraffin and phenol, a polymethacrylate, and a polyalkylstyrene.

[0087] Examples of the metal-based friction modifier include molybdenum-based friction modifiers such as molybdenum dithiocarbamate (MoDTC), molybdenum dithiophosphate (MoDTP), and an amine salt of molybdic acid.

[0088] Examples of the rust inhibitor include a fatty acid, an alkenyl succinic acid half ester, a fatty acid soap, an alkyl sulfonic acid salt, a polyhydric alcohol fatty acid ester, a fatty acid amine, oxidized paraffin, and an alkyl polyoxyethylene ether.

[0089] Examples of the metal deactivator include a benzotriazole compound, a tolyltriazole compound, a thiadiazole compound, an imidazole compound, and a pyrimidine compound.

[0090] Examples of the demulsifier include anionic surfactants such as a sulfate ester salt of castor oil and a sulfonate salt of petroleum; cationic surfactants such as a quaternary ammonium salt and an imidazoline; a polyoxyalkylene polyglycol and a dicarboxylic acid ester thereof; and an alkylene oxide adduct of alkyl phenol-formaldehyde polycondensate.

[0091] Examples of the anti-foaming agent include a silicone anti-foaming agent, a fluorinated anti-foaming agent such as fluorosilicone oil and a fluoroalkyl ether, and a polyacrylate-based anti-foaming agent.

[0092] The content of each of the additives for lubricating oil can be appropriately adjusted as long as the effects of the present invention are not impaired, and it is typically 0.001 to 15% by mass, preferably 0.005 to 10% by mass, more preferably 0.01 to 7% by mass, and even more preferably 0.03 to 5% by mass, based on the whole amount (100% by mass) of the lubricating oil composition for two-wheeled motor vehicles.

[0093] In the lubricating oil composition for two-wheeled motor vehicles of the present embodiment, the total content of the component (A), the component (B), the component (C), and the component (D) is preferably 60% by mass or more, more preferably 70% by mass or more, even more preferably 80% by mass or more, even more preferably 90% by mass or more, and particularly preferably 95% by mass or more, and typically 100% by mass or less, based on the whole amount (100% by mass) of the lubricating oil composition.

[Various Properties of Lubricating Oil Composition for Two-Wheeled Motor Vehicles]

[0094] The kinematic viscosity at 100° C. of the lubricating oil composition for two-wheeled motor vehicles of the present embodiment is preferably 6.0 to 20.0 mm²/s, more preferably 7.0 to 18.0 mm²/s, and even more preferably 8.0 to 17.0 mm²/s.

[0095] The kinematic viscosity at 40° C. of the lubricating oil composition for two-wheeled motor vehicles of the present embodiment is preferably 20.0 to 140.0 mm²/s, more preferably 40.0 to 100.0 mm²/s, and even more preferably 50.0 to 95.0 mm²/s.

[0096] The viscosity index of the lubricating oil composition for two-wheeled motor vehicles of the present embodiment is preferably 100 or more, more preferably 120 or more, and even more preferably 130 or more.

[0097] In the lubricating oil composition for two-wheeled motor vehicles of the present embodiment, the coefficient of friction measured with a MTM tester under a condition described in Examples, which will be described later, needs to be less than 0.0900, and is preferably 0.0880 or less, more preferably 0.0870 or less, and even more preferably 0.0860 or less. The lower limit value of the coefficient of friction is preferably 0.0600 or more, more preferably 0.0700 or more, and even more preferably 0.0800 or more, in view of a balance between the coefficient of friction and other characteristics.

[0098] The performance classification evaluated in accordance with a clutch friction characteristics test of JASO T903:2016 of the lubricating oil composition for two-wheeled motor vehicles of the present embodiment is preferably MA2.

[HTHS Viscosity]

[0099] The HTHS viscosity at 150° C. of the lubricating oil composition for two-wheeled motor vehicles of the present embodiment is preferably 1.5 mPa·s or more, more preferably 1.7 mPa·s or more, and even more preferably 2.9 mPa·s or more. It is preferably less than 4.0 mPa·s, more preferably less than 3.9 mPa·s, and even more preferably less than 3.5 mPa·s.

[0100] The HTHS viscosity at 150° C. of the lubricating oil composition for two-wheeled motor vehicles of the present embodiment can be measured at a shear rate of 106/s with a TBS high-temperature viscometer (Tapered Bearing Simulator Viscometer) in accordance with ASTM D4683.

[Application of Lubricating Oil Composition]

[0101] The lubricating oil composition of the present embodiment is used for a two-wheeled motor vehicle lubricated using a common oil solution as a lubricating oil for engines and a lubricating oil for power transmission.

[0102] The present embodiment also provides a method for lubricating an engine and a transmission of a two-wheeled motor vehicle using the lubricating oil composition for two-wheeled motor vehicles.

[0103] Furthermore, the present embodiment provides a method for producing the lubricating oil composition for two-wheeled motor vehicles including mixing the base oil (A) and the metal phenate (B), wherein the coefficient of friction measured with a MTM tester under the condition of the lubricating oil composition for two-wheeled motor vehicles is less than 0.0900.

[0104] Regarding the lubricating oil composition for two-wheeled motor vehicles in the lubricating method and the method for producing the lubricating oil composition for two-wheeled motor vehicles, suitable aspects of components and suitable properties and the like of the lubricating oil composition for two-wheeled motor vehicles are as described above.

EXAMPLE

[0105] Next, the present invention will be described in more detail by Examples, but the present invention is not limited to the examples. Various properties of components and obtained lubricating oil compositions used in Examples and Comparative Examples were measured by the following methods.

<Kinematic Viscosity and Viscosity Index>

[0106] Measurement and determination were performed in accordance with JIS K 2283:2000.

<HTHS Viscosity>

[0107] The HTHS viscosity of a lubricating oil composition was measured under a temperature condition of 150° C. at a shear rate of 106/s with a TBS high-temperature viscometer (Tapered Bearing Simulator Viscometer) in accordance with ASTM D4683.

<Content of Calcium Atom>

[0108] Measurement was performed in accordance with JPI-5S-38-03.

<Base Number (Perchloric Acid Method)>

[0109] Measurement was performed in accordance with JIS K 2501.

Examples 1 and 2 and Comparative Examples 1 to 4

[0110] A base oil and various additives described below were added in blending amounts shown in Table 1, and sufficiently mixed to prepare each lubricating oil composition.

[0111] Details of the base oils and the additives used in Examples and Comparative Examples are as follows.

(Component (A))

[0112] Base oil: mineral oil that is classified into Group III in API base oil category and is subjected to a hydrogenation refining (kinematic viscosity at 40° C.=35.38 mm²/s, kinematic viscosity at 100° C.=6.381 mm²/s, viscosity index=133).

(Component (B))

[0113] Overbased Ca phenate 1: calcium phenate, base number: 251 mgKOH/g, content of calcium atom: 9.5% by mass, content of sulfur atom: 3.07% by mass

[0114] Overbased Ca phenate 2: calcium phenate, base number: 250 mgKOH/g, content of calcium atom: 9.25% by mass, content of sulfur atom: 3.46% by mass

(Component (C))

[0115] Overbased Ca sulfonate 1: calcium sulfonate, base number: 251 mgKOH/g, content of calcium atom: 11.9% by mass

[0116] Overbased Ca sulfonate 2: calcium sulfonate, base number: 307 mgKOH/g, content of calcium atom: 11.6% by mass

[0117] Overbased Ca salicylate: calcium salicylate, base number: 225 mgKOH/g, content of calcium atom: 8.0% by mass

(Component (D))

[0118] Viscosity index improver: diblock star polymer available from Infineum, weight-average molecular weight: 780,000

(Additional Additives)

[0119] An additive package containing a pour point depressant, an anti-foaming agent, a dispersant, an antioxidant, an anti-wear agent (zinc dialkyldithiophosphate (ZnDTP)), and a metal-based detergent

[0120] The prepared lubricating oil compositions were subjected to the following tests. The results are shown in Table 1.

[Coefficient of Intermetallic Friction]

[0121] The coefficient of friction was measured with a mini traction machine (MTM) tester under the following condition. A value of coefficient of friction of less than 0.0900 was determined to be good.

[0122] Test piece: a disk of a standard test piece (AISI 52100) and a ball (3/4 inches) of the same material

[0123] Operation time: 2 hours

[0124] Load: 30 N

[0125] Oil temperature: 80° C.

[0126] Speed: 100 mm/s

[0127] Slip-to-roll ratio (SRR): 50%

[Clutch Friction Characteristics]

[0128] The clutch friction characteristics of the lubricating oil compositions were graded under the following test conditions in accordance with a clutch friction characteris-

tics evaluation test method described in JASO T903:2016. Grades “MA”, “MA1”, and “MA2” represent good clutch friction characteristics, and “MA2” represents excellent clutch friction characteristics.

<Test Conditions>

[0129] Test machine: SAE No. 2 test machine (manufactured by Automax Co., Ltd.)

[0130] Dynamic friction test: in accordance with 3.3.1 of JASO M348

[0131] Static friction test: in accordance with 3.3.2 of JASO M348

[0132] Test cycle: 1,000

[0133] Evaluation method: Grading into MB, MA, MA1, and MA2 in accordance with JASO T903:2016. A lubricating oil composition that does not satisfy physicochemical properties defined by JASO T903:2016 is “out of a specification”.

[Hot Tube Test]

[0134] A test oil (prepared lubricating oil composition) was subjected to a hot tube test at a test temperature of 290° C. for a test time of 16 hours in accordance with JPI-5S-55-99.

[0135] A lacquer attached to a test tube was graded into 21 levels of 0 (black) to 10 (colorless) as a rating after the test in accordance with JPI-5S-55-99.

[0136] A larger value of the score indicates less sediment and better detergency.

[0137] A lubricating oil composition having a score of 8.0 or more was acceptable in Examples.

[Shift Feeling]

[0138] Four subjects performed a running test, and evaluated shift pedal operativity according to a rating method. The frequency of catching in the running test was measured and evaluated.

(Running Condition)

[0139] Running was performed at a speed of 30 to 60 km/h on a general concrete paved road, and in the running, a shift position was changed stepwise. The engine speed was set to be 4,000 to 6,500 rpm.

(Score)

[0140] The score of a predetermined standard oil is defined as a benchmark of 0.0, the score in the case where the shift pedal operativity is good is defined as plus, and the score in the case where the shift pedal operativity is poor is defined as minus. A score of +2.0 to -2.0 was imparted.

TABLE 1

				Comparative		
				Example 1	Example 2	Example 1
Composition	Component (A)	Base oil	% by mass	91.18	91.18	91.57
	Component (B)	Overbased Ca phenate 1	% by mass	1.39	1.00	1.00
		Overbased Ca phenate 2	% by mass		0.39	
	Component (C)	Overbased Ca sulfonate 1	% by mass			
		Overbased Ca sulfonate 2	% by mass			
		Overbased Ca salicylate	% by mass			

TABLE 1-continued

	Component (D)	Viscosity index improver (in terms of resin content)	% by mass	0.43	0.43	0.43
	Additional additive		% by mass	7.00	7.00	7.00
Various properties of lubricating oil composition	—	Total	% by mass	100.00	100.00	100.00
		Kinematic viscosity (40° C.)	mm ² /s	63.88	63.81	63.40
		Kinematic viscosity (100° C.)	mm ² /s	10.48	10.46	10.42
		Viscosity index	—	153	153	153
		HTHS viscosity (150° C.)	mPa · s	3.12	3.11	3.09
	Base number		mgKOH/g	8.59	8.57	7.57
Content of component (B) (in terms of Ca)			% by mass	0.12	0.13	0.10
Test items	Coefficient of intermetallic friction		—	0.0847	0.0843	0.0905
	Clutch friction characteristics		—	MA2	MA2	MA
	Hot tube test		—	8.5	8.5	7.0
	Shift feeling		—	2.0	2.0	1.0
				Comparative Example 2	Comparative Example 3	Comparative Example 4
Composition	Component (A)	Base oil	% by mass	91.11	91.26	91.25
	Component (B)	Overbased Ca phenate 1	% by mass	1.00	1.00	1.00
	Component (C)	Overbased Ca phenate 2	% by mass			
		Overbased Ca sulfonate 1	% by mass		0.31	
		Overbased Ca sulfonate 2	% by mass			0.32
	Component (D)	Overbased Ca salicylate	% by mass	0.46		
		Viscosity index improver (in terms of resin content)	% by mass	0.43	0.43	0.43
	Additional additive		% by mass	7.00	7.00	7.00
	Various properties of lubricating oil composition	—	Total	% by mass	100.00	100.00
		Kinematic viscosity (40° C.)	mm ² /s	64.02	63.71	63.77
		Kinematic viscosity (100° C.)	mm ² /s	10.50	10.46	10.47
		Viscosity index	—	153	153	153
		HTHS viscosity (150° C.)	mPa · s	3.11	3.10	3.11
	Base number		mgKOH/g	8.61	8.52	8.52
Content of component (B) (in terms of Ca)			% by mass	0.10	0.10	0.10
Test items	Coefficient of intermetallic friction		—	0.108	0.1027	0.0971
	Clutch friction characteristics		—	MA	MA2	MA2
	Hot tube test		—	8.5	8.0	7.5
	Shift feeling		—			

[0141] The lubricating oil compositions prepared in Examples 1 and 2 satisfied high-temperature detergency required for a lubricating oil for engine oil and achieved a good shift feeling while a high coefficient of friction was kept in a wet clutch.

[0142] In contrast, the coefficients of intermetallic friction measured with a MTM test machine of the lubricating oil compositions prepared in Comparative Examples 1 to 4 were high, and the shift feeling based on the evaluation by the subjects was insufficient. The clutch friction characteristics of the lubricating oil compositions prepared in Comparative Examples 1 and 2 were MA. In addition, the scores in the hot tube test of the lubricating oil compositions prepared in Comparative Examples 1 to 4 were less than 8.0, and they had low high-temperature detergency.

1. A lubricating oil composition, comprising:

a base oil; and

a metal phenate,

wherein the lubricating oil composition has a coefficient of friction of less than 0.0900 when measured with a disk of a standard test piece (AISI 52100) and a ¾ inch ball of the same material for 2 hours, with a load of 30 N, at a speed of 100 mm/s, at an oil temperature of 80° C., and with a slip-to-roll ratio (SRR) of 50%.

2. The lubricating oil composition of claim 1, wherein a content of a sulfur atom in the metal phenate is 1.00 to 8.00% by mass.

3. The lubricating oil composition of claim 1, wherein the metal phenate is an overbased calcium phenate.

4. The lubricating oil composition of claim 1, wherein a content of the metal phenate is 1.10% by mass or more and 2.00% by mass or less based on a whole amount of the lubricating oil composition.

5. The lubricating oil composition of claim 1, further comprising:

a viscosity index improver.

6. The lubricating oil composition of claim 1, wherein a performance classification evaluated in accordance with a clutch friction characteristics test of JASO T903:2016 is MA2.

7. A method for lubricating an engine and a transmission of a two-wheeled motor vehicle, comprising:

applying the lubricating oil of claim 1 to the engine and the transmission.

8. A method for producing a lubricating oil composition, comprising:

mixing a base oil and a metal phenate,

wherein a coefficient of friction of the lubricating oil is less than 0.0900 when measured with a disk of a standard test piece (AISI 52100) and a ¾ inch ball of the same material for 2 hours, with a load of 30 N, at a speed of 100 mm/s, at an oil temperature of 80° C., and with a slip-to-roll ratio (SRR) of 50%.

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