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Honda et al.

(54) SYNTHETIC LUBRICANT

(75) Inventors: **You Honda**, Osaka (JP); **Naritoshi Kawata**, Osaka (JP); **Masahiro Yamaguchi**, Osaka (JP); **Shigeyuki Mori**, Osaka (JP)

(73) Assignee: **THE NIPPON SYNTHETIC CHEMICAL INDUSTRY CO., LTD.**, Osaka (JP)

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(57) **ABSTRACT**

Provided is a lubricating oil additive which is able to impart friction adjusting performance and rust preventing performance which are essential for practical use of a lubricant composed of an ionic liquid, and is dissolved or dispersed in the ionic liquid even when blended with the ionic liquid, and thus, does not inhibit performances as a base oil of the ionic liquid. The present invention relates to a synthetic lubricant including a fluorine atom-containing ionic liquid (A) as a main component, wherein the synthetic lubricant contains an imidazolium phosphate ester salt (B).

SYNTHETIC LUBRICANT

TECHNICAL FIELD

[0001] The present invention relates to a synthetic lubricant including an ionic liquid as a main component, and particularly relates to a synthetic lubricant which is excellent in friction adjusting performance and rust preventing performance, composed of an ionic liquid as a main component.

BACKGROUND ART

[0002] Traditionally, as a lubricating oil used in mechanical devices, power transmission devices, metal working oil, grease and the like, one or mixture of base oils that most closely matches a desired physical property has been selected and used among base oils such as poly-α-olefin, diester, polyolester, silicone and the like or a combination thereof as necessary. Furthermore, a plurality of lubricant additives, such as antioxidant, viscosity index improver, pour point depressant, friction modifier, extreme pressure agent, antifoaming agent, rust preventive agent, anticorrosion agent and the like, have been added to make a lubricating oil suitable for use environment.

[0003] Recently, as devices have higher performance and higher efficiency, there is a demand for a lubricant which is able to exhibit even higher oxidation resistance, higher evaporation resistance, stable lubricating performance over a long period, and as a means for solving the problem, it has been reported that ionic liquids (ambient temperature molten salts) composed of a combination of specific organic cation and inorganic anion may be used as a lubricant. Since ionic liquids have very low vapor pressure and stay liquid in a wide temperature range, and thus, have not only excellent stability and incombustibility, but also high viscosity index, it is known that ionic liquids have possibility as a new material for a lubricating oil (see Non-Patent Document 1).

[0004] Lubricating oil using these ionic liquids could control and improve properties required for lubricating oil, such as oxidation resistance, viscosity index, and pour point by adjusting molecular design of an ionic liquid itself, but properties other than above were difficult to gain by improving an ionic liquid itself. Therefore, it has been considered necessary to use various known additives.

[0005] However, many of these known additives are immiscible in ionic liquids, and thus, it is currently impossible to obtain lubricating oil additives which is practically usable for the synthetic lubricant including an ionic liquid as a main component. This has become an obstacle when an ionic liquid is put to practical use as a lubricating oil.

RELATED ART

Non-Patent Document

[0006] [Non-Patent Document 1] R. A. Reich et al., Journal of the Society of Tribologists and Lubrication Engineers, July 2003, p. 16-21

DISCLOSURE OF INVENTION

Problems to Be Solved by the Invention

[0007] Thus, under such a background, an object of the present invention is to provide a synthetic lubricant obtained by blending an additive which is able to impart friction adjusting performance and rust preventing performance which are essential for practical use of a synthetic lubricant composed of an ionic liquid. The additive can be dissolved or dispersed in the ionic liquid even when blended with the ionic liquid, and thus, does not inhibit performances of the ionic liquid as a base oil, in particular, a fluorine-based ionic liquid which has low viscosity and is useful for lubricant use.

Means for Solving the Problems

[0008] Present inventors have conducted intensive studies in consideration of these situations, and as a result, found out that a synthetic lubricant having excellent friction adjusting performance and rust preventing performance may be obtained by blending an imidazolium phosphate ester salt as an additive with a synthetic lubricant including a fluorine-based ionic liquid as a main component, thereby completing the present invention.

[0009] The present invention includes the following aspects.

[0010] [1] A synthetic lubricant including a fluorine atom-containing ionic liquid (A) as a main component, wherein the synthetic lubricant contains an imidazolium phosphate ester salt (B).

[0011] [2] The synthetic lubricant according to [1], wherein a cation moiety of the fluorine atom-containing ionic liquid (A) is an imidazolium cation.

[0012] [3] The synthetic lubricant according to [1] or [2], wherein an anion moiety of the fluorine atom-containing ionic liquid (A) is a fluorine-containing imide anion represented by the following general formula (1):

[Chem. 1]

$$(C_nF_{2n+1}SO_2)_2N^- \quad (1)$$

[0013] (wherein n is an integer of 0 to 15).

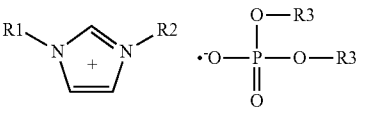
[0014] [4] The synthetic lubricant according to any one of [1] to [3], wherein the anion moiety of the fluorine atom-containing ionic liquid (A) is bis(fluorosulfonyl)imide or bis(trifluoromethanesulfonyl)imide.

[0015] [5] The synthetic lubricant according to any one of [1] to [4], wherein the imidazolium cation of the imidazolium phosphate ester salt (B) is a 1,3-disubstituted imidazolium cation.

[0016] [6] The synthetic lubricant according to any one of [1] to [5], wherein the phosphate ester anion of the imidazolium phosphoric acid ester salt (B) is a phosphate ester anion having a diester structure.

[0017] [7] The synthetic lubricant according to any one of [1] to [6], wherein the imidazolium phosphate ester salt (B) is a compound represented by the following general formula (2):

[Chem. 2]



(2)

[0018] (wherein each of R1 and R2 is independently an alkyl group having 1 to 16 carbon atoms, and R3 is an alkyl group having 1 to 8 carbon atoms).

Effects of the Invention

[0019] According to the present invention, the friction coefficient, the abrasion amount of a material in contact with a lubricant, and the rust generation of a material may be reduced while maintaining characteristics of a fluorine atom-containing ionic liquid, such as low volatility, a wide range of temperature stability and high viscosity index, by adding an imidazolium phosphate ester salt to an ionic liquid lubricant including a fluorine atom-containing ionic liquid as a main component.

[0020] In addition, even when the fluorine atom-containing ionic liquid is an imidazolium-based ionic liquid (having an imidazolium cation at the cation moiety thereof) which is useful as a lubricant, the imidazolium cation has an alkyl substituent having a relatively low number of carbon atoms, and the hydrophobicity of the ionic liquid lubricating oil is low, the imidazolium phosphate ester salt of the present invention may be sufficiently dissolved, thereby exhibiting excellent friction adjusting performance and rust preventing performance.

[0021] Meanwhile, although the mechanism for exhibiting these effects has not been completely elucidated, it is presumed that the imidazolium phosphate ester salt has high affinity with metal surface, compared to the fluorine atom-containing ionic liquid which is a main component, and thus, it is possible for the salt to be stably adsorbed (remain) on the friction surface of the metal surface, resulting in efficiently improved friction properties.

[0022] Further, since the slight blending amount of the imidazolium phosphate ester salt has the effects, the effects on physical properties of the ionic liquid which is a main component are also small.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0023] Hereinafter, the present invention will be described in detail.

[0024] The synthetic lubricant of the present invention includes a fluorine atom-containing ionic liquid (A) as a main component and contains an imidazolium phosphate ester salt (B).

[0025] Meanwhile, the ionic liquid in the present invention refers to an ionic material which is in a molten state at ambient temperature (25° C.) and is composed of a cation moiety and an anion moiety.

[0026] As the fluorine atom-containing ionic liquid (A) of the present invention, a commonly known ionic liquid containing a fluorine atom may be used, and the liquid may contain typically from 1 to 50 fluorine atoms and may have a fluorine atom on at least one of the cation moiety or the anion moiety, but, in particular, it is preferred that the ionic liquid contains a fluorine atom only on the anion moiety.

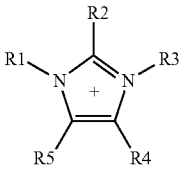
[0027] The ionic liquid (A) will be described in detail with respect to a cation moiety and an anion moiety, separately.

[0028] As the cation moiety of the ion liquid (A), cations used in typical ionic liquids may be used, but among them, it is preferred to have an organic cation selected from the group consisting of an onium cation of a 5- to 6-membered ring compound having 1 to 3 nitrogen atoms, a quaternary ammonium cation and a quaternary phosphonium cation.

[0029] Examples of the onium cation of a 5- to 6-membered ring compound having 1 to 3 nitrogen atoms include an onium cation of a five-membered ring compound, such as an imidazolium cation, a pyrrolidinium cation and the like, or an onium cation of a six-membered compound, such as a pyridinium cation, a piperidinium cation and the like. Among them, an imidazolium cation is preferred in that the cation has a low melting point and is easily transformed into the liquid phase.

[0030] The imidazolium cation is not particularly limited, but may be exemplified by an imidazolium cation having a structure of the following formula (3):

[Chem. 3]



(3)

[0031] (wherein, each of R1 to R5 is independently a hydrogen atom, a halogen atom, an alkyl group, an alkenyl group, an alkynyl group, an alkoxyl group and an acyl group, which may be straight chained or branched and have 1 to 16 carbon atoms, an amide group, a cyano group, a nitro group and an amino group, and the alkyl group, the alkenyl group, the alkynyl group, the alkoxyl group and the acyl group may include a heteroatom selected from N, S and 0, and may include a conjugated or independent double bond or triple bond).

[0032] When the substituents R1 to R5 are an alkyl group, an alkenyl group, an alkynyl group, an alkoxyl group or an acyl group, the number of carbon atoms thereof is preferably 1 to 16, more preferably 1 to 12, and even more preferably 1 to 6. Those substituents may be straight chained or have branched structure, but if the number of carbon atoms thereof is too high, the intermolecular interaction on side chains thereof acts, and thus, the viscosity thereof tends to increase.

[0033] The above alkyl group, alkenyl group, alkynyl group, alkoxyl group and acyl group may include a heteroatom selected from N, S and O, and the number of heteroatoms to be contained is not particularly limited. Further, the groups may include a conjugated or independent double bond or triple bond, and the number of unsaturated bonds thereof is not particularly limited as well.

[0034] Specific examples of the alkyl group include a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, a pentyl group, a hexyl group, a cyclopropyl group, a cyclopentyl group, a cyclohexyl group and the like. Further, examples of the alkenyl group include a vinyl group, an allyl group, a 1-propenyl group, an isopropenyl group, a 2-butenyl group, an 1,3-butadienyl group, a 2-pentenyl group, a 2-hexenyl group and the like. In addition, examples of the alkynyl group include an ethynyl group, a 1-propynyl group, a 2-propynyl group and the like, examples of the alkoxyl group include a methoxy group, an ethoxy group, an n-propoxy group, an isopropoxy group, a t-butoxy group and the like, examples of the acyl group include an acetyl group, a propionyl group, a butyryl group, a benzoyl group and the like, and examples of the amino group also include an N,N-dimethylamino group, an N,N-diethylamino group and the like. Considering the industrial availability, an alkoxyl group,

an acyl group, an amide group, a cyano group, a nitro group, an amino group and the like are preferred in that the groups may be easily subjected to decomposition by enzymes to increase the biodegradability thereof.

[0035] Specific examples of the imidazolium cation represented by Formula (3) include dialkylimidazolium cation such as 1,3-dimethylimidazolium cation, 1-ethyl-3-methylimidazolium cation, 1-methyl-3-propylimidazolium cation, 1-butyl-3-methylimidazolium cation, 1-methyl-3-pentylimidazolium cation, 1-hexyl-3-methylimidazolium cation, 1-heptyl-3-methylimidazolium cation, 1-methyl-3-octylimidazolium cation, 1-decyl-3-methylimidazolium cation, 1-dodecyl-3-methylimidazolium cation, 1-ethyl-3-propylimidazolium cation, 1-butyl-3-ethylimidazolium cation and the like; and trialkylimidazolium cation such as a 3-ethyl-1, 2-dimethyl-imidazolium cation, 1,2-dimethyl-3-propylimidazolium cation, 1-butyl-2,3-dimethylimidazolium cation, 1,2-dimethyl-3-hexylimidazolium cation, 1,2-dimethyl-3-octylimidazolium cation, 1-ethyl-3,4-dimethylimidazolium cation, 1-isopropyl-2,3-dimethylimidazolium cation and the like.

[0036] Among these imidazolium cations, from the viewpoint of ease of synthesis, 1,3-disubstituted imidazolium cation and 1,2,3-trisubstituted imidazolium cation are preferably used, and 1,3-disubstituted imidazolium cation is particularly preferably used. Each substituent in these derivatives may be the same as or different from every other substituent, and may contain a multiple bond or a branched chain.

[0037] The above substituent is the same as the substituent in general formula (3), and is appropriately selected and used among them.

[0038] Examples of the above pyrrolidinium cation include N,N-dimethylpyrrolidinium cation, N-ethyl-N-methylpyrrolidinium cation, N-methyl-N-propylpyrrolidinium cation, N-butyl-N-methylpyrrolidinium cation, N-methyl-N-pentylpyrrolidinium cation, N-hexyl-N-methylpyrrolidinium cation, N-methyl-N-octylpyrrolidinium cation, N-decyl-N-methylpyrrolidinium cation, N-dodecyl-N-methylpyrrolidinium cation, N-(2-methoxyethyl)-N-methylpyrrolidinium cation, N-(2-ethoxyethyl)-N-methylpyrrolidinium cation, N-(2-propoxyethyl)-N-methylpyrrolidinium cation, N-(2-isopropoxyethyl)-N-methylpyrrolidinium cation and the like.

[0039] Examples of the above pyrridinium cation include a pyrridinium cation substituted with an alkyl group having 1 to 16 carbon atoms, such as N-methylpyrridinium cation, N-ethylpyrridinium cation, N-butylpyrridinium cation, N-propylpyrridinium cation and the like.

[0040] Examples of the above piperidinum cation include N,N-dimethylpiperidinium cation, N-ethyl-N-methylpiperidinium cation, N-methyl-N-propylpiperidinium cation, N-butyl-N-methylpiperidinium cation, N-methyl-N-pentylpiperidinium cation, N-hexyl-N-methylpiperidinium cation, N-methyl-N-octylpiperidinium cation, N-decyl-N-methylpiperidinium cation, N-dodecyl-N-methylpiperidinium cation, N-(2-methoxyethyl)-N-methylpiperidinium cation, N-(2-methoxyethyl)-N-ethylpiperidinium cation, N-(2-ethoxyethyl)-N-methylpiperidinium cation, N-methyl-N-(2-methoxyphenyl)piperidinium cation, N-methyl-N-(4-methoxyphenyl)piperidinium cation, N-ethyl-N-(2-methoxyphenyl)piperidinium cation, N-ethyl-N-(4-methoxyphenyl)piperidinium cation and the like.

[0041] Further, in the present invention, a quaternary ammonium cation and a quaternary phosphonium cation are used besides the above onium cation of the 5- to 6-membered ring compound having 1 to 3 nitrogen atoms.

[0042] Examples of the above quaternary ammonium cation include N,N,N,N-tetramethylammonium cation, N,N,N-trimethylethylammonium cation, N,N,N-trimethylpropylammonium cation, N,N,N-trimethylbutylammonium cation, N,N,N-trimethylpentylammonium cation, N,N,N-trimethylhexylammonium cation, N,N,N-trimethylheptylammonium cation, N,N,N-trimethyloctylammonium cation, N,N,N-trimethyldecylammonium cation, N,N,N-trimethyldodecylammonium cation, N-ethyl-N,N-dimethylpropylammonium cation, N-ethyl-N,N-dimethylbutylammonium cation, N-ethyl-N,N-dimethylhexylammonium cation, 2-methoxy-N,N,N-trimethylethylammonium cation, 2-ethoxy-N,N,N-trimethylethylammonium cation, 2-propoxy-N,N,N-trimethylethylammonium cation, N-(2-methoxyethyl)-N,N-dimethylpropylammonium cation, N-(2-methoxyethyl)-N,N-dimethylbutylammonium cation and the like.

[0043] Examples of the above quaternary phosphonium cation include quaternary phosphonium cation substituted with an alkyl group having 1 to 16 carbon atoms, such as tetramethylphosphonium cation, tetraethylphosphonium cation, tetrabutylphosphonium cation and the like.

[0044] For the cation moiety of the ionic liquid (A), it is possible to use an anion used in a general ionic liquid, such as, for example, Cl^-, Br^-, $AlCl_4^-$, $Al_2Cl_7^-$, BF_4^-, PF_6^-, ClO_4^-, NO_3^-, CH_3COO^-, CF_3COO^-, $CH_3SO_3^-$, $CF_3SO_3^-$, $(CF_3SO_2)_2N^-$, $(CF_3SO_2)_3C^-$, AsF_6^-, SbF_6^-, NbF_6^-, TaF_6^-, $F(HF)_n^-$, $(CN)_2N^-$, SCN^-, $C_4F_9SO_3^-$, $(C_2F_5SO_2)_2N^-$, $C_3F_7COO^-$, $(CF_3SO_2)(CF_3CO)N^-$ and the like.

[0045] Among them, an anion having a halogen atom is preferred, a fluorine atom-containing anion is particularly preferred, and it is particularly preferred to use a fluorine-containing imide anion represented by the following general formula (1) in that the resulting ionic liquid has a low solubility in water and corresponds to the use purpose as a lubricant.

[Chem. 4]

$$C_nF_{2n+1}SO_2)_2N^- \quad (1)$$

[0046] (In the formula, n is an integer of 0 to 15)

[0047] For the fluorine-containing imide anion represented by general formula (1), the melting point and viscosity of the resulting ionic liquid are changed by the number of carbon n in general formula (1), and thus, it is necessary to select a hydrocarbon group of a chain length which is adapted to use conditions of a device using a lubricant. For the purpose of developing a lubricant in the low temperature region, it is preferred that a low value of n is used. Specifically, a bis(fluorosulfonyl)imide anion or a bis(trifluoromethanesulfonyl)imide anion is preferably used. The n is typically 0 to 15, preferably 0 to 8 and particularly preferably 0 to 4.

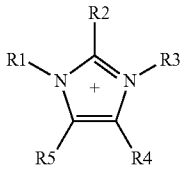
[0048] The preparation method of an ionic liquid is not particularly limited, and a method known in the art, such as an anion exchange method, an acid ester method or the like may be applied. For example, the ionic liquid may be obtained by an anion exchange reaction using a halide salt of the used organic cation and an alkali metal salt of a perfluoroalkyl sulfonate anion. The halogen of the halide salt includes chlorine or bromine. The alkali metal of the alkali metal salt includes sodium, potassium and the like.

[0049] As the imidazolium phosphate ester salt (B) in the present invention (with proviso that (A) is excluded), a salt including an imidazolium cation and a phosphate ester anion

may be used, and when used as a lubricant, it is preferred that a fluorine atom is not contained in that the affinity with metal surface is increased, and thus, it is possible for the salt to be stably adsorbed (remain) on the friction surface of the metal surface such that friction characteristics may be efficiently improved.

[0050] Examples of the imidazolium cation include a cation having a structure of the following general formula (4):

[Chem. 5]



(4)

[0051] (wherein, each of R1 to R5 is independently a hydrogen atom, a halogen atom, a straight chained or branched alkyl group, an alkenyl group, an alkynyl group, an alkoxyl group and an acyl group, which may be straight chained or branched and have 1 to 16 carbon atoms, an amide group, a cyano group, a nitro group and an amino group, and the alkyl group, the alkenyl group, the alkynyl group, the alkoxyl group and the acyl group may include a heteroatom selected from N, S and O, and may include a conjugated or independent double bond or triple bond).

[0052] When the above substituents R1 to R5 are an alkyl group, an alkenyl group, an alkynyl group, an alkoxyl group or an acyl group, the number of carbon atoms thereof is preferably 1 to 16, more preferably 1 to 12, and even more preferably 1 to 6. Those substituents may be a straight chained or have branched structure, but if the carbon number thereof is too high, the intermolecular interaction on side chains thereof acts, and thus, the viscosity thereof tends to increase.

[0053] The above alkyl group, alkenyl group, alkynyl group, alkoxyl group and acyl group may include a heteroatom selected from N, S and O, and the number of heteroatoms to be contained is not particularly limited. In addition, the groups may include a conjugate or independent double bond or triple bond, and the number of unsaturated bonds thereof is not particularly limited as well.

[0054] Specific examples of the alkyl groups include a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, an isobutyl group, a sec-butyl group, a tert-butyl group, a pentyl group, a hexyl group, a heptyl group, an octyl group, a cyclopropyl group, a cyclopentyl group, a cyclohexyl group and the like. Further, examples of the alkenyl group include a vinyl group, an allyl group, a 1-propenyl group, an isopropenyl group, a 2-butenyl group, an 1,3-butadienyl group, a 2-pentenyl group, a 2-hexenyl group and the like. In addition, examples of the alkynyl group include an ethynyl group, a 1-propynyl group, a 2-propynyl group and the like, examples of the alkoxyl group include a methoxy group, an ethoxy group, an n-propoxy group, an isopropoxy group, a t-butoxy group and the like, examples of the acyl group include an acetyl group, a propionyl group, a butyryl group, a benzoyl group and the like, and examples of the amino group also include an N,N-dimethylamino group, an N,N-diethylamino group and the like. Considering the industrial availability, an alkoxyl group, an acyl group, an amide group, a cyano group, a nitro group, an amino group and the like are preferred in that the groups may be easily subjected to decomposition by enzymes to increase the biodegradability thereof.

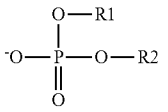
[0055] Specific examples of the imidazolium cation represented by the above formula (4) include dialkylimidazolium cation such as 1,3-dimethylimidazolium cation, 1-ethyl-3-methylimidazolium cation, 1-methyl-3-propylimidazolium cation, 1-butyl-3-methylimidazolium cation, 1-methyl-3-pentylimidazolium cation, 1-hexyl-3-methylimidazolium cation, 1-heptyl-3-methylimidazolium cation, 1-methyl-3-octylimidazolium cation, 1-decyl-3-methylimidazolium cation, 1-dodecyl-3-methylimidazolium cation, 1-hexadecyl-3-methylimidazolium cation, 1-ethyl-3-propylimidazolium cation, 1-butyl-3-ethylimidazolium cation and the like; and trialkylimidazolium cation such as 3-ethyl-1,2-dimethyl-imidazolium cation, 1,2-dimethyl-3-propylimidazolium cation, 1-butyl-2,3-dimethylimidazolium cation, 1,2-dimethyl-3-hexylimidazolium cation, 1,2-dimethyl-3-octylimidazolium cation, 1-ethyl-3,4-dimethylimidazolium cation, 1-isopropyl-2,3-dimethylimidazolium cation and the like.

[0056] Among these imidazolium cations, from the viewpoint of ease of synthesis, a 1,3-disubstituted imidazolium cation and a 1,2,3-trisubstituted imidazolium cation are preferably used, and a 1,3-disubstituted imidazolium cation is particularly preferably used. Each substituent in these derivatives may be the same as or different, from every other substituent, and may contain a multiple bond or a branched chain.

[0057] The above phosphate ester anion may include any of a phosphate ester anion having a monoester structure or a phosphate ester anion having a diester structure, but a phosphate ester anion having a diester structure is preferred because of ease of synthesis.

[0058] As the phosphate ester anion having a diester structure, the anion represented by the following general formula (5) is preferred.

[Chem. 6]



(5)

[0059] (In the formula, each of R1 and R2 is independently an alkyl group having a carbon number of 1 to 8.)

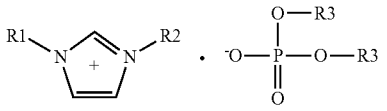
[0060] The number of carbon atoms of the alkyl group of R1 and R2 is typically 1 to 8 and preferably 1 to 4. Each of R1 and R2 may be the same as or different from every other R1 and R2, but it is preferred that R1 and R2 are the same because of ease of synthesis.

[0061] Examples of the phosphate ester anion represented by general formula (5) include dimethyl phosphate anion, diethyl phosphate anion, dipropyl phosphate anion, dibutyl phosphate anion, dipentyl phosphate anion, dihexyl phosphate anion, diheptyl phosphate anion, dioctyl phosphate anion and the like, but among them, dimethyl phosphate anion, diethyl phosphate anion, dipropyl phosphate anion and dibutyl phosphate anion are preferred.

[0062] As the imidazolium phosphate ester salt (B) in the present invention, a compound represented by the following general formula (2) is preferred in that the compound has a

low melting point and is also easily compatible with a fluorine atom-containing ionic liquid which is a main component.

[Chem. 7]



(2)

[0063] (In the formula, each of R1 and R2 is independently an alkyl group having 1 to 16 carbon atoms, and R3 is an alkyl group having 1 to 8 carbon atoms.)

[0064] Specific examples of the compound represented by general formula (2) include a dimethyl phosphate anion-based salt such as 1,3-dimethylimidazolium dimethyl phosphate, 1-ethyl-3-methylimidazolium dimethyl phosphate, 1-methyl-3-propylimidazolium dimethyl phosphate, 1-butyl-3-methylimidazolium dimethyl phosphate, 1-methyl-3-pentylimidazolium dimethyl phosphate, 1-hexyl-3-methylimidazolium dimethyl phosphate, 1-heptyl-3-methylimidazolium dimethyl phosphate, 1-methyl-3-octylimidazolium dimethyl phosphate, 1-methyl-3-nonylimidazolium dimethyl phosphate, 1-decyl-3-methylimidazolium dimethyl phosphate, 1-methyl-3-undecylimidazolium dimethyl phosphate, 1-dodecyl-3-methylimidazolium dimethyl phosphate, 1-hexadecyl-3-methylimidazolium dimethyl phosphate, 1,3-diethylimidazolium dimethyl phosphate, 1-ethyl-3-propylimidazolium dimethyl phosphate, 1-butyl-3-ethylimidazolium dimethyl phosphate, 1-ethyl-3-pentylimidazolium dimethyl phosphate, 1-ethyl-3-hexylimidazolium dimethyl phosphate, 1-ethyl-3-heptylimidazolium dimethyl phosphate, 1-ethyl-3-octylimidazolium dimethyl phosphate, 1-ethyl-3-nonylimidazolium dimethyl phosphate, 1-decyl-3-ethylimidazolium dimethyl phosphate, 1-ethyl-3-undecylimidazolium dimethyl phosphate, 1-dodecyl-3-ethylimidazolium dimethyl phosphate, 1-ethyl-3-hexadecylimidazolium dimethyl phosphate, 1-butyl-3-dodecylimidazolium dimethyl phosphate, 1-butyl-3-hexadecylimidazolium dimethyl phosphate and the like, a diethyl phosphate anion-based salt such as 1,3-dimethylimidazolium diethyl phosphate, 1-ethyl-3-methylimidazolium diethyl phosphate, 1-methyl-3-propylimidazolium diethyl phosphate, 1-butyl-3-methylimidazolium diethyl phosphate, 1-methyl-3-pentylimidazolium diethyl phosphate, 1-hexyl-3-methylimidazolium diethyl phosphate, 1-heptyl-3-methylimidazolium diethyl phosphate, 1-methyl-3-octylimidazolium diethyl phosphate, 1-methyl-3-nonylimidazolium diethyl phosphate, 1-decyl-3-methylimidazolium diethyl phosphate, 1-methyl-3-undecylimidazolium diethyl phosphate, 1-dodecyl-3-methylimidazolium diethyl phosphate, 1-hexadecyl-3-methylimidazolium diethyl phosphate, 1,3-diethylimidazolium diethyl phosphate, 1-ethyl-3-propylimidazolium diethyl phosphate, 1-butyl-3-ethylimidazolium diethyl phosphate, 1-ethyl-3-pentylimidazolium diethyl phosphate, 1-ethyl-3-hexylimidazolium diethyl phosphate, 1-ethyl-3-heptylimidazolium diethyl phosphate, 1-ethyl-3-octylimidazolium diethyl phosphate, 1-ethyl-3-nonylimidazolium diethyl phosphate, 1-decyl-3-ethylimidazolium diethyl phosphate, 1-ethyl-3-undecylimidazolium diethyl phosphate, 1-dodecyl-3-ethylimidazolium diethyl phosphate, 1-ethyl-3-hexadecylimidazolium diethyl phosphate, 1-butyl-3-dodecylimidazolium diethyl phosphate, 1-butyl-3-hexadecylimidazolium diethyl phosphate and the like, a dipropyl phosphate anion-based salt such as 1,3-dimethylimidazolium dipropyl phosphate, 1-ethyl-3-methylimidazolium dipropyl phosphate, 1-methyl-3-propylimidazolium dipropyl phosphate, 1-butyl-3-methylimidazolium dipropyl phosphate, 1-methyl-3-pentylimidazolium dipropyl phosphate, 1-hexyl-3-methylimidazolium dipropyl phosphate, 1-heptyl-3-methylimidazolium dipropyl phosphate, 1-methyl-3-octylimidazolium dipropyl phosphate, 1-methyl-3-nonylimidazolium dipropyl phosphate, 1-decyl-3-methylimidazolium dipropyl phosphate, 1-methyl-3-undecylimidazolium propyl phosphate, 1-dodecyl-3-methylimidazolium dipropyl phosphate, 1-hexadecyl-3-methylimidazolium dipropyl phosphate, 1,3-diethylimidazolium dipropyl phosphate, 1-ethyl-3-propylimidazolium dipropyl phosphate, 1-butyl-3-ethylimidazolium dipropyl phosphate, 1-ethyl-3-pentylimidazolium dipropyl phosphate, 1-ethyl-3-hexylimidazolium dipropyl phosphate, 1-ethyl-3-heptylimidazolium dipropyl phosphate, 1-ethyl-3-octylimidazolium dipropyl phosphate, 1-ethyl-3-nonylimidazolium dipropyl phosphate, 1-decyl-3-ethylimidazolium dipropyl phosphate, 1-ethyl-3-undecylimidazolium dipropyl phosphate, 1-dodecyl-3-ethylimidazolium dipropyl phosphate, 1-ethyl-3-hexadecylimidazolium dipropyl phosphate, 1-butyl-3-dodecylimidazolium dipropyl phosphate, 1-butyl-3-hexadecylimidazolium dipropyl phosphate and the like, and a dibutyl phosphate anion-based salt such as 1,3-dimethylimidazolium dibutyl phosphate, 1-ethyl-3-methylimidazolium dibutyl phosphate, 1-methyl-3-propylimidazolium dibutyl phosphate, 1-butyl-3-methylimidazolium dibutyl phosphate, 1-methyl-3-pentylimidazolium dibutyl phosphate, 1-hexyl-3-methylimidazolium dibutyl phosphate, 1-heptyl-3-methylimidazolium dibutyl phosphate, 1-methyl-3-octylimidazolium dibutyl phosphate, 1-methyl-3-nonylimidazolium dibutyl phosphate, 1-decyl-3-methylimidazolium dibutyl phosphate, 1-methyl-3-undecylimidazolium dibutyl phosphate, 1-dodecyl-3-methylimidazolium dibutyl phosphate, 1-hexadecyl-3-methylimidazolium dibutyl phosphate, 1,3-diethylimidazolium dibutyl phosphate, 1-ethyl-3-propylimidazolium dibutyl phosphate, 1-butyl-3-ethylimidazolium dibutyl phosphate, 1-ethyl-3-pentylimidazolium dibutyl phosphate, 1-ethyl-3-hexylimidazolium dibutyl phosphate, 1-ethyl-3-heptylimidazolium dibutyl phosphate, 1-ethyl-3-octylimidazolium dibutyl phosphate, 1-ethyl-3-nonylimidazolium dibutyl phosphate, 1-decyl-3-ethylimidazolium dibutyl phosphate, 1-ethyl-3-undecylimidazolium dibutyl phosphate, 1-dodecyl-3-ethylimidazolium dibutyl phosphate, 1-ethyl-3-hexadecylimidazolium dibutyl phosphate, 1-butyl-3-dodecylimidazolium dibutyl phosphate, 1-butyl-3-hexadecylimidazolium dibutyl phosphate and the like, and among them, it is preferred to contain a dipropyl phosphate anion-based salt or a dibutyl phosphate anion-based salt in that the salt has excellent compatibility with the ionic liquid and lubrication characteristics.

[0065] The blending amount of the imidazolium phosphate ester salt (B) is, for example, preferably 0.001 parts by weight to 5 parts by weight, particularly preferably 0.01 parts by weight to 2 parts by weight, and more particularly preferably 0.05 parts by weight to 1 part by weight, based on 100 parts by

weight of the ionic liquid (A). When the blending amount of the compound (B) is too small, the function as a lubricating oil additive tends to be difficult to be exhibited. When the amount is too large, the compound (B) tends not to be uniformly distributed or dissolved in the lubricant.

[0066] In the present invention, including the ionic liquid "as a main component" indicates that a synthetic lubricant contains typically 50 wt % or more, preferably 70 wt % or more, and particularly preferably 80 wt % or more of the ionic liquid.

[0067] The synthetic lubricant of the present invention is obtained by, for example, a method of appropriately blending the ionic liquid (A) with the imidazolium phosphate ester salt (B), and if necessary, stirring the resulting mixture while heating, and the like.

[0068] The ionic liquid composition obtained may be in a solution state where the imidazolium phosphate ester salt (B) is dissolved in the ionic liquid (A), and may be in a state where the imidazolium phosphate ester salt (B) is dispersed in the ionic liquid (A).

[0069] In addition, the synthetic lubricant of the present invention may include, if necessary, various additives known in the related art, such as a lubricating oil base oil, an extreme pressure agent, an oiliness agent and the like in such an amount that the effects of the present invention may not be impaired.

[0070] The synthetic lubricant thus obtained, including the ionic liquid (A) and the imidazolium phosphate ester salt (B), may vary depending on use conditions of the lubricant and the like, but it is preferred that the following lubrication performance is satisfied.

[0071] If the object is to use a lubricant having low viscosity, the typical viscosity of the synthetic lubricant at 25° C. is preferably 30 mPa·s or less, and more preferably 20 mPa·s or less. When the viscosity is too high, energy loss caused by the viscosity of the lubricant itself tends to be generated. Further, the lower limit of the viscosity is typically 2 mPa·s, and when the viscosity is less than the lower limit, the synthetic lubricant tends to be easily scattered because of low viscosity.

[0072] The viscosity index of the synthetic lubricant is preferably 180 or more, more preferably 200 or more, and particularly preferably 220 or more. Here, the viscosity index is an index showing the relationship between temperature and viscosity, and a calculating method for viscosity index is stipulated in the Japanese Industrial Standards (JIS) K2283 (a testing method for kinematic viscosity of crude oil and petroleum products and a calculating method for viscosity index of petroleum products).

[0073] Meanwhile, the higher the viscosity index is, the smaller the change in viscosity by temperature is, indicating that the lubricant is excellent as a lubricant.

[0074] The lubricant may be considered in the case where the height of absolute viscosity is of importance depending on its use, or in the case where other physical properties such as contact angle with a metal and the like are regarded as more important than the absolute viscosity. At that time, depending on necessary physical properties, the organic cation is selected from an imidazolium cation, a pyrridinium cation, a quaternary ammonium cation and a quaternary phosphonium cation, and physical properties are controlled by changing substituents, if necessary. Even in this case, the viscosity index is regarded as an important physical property. When the viscosity index is less than the lower limit, the ratio of change in viscosity by temperature tends to be too high.

[0075] The synthetic lubricant of the present invention has excellent viscosity characteristics that the ionic liquid has, and combines various physical properties such as non-volatility, thermal stability and the like with lubricating ability and rust preventive property, which may not be obtained by the ionic liquid alone, and thus, may be widely used as a lubricant for mechanical devices such as automobiles, electronic products and the like, power transmission devices, and precision machines, a metal working oil and a lubricant under special environments.

Example

[0076] Hereinafter, the present invention will be described in more detail with reference to Examples, but the present invention is not limited to the following Example as long as the gist thereof is not deviated. Meanwhile, in Examples, "part" and "%" mean on the basis of weight unless otherwise stated.

Preparation Example of Fluorine Atom-Containing Ionic Liquid (A)

Preparation Example 1

Synthesis of 1-ethyl-3-methylimidazolium bis(fluorosulfonyl)imide (A-1)

[0077] 6.28 g (76.5 mmol) of 1-methylimidazole was placed in a flask equipped with a reflux condenser, 33.01 g (302.9 mmol) of ethyl bromide and 8.20 g of acetonitrile were added thereto, and reaction was performed at 40° C. for 8 hr to obtain 13.41 g (70.2 mmol, yield 91.8%) of 1-ethyl-3-methylimidazolium bromide. 11.04 g (57.8 mmol) of the obtained 1-ethyl-3-methylimidazolium bromide and 13.29 g (60.6 mmol) of potassium salt of bis(fluorosulfonyl)imide were reacted in 20 g of water at 50° C. for 4 hr, and then 50 ml of methylene chloride was added thereto to separate a methylene chloride layer. The methylene chloride layer was washed with water, followed by drying under reduced pressure to obtain 15.85 g (54.4 mmol, yield 94.2%) of 1-ethyl-3-methylimidazolium bis(fluorosulfonyl)imide.

Preparation Example 2

Synthesis of 1-ethyl-3-methylimidazolium bis(trifluoromethanesulfonyl)imide (A-2)

[0078] 11.04 g (60.6 mmol) of the 1-ethyl-3-methylimidazolium bromide obtained by the same method as in Preparation Example 1 and 20.33 g (63.66 mmol) of potassium salt of bis(trifluoromethanesulfonyl)imide anion were reacted in 20 g of water-methylene chloride at 40° C. for 4 hr, then the aqueous layer was separated by a separatory funnel and washed with water, followed by drying under reduced pressure to obtain 22.53 g (57.6 mmol, yield 95%) of 1-ethyl-3-methylimidazolium bis(trifluoromethanesulfonyl)imide.

Preparation Example 3

Synthesis of 1-methyl-3-octylimidazolium bis(trifluoromethanesulfonyl)imide (A-3)

[0079] Except that 1-ethyl-3-methylimidazolium bromide in Preparation Example 2 was changed into 16.7 g of 1-methyl-3-octylimidazolium bromide, synthesis was performed in the same manner as in Preparation Example 2 to obtain 26.2 g (yield 91%) of the desired 1-methyl-3-octylimidazolium bis(trifluoromethanesulfonyl)imide.

Preparation Example of Imidazolium Phosphate Ester Salt (B)

[0080] The following imidazolium phosphate ester salt (B) was synthesized in accordance with WO2008-114584 and Feul vol. 87 page 79-84 2008.

Preparation Example 4

Synthesis of 1-ethyl-3-methylimidazolium dimethyl phosphate (B-1)

[0081] 17.5 g of trimethyl phosphate was placed in 10.0 g of 1-ethylimidazole, followed by heating at 80° C. for 72 hr. After heating, the mixture was cooled to room temperature and was washed with 50 ml of toluene five times. 1-Ethyl-3-methylimidazolium dimethyl phosphate in the lower layer was dried under vacuum at 60° C. to obtain 24.4 g of the titled material.

Preparation Example 5

Synthesis of 1-dodecyl-3-methylimidazolium dimethyl phosphate (B-2)

[0082] Except that 10.0 g of 1-ethylimidazole in Preparation Example 4 was changed into 10.0 g of 1-dodecylimidazole and 17.5 g of trimethyl phosphate was changed into 7.1 g, operation was performed in the same manner to obtain 15.4 g of the titled material.

Preparation Example 6

Synthesis of 1-hexadecyl-3-methylimidazolium dimethyl phosphate (B-3)

[0083] Except that 10.0 g of 1-ethylimidazole in Preparation Example 4 was changed into 10.0 g of 1-hexadecylimidazole and 17.5 g of trimethyl phosphate was changed into 5.7 g, operation was performed in the same manner to obtain 13.2 g of the titled material.

Preparation Example 7

Synthesis of 1-ethyl-3-methylimidazolium diethyl phosphate (B-4)

[0084] Except that 10.0 g of 1-ethylimidazole in Preparation Example 4 was changed into 10.0 g of 1-methylimidazole and 17.5 g of trimethyl phosphate was changed into 26.7 g of triethyl phosphate, operation was performed in the same manner to obtain 33.1 g of the titled material.

Preparation Example 8

Synthesis of 1-ethyl-3-dodecylimidazolium diethyl phosphate (B-5)

[0085] Except that 10.0 g of 1-ethylimidazole in Preparation Example 4 was changed into 10.0 g of 1-dodecylimidazole, 17.5 g of trimethyl phosphate was changed into 9.3 g of triethyl phosphate, and 50 ml of toluene was changed into 15 ml of dibutyl ether, operation was performed in the same manner to obtain 7.2 g of the titled material.

Preparation Example 9

Synthesis of 1-butyl-3-ethylimidazolium dibutyl phosphate (B-6)

[0086] 33.3 g of tributyl phosphate was placed in 10.0 g of 1-ethylimidazole, followed by heating at 120° C. for 120 hr. After heating, the mixture was cooled to room temperature and was washed with 50 ml of hexane six times. 1-butyl-3-ethylimidazolium dibutyl phosphate in the lower layer was dried under vacuum at 60° C. to obtain 25.0 g of the titled material.

Preparation Example 10

Synthesis of 1-butyl-3-dodecylimidazolium dibutyl phosphate (B-7)

[0087] Except that 10.0 g of 1-ethylimidazole in Preparation Example 9 was changed into 10.0 g of 1-dodecylimidazole and the amount of tributyl phosphate was changed into 13.5 g, operation was performed in the same manner to obtain 6.5 g of the titled material.

Preparation Example 11

Synthesis of 1-butyl-3-hexadecylimidazolium dibutyl phosphate (B-8)

[0088] Except that 10.0 g of 1-ethylimidazole in Preparation Example 9 was changed into 10.0 g of 1-hexadecylimidazole and the amount of tributyl phosphate was changed into 10.9 g, operation was performed in the same manner to obtain 8.7 g of the titled material.

Preparation Example 12

Synthesis of 1-(O,O,dimethylphosphoryl)-3-n-octylimidazolium PF_6 salt

[0089] 3 mol of dimethyl phosphate chloride ester was added to 1 mol of 1-octylimidazole, 100 ml of methylene chloride was placed therein, followed by stirring under reflux for several days to concentrate methylene chloride, washing with a solvent, and drying to obtain 1-(O,O,dimethylphosphoryl)-3-n-octylimidazolium chloride. 1 mol of KPF_6 and 300 ml of water were placed in 1 mol of 1-(O,O,dimethylphosphoryl)-3-n-octylimidazolium chloride, followed by stirring at room temperature for 5 hr, separating the liquid, and then drying the lower layer to quantitatively obtain 1-(O,O,dimethylphosphoryl)-3-n-octylimidazolium hexafluorophosphate.

Examples 1 to 5

[0090] Synthetic lubricants in Examples 1 to 5 were obtained by adding each of 0.5 parts by weight of imidazolium phosphate ester salt (B-1, 4 to 7) to 100 parts by weight of the ionic liquid (A-1) obtained in Preparation Example 1 and sufficiently mixing and stirring the mixture with heating to 40° C.

Comparative Example 1

[0091] A synthetic lubricant was obtained in the same manner as in Examples 1 to 5, except that the imidazolium phosphate ester salt (B) was not used in the ionic liquid (A-1).

Example 6

[0092] A synthetic lubricant in Examples 6 was obtained by adding 0.5 parts by weight of imidazolium phosphate ester salt (B-5) to 100 parts by weight of the ionic liquid (A-2) obtained in Preparation Example 2 and sufficiently mixing and stirring the mixture with heating to 40° C.

Comparative Example 2

[0093] A synthetic lubricant was obtained in the same manner as in Example 6, except that the imidazolium phosphate ester salt (B) was not used in the ionic liquid (A-2).

Examples 7 to 13

[0094] Synthetic lubricants in Examples 7 to 13 were obtained by adding each of 0.5 parts by weight of imidazolium phosphate ester salt (B-2 to 8) to 100 parts by weight of the ionic liquid (A-3) obtained in Preparation Example 3 and sufficiently mixing and stirring the mixture with heating to 40° C.

Comparative Example 3

[0095] A synthetic lubricant was obtained in the same manner as in Examples 7 to 13, except that the imidazolium phosphate ester salt (B) was not used in the ionic liquid (A-3).

Example 14

[0096] A synthetic lubricant in Examples 14 was obtained by adding 0.5 parts by weight of imidazolium phosphate ester salt (B-6) to 100 parts by weight of the ionic liquid (A-1) obtained in Preparation Example 1 and sufficiently mixing and stirring the mixture with heating to 40° C.

Comparative Example 4

[0097] A synthetic lubricant in Comparative Example 4 was obtained by adding 0.5 parts by weight of 1-(O,O,dimethylphosphoryl)-3-n-octylimidazolium PF_6 salt (hereinafter, described as $[PO(OMe)_2O_cI_m]PF_6$) to 100 parts by weight of the ionic liquid (A-1) obtained in Preparation Example 1 and sufficiently mixing and stirring the mixture with heating to 40° C.

Comparative Example 5

[0098] A synthetic lubricant was obtained in the same manner as in Example 14, except that the imidazolium phosphate ester salt (B-6) was not used in the ionic liquid (A-1).

[0099] The following lubrication performance evaluation and rust preventing performance evaluation were performed on the synthetic lubricants obtained. The results are shown in Table 1.

[0100] Lubrication Performance Evaluation

[0101] <Friction Coefficient>

[0102] A lubricating oil friction tester (manufactured by Kyoshin Inc., "KT-1203") was used to measure a friction coefficient under the following conditions. Meanwhile, the value of the friction coefficient was shown as an average value obtained by excluding the initial measurement value (from 0 to 30 sec) from the total coefficient data obtained during the measurement time under the following conditions.

[0103] [Measuring Conditions]

[0104] Experimental material: 3/16 inch-SUJ-2 steel ball, SCM435 bearing steel plate (ϕ25 mm×5 mm, HRC>40, Rz≈0.8 (μm))

[0105] Applied load: 0.1 kgf

[0106] Friction speed: 5 mm/sec

[0107] Double stroke: 5 mm

[0108] Data recording interval: 4 sec

[0109] Measuring temperature: Examples 1 to 5 and Comparative Example 1; from room temperature to 150° C. (stepwise heating)

[0110] : Examples 6 to 14 and Comparative Examples 2 to 5; from room temperature to 200° C. (stepwise heating)

[0111] Measuring time: for 20 min

[0112] <Friction Volume>

[0113] The friction volume was obtained by the following equation from the wear scar diameter (minor axis: a, major axis: b) of the SUJ-2 steel ball after the completion of the friction test.

[0114] Friction volume=πa3b/32D (D: steel ball diameter) (Unit: μm^3)

[0115] [Criteria]

[0116] A . . . Less than 4,000 μm^3

[0117] B . . . 4,000 μm^3 or more and less than 10,000 μm^3

[0118] C . . . 10,000 μm^3 and more and less than 20,000 μm^3

[0119] D . . . 20,000 μm^3 or more

[0120] Rust Preventing Performance Evaluation

[0121] It was decided whether rust was generated on the wear scar produced on the test steel plate after the completion of the friction test.

[0122] [Criteria]

[0123] A . . . Rust not acknowledged even though the wear scar on the test steel plate was magnified and observed

[0124] B . . . Rust acknowledged when the wear scar on the test steel plate was magnified and observed

[0125] C . . . Rust acknowledged with naked eyes on the wear scar on the test steel plate

TABLE 1

	Fluorine atom-containing ionic liquid (A)	imidazolium phosphate ester salt (B)	Lubrication performance evaluation: Friction coefficient	Friction volume: Measurement value (μm^3)	Friction volume: Evaluation	Rust preventing performance evaluation
Example 1	A-1	B-1	0.153	19,000	C	B
Example 2	A-1	B-4	0.142	8,000	B	A
Example 3	A-1	B-5	0.126	9,000	B	A
Example 4	A-1	B-6	0.152	3,600	A	A
Example 5	A-1	B-7	0.152	2,900	A	A
Comparative Example 1	A-1	—	0.183	22,000	D	C

TABLE 1-continued

	Fluorine atom-containing ionic liquid (A)	imidazolium phosphate ester salt (B)	Lubrication performance evaluation: Friction coefficient	Friction volume: Measurement value (μm^3)	Friction volume: Evaluation	Rust preventing performance evaluation
Example 6	A-2	B-5	0.14	2,600	A	A
Comparative Example 2	A-2	—	0.186	50,000	D	C
Example 7	A-3	B-2	0.171	8,400	B	A
Example 8	A-3	B-3	0.15	6,600	B	A
Example 9	A-3	B-4	0.154	2,700	A	A
Example 10	A-3	B-5	0.146	3,100	A	A
Example 11	A-3	B-6	0.131	1,700	A	A
Example 12	A-3	B-7	0.135	1,300	A	A
Example 13	A-3	B-8	0.134	630	A	A
Comparative Example 3	A-3	—	0.212	51,000	D	C
Example 14	A-1	B-6	0.118	1,800	A	A
Comparative Example 4	A-1	$[PO(OMe)_2O_cL_m]PF_6$	0.155	30,000	D	B
Comparative Example 5	A-1	—	0.188	30,500	D	C

* In Table, — indicates no addition.

[0126] From the result in Table 1, it can be understood that the synthetic lubricant in which imidazolium phosphate ester salt was blended with the ionic liquid in Examples has better friction performance and rust preventing performance than those of the synthetic lubricant in which imidazolium phosphate ester salt was not blended in Comparative Examples.

[0127] Further, from Comparative Example 4, it can be understood that the imidazolium phosphate ester salt of the present invention having a phosphate ester structure on the anion moiety has better effects as a friction adjuster than a salt having a phosphate ester structure on the cation moiety.

[0128] This indicates that the imidazolium phosphate ester salt of the present invention is a useful compound as a friction adjuster and a rust preventive agent of a synthetic lubricant including an ionic liquid as a main component.

[0129] Although the present application has been described with reference to detailed and specific embodiments thereof, it is obvious to those skilled in the art that various changes or modifications may be made without departing from the spirit and scope of the present invention.

[0130] The present application is based on Japanese Patent Application (Patent Application 2010-019934) filed on Feb. 1, 2010, the content of which is incorporated herein by reference.

INDUSTRIAL APPLICABILITY

[0131] The lubricant composition of the present invention has essential lubrication performance when the composition retaining characteristics of an ionic liquid as a base oil of a lubricating oil is put to practical use, which is improved by additives, and is useful as a lubricant for mechanical devices such as automobiles, ships, electronic products and the like, power transmission devices, and precision machines and a lubricant under special environments.

1. A synthetic lubricant including a fluorine atom-containing ionic liquid (A) as a main component, wherein the synthetic lubricant contains an imidazolium phosphate ester salt (B).

2. The synthetic lubricant according to claim **1**, wherein a cation moiety of the fluorine atom-containing ionic liquid (A) is an imidazolium cation.

3. The synthetic lubricant according to claim **1**, wherein an anion moiety of the fluorine atom-containing ionic liquid (A) is a fluorine-containing imide anion represented by the following formula (1):

$$(C_nF_{2n+1}SO_2)_2N^- \quad (1)$$

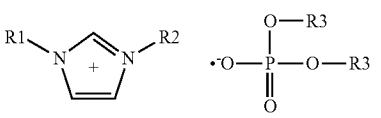
wherein n is an integer of 0 to 15.

4. The synthetic lubricant according to claim **1**, wherein the anion moiety of the fluorine atom-containing ionic liquid (A) is bis(fluorosulfonyl)imide or bis(trifluoromethanesulfonyl) imide.

5. The synthetic lubricant according to claim **1**, wherein the imidazolium cation of the imidazolium phosphate ester salt (B) is a 1,3-disubstituted imidazolium cation.

6. The synthetic lubricant according to claim **1**, wherein the phosphate ester anion of the imidazolium phosphate ester salt (B) is a phosphate ester anion having a diester structure.

7. The synthetic lubricant according to claim **1**, wherein the imidazolium phosphate ester salt (B) is a compound represented by the following formula (2):



(2)

wherein each of R1 and R2 is independently an alkyl group having 1 to 16 carbon atoms, and R3 is an alkyl group having 1 to 8 carbon atoms.

* * * * *