

(19)



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(11)

EP 0 881 276 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

02.12.1998 Bulletin 1998/49

(51) Int Cl.⁶: **C10M 129/10**, C10M 129/36,
C10M 129/44, C10M 135/10,
C10M 135/30, C10M 137/12,
C10M 159/20, C10M 159/22,
C10M 159/24
// C10N30:06

(21) Application number: **98304250.8**

(22) Date of filing: **29.05.1998**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

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(30) Priority: **30.05.1997 JP 157887/97**
31.03.1998 JP 104090/98

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(54) Lubricating oil composition containing a mixture of metal salts of aromatic organic acids

(57) To provide a novel lubricating oil composition containing an organic acid metal salt having excellent friction coefficient reducing effects.

A lubricating oil composition comprising a lubricating base stock and an effective amount of a mixture of metal salts of chain-hydrocarbon-group-substituted ar-

omatic organic acids. Each of the aromatic groups has been substituted by at least one chain hydrocarbon group. The number of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group bonded thereto is in a range of from 30% to 90% of the total number of the chain hydrocarbon groups.

EP 0 881 276 A2

DescriptionBACKGROUND OF THE INVENTION5 FIELD OF THE INVENTION

This invention relates to a lubricating oil composition, and more specifically to a lubricating oil composition with a novel metal salt of an organic acid added therein, said metal salt having a chain-hydrocarbon-group-substituted aromatic structure and high friction characteristics improving effects.

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DESCRIPTION OF THE PRIOR ART

It is the fundamental theme of lubrication to reduce friction and wear which occur at sliding surfaces of moving parts in machineries, devices, equipments and the like. Technical developments have been continued for many years. In recent years, still further improvements are required in lubrication technology for the reduction of friction and wear in the field of lubrication especially from the viewpoint of resource and energy saving, and in attempts to achieve low friction and low wear by improvements in the quality of lubricating oils, investigations are now under way from a variety of viewpoints. For the production of a lubricating oil excellent in friction characteristics with such technical developments as a basis, it has already become indispensable to incorporate additives in base stocks for lubricating oils so that the base stocks can be provided with desired friction characteristics. Accordingly a number of various friction modifiers have been proposed, resulting in the use of fatty acids and their metal salts, alcohols, esters, amines and the like - all of which are of the oiliness improver type - and phosphate esters, phosphite esters, zinc dithiophosphate and the like - all of which are of the extreme pressure agent type - in automatic transmission fluids, wet brake oils, sliding surface oils, plastic working oils and the like; and also in the use of phosphate esters, phosphite esters, acidic phosphite ester amine salts, molybdenum dithiophosphate, molybdenum dithiocarbamate and the like - all of which are of the extreme pressure agent type - in engine oils, gear oils, cutting oils and the like.

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Meanwhile, an automatic transmission fluid has been proposed, which contains magnesium sulfonate, especially over-based magnesium sulfonate having a base number of 300 mg-KOH/g or greater and added to improve its friction characteristics (see JP Kokai 62-84190). Further, it has also been proposed to use calcium salicylate, which has been used as a metallic detergent, as a friction coefficient modifier for automatic transmission fluids (see JP Kokai 5-163496).

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No matter whether these conventionally-proposed friction modifiers are of the organic type or of the metallic type, their friction reducing effects are however not sufficient. Especially, magnesium sulfonate, calcium salicylate and the like are still insufficient in assuring stable reducing effects for friction characteristic as their effects vary significantly depending on the kind and use conditions of a lubricating base stock, although they provide friction reducing effects to some extents. Therefore they merely exhibit advantageous effects as friction-reducing adjuvants which show their effects when employed in combination with other friction modifiers. If an organic acid metal salt is discovered with long-lasting stable friction reducing effects, it will find utility in a much wider range of fields and hence to have a significantly-increased industrial value. Its development has therefore been desired strongly.

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In view of the technical developments on friction reducing technology in lubrication field and the circumstances of development of conventional friction modifiers as described above, the present invention has as an object thereof the provision of a lubricating oil composition which contains a novel metal salt of an organic acid, said metal salt having friction characteristics improving ability.

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PRESENT INVENTION

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It has been found that it is important for an organic acid metal salt to have a specific chain-hydrocarbon-group-substituted aromatic structure and also that an organic acid metal salt, said metal salt being a metal salt of an aromatic organic acid having a chain hydrocarbon group with the aromatic group thereof being bonded to the chain hydrocarbon group at a particular position of the chain hydrocarbon group, is excellent in friction characteristics improving effects. Based on these findings, the present inventors have come to the completion of the present invention.

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Namely, the present invention relates to a lubricating oil composition characterized in that said composition comprises:

a lubricating base stock; and

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a mixture of metal salts of chain-hydrocarbon-group-substituted aromatic organic acids, each of said aromatic groups having been substituted by at least one chain hydrocarbon group, and the number of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group being in a range of from 30% to 90%

of the total number of said chain hydrocarbon groups.

The present invention will hereinafter be described in detail.

No particular limitation is imposed on the lubricating base stock which is used as a component of the lubricating oil composition according to the present invention. The base stock can be any one of those conventionally used as base stocks for lubricating oils, for example, any one of mineral base stocks, synthetic base stocks and vegetable base stocks, or can be a blended base stock of two or more of these base stocks.

As a mineral base stock, it is possible to use, for example, a mineral oil obtained by the treatment of a lubricating oil fraction, which is in turn available by vacuum distillation of an atmosphere distillation residue of paraffin-base, neutral or naphthene-base crude oil, through a refining step such as solvent refining, hydrocracking, hydrotreatment, hydrorefining, catalytic dewaxing, solvent dewaxing or clay treatment; a mineral oil obtained by subjecting a vacuum distillation residue to solvent deasphalting and then treating the resulting deasphalted oil through the above-described refining step; a mineral oil obtained by isomerizing wax components; or a blended oil thereof. In the above solvent refining, an aromatic extraction solvent such as phenol, furfural or N-methylpyrrolidone can be used, whereas as a solvent for the solvent dewaxing, liquefied propane, MEK/toluene, MEK/MIBK, or the like can be used. Further, shape-selective zeolites can also be used in catalytic dewaxing.

Examples of synthetic base stocks, on the other hand, can include poly(α -olefin) oligomers; polybutene; alkylbenzenes; polyol esters such as trimethylolpropane esters and pentaerythritol esters; polyoxyalkylene glycols; polyoxyalkylene glycol esters; polyoxyalkylene glycol ethers; dibasic acid esters; phosphate esters; and silicone oils.

Further, usable examples of vegetable base stocks can include castor oil, rape seed oil, palm oil, coconut oil, olive oil and sunflower oil.

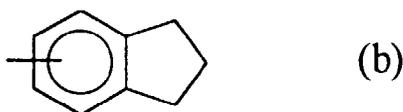
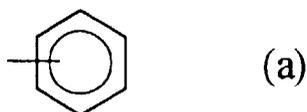
As various lubricating base stock such as those described above, it is possible to use a blended base stock obtained by suitably blending plural base stocks so that the blended base stock has a viscosity and other properties desired for the intended application of the lubricating oil composition. For example, it is preferred to control the kinematic viscosity at 100°C in a range of from 2 mm²/s to 30 mm²/s, especially from 3 mm²/s to 10 mm²/s for a lubricating oil for internal combustion engines, and the kinematic viscosity at 100°C in a range of from 2 mm²/s to 30 mm²/s, especially from 3 mm²/s to 15 mm²/s for an automatic transmission fluid.

The organic acid metal salt added in the lubricating oil composition according to the present invention is composed of an organic acid portion, which has a chain-hydrocarbon-group-substituted aromatic structure, and a metal component portion. Specific examples can include metal sulfonates, metal phenates, metal phenate sulfides, metal salicylates, metal salicylate sulfides, metal phosphonates, and the like.

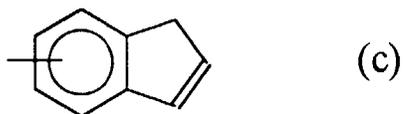
The metal component of the organic acid metal salt according to the present invention can be an alkali metal or an alkaline earth metal. Generally, a metal of an atomic number in a range of from 3 to 56 can also be mentioned. Specific examples can include sodium, potassium, lithium, calcium, magnesium and barium. In addition, aluminum, zinc, tin, chromium, copper, cobalt and the like are also usable. In particular, calcium, magnesium, barium and the like are preferred.

Accordingly, preferred examples of the organic acid metal salt according to the present invention include the sulfonates, phenates, salicylates and the like of alkaline earth metals such as calcium, magnesium and barium.

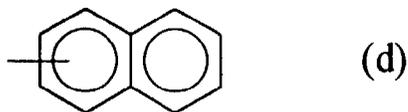
The chain-hydrocarbon-group-substituted aromatic structure of the organic acid metal salt according to the present invention is composed of aromatic groups, as substituent groups, and a chain hydrocarbon group bonded together. Each of the aromatic groups bonded to the chain hydrocarbon group can be either monocyclic or fused polycyclic. Those represented by the following formulas (a) to (g), respectively, are effective, with a phenyl group (a) and a naphthyl group (d) being particularly preferred.



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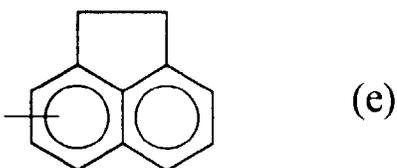


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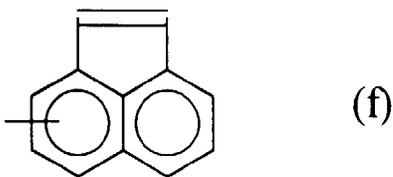
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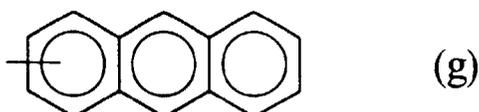


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40 No particular limitation is imposed on the chain hydrocarbon group of the chain-hydrocarbon-group-substituted aromatic structure, but alkyl and alkenyl groups and the like with 4-32 carbon atoms are preferred. Specific examples can include alkyl groups such as butyl, pentyl, hexyl, octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, penta-
 45 decyl, hexadecyl, heptadecyl, octadecyl, nonadecyl, eicosyl, tetracosyl, pentacosyl, hexacosyl, heptacosyl, octacosyl, nonacosyl and triacontyl and their corresponding alkenyl groups. Further, these alkyl and alkenyl groups may contain one or more groups such as allyl, ester, ketone, ether, amine, amide, imide and/or like groups.

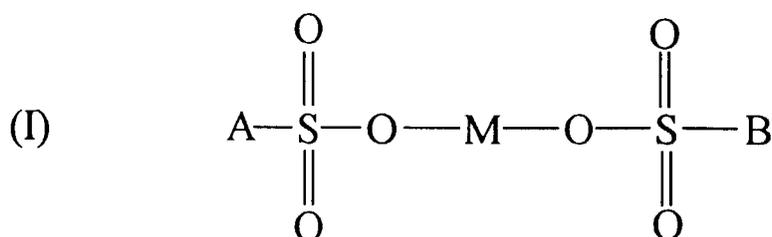
Specific examples of the chain-hydrocarbon-group-substituted aromatic structure of the organic acid metal salt according to the present invention can include alkylbenzenes, alkenylbenzenes, alkylnaphthalenes, alkenylnaphthalenes, alkylanthracenes, alkenylanthracenes, and the like. In the organic acid metal salt of the present invention, alkyl-
 50 benzenes, alkenylbenzenes, alkylnaphthalenes, alkenylnaphthalenes and the like are particularly preferred. The number of substituted alkyl groups in the chain-hydrocarbon-group-substituted aromatic structure, for example, an alkylbenzene may range from 1 to 4, and the particularly-preferred chain-hydrocarbon-group-substituted aromatic structure is one containing at least 25% of a chain-hydrocarbon-group-substituted aromatic structure which contains one substituted alkyl group.

55 In the chain-hydrocarbon-group-substituted aromatic structure of each organic acid metal salt according to the present invention, the chain hydrocarbon group may be one carrying an associated aromatic group at C-2, C-3, C-4 or another carbon of the chain hydrocarbon group. According to an investigation by the present inventors, however, it has become evident that a mixture of chain-hydrocarbon-group-substituted aromatic structures of organic acid metal salts, in which the sum of the number of chain hydrocarbon groups each carrying at C-2 thereof an associated aromatic

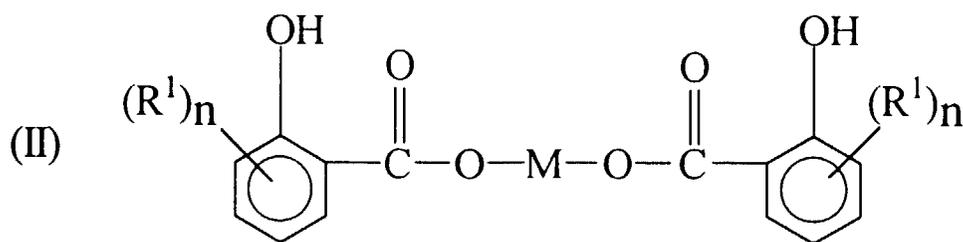
group bonded thereto and the number of chain hydrocarbon groups each carrying at C-3 thereof an associated aromatic group bonded thereto falls within a range of from at least 30%, preferably 30% to 90%, especially from 35% to 70% of the total number of the chain hydrocarbon groups, is particularly good in friction reducing effects. If the number of the chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group bonded thereto does not reach 30%, no sufficient friction coefficient reducing effects can be brought about. Even if this number exceeds 90%, the friction coefficient reducing effects cannot be obtained to such an extent as corresponding to the increased proportion.

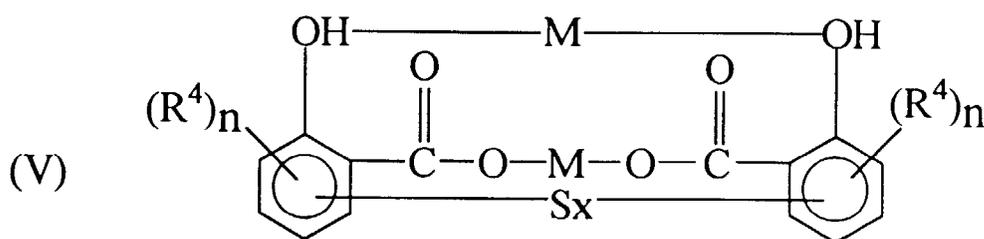
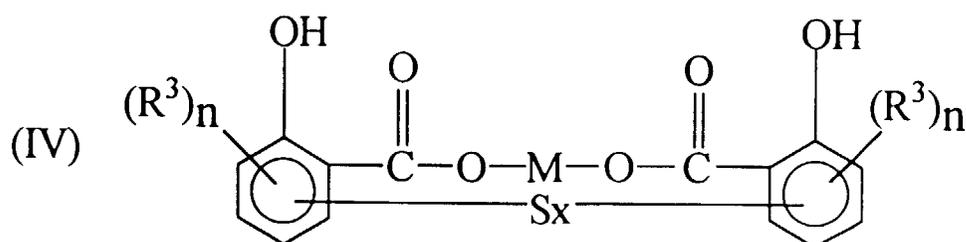
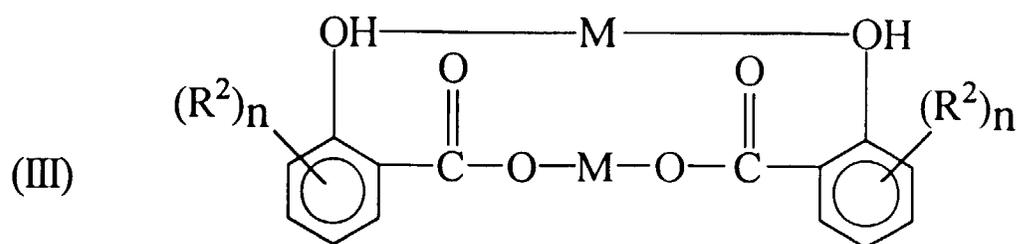
Further, if the number of chain hydrocarbon groups each carrying at C-2 thereof the associated aromatic group bonded thereto accounts for 10% or more of the total number of the chain hydrocarbon groups, the friction coefficient improving effects are improved further. A chain-hydrocarbon-group-substituted aromatic structure, in which the ratio of the number of chain hydrocarbon group(s) each carrying at C-2 thereof an associated aromatic group bonded thereto to the number of chain hydrocarbon group(s) each carrying at C-3 thereof an associated aromatic group bonded thereto falls within a range of from 10:90 to 90:10, notably from 30:70 to 70:30, brings about still higher friction reducing effects and moreover, has better rubber compatibility improving effects.

Certain representative compounds of the organic acid metal salt which can be added in the lubricating base stock in the present invention will be exemplified below.

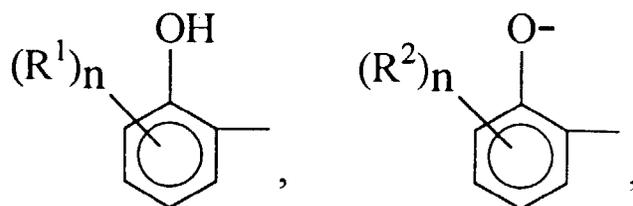


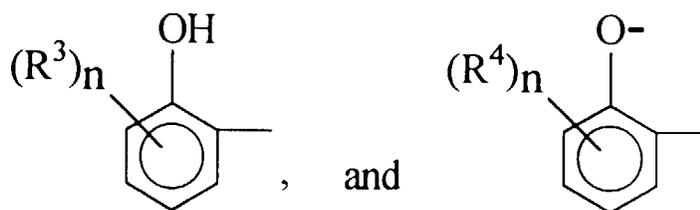
The above formula (I) exemplifies metal sulfonates. In the formula, A and B represent chain-hydrocarbon-group-substituted aromatic structures, which may be the same or different, and M represents an alkaline earth metal. Each chain-hydrocarbon-group-substituted aromatic structure is composed of an aromatic group with at least one chain hydrocarbon group substituted thereon, and the sum of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group bonded thereto ranges from 30% to 90% of the total number of chain hydrocarbon groups. Each aromatic group may preferably be either monocyclic or dicyclic, typically a phenyl group or a naphthyl group. The chain hydrocarbon groups are alkyl groups each having 4-32 carbon atoms, preferably linear alkyl groups each having 12-30 carbon atoms.





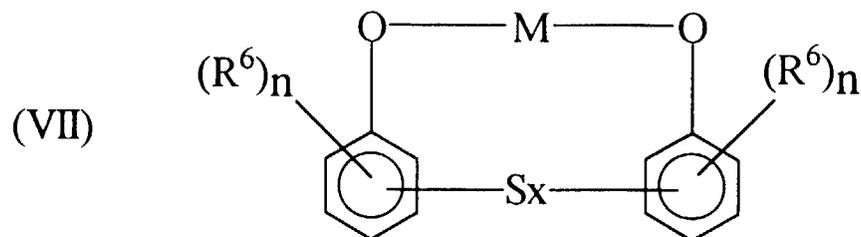
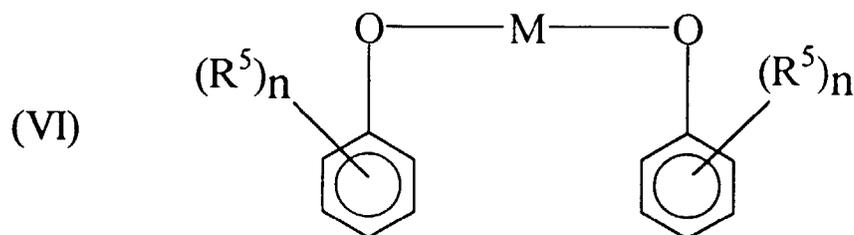
The above formulas (II) to (V) exemplify metal salicylates and metal salicylate sulfides, and in the respective formulas,



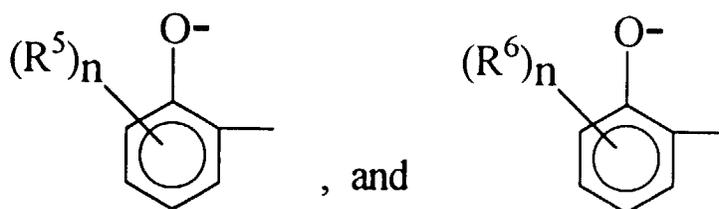


15 are chain-hydrocarbon-group-substituted aromatic structures. In the formulas (II) to (V), R¹s to R⁴s are alkyl groups having 4 to 32 carbon atoms, and in each formula, these alkyl groups may be the same or different. Preferred alkyl groups are those containing 12 to 30 carbon atoms, respectively. M represents an alkaline earth metal, and n indicates the number of alkyl group(s) substituted on the associated aromatic group. Further, in the formulas (IV) and (V), x stands for a number of 1 to 5.

20 In these chain-hydrocarbon-group-substituted aromatic structures, the sum of the numbers of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group bonded thereto is 30% to 90% of the total number of the chain hydrocarbon groups.



45 The above formulas (VI) and (VII) exemplify metal phenates and metal phenate sulfides having chain-hydrocarbon-group-substituted aromatic structures. In the respective formulas, the chain-hydrocarbon-group-substituted aromatic structures are:



In the formulas (VI) and (VII), R⁵ and R⁶ are alkyl groups having 4 to 32 carbon atoms, which may be the same or different. Preferred alkyl groups are those having 12 to 30 carbon atoms. M represents an alkaline earth metal, and n indicates the number of alkyl group(s) substituted on the associated aromatic group. In the formula (VII), x stands for a number of 1 to 5.

In these chain-hydrocarbon-group-substituted aromatic structures, the sum of the numbers of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group substituted thereon is 30% to 90% of the total number of the chain hydrocarbon groups.

The organic acid metal salt according to the present invention can provide friction coefficient reducing effects no matter whether it is a neutral salt or an over-based salt. An over-based salt is in the form of a colloidal system in which a metal hydroxide or metal carbonate is primarily dispersed in the form of fine particles in an organic acid metal salt. As an over-basing method, a method known well to date can be adopted, for example, an acidic substance is reacted with a reaction mixture of an organic acid or a salt thereof and a metal compound. As the acidic substance, a gas such as carbon dioxide or sulfur dioxide can be used. For example, an over-based alkaline earth metal salicylate can also be produced by treating its neutral salt with carbon dioxide (see, for example, U.S. Patent No. 3,057,896).

Concerning the proportion of the organic acid metal salt to be added in the lubricating oil composition according to the present invention, sufficient friction reducing effects can be exhibited provided that the organic acid metal salt is added in a proportion of from 0.01 wt% to 10 wt%, preferably from 0.05 to 5 wt% based on the whole weight of the lubricating oil composition or in a proportion of from 1 ppm to 10,000 ppm, preferably from 50 ppm to 5,000 ppm in terms of the content of the metal although the proportion varies depending on the application purpose of the lubricating.

To the lubricating oil composition according to the present invention, it is also possible to add selected ones of viscosity index improvers, ashless dispersants, anti-oxidants, extreme pressure agents, wear inhibitors, metal deactivators, pour-point depressants, rust inhibitors, other friction modifiers and other additives as desired.

Illustrative usable examples of the viscosity index improvers can include polymethacrylates, polyisobutylenes, ethylene-propylene copolymers, and hydrogenated styrene-butadiene copolymers. These viscosity index improvers are used generally in a proportion of from 3 wt% to 35 wt%.

Illustrative of the ashless dispersants can be polybutenylsuccinimides, polybutenylsuccinamides, benzylamines, and succinate esters. They can be used generally in a proportion of from 0.05 wt% to 7 wt%.

Illustrative examples of the anti-oxidants can include amine-type anti-oxidants such as alkylated diphenylamines, phenyl- α -naphthylamine and alkylated phenyl- α -naphthylamines; phenol-type anti-oxidants such as 2,6-di-t-butylphenol and 4,4'-methylene-bis(2,6-di-t-butylphenol); and zinc dithiophosphate. They can be used generally in a proportion of from 0.05 wt% to 5 wt%.

Illustrative of the extreme pressure agents can be dibenzyl sulfide and dibutyl disulfide. They can be used generally in a proportion of from 0.05 wt% to 3 wt%.

Illustrative examples of the metal deactivators can include benzotriazole, benzotriazole derivatives, and thiadiazole. They can be used generally in a proportion of from 0.01 wt% to 3 wt%.

Illustrative of the pour-point depressants can be ethylene-vinyl acetate copolymers, chlorinated paraffin-naphthalene condensation products, chlorinated paraffin-phenol condensation products, polymethacrylates, and polyalkylstyrenes. They can be used generally in a proportion of from 0.1 wt% to 10 wt%.

Illustrative of the wear inhibitors can be phosphate esters, acidic phosphate esters, phosphite esters, acidic phosphite esters, zinc dialkyldithiophosphates, and sulfur compounds. They can be used generally in a proportion of from 0.01 wt% to 5 wt%.

Other additives can also be selectively used as described provided that they do not inhibit the action of the organic metal salt according to the present invention.

The organic acid metal salt according to the present invention can be used in a form dissolved in a solvent such as a mineral oil. It can also be used as a component of an additive package.

As preferred embodiments of the present invention, it is possible to provide:

(i) A lubricating oil composition comprising:

a lubricating base stock; and

a mixture of metal salts of chain-hydrocarbon-group-substituted aromatic organic acids, each of said aromatic groups having been substituted by at least one chain hydrocarbon group, and the sum of the number of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group bonded thereto being in a range of from 35% to 70% of the total number of the chain hydrocarbon groups.

(ii) A lubricating oil composition comprising:

a lubricating base stock; and

a mixture of metal salts of chain-hydrocarbon-group-substituted aromatic organic acids, each of said aromatic groups having been substituted by at least one chain hydrocarbon group, the number of chain hydrocarbon groups each carrying at C-2 thereof the associated aromatic group bonded thereto is at least 10% of the total number of the chain hydrocarbon groups, and the ratio of the number of the chain hydrocarbon groups each carrying at C-2 thereof the associated aromatic group bonded thereto to that of chain hydrocarbon groups each carrying at C-3 thereof an associated aromatic group bonded thereto is in a range of from 10:90 to 90:10.

(iii) A lubricating oil composition comprising:

a lubricating base stock; and

a mixture of metal salts of chain-hydrocarbon-group-substituted aromatic organic acids, each of said aromatic groups having been substituted by at least one chain hydrocarbon group, the number of chain hydrocarbon groups each carrying at C-2 thereof the associated aromatic group bonded thereto is greater than 10% of the total number of the chain hydrocarbon groups, and the ratio of the number of the chain hydrocarbon groups each carrying at C-2 thereof the associated aromatic group bonded thereto to that of chain hydrocarbon groups each carrying at C-3 thereof an associated aromatic group bonded thereto is in a range of from 10:90 to 65:35.

(iv) A lubricating oil composition comprising:

a lubricating base stock;

a mixture of metal salts of chain-hydrocarbon-group-substituted aromatic organic acids each substituted by at least one chain hydrocarbon group, the number of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group bonded thereto being in a range of from 30% to 90% of the total number of the chain hydrocarbon groups; and

at least one additive selected from the group consisting of viscosity index improvers, ashless dispersants, anti-oxidants, wear inhibitors and metal deactivators.

EXAMPLES

The present invention will next be described specifically by Examples and Comparative Examples.

For the structure analysis of each chain-hydrocarbon-group-substituted aromatic structure in each organic acid metal salt and also for the evaluation of performance (coefficient of friction) of each lubricating oil composition, the following measuring methods were adopted.

Structure analysis of chain-hydrocarbon-group-substituted aromatic structure in organic acid metal salt analyzed by a ¹³C-NMR measurement.

Measuring method of friction coefficient:

By a testing method similar to JASO M348-95 entitled "ATF (Automatic Transmission Fluid) Friction Characteristics Testing Method", a static friction coefficient after 10 c/c was measured by using an SAE No. 2 friction machine. As a friction material, SD1777 was used.

Example 1

Refined mineral oil 100SN (kinematic viscosity: 4.1 mm²/s at 100°C) was used as a lubricating base stock. To the refined mineral oil, 1.0 wt% (1,000 ppm in terms of Ca content) of an over-based alkylbenzene calcium sulfonate - in which, as shown in Table 1, the average carbon number of alkyl groups was 23, the number of alkyl groups each carrying at C-2 thereof an associated phenyl group bonded thereto was 27% of the total number of the alkyl groups, and the sum of the number of alkyl groups each carrying at C-2 or C-3 thereof an associated phenyl group bonded thereto was 53% of the total number of the [phenyl] alkyl groups - was added as an organic acid metal salt, whereby a lubricating oil composition was formulated. The friction coefficient of the thus-obtained lubricating oil composition was measured by the above-described method. It was found to be 0.133.

Example 2

To the refined mineral oil 100SN (kinematic viscosity: 4.1 mm²/s at 100°C), 1.0 wt% (100 ppm in terms of Ca content) of a neutral alkylbenzene calcium sulfonate - in which the average carbon number of alkyl groups was 22, the number of alkyl groups each carrying at C-2 thereof an associated phenyl group bonded thereto was 28% of the total number of the alkyl groups, and the sum of the number of alkyl groups each carrying at C-2 or C-3 thereof an associated phenyl group bonded thereto was 45% of the total number of the alkyl groups - was added, whereby a lubricating oil composition was formulated. As a result of a measurement of the friction coefficient of the thus-obtained lubricating oil composition, it was found to be 0.134.

Example 3

To the refined mineral oil 100SN (kinematic viscosity: 4.1 mm²/s at 100°C), 1.0 wt% (1,000 ppm in terms of Ca content) of an over-based alkylbenzene calcium sulfonate - in which the number of alkyl groups each carrying at C-2 thereof an associated phenyl group bonded thereto was 14% of the total number of the alkyl groups, and the number of alkyl groups each carrying at C-2 or C-3 thereof an associated phenyl group bonded thereto was 37% of the total number of the alkyl groups - was added, whereby a lubricating oil composition was formulated. The friction coefficient of the thus-obtained lubricating oil composition was found to be 0.140.

Comparative Example 1

The refined mineral oil 100SN (kinematic viscosity: 4.1 mm²/s at 100°C) was used as a lubricating base stock. The friction coefficient of the lubricating base stock alone was measured without addition of an organic acid metal salt. It was found to be 0.168.

Comparative Example 2

To the refined mineral oil 100SN (kinematic viscosity: 4.1 mm²/s at 100°C), 1.0 wt% (1,000 ppm in terms of Ca content) of an over-based alkylbenzene calcium sulfonate - in which the average carbon number of alkyl groups was 25.5, the number of alkyl groups each carrying at C-2 thereof an associated phenyl group bonded thereto was 6% of the total number of the alkyl groups, and the sum of the number of alkyl groups each carrying at C-2 or C-3 thereof an associated phenyl group bonded thereto was 9% of the total number of the alkyl groups - was added, whereby a lubricating oil composition was formulated. As a result of a measurement of the friction coefficient of the thus-obtained lubricating oil composition, it was found to be 0.164.

The structures of the organic acid metal salts used in the Examples and the Comparative Examples and the performance evaluation results (SAE No. 2 friction coefficient measurement results) of the lubricating oil compositions are shown in Table 1.

TABLE I

	Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2
Base stock	Refined mineral oil 100SN				
Organic acid metal salt	Over-based alkyl-benzene Ca sulfonate	Neutral alkyl-benzene Ca sulfonate	Over-based alkyl-benzene Ca sulfonate	Not added	Over-based alkyl-benzene Ca sulfonate
Amount added	1.0%	1.0%	1.0%	--	1.0%
Average carbon number of alkyl group	23	22	22	--	25.5
Percentage of alkyl groups each carrying at C-2 thereof its associated aromatic group bonded thereto	27%	28%	14%	--	6%
Percentage of alkyl groups each carrying at C-3 thereof its associated aromatic group bonded thereto	26%	17%	23%	--	3%
Percentage of alkyl groups each carrying at C-4 thereof its associated aromatic group bonded thereto	22%	18%	48%	--	9%

TABLE 1 (continued)

	Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2
Base stock	Refined mineral oil 100SN				
Percentage of alkyl groups each carrying at C-2 or C-3 thereof its associated aromatic group bonded thereto	53%	45%	37%	--	9%
Percentage of alkyl groups each carrying at C-2, C-3 or C-4 thereof its associated aromatic group bonded thereto	75%	63%	85%	--	18%
SAE No. 2 friction coefficient	0.133	0.134	0.140	0.168	0.164

From the above Examples and Comparative Examples, the friction coefficient reducing effects by the control of the total percentage of chain hydrocarbon group(s) each carrying at C-2 thereof an associated aromatic group bonded thereto and chain hydrocarbon group(s) each carrying at C-3 thereof an associated aromatic group bonded thereto has been clarified although there is no correlation between the individual percentages of the hydrocarbon groups each carrying at C-3 thereof the associated aromatic group bonded thereto and the chain hydrocarbon groups each carrying at C-4 thereof an associated aromatic group bonded thereto and a friction coefficient. Namely, it has been demonstrated that the friction coefficient is significantly lowered when the percentage of the number of chain hydrocarbon groups each carrying C-2 or C-3 thereof an associated aromatic group bonded thereto based on the number of all the chain hydrocarbon groups is 30% or higher.

Thus it is seen that a lubricating oil composition containing a mixture of organic acid metal salts having chain-hydrocarbon-group-substituted aromatic structures in which the sum of the number of chain hydrocarbon groups each carrying at C-2 or C-3 thereof an associated aromatic group bonded thereto is 30% to 90% of the total number of the chain hydrocarbon groups. For example, a calcium sulfonate with aromatic group(s) bonded concentrating on a specific position of C-2 or C-3 of an associated chain hydrocarbon group(s) exhibits extremely high friction coefficient improving effects. Use of the enumerated metal salts makes it possible to provide a lubricating oil composition of improved in friction characteristics.

Claims

1. A lubricating oil composition characterized in that said composition comprises:

a lubricating base stock; and

a mixture of metal salts of chain-hydrocarbon-group-substituted aromatic organic acids, each of said aromatic groups having been substituted by at least one chain hydrocarbon group, and the sum of the number of chain hydrocarbon groups each carrying at C-2 or C-3 thereof the associated aromatic group being at least 30% of the total number of said chain hydrocarbon groups.

2. The lubricating oil composition of claim 1 wherein the sum of the number of claim hydrocarbon groups each carrying at C-2 or C-3 thereof the associated group is in the range of from 30% to 90% of the total number of the chain hydrocarbon groups.

3. The lubricating oil composition of claim 1 or 2 wherein the number of chain hydrocarbon groups each carrying at C-2 thereof the associated aromatic group bonded thereto constitutes 10% or more of the total number of chain hydrocarbon groups.

4. The lubricating oil composition of claim 1 or 2 wherein the ratio of the number of chain hydrocarbon groups each carrying at C-2 thereof an associated aromatic group bonded thereto to the number of chain hydrocarbon groups each carrying at C-3 thereof an associated aromatic group bonded thereto falls within the range of from 10:90 to 90:10.

5. The lubricating oil composition of claim 3 wherein the ratio of the number of chain hydrocarbon groups each carrying at C-2 thereof an associated aromatic group bonded thereto to the number of chain hydrocarbon groups each carrying at C-3 thereof an associated aromatic group bonded thereto falls within the range of from 10:90 to 90:10.

6. The lubricating oil composition of claim 1 or 2 wherein the chain hydrocarbon groups are alkyl groups each containing 4-32 carbon atoms.

7. The lubricating oil composition of claim 3 wherein the chain hydrocarbon groups are alkyl groups each containing 4-32 carbon atoms.

8. The lubricating oil composition of claim 1 or 2 wherein the amount of metal salt in the lubricant is 0.01 to 10 wt% based on the whole weight of the lubricating oil composition.

9. The lubricating oil composition of claim 3 wherein the amount of metal salt in the lubricant is 0.01 to 10 wt% based on the whole weight of the lubricating oil composition.

EP 0 881 276 A2

10. The lubricating oil composition of claim 1 or 2 further containing at least one additional additive selected from the group consisting of viscosity index improvers, ashless dispersants, anti oxidants, wear inhibitors, metal deactivators.

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