

(19)



(11)

EP 3 950 891 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:

09.02.2022 Bulletin 2022/06

(51) International Patent Classification (IPC):

C10L 1/189 ^(2006.01)

(21) Application number: **20779052.8**

(52) Cooperative Patent Classification (CPC):

C10L 1/189

(22) Date of filing: **23.03.2020**

(86) International application number:

PCT/JP2020/012671

(87) International publication number:

WO 2020/196386 (01.10.2020 Gazette 2020/40)

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

KH MA MD TN

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(30) Priority: **28.03.2019 JP 2019062124**

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(54) **FUEL OIL COMPOSITION**

(57) The present invention provides a fuel oil composition, including: a fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass%; and a calcium salicylate having a total base number of from 100 mgKOH/g to 1,200 mgKOH/g.

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Description

Technical Field

5 **[0001]** The present invention relates to a fuel oil composition that is suppressed from causing deposition of sludge at the time of its storage or at the time of its use.

Background Art

10 **[0002]** Various kinds of detergents and sludge dispersants have been developed for preventing the occurrence of a precipitate or a deposit in a fuel oil to be used in, for example, an internal combustion engine, a ship, an aircraft, or an external combustion engine at the time of its storage or at the time of its use (see, for example, Patent Literatures 1 to 3). In recent years, however, to suppress the occurrence of an environmental pollutant, such as a sulfur oxide, in the fuel oil at the time of its combustion, regulations for reducing a sulfur content in the fuel oil have been spreading. From 15 2020, regulations on, for example, a fuel oil for a ship are expected to be strengthened so that the sulfur content of the fuel oil may be 0.5% or less. Accordingly, the design and development of a fuel oil having composition corresponding to such regulations have become urgent issues. A reduction in sulfur content of a fuel oil base oil is effective in reducing the sulfur content in the fuel oil. However, such change in composition of the base oil has a large influence on the occurrence of a precipitate or a deposit in the fuel oil at the time of its storage or at the time of its use, and hence the 20 cleaning and dispersing effects of the detergents and the sludge dispersants that have heretofore been used are assumed to be insufficient.

[0003] In view of such circumstances, in recent years, a heavy oil composition subjected to low-sulfurization, the composition being capable of suppressing the occurrence of sludge even without containing any sludge dispersant, has been developed (see Patent Literature 4). However, for example, the composition of a fuel oil composition is limited, 25 and hence a fuel oil composition that can effectively suppress the deposition of sludge under various blending conditions, storage conditions, and use conditions has been demanded in the market.

Citation List

30 Patent Literature

[0004]

35 [PTL 1] JP 48-38761 B1
[PTL 2] JP 53-65306 A
[PTL 3] JP 05-331470 A
[PTL 4] JP 2012-92253 A

Summary of Invention

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Technical Problem

[0005] Accordingly, an object of the present invention is to provide a fuel oil composition that can effectively suppress the deposition of sludge at the time of its storage or at the time of its use.

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Solution to Problem

[0006] The inventors of the present invention have made extensive investigations with a view to solving the above-mentioned problems, and as a result, have found that a fuel oil composition including a specific fuel oil base oil and a specific sludge dispersant is excellent in suppression of the deposition of sludge at the time of its storage or at the time of its use. Thus, the inventors have completed the present invention. That is, according to one embodiment of the present invention, there is provided a fuel oil composition, comprising: a fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass%; and a calcium salicylate having a total base number of from 100 mgKOH/g to 1,200 mgKOH/g.

55 Advantageous Effects of Invention

[0007] According to the present invention, there can be provided the fuel oil composition that can suppress the deposition of sludge at the time of its storage or at the time of its use.

Description of Embodiments

[0008] A fuel oil base oil to be used in the present invention is a fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass%. Such fuel oil base oil is not particularly limited as long as its sulfur element content is from 0.01 mass% to 0.50 mass%, and a liquid fuel oil that may be used as a fuel oil is appropriately selected in accordance with use purposes and conditions. For example, a fuel oil having an adjusted sulfur element content, such as gasoline, light oil, heavy oil, kerosene, or a biofuel, may be used. Specific examples of such fuel oil include JIS Special No. 1 light oil, JIS No. 1 light oil, JIS No. 2 light oil, JIS No. 3 light oil, JIS Special No. 3 light oil, JIS A-type heavy oil, JIS B-type heavy oil, JIS C-type heavy oil, JIS No. 1 kerosene, JIS No. 2 kerosene, a marine gas oil (MGO), a marine diesel oil (MDO), a very low sulfur fuel oil (VLSFO), an ultra low sulfur fuel oil (ULSFO), palm oil, coconut oil, rapeseed oil, soybean oil, sunflower oil, corn oil, sesame oil, tall oil, bone oil, and whale oil. Those fuel oils may be used alone or in combination thereof. A straight-run light oil fraction, a vacuum light oil fraction, a desulfurized light oil fraction, a cracked base oil fraction, a directly desulfurized light oil fraction, an atmospheric distillation residual oil, a vacuum distillation residual oil, directly desulfurized heavy oil, cracked heavy oil, or the like may be used as light oil or heavy oil out of those fuel oils. In addition, in the present invention, such fuel oils as described above may be subjected to hydrogenation treatment before their use.

[0009] The fuel oil base oil to be used in the present invention is excellent in sludge deposition-suppressing property when its sulfur element content falls within the range of from 0.01 mass% to 0.50 mass%. In addition, from the viewpoints of various characteristics of a fuel oil, the sulfur element content in the fuel oil base oil is preferably from 0.03 mass% to 0.48 mass%, more preferably from 0.10 mass% to 0.45 mass%.

[0010] However, the term "sulfur element content in the fuel oil base oil" refers to a sulfur element content derived only from the fuel oil base oil, and a sulfur element derived from an additive is not included in the calculation of the content.

[0011] In the present invention, the sulfur element content is measured by an ultraviolet fluorescence method described in JIS K 2541-6 (2003).

[0012] A method of adjusting the sulfur element content of the fuel oil base oil is not particularly limited, and the sulfur element content only needs to be adjusted to from 0.01 mass% to 0.50 mass% by a known method. For example, the sulfur element content of a fuel oil containing more than 0.50 mass% of a sulfur element may be set to from 0.01 mass% to 0.50 mass% by subjecting the fuel oil to direct desulfurization treatment, indirect desulfurization treatment, or the like. In addition, the following adjustment may be performed: a fuel oil containing more than 0.50 mass% of a sulfur element and a fuel oil containing less than 0.50 mass% of a sulfur element are mixed to provide a fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass%.

[0013] With regard to the viscosity of the fuel oil base oil to be used in the present invention, from the viewpoint of the effect of the present invention, its kinematic viscosity at 40°C is preferably from 1 mm²/s to 600 mm²/s, more preferably from 2 mm²/s to 500 mm²/s, still more preferably from 2 mm²/s to 400 mm²/s, still more preferably from 2 mm²/s to 250 mm²/s. In the present invention, the kinematic viscosity is measured by a method described in JIS K 2283 (2000).

[0014] In the present invention, from the viewpoint of the effect of the present invention, a fuel oil base oil containing at least one selected from light oil (including light oil special grade 1, light oil grade 1, light oil grade 2, light oil grade 3, light oil special grade 3, and a MGO) and heavy oil (including heavy oil A, heavy oil B, heavy oil C, a MDO, a VLSFO, and an ULSFO) is preferably used. At this time, the total content of the light oil and the heavy oil in the fuel oil base oil is not particularly limited, but from the viewpoint of the effect of the present invention, the total amount of the light oil and the heavy oil is preferably from 10 mass% to 100 mass%, more preferably from 40 mass% to 100 mass%, still more preferably from 80 mass% to 100 mass% with respect to the total amount of the fuel oil base oil. Of such fuel oil base oils, a fuel oil base oil in which a content ratio between the light oil and the heavy oil is from 0:100 to 90:10 in terms of mass ratio is preferred. In addition, from the viewpoint of the effect of the present invention, a fuel oil base oil containing at least one selected from the MGO and the heavy oil is particularly preferably used as the fuel oil base oil. At this time, the total content of the MGO and the heavy oil in a fuel oil base oil is not particularly limited, but from the viewpoint of the effect of the present invention, the total amount of the MGO and the heavy oil is preferably from 10 mass% to 100 mass%, more preferably from 40 mass% to 100 mass%, still more preferably from 80 mass% to 100 mass%, particularly preferably 100 mass% with respect to the total amount of the fuel oil base oil. In addition, a content ratio between the MGO and the heavy oil when the total amount of the MGO and the heavy oil in the fuel oil base oil is 100 mass% is not particularly limited. For example, the content ratio between the MGO and the heavy oil may be set to from 0:100 to 100:0 in terms of mass ratio, and is preferably set to from 0:100 to 90:10.

[0015] A calcium salicylate to be used in the present invention is a calcium salicylate having a total base number of from 100 mgKOH/g to 1,200 mgKOH/g. In the present invention, the total base number is a value measured in conformity with ASTM D2896. From the viewpoint of the effect of the present invention, the total base number of the calcium salicylate is preferably from 200 mgKOH/g to 1,000 mgKOH/g, more preferably from 300 mgKOH/g to 900 mgKOH/g, still more preferably from 370 mgKOH/g to 800 mgKOH/g.

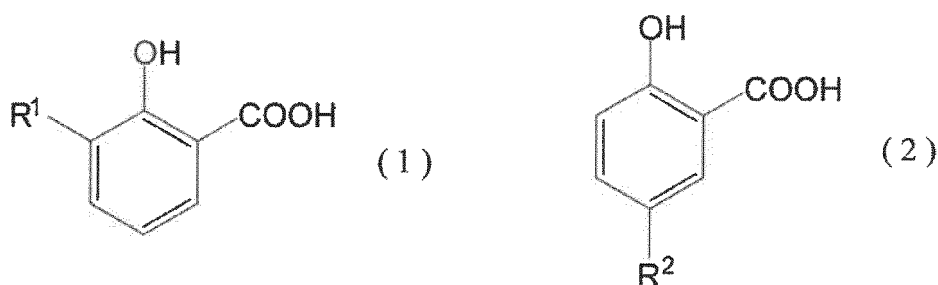
[0016] The term "calcium salicylate having a total base number of from 100 mgKOH/g to 1,200 mgKOH/g" means that

the total base number of the calcium salicylate itself is from 100 mgKOH/g to 1,200 mgKOH/g, and when the fuel oil composition of the present invention uses two or more kinds of calcium salicylates, the total base number means the total base number of a mixture formed of the calcium salicylates.

[0017] Accordingly, as described below, in the case where the calcium salicylate is diluted with a fuel oil base oil before its addition to the fuel oil, a desired effect is exhibited even when the total base number of the diluted product is a value lower than 100 mgKOH/g.

[0018] A commercial product and a product produced by a known method may each be used as the calcium salicylate to be used in the present invention, and examples thereof include calcium salicylates obtained by: a method including causing an alkyl phenol, which is obtained by alkylating phenol with an olefin having 4 to 32 carbon atoms, to react with an alkali metal hydroxide to provide an alkyl phenoxide, then causing the alkyl phenoxide to react with a carbon dioxide gas to carboxylate the phenoxide, and then causing the carboxylated product to react with a calcium compound; and a method including causing salicylic acid and an olefin having 4 to 32 carbon atoms to react with each other through use of an alkylating agent to provide an alkylsalicylic acid, and then causing the alkylsalicylic acid to react with a calcium compound. In addition, calcium salicylates described in, for example, UK Patent No. 734598, JP 60-101196 A, JP 05-163496 A, and JP 07-258675 A may be used.

[0019] The calcium salicylate to be used in the present invention may be specifically, for example, a calcium salt of an alkylsalicylic acid represented by the following general formula (1) or general formula (2).



[0020] In the general formula (1), R¹ represents a hydrocarbon group having 4 to 32 carbon atoms. Examples of such group include: a linear alkyl group having 4 to 32 carbon atoms; a branched alkyl group having 4 to 32 carbon atoms; a linear alkenyl group having 4 to 32 carbon atoms; a branched alkenyl group having 4 to 32 carbon atoms; an alicyclic hydrocarbon group having 4 to 32 carbon atoms; and an aromatic hydrocarbon group having 6 to 32 carbon atoms. From the viewpoint of the effect of the present invention, R¹ represents preferably a hydrocarbon group having 6 to 30 carbon atoms, more preferably a hydrocarbon group having 12 to 28 carbon atoms out of those groups.

[0021] In the general formula (2), R² represents a hydrocarbon group having 4 to 32 carbon atoms. Examples of such group include: a linear alkyl group having 4 to 32 carbon atoms; a branched alkyl group having 4 to 32 carbon atoms; a linear alkenyl group having 4 to 32 carbon atoms; a branched alkenyl group having 4 to 32 carbon atoms; an alicyclic hydrocarbon group having 4 to 32 carbon atoms; and an aromatic hydrocarbon group having 6 to 32 carbon atoms. From the viewpoint of the effect of the present invention, R² represents preferably a hydrocarbon group having 6 to 30 carbon atoms, more preferably a hydrocarbon group having 12 to 28 carbon atoms out of those groups.

[0022] One or more kinds of calcium salts of alkylsalicylic acids each represented by the general formula (1) described above may be used as the calcium salicylate to be used in the present invention, one or more kinds of calcium salts of alkylsalicylic acids each represented by the general formula (2) may be used, or the one or more kinds of calcium salts of alkylsalicylic acids each represented by the general formula (1) and the one or more kinds of calcium salts of alkylsalicylic acids each represented by the general formula (2) may be used in combination. In the present invention, for example, a calcium salt obtained by treating an alkylsalicylic acid represented by the general formula (1) or the general formula (2) with a calcium compound, such as calcium hydroxide, calcium carbonate, calcium borate, calcium chloride, or heavy calcium carbonate, may be used.

[0023] From the viewpoint of the effect of the present invention, the calcium salicylate to be used in the present invention preferably contains at least one of calcium salt of an alkylsalicylic acid represented by the general formula (1) or the general formula (2), and is more preferably a mixture of a calcium salt of an alkylsalicylic acid represented by the general formula (1) and a calcium salt of an alkylsalicylic acid represented by the general formula (2). When the calcium salicylate contains the calcium salt of the alkylsalicylic acid represented by the general formula (1) and the calcium salt of the alkylsalicylic acid represented by the general formula (2), a content ratio between the respective alkylsalicylic acids is not particularly limited. However, from the viewpoint of the effect of the present invention, a content molar ratio between the alkylsalicylic acid represented by the general formula (1) and the alkylsalicylic acid represented by the general formula (2) is preferably from 10:1 to 0.1:1, more preferably from 8.0:1 to 0.5:1, still more preferably from 5.0:1

to 1.0:1, particularly preferably from 4.0:1 to 1.5:1.

[0024] When the calcium salicylate to be used in the present invention contains the calcium salts of the alkylsalicylic acids represented by the general formula (1) and the general formula (2), or is a mixture formed of the calcium salts, R¹ and R² each preferably represent an alkyl group having 14 to 18 carbon atoms. In another embodiment, R¹ and R² each preferably represent an alkyl group having 16 to 18 carbon atoms. In still another embodiment, R¹ and R² each preferably represent an alkyl group having 20 to 28 carbon atoms. In still another embodiment, R¹ and R² each preferably represent an alkyl group having 16 carbon atoms. In still another embodiment, R¹ and R² each preferably represent an alkyl group having 14 to 28 carbon atoms.

[0025] Although a metal ratio with respect to the calcium salicylate to be used in the present invention (calcium element content (mol)×2/alkylsalicylic acid content (mol)) is not particularly limited, from the viewpoint of the effect of the present invention, the ratio is preferably from 0.2 to 10, more preferably from 0.5 to 8.0, still more preferably from 1.0 to 5.0. The metal ratio with respect to the calcium salicylate can be adjusted by adjusting a ratio between the calcium element content and the alkylsalicylic acid content (adjusting a raw material ratio at the time of the treatment of the alkylsalicylic acid with the calcium compound). The metal ratio may be increased by, for example, treating the alkylsalicylic acid with an excess amount of the calcium compound. In addition, the metal ratio can be set to less than 1.0 by reducing the ratio of the calcium compound.

[0026] Although a calcium element ratio with respect to the calcium salicylate to be used in the present invention is not particularly limited, from the viewpoint of the effect of the present invention, the ratio may be set to, for example, from 1.0 mass% to 35 mass%, and is preferably from 1.0 mass% to 30 mass%, more preferably from 5.0 mass% to 30 mass%, still more preferably from 10 mass% to 28 mass%.

[0027] From the viewpoint of handleability, the calcium salicylate to be used in the present invention may be treated as follows before its use: before the preparation of the fuel oil composition, the calcium salicylate is diluted with a fuel oil base oil in advance to be turned into a calcium salicylate-diluted product. At this time, the content of the calcium salicylate in the calcium salicylate-diluted product can be appropriately adjusted in accordance with purposes. For example, the content ratio of the calcium salicylate may be set to from 10 mass% to 99 mass% with respect to the total amount of the calcium salicylate-diluted product.

[0028] The fuel oil base oil for diluting the calcium salicylate may be the same fuel oil base oil as the fuel oil base oil to be used in the fuel oil composition of the present invention, or may be a fuel oil base oil different therefrom.

[0029] Although the total base number of the calcium salicylate-diluted product that may be used in the present invention is not particularly limited, for example, the total base number is preferably from 30 mgKOH/g to 400 mgKOH/g, more preferably from 60 mgKOH/g to 360 mgKOH/g, still more preferably from 100 mgKOH/g to 300 mgKOH/g, particularly preferably from 150 mgKOH/g to 260 mgKOH/g.

[0030] Although a calcium element ratio with respect to the calcium salicylate in the calcium salicylate-diluted product that may be used in the present invention is not particularly limited, from the viewpoint of the effect of the present invention, the ratio may be set to, for example, from 1.0 mass% to 35 mass%, and is preferably from 1.0 mass% to 30 mass%, more preferably from 2.0 mass% to 20 mass%, still more preferably from 10 mass% to 28 mass%, still more preferably from 5.0 mass% to 12.0 mass%, particularly preferably from 6.0 mass% to 9.0 mass%.

[0031] From the viewpoint of the effect of the present invention, the content of the calcium salicylate in the fuel oil composition of the present invention is preferably from 0.001 mass% to 5.0 mass%, more preferably from 0.005 mass% to 3.0 mass%, still more preferably from 0.01 mass% to 2.0 mass% with respect to the total amount of the fuel oil composition. In addition, from the viewpoint of the effect of the present invention, the content of the calcium salicylate in the fuel oil composition of the present invention is preferably from 1 ppm by mass to 2,000 ppm by mass, more preferably from 5 ppm by mass to 1,500 ppm by mass, still more preferably from 10 ppm by mass to 1,000 ppm by mass with respect to the total amount of the fuel oil composition in terms of calcium element content.

[0032] In the fuel oil composition of the present invention, from the viewpoint of the effect of the present invention, a ratio between the sulfur element content in the fuel oil base oil and a calcium element content derived from the calcium salicylate is preferably from 1,000:1 to 0.5:1, more preferably from 800:1 to 1:1, still more preferably from 500:1 to 2:1 in terms of mass ratio.

[0033] The fuel oil composition of the present invention can be produced through the mixing of the fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass% and the calcium salicylate or the calcium salicylate-diluted product by a known method. The composition may be produced by, for example, adding the total amount of the calcium salicylate or the calcium salicylate-diluted product to the fuel oil base oil in one stroke, or adding the calcium salicylate or the calcium salicylate-diluted product thereto in a plurality of batches, under an environment at from normal temperature to 100°C, and stirring and mixing the materials at from normal temperature to 150°C.

[0034] In the present invention, from the viewpoint of more effectively suppressing the deposition of sludge at the time of the storage of the fuel oil composition or at the time of the use thereof, the composition preferably further includes a sorbitan ester. The sorbitan ester that may be used in the present invention is not particularly limited as long as the sorbitan ester is a compound obtained by esterifying the entirety or part of the hydroxy groups of sorbitol or anhydrous

sorbitol. Examples thereof include a sorbitan monofatty acid ester, a sorbitan difatty acid ester, a sorbitan trifatty acid ester, a sorbitan sesquifatty acid ester, and a polyoxyalkylene-condensed sorbitan fatty acid ester. Of those, from the viewpoint of the effect of the present invention, a sorbitan ester whose fatty acid is any one of lauric acid, stearic acid, and oleic acid is preferably used.

[0035] Although the HLB of the sorbitan ester is not particularly limited, the HLB is preferably from 1.2 to 12.0, more preferably from 1.5 to 11.0, still more preferably from 1.8 to 10.0.

[0036] The HLB is described in detail in, for example, WO 2019/245024 A1 as described below.

[0037] The hydrophilic-lipophilic balance (HLB) represents the ratio of the molecular weight of a hydrophilic group moiety to the total molecular weight of a surfactant, and the HLB of a nonionic surfactant is determined from Griffin's equation.

[0038] The HLB of a mixed surfactant including two or more kinds of nonionic surfactants is determined as described below. The HLB of the mixed surfactant is obtained by arithmetically averaging the HLB values of the respective nonionic surfactants on the basis of their blending ratios:

$$\text{Mixed HLB} = \sum (\text{HLB}_x \cdot W_x) / \sum W_x$$

where

HLB_x represents the HLB value of a nonionic surfactant X, and

W_x represents the mass (g) of the nonionic surfactant X having the value HLB_x.

[0039] Although the content of the sorbitan ester if the fuel oil composition of the present invention includes the sorbitan ester is not particularly limited, from the viewpoint of the effect of the present invention, the content of the sorbitan ester is preferably from 0.001 mass% to 5.0 mass%, more preferably from 0.005 mass% to 3.0 mass%, still more preferably from 0.01 mass% to 2.0 mass% with respect to the total amount of the fuel oil composition.

[0040] In addition, when the fuel oil composition of the present invention includes the sorbitan ester, a ratio between the calcium element content derived from the calcium salicylate and the content of the sorbitan ester in the fuel oil composition is not particularly limited. However, from the viewpoint of the effect of the present invention, the ratio between the calcium element content derived from the calcium salicylate and the content of the sorbitan ester in the fuel oil composition may be set to, for example, from 1:1 to 1:10,000 in terms of mass ratio, and is set to preferably from 1:1 to 1:1,000, more preferably from 1:2 to 1:500.

[0041] When the fuel oil composition of the present invention is formed as described above, there can be easily produced a fuel oil composition, which can suppress the deposition of sludge at the time of its storage or at the time of its use, and has various characteristics, such as combustibility, storage stability, low-temperature fluidity, and handleability.

[0042] The fuel oil composition of the present invention may further include any other additive in accordance with purposes such as improvements in combustibility, storage stability, oxidation stability, wear resistance, uniformity, safety, environmental compatibility, startability, low-temperature fluidity, and handleability. One or more kinds selected from, for example, a surface ignition inhibitor, an octane number improver, a cetane number improver, an antimicrobial or microbicidal agent, a rust inhibitor, a deposit improver, an antioxidant, a metal deactivator, an antiwear agent, a detergent or a dispersant (excluding a calcium salicylate), a fluidity improver, a deicing agent, an antiknock agent, a corrosion inhibitor, an antistatic agent, a combustion improver, and a dye may be incorporated as such additives in a total amount of from 0.0001 mass% to 50 mass% with respect to the total amount of the fuel oil composition.

[0043] Examples of the surface ignition inhibitor include: organic phosphorus-based compounds, such as tributyl phosphite, trimethyl phosphite, tricresyl phosphate, tricyclohexyl phosphate, cresyl diphenyl phosphate, trimethyl phosphate, and methyl phenyl phosphate; and organic boron-based compounds, such as 2-ethylhexyl boronate and butyl diisobutyl boronate. Those inhibitors may be used alone or in combination thereof. Although the content of the surface ignition inhibitor is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0044] Examples of the octane number improver include methanol, ethanol, butanol, butyl acetate, methyl-tert-butyl ether, ethyl-tert-butyl ether, methyl-tert-amyl ether, N-methylaniline, methylcyclopentadienyl manganese tricarbonyl, and tetraethyllead. Those improvers may be used alone or in combination thereof. Although the content of the octane number improver is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0045] Examples of the cetane number improver include: aliphatic nitrates, such as ethyl nitrate, methoxyethyl nitrate, isopropyl nitrate, amyl nitrate, hexyl nitrate, heptyl nitrate, octyl nitrate, 2-ethylhexyl nitrate, and cyclohexyl nitrate; and peroxides such as di-tert-butyl peroxide. Those improvers may be used alone or in combination thereof. Although the

content of the cetane number improver is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0046] Examples of the antimicrobial or microbicidal agent include: inorganic microbicidal agents, such as silver sulfate, silver nitrate, zinc sulfate, zinc nitrate, copper sulfate, and copper ethylenediaminetetraacetate; organic nitrogen-based antimicrobial agents, such as hexahydro-1,3,5-tris(2-hydroxyethyl)-triazine; organic bromine-based antimicrobial agents, such as 2,2-dibromo-3-nitropropionamide, 1,4-bis(bromoacetoxy)-2-ethane, and bistribromomethylsulfone; and isothiazoline-based antimicrobial agents, such as 2-methyl-4-isothiazolin-3-one, 2-methyl-4,5-trimethylene-4-isothiazolin-3-one, 5-chloro-2-methyl-4-isothiazolin-3-one, 2-n-octylisothiazolin-3-one, 4,5-dichloro-2-n-octylisothiazolin-3-one, 1,2-benzisothiazolin-3-one, and N-n-butyl-1,2-benzisothiazolin-3-one. Those agents may be used alone or in combination thereof. Although the content of the antimicrobial or microbicidal agent is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0047] Examples of the rust inhibitor include an aliphatic amine and a salt thereof, an organic phosphoric acid ester, and an organic sulfonic acid salt. Those inhibitors may be used alone or in combination thereof. Although the content of the rust inhibitor is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0048] Examples of the deposit improver include tricresyl phosphate, trimethyl phosphate, tris(chloroethyl) phosphate, polypropylene, polybutene, polyisobutylene amine, polyether amine, polyalkylamine, polyoxyalkyleneamine, polyalkylphenoxyaminoalkane, and polyalkylene succinimide. Those improvers may be used alone or in combination thereof. Although the content of the deposit improver is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0049] Examples of the antioxidant include: amine-based antioxidants, such as N,N'-diisopropyl-p-phenylenediamine, N,N'-dibutyl-p-phenylenediamine, N,N'-dioctyl-p-phenylenediamine, N,N'-diphenyl-p-phenylenediamine, N,N'-ditolyl-p-phenylenediamine, and N-tolyl-N'-xylenyl-p-phenylenediamine; phenol-based antioxidants, such as 2-t-butylphenol, 2,6-ditertiarybutylphenol, 2,6-ditertiarybutyl-4-methylphenol, 2,4-dimethyl-6-tertiarybutylphenol, and 2,4,6-tri-t-butylphenol; and sulfur-based antioxidants, such as dilauryl 3,3'-thiodipropionate, distearyl 3,3'-thiodipropionate, lauryl stearyl 3,3'-thiodipropionate, dimyristyl 3,3'-thiodipropionate, distearyl β,β' -thiodibutylate, and dilauryl sulfide. Those antioxidants may be used alone or in combination thereof. Although the content of the antioxidant is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0050] Examples of the metal deactivator include: amino compounds, such as ethylenediamine; salicylidene-based compounds, such as N,N'-disalicylidene-1,2-diaminopropane, N,N'-disalicylidene-2-cyclohexanediamine, N,N'-disalicylidene ethylenediamine, N,N'-bis(dimethylsalicylidene)ethylenediamine, N,N'-bis(dimethylsalicylidene)ethylenetetramine, and salicylaldoxime; triazole-based compounds, such as 1-[bis(2-ethylhexyl)aminomethyl]-1,2,4-triazole, 1-(1-butoxyethyl)-1,2,4-triazole, 4,4'-methylenebis(2-undecyl-5-methylimidazole), and bis[(N-methyl)imidazol-2-yl]carbinol octyl ether; and benzotriazole-based compounds, such as a 4-alkylbenzotriazole, 4,5,6,7-tetrahydrobenzotriazole, 5,5'-methylenebisbenzotriazole, 1-[bis(2-ethylhexyl)aminomethyl]triazole, 1-[bis(2-ethylhexyl)aminomethyl]benzotriazole, 1-(nonyloxymethyl)benzotriazole, and 1-(1-butoxyethyl)benzotriazole. Those deactivators may be used alone or in combination thereof. Although the content of the metal deactivator is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0051] Examples of the antiwear agent include: sulfur-based antiwear agents, such as sulfurized fats and oils, an olefin polysulfide, a sulfurized olefin, dibenzyl sulfide, ethyl-3-[[bis(1-methylethoxy)phosphinothioyl]thio]propionate, a tris-[(2 or 4)-isoalkylphenol]thiophosphate, 3-(di-isobutoxy-thiophosphorylsulfanyl)-2-methyl-propionic acid, triphenyl phosphorothionate, β -dithiophosphorylated propionic acid, methylenebis(dibutylthiocarbamate), O,O-diisopropyl-dithiophosphorylethyl propionate, 2,5-bis(n-nonyldithio)-1,3,4-thiadiazole, 2,5-bis(1,1,3,3-tetramethylbutanethio)-1,3,4-thiadiazole, and 2,5-bis(1,1,3,3-tetramethyldithio)-1,3,4-thiadiazole; phosphorus-based compounds, such as mono-octyl phosphate, dioctyl phosphate, trioctyl phosphate, monobutyl phosphate, dibutyl phosphate, tributyl phosphate, monophenyl phosphate, diphenyl phosphate, triphenyl phosphate, tricresyl phosphate, monoisopropylphenyl phosphate, diisopropylphenyl phosphate, triisopropylphenyl phosphate, monotertiarybutylphenyl phosphate, di-tert-butylphenyl phosphate, tri-tert-butylphenyl phosphate, triphenyl thiophosphate, mono-octyl phosphite, dioctyl phosphite, trioctyl phosphite, monobutyl phosphite, dibutyl phosphite, tributyl phosphite, monophenyl phosphite, diphenyl phosphite, triphenyl phosphite, monoisopropylphenyl phosphite, diisopropylphenyl phosphite, triisopropylphenyl phosphite, mono-tert-butylphenyl phosphite, di-tert-butylphenyl phosphite, and tri-tert-butylphenyl phosphite; fatty acids, such as caprylic acid, 2-ethylhexanoic acid, nonanoic acid, isononanoic acid, capric acid, lauric acid, myristic acid, palmitic acid, stearic acid, arachidic acid, and behenic acid; organometallic compounds, such as a naphthenic acid metal salt, a fatty acid metal salt, a phosphoric acid metal salt, a phosphoric acid ester metal salt, and a phosphorous acid ester metal salt; and a boron compound, alkylamine salts of monohexyl and dihexyl phosphates, a phosphoric acid ester amine salt, and a mixture of a triphenylthiophosphoric acid ester and a tert-butylphenyl derivative. Although the content of the antiwear agent is not particularly limited, the content is preferably, for example, from 0.01 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0052] Examples of the detergent or the dispersant include a phosphoric amide, an aminoalkane, an alkylamine phosphoric acid ester, polyether amine, polybutenylamine, an alkenyl succinimide, an alkenyl succinic acid ester, a salicylic acid metal salt (excluding a calcium salicylate), a sulfonic acid metal salt, a carboxylic acid metal salt, and a phosphonic acid metal salt. Those detergents and dispersants may be used alone or in combination thereof. Although the content of the detergent or the dispersant is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0053] Examples of the fluidity improver include a polymethacrylate-based polymer, a polyacrylate-based polymer, an olefinically unsaturated polymer, an ethylene-vinyl acetate-based copolymer, a polyolefin-substituted phenol-based polymer, an alkenyl succinamide, a fatty acid ester of an alkylene oxide adduct of an alkane polyol, and a fatty acid ester of an alkylene oxide adduct of an alkanolamine. Those improvers may be used alone or in combination thereof. Although the content of the fluidity improver is not particularly limited, the content is preferably, for example, from 0.001 mass% to 10 mass% with respect to the total amount of the fuel oil composition.

[0054] Although the calculated carbon aromaticity index (CCAI) of the fuel oil composition of the present invention is not particularly limited, from the viewpoints of various characteristics of the fuel oil composition, the CCAI is preferably 780 or more and 900 or less, more preferably 800 or more and 860 or less. In the present invention, the CCAI of the fuel oil composition is calculated on the basis of ISO 8217.

[0055] Although the flash point of the fuel oil composition of the present invention is not particularly limited, from the viewpoints of various characteristics of the fuel oil composition, the flash point is preferably 40°C or more and 120°C or less. In the present invention, the flash point of the fuel oil composition is measured by a Pensky-Martens closed cup method described in JIS K 2265-3 (2007).

[0056] Although the pour point of the fuel oil composition of the present invention is not particularly limited, from the viewpoints of various characteristics of the fuel oil composition, the pour point is preferably -40°C or more and 30°C or less. In the present invention, the pour point of the fuel oil composition is measured by a method described in JIS K 2269 (1987).

[0057] Although the kinematic viscosity of the fuel oil composition of the present invention is not particularly limited, from the viewpoints of various characteristics of the fuel oil composition, the kinematic viscosity thereof at 40°C is preferably from 1 mm²/s to 400 mm²/s, more preferably from 2 mm²/s to 200 mm²/s, most preferably from 2 mm²/s to 100 mm²/s.

[0058] Although the density of the fuel oil composition of the present invention is not particularly limited, from the viewpoints of various characteristics of the fuel oil composition, the density thereof at 15°C is preferably 0.70 g/cm³ or more and 1.00 g/cm³ or less, more preferably 0.80 g/cm³ or more and 0.98 g/cm³ or less. In the present invention, the density of the fuel oil composition is measured by a method described in JIS K 2249 (2011).

[0059] The fuel oil composition of the present invention can be used without any particular limitation as long as its mode of use is such that a liquid fuel oil is used. The composition may be used as, for example, a fuel oil for an automobile such as a passenger car or a truck, a fuel oil for a ship such as a passenger ship or a cargo ship, a fuel oil for an aircraft such as an airplane or a helicopter, a fuel oil for a railway vehicle, such as a diesel locomotive, a fuel oil for agricultural machinery, or a fuel oil for construction machinery. The composition is preferably used as a fuel oil for a ship out of those fuel oils.

Examples

[0060] The present invention is more specifically described below by way of the Examples. In the Examples below, the term "%" is on a mass basis unless otherwise stated. Respective components used in the Examples are described below.

[Preparation of Calcium Salicylate-diluted Product]

[0061] The following fuel oil base oil, and calcium salicylates 1 to 17 and a low-base number calcium salicylate (comparative compound) shown in Table 1 were used, and the respective calcium salicylates were mixed and diluted with the following fuel oil base oil A at a mass ratio of 40:60 to prepare calcium salicylate-diluted products 1 to 17 and a low-base number calcium salicylate-diluted product, respectively. In Table 1, the column "(1):(2) structure ratio" shows a molar ratio between a compound represented by the general formula (1) and a compound represented by the general formula (2) in each calcium salicylate, and the column "Structure represented by R¹ or R²" shows a structure represented by R¹ in each calcium salicylate represented by the general formula (1) and a structure represented by R² in each calcium salicylate represented by the general formula (2).

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<Fuel Oil Base Oil>

[0062] Fuel oil base oil A: A fuel oil base oil formed of a cracked base oil fraction having a sulfur element content of 0.25% and a kinematic viscosity at 40°C of 25.0 mm²/s.

Table 1

	Total base number (mgKOH/g)	Ca element content ratio (mass%)	(1) : (2) structure ratio	Structure represented by R ¹ or R ²
Calcium salicylate 1	560	20%	2.2:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 2	390	14%	2.2:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 3	278	10%	2.2:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 4	860	32%	2.2:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 5	420	14%	1.8:1	Alkyl group having 16 to 18 carbon atoms
Calcium salicylate 6	700	25%	1.5:1	Alkyl group having 16 to 18 carbon atoms
Calcium salicylate 7	668	25%	2.5:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 8	400	16%	2.5:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 9	425	15%	3.1:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 10	573	20%	3.5:1	Alkyl group having 20 to 28 carbon atoms
Calcium salicylate 11	800	28%	3.5:1	Alkyl group having 20 to 28 carbon atoms
Calcium salicylate 12	158	5.2%	3.5:1	Alkyl group having 20 to 28 carbon atoms
Calcium salicylate 13	425	15%	3.0:1	Alkyl group having 14 to 28 carbon atoms
Calcium salicylate 14	475	17%	3.2:1	Alkyl group having 14 to 18 carbon atoms
Calcium salicylate 15	698	29%	1.5:1	Alkyl group having 16 carbon atoms
Calcium salicylate 16	600	24%	1.5:1	Alkyl group having 16 carbon atoms
Calcium salicylate 17	433	16%	1.5:1	Alkyl group having 16 carbon atoms
Low-base number calcium salicylate	40	2.3%	2.2:1	Alkyl group having 14 to 18 carbon atoms

[Fuel Oil Composition Preparation A]

[0063] Fuel oil compositions were prepared by using fuel oil base oils, calcium salicylate-diluted products, sorbitan

esters, and dispersants, which were comparative compounds, described below as shown in Tables 2 to 9 below. In addition, calcium element contents derived from the calcium salicylates in the calcium salicylate-diluted products, or the comparative compounds, in the respective fuel oil compositions are also shown in Tables 2 to 9.

<Fuel Oil Base Oil>

[0064] Fuel oil base oil 1: A fuel oil base oil having a sulfur element content of 0.44% and a kinematic viscosity at 40°C of 5.5 mm²/s (mixed base oil containing 20 mass% of heavy oil C having a sulfur element content of 2.1% and 80 mass% of a MGO having a sulfur element content of 0.03%)

[0065] Fuel oil base oil 2: A fuel oil base oil having a sulfur element content of 0.24% and a kinematic viscosity at 40°C of 4.2 mm²/s (mixed base oil containing 10 mass% of heavy oil C having a sulfur element content of 2.1% and 90 mass% of a MGO having a sulfur element content of 0.03%)

[0066] Fuel oil base oil 3: A fuel oil base oil having a sulfur element content of 0.04% and a kinematic viscosity at 40°C of 3.1 mm²/s (mixed base oil containing 0.5 mass% of heavy oil C having a sulfur element content of 2.1% and 99.5 mass% of a MGO having a sulfur element content of 0.03%)

[0067] Fuel oil base oil 6: A fuel oil base oil having a sulfur element content of 0.36% and a kinematic viscosity at 40°C of 120 mm²/s (mixed base oil containing 5 mass% of a VLSFO having a sulfur element content of 0.46% and 95 mass% of a VLSFO having a sulfur element content of 0.35%)

[0068] Fuel oil base oil 7: A fuel oil base oil formed of a VLSFO having a sulfur element content of 0.46% and a kinematic viscosity at 40°C of 138 mm²/s

[0069] Fuel oil base oil 8: A fuel oil base oil formed of a VLSFO having a sulfur element content of 0.47% and a kinematic viscosity at 40°C of 475 mm²/s

[0070] Fuel oil base oil 9: A fuel oil base oil formed of a VLSFO having a sulfur element content of 0.44% and a kinematic viscosity at 40°C of 8.1 mm²/s

<Calcium Salicylate-diluted Product>

[0071] Calcium salicylate-diluted product 1: A diluted product having a total base number of 224 mgKOH/g and a calcium element ratio of 8.1%

[0072] Calcium salicylate-diluted product 2: A diluted product having a total base number of 156 mgKOH/g and a calcium element ratio of 5.5%

[0073] Calcium salicylate-diluted product 3: A diluted product having a total base number of 111 mgKOH/g and a calcium element ratio of 4.0%

[0074] Calcium salicylate-diluted product 4: A diluted product having a total base number of 344 mgKOH/g and a calcium element ratio of 12.9%

[0075] Calcium salicylate-diluted product 5: A diluted product having a total base number of 168 mgKOH/g and a calcium element ratio of 5.6%

[0076] Calcium salicylate-diluted product 6: A diluted product having a total base number of 280 mgKOH/g and a calcium element ratio of 10.0%

[0077] Calcium salicylate-diluted product 7: A diluted product having a total base number of 267 mgKOH/g and a calcium element ratio of 10.0%

[0078] Calcium salicylate-diluted product 8: A diluted product having a total base number of 160 mgKOH/g and a calcium element ratio of 6.3%

[0079] Calcium salicylate-diluted product 9: A diluted product having a total base number of 170 mgKOH/g and a calcium element ratio of 6.1%

[0080] Calcium salicylate-diluted product 10: A diluted product having a total base number of 229 mgKOH/g and a calcium element ratio of 8.0%

[0081] Calcium salicylate-diluted product 11: A diluted product having a total base number of 320 mgKOH/g and a calcium element ratio of 11.0%

[0082] Calcium salicylate-diluted product 12: A diluted product having a total base number of 63 mgKOH/g and a calcium element ratio of 2.1%

[0083] Calcium salicylate-diluted product 13: A diluted product having a total base number of 170 mgKOH/g and a calcium element ratio of 6.1%

[0084] Calcium salicylate-diluted product 14: A diluted product having a total base number of 190 mgKOH/g and a calcium element ratio of 6.7%

[0085] Calcium salicylate-diluted product 15: A diluted product having a total base number of 279 mgKOH/g and a calcium element ratio of 11.7%

[0086] Calcium salicylate-diluted product 16: A diluted product having a total base number of 240 mgKOH/g and a

calcium element ratio of 9.6%

[0087] Calcium salicylate-diluted product 17: A diluted product having a total base number of 173 mgKOH/g and a calcium element ratio of 6.2%

5 <Sorbitan Ester>

[0088]

10 Sorbitan ester 1: Sorbitan sesquioleate (HLB: 3.7)
Sorbitan ester 2: Sorbitan monooleate (HLB: 4.3)
Sorbitan ester 3: Sorbitan trioleate (HLB: 1.8)
Sorbitan ester 4: Polyoxyethylene (6) sorbitan monooleate (HLB: 10.0)

15 <Comparative Compound>

[0089] Low-base number calcium salicylate-diluted product: A diluted product of the low-base number calcium salicylate (total base number: 16 mgKOH/g, calcium element ratio: 0.9%)

20 **[0090]** Calcium sulfonate-diluted product: A diluted product having a total base number of 300 mgKOH/g and a calcium element ratio of 11.8% (diluted product obtained by mixing calcium sulfonate having a total base number of 750 mgKOH/g and a calcium element ratio of 30%, and the fuel oil base oil A at a mass ratio of 40:60)

[0091] Alkyl salicylate: 5-Methylsalicylic acid

[0092] Salicylic acid alkyl ester: 2-Ethylhexyl salicylate Succinimide-based dispersant: Polyisobutene succinimide

[0093] Phosphoric acid ester-based dispersant: An oleyl-4EO phosphoric acid ester

[0094] Pluronic dispersant: A POE-POP block polymer of ethylenediamine

25 **[0095]** Polycarboxylic acid-based dispersant: A sodium salt of an olefin/maleic acid copolymerized product

[0096] Acetylene-based dispersant: A POE-POP block polymer of acetylenediol

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Table 2

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9
Fuel oil base oil	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance
Fuel oil base oil 1									
Fuel oil base oil 2									
Fuel oil base oil 3									
Calcium salicylate-diluted product 1	0.10%	0.10%	0.10%	0.04%	0.30%	0.50%	1.0%		
Calcium salicylate-diluted product 2								0.30%	
Calcium salicylate-diluted product 3									0.30%
Calcium salicylate-diluted product 4									
Calcium salicylate-diluted product 5									
Calcium salicylate-diluted product 6									
Calcium salicylate-diluted product 7									
Calcium salicylate-diluted product 8									
Calcium salicylate-diluted product 9									
Calcium salicylate-diluted product 10									
Calcium salicylate-diluted product 11									
Calcium salicylate-diluted product 12									

(continued)

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9
Calcium salicylate-diluted product 13									
Calcium salicylate-diluted product 14									
Calcium salicylate-diluted product 15 Calcium salicylate-diluted product									
Calcium salicylate-diluted product 16									
Calcium salicylate-diluted product 17									
Calcium element content (ppm by mass)	81	81	81	32	243	405	810	165	120
Spot test evaluation result	2	2	1	2	1	1	1	1	1

Table 3

	Example 10	Example 11	Example 12	Example 13	Example 14	Example 15	Example 16	Example 17
Fuel oil base oil 1								
Fuel oil base oil 2	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance
Fuel oil base oil 3								
Calcium salicylate-diluted product 1								
Calcium salicylate-diluted product 2								
Calcium salicylate-diluted product 3								
Calcium salicylate-diluted product 4	0.30%							
Calcium salicylate-diluted product 5		0.30%						
Calcium salicylate-diluted product 6			0.30%					
Calcium salicylate-diluted product 7				0.30%				
Calcium salicylate-diluted product 8					0.10%	0.30%		
Calcium salicylate-diluted product 9							0.30%	
Calcium salicylate-diluted product 10								0.30%
Calcium salicylate-diluted product 11								
Calcium salicylate-diluted product 12								
Calcium salicylate-diluted product 13								

(continued)

		Example 10	Example 11	Example 12	Example 13	Example 14	Example 15	Example 16	Example 17
	Calcium salicylate-diluted product 14								
	Calcium salicylate-diluted product 15								
	Calcium salicylate-diluted product 16								
	Calcium salicylate-diluted product 17								
	Calcium element content (ppm by mass)	387	168	300	300	63	189	183	240
	Spot test evaluation result	2	1	1	2	2	1	1	1

Table 4

		Example 18	Example 19	Example 20	Example 21	Example 22	Example 23	Example 24	Example 25
	Fuel oil base oil 1	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance
	Fuel oil base oil 2								
	Fuel oil base oil 3								
	Calcium salicylate-diluted product 1								
	Calcium salicylate-diluted product 2								
	Calcium salicylate-diluted product 3								
	Calcium salicylate-diluted product 4								
	Calcium salicylate-diluted product 5								
	Calcium salicylate-diluted product 6								
	Calcium salicylate-diluted product 7								
	Calcium salicylate-diluted product 8								
	Calcium salicylate-diluted product 9								
	Calcium salicylate-diluted product 10								
	Calcium salicylate-diluted product 11	0.30%							
	Calcium salicylate-diluted product 12		0.30%						
	Calcium salicylate-diluted product 13			0.10%	0.30%				

(continued)

		Example 18	Example 19	Example 20	Example 21	Example 22	Example 23	Example 24	Example 25
	Calcium salicylate-diluted product 14					0.30%			
	Calcium salicylate-diluted product 15						0.30%		
	Calcium salicylate-diluted product 16							0.30%	
	Calcium salicylate-diluted product 17								0.30%
	Calcium element content (ppm by mass)	330	63	61	183	201	351	288	186
	Spot test evaluation result	2	2	2	1	2	2	2	2

Table 5

	Comparative Exam ple 1	Comparative Exam ple 2	Comparative Exam ple 3	Comparative Exam ple 4	Comparative Exam ple 5	Comparative Example 6	Comparative Exam ple 7	Comparative Exam ple 8	Comparative Exam ple 9
	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance
Fuel oil base oil	Fuel oil base oil 1	Fuel oil base oil 2	Fuel oil base oil 3						
Comparative compound	Low-base number calcium salicylate-diluted product			0.30%	0.50%				
	Calcium sulfonate-diluted product					0.10%	0.30%		
	Alkyl salicylate							0.10%	0.30%
	Salicylic acid alkyl ester								
	Succinimide-based dispersant								
	Phosphoric acid ester-based dispersant								
	Pluronic dispersant								
	Polycarboxylic acid-based dispersant								
	Acetylene-based dispersant								
	Calcium element content (ppm by mass)	0	0	0	27	45	118	0	0
Spot test evaluation result		5	5	3	4	3	4	5	4

Table 6

Fuel oil base oil	Comparati ve Examl e 10	Comparati ve Examl e 11	Comparati ve Examl e 12	Comparati ve Examl e 13	Comparati ve Examl e 14	Comparati ve Examl e 15	Comparati ve Examl e 16
	Balance	Balance	Balance	Balance	Balance	Balance	Balance
Fuel oil base oil 1							
Fuel oil base oil 2	Balance						
Fuel oil base oil 3							
Low-base number calcium salicylate-diluted product							
Calcium sulfonate-diluted product							
Alkyl salicylate							
Salicylic acid alkyl ester	0.10%	0.30%					
Succinimide-based dispersant			1.0%				
Phosphoric acid ester-based dispersant				0.30%			
Pluronic dispersant					1.0%		
Polycarboxylic acid-based dispersant						1.0%	
Acetylene-based dispersant							
Calcium element	0	0	0	0	0	0	1.0% 0
Spot test	4	3	4	3	4	4	4

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Table 7

		Example 26	Example 27	Example 28	Example 29	Example 30	Example 31	Example 32
5								
	Fuel oil base oil 1							
10	Fuel oil base oil 2	Balance	Balance	Balance	Balance	Balance	Balance	Balance
	Fuel oil base oil 3							
15	Fuel oil base oil 6							
	Fuel oil base oil 7							
20	Fuel oil base oil 8							
	Fuel oil base oil 9							
	Calcium salicylate- diluted product 1	0.02%	0.04%	0.10%	0.15%	0.10%	0.10%	0.10%
25								
	Sorbitan ester 1	0.50%	0.50%	0.30%	0.15%			
30	Sorbitan ester 2					0.50%		
	Sorbitan ester 3						0.50%	
	Sorbitan ester 4							0.50%
35	Calcium element content (ppm by mass)	16	32	81	122	81	81	81
	Spot test evaluation result	2	1	1	1	1	1	1

Table 8

	Example 33	Example 34	Example 35	Example 36	Example 37	Example 38	Example 39	Example 40	Example 41
Fuel oil base oil 1 Fuel oil base oil 1									
Fuel oil base oil 2									
Fuel oil base oil 3									
Fuel oil base oil 6	Balance	Balance				Balance			
Fuel oil base oil 7			Balance				Balance		
Fuel oil base oil 8				Balance				Balance	
Fuel oil base oil 9					Balance				Balance
Calcium salicylate-diluted product 1	0.01%	0.10%	0.02%	0.02%	0.02%	0.01%	0.01%	0.01%	0.01%
Sorbitan ester 1						0.30%	0.30%	0.30%	0.30%
Sorbitan ester 2									
Sorbitan ester 3									
Sorbitan ester 4									
Calcium element content (ppm by mass)	8	81	16	16	16	8	8	8	8
Spot test evaluation result	2	1	2	2	2	1	1	1	1

Table 9

		Comparative Example 17	Comparative Example 18	Comparative Example 19	Comparative Example 20
5 10 15 20	Fuel oil base oil 1				
	Fuel oil base oil 2				
	Fuel oil base oil 3				
	Fuel oil base oil 6	Balance			
	Fuel oil base oil 7		Balance		
	Fuel oil base oil 8			Balance	
	Fuel oil base oil 9				Balance
25 30 35	Calcium salicylate-diluted product 1				
	Sorbitan ester	Sorbitan ester 1			
		Sorbitan ester 2			
		Sorbitan ester 3			
		Sorbitan ester 4			
	Calcium element content (ppm by mass)		0	0	0
	Spot test evaluation result		3	3	3

<Evaluation of Sludge Dispersibility>

[0097] The fuel oil compositions prepared in Examples 1 to 41 and Comparative Examples 1 to 20 were evaluated for their sludge dispersion-deposition characteristics by a spot test method described in ASTM D 4740 (2014). Specifically, each of the fuel oil compositions heated to 90°C was dropped onto filter paper (test paper), and was held at 100°C for 1 hour. After that, a spot test evaluation was performed by evaluating the state of a spot on the filter paper in accordance with the following evaluation indices. In this evaluation, an evaluation index 1 means that the evaluated composition is most excellent in sludge dispersibility (suppression of the deposition of sludge), and the evaluation index 1 or an evaluation index 2 means that the composition has practicality. The results were shown in Tables 2 to 9 above.

<Evaluation Indices of Spot Test>

[0098]

- 1: No inner ring is observed, and the spot is uniform.
- 2: An inner ring is slightly or incompletely observed.
- 3: An inner ring that is slightly darker than a background is observed.
- 4: An inner ring that is deeper than that of the index 3 and is somewhat darker than the background is observed.

5: A particle or a particulate substance is observed at the center of an inner ring, and is clearly darker than the background.

[0099] It can be said from the foregoing results that the fuel oil composition of the present invention is excellent in sludge dispersibility, and is hence excellent in suppression of the deposition of sludge at the time of its storage or at the time of its use.

[Fuel Oil Composition Preparation B]

[0100] Blending examples of fuel oil compositions prepared by using the following fuel oil base oils, calcium salicylate-diluted products, sorbitan esters, and other additives are shown in Tables 10 to 15.

<Fuel Oil Base Oil>

[0101] Fuel oil base oil 1: A fuel oil base oil having a sulfur element content of 0.44% and a kinematic viscosity at 40°C of 5.5 mm²/s (mixed base oil containing 20 mass% of heavy oil C having a sulfur element content of 2.1% and 80 mass% of a MGO having a sulfur element content of 0.03%)

[0102] Fuel oil base oil 2: A fuel oil base oil having a sulfur element content of 0.24% and a kinematic viscosity at 40°C of 4.2 mm²/s (mixed base oil containing 10 mass% of heavy oil C having a sulfur element content of 2.1% and 90 mass% of a MGO having a sulfur element content of 0.03%)

[0103] Fuel oil base oil 3: A fuel oil base oil having a sulfur element content of 0.04% and a kinematic viscosity at 40°C of 3.1 mm²/s (mixed base oil containing 0.5 mass% of heavy oil C having a sulfur element content of 2.1% and 99.5 mass% of a MGO having a sulfur element content of 0.03%)

[0104] Fuel oil base oil 4: A fuel oil base oil having a sulfur element content of 0.03% and a kinematic viscosity at 40°C of 3.1 mm²/s (100 mass% of a MGO having a sulfur element content of 0.03%)

[0105] Fuel oil base oil 5: A fuel oil base oil having a sulfur element content of 0.30% and a kinematic viscosity at 40°C of 90 mm²/s (mixed base oil containing 20 mass% of an ULSFO having a sulfur element content of 0.08% and 80 mass% of a VLSFO having a sulfur element content of 0.35%)

[0106] Fuel oil base oil 6: A fuel oil base oil having a sulfur element content of 0.36% and a kinematic viscosity at 40°C of 120 mm²/s (mixed base oil containing 5 mass% of a VLSFO having a sulfur element content of 0.46% and 95 mass% of a VLSFO having a sulfur element content of 0.35%)

[0107] Fuel oil base oil 7: A fuel oil base oil formed of a VLSFO having a sulfur element content of 0.46% and a kinematic viscosity at 40°C of 138 mm²/s

[0108] Fuel oil base oil 8: A fuel oil base oil formed of a VLSFO having a sulfur element content of 0.47% and a kinematic viscosity at 40°C of 475 mm²/s

[0109] Fuel oil base oil 9: A fuel oil base oil formed of a VLSFO having a sulfur element content of 0.44% and a kinematic viscosity at 40°C of 8.1 mm²/s

<Calcium Salicylate-diluted Product>

[0110] Calcium salicylate-diluted product 3: A diluted product having a total base number of 111 mgKOH/g and a calcium element ratio of 4.0%

[0111] Calcium salicylate-diluted product 9: A diluted product having a total base number of 170 mgKOH/g and a calcium element ratio of 6.1%

[0112] Calcium salicylate-diluted product 11: A diluted product having a total base number of 320 mgKOH/g and a calcium element ratio of 11.0%

[0113] Calcium salicylate-diluted product 16: A diluted product having a total base number of 240 mgKOH/g and a calcium element ratio of 9.6%

<Sorbitan Ester>

[0114]

Sorbitan ester 1: Sorbitan sesquioleate (HLB: 3.7)

Sorbitan ester 2: Sorbitan monooleate (HLB: 4.3)

Sorbitan ester 3: Sorbitan trioleate (HLB: 1.8)

Sorbitan ester 4: Polyoxyethylene (6) sorbitan monooleate (HLB: 10.0)

<Antimicrobial or Microbicidal Agent>

- [0115] Antimicrobial or microbicidal agent 1: POE lauryl amine
 [0116] Antimicrobial or microbicidal agent 2: Hexahydro-1,3,5-tris(2-hydroxyethyl)-triazine
 [0117] Antimicrobial or microbicidal agent 3: 1,2-Benzisothiazolin-3-one

<Rust Inhibitor>

- [0118] Rust inhibitor 1: Octylamine
 [0119] Rust inhibitor 2: A tetrapropenylsuccinic acid ester

<Antioxidant>

- [0120] Antioxidant 1: 2,6-Ditertiarybutylphenol
 [0121] Antioxidant 2: N,N'-Dioctyl-p-phenylenediamine
 [0122] Antioxidant 3: Distearyl β,β' -thiodibutylate

<Antiwear Agent>

- [0123] Antiwear agent 1: Oleic acid
 [0124] Antiwear agent 2: An octylic acid-type phosphoric acid ester
 [0125] Antiwear agent 3: Zinc dibutyl dithiophosphate

<Fluidity Improver>

- [0126] Fluidity improver 1: An ethylene-vinyl acetate copolymer
 [0127] Fluidity improver 2: A methyl methacrylate-hexadecyl acrylate copolymer
 [0128] Fluidity improver 3: A behenic acid ester of an EO adduct of triethanolamine

Table 10

	Blending example 1	Blending example 2	Blending example 3	Blending example 4	Blending example 5	Blending example 6	Blending example 7	Blending example 8	Blending example 9	Blending example 10
oilFuel oil base oil 1	Balance	Balance	Balance	Balance	Balance	Balance				
Fuel oil base oil 2									Balance	Balance
Fuel oil base oil 3										
Fuel oil base oil 4										
Fuel oil base oil 5										
Fuel oil base oil 6										
Fuel oil base oil						0.10%				
	Calcium salicylate-diluted product 3						0.10%			
	Calcium salicylate-diluted product 9	0.10%								
	Calcium salicylate-diluted product 11		0.05%	0.30%				0.05%	0.10%	
	Calcium salicylate-diluted product 16				0.10%					0.10%

(continued)

	Blending example 1	Blending example 2	Blending example 3	Blending example 4	Blending example 5	Blending example 6	Blending example 7	Blending example 8	Blending example 9	Blending example 10
Antimicrobial or microbicidal agent 1	0.01%	0.01%							0.01%	0.005%
Antimicrobial or microbicidal agent 2			0.01%			0.01%	0.01%			
Antimicrobial or microbicidal agent 3				0.01%	0.01%			0.03%		
Rust inhibitor 1	0.005%	0.002%	0.002%						0.005%	0.002%
Rust inhibitor 2				0.001%	0.002%	0.001%	0.002%	0.002%		
Antioxidant 1	0.005%			0.005%		0.005%			0.02%	
Antioxidant 2		0.005%			0.01%		0.01%			0.005%
Antioxidant 3			0.01%					0.005%		
Antiwear agent 1	0.04%		0.04%		0.04%		0.04%			
Antiwear agent 2				0.01%		0.04%		0.04%		0.04%
Antiwear agent 3		0.04%							0.01%	
Fluidity improver 1				0.10%						0.05%
Fluidity improver 2		0.05%	0.05%					0.02%	0.05%	
Fluidity improver 3	0.02%				0.05%	0.05%	0.05%			

Table 11

	Blending example 11	Blending example 12	Blending example 13	Blending example 14	Blending example 15	Blending example 16	Blending example 17	Blending example 18	Blending example	Blending example
Fuel oil base oil 1										
Fuel oil base oil 2										
Fuel oil base oil 3	Balance	Balance	Balance	Balance	Balance					
Fuel oil base oil 4						Balance	Balance	Balance	Balance	Balance
Fuel oil base oil 5										
Fuel oil base oil 6										
Calcium salicylate-diluted product 3	0.10%					0.10%				
Calcium salicylate-diluted product 9		0.10%					0.30%			
Calcium salicylate-diluted product 11			0.05%	0.10%				0.05%	0.10%	
Calcium salicylate-diluted product 16					0.10%					0.10%

(continued)

		Blending example 11	Blending example 12	Blending example 13	Blending example 14	Blending example 15	Blending example 16	Blending example 17	Blending example 18	Blending example	Blending example
	Antimicrobial or microbicial agent 1			0.01%			0.01%	0.005%			
	Antimicrobial or microbicial agent 2				0.01%	0.01%			0.01%		
	Antimicrobial or microbicial agent 3	0.005%	0.01%							0.01%	0.01%
	Rust inhibitor 1	0.005%	0.002%	0.002%						0.005%	0.002%
	Rust inhibitor 2				0.001%	0.002%	0.001%	0.002%	0.002%		
	Antioxidant 1	0.01%			0.005%				0.01%		
	Antioxidant 2		0.005%			0.01%	0.005%			0.01%	
	Antioxidant 3			0.005%							
	Antiwear agent 1	0.04%				0.04%		0.04%		0.04%	
	Antiwear agent 2		0.01%		0.04%				0.04%		0.04%
	Antiwear agent 3			0.04%			0.01%				

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(continued)

	Blending example 11	Blending example 12	Blending example 13	Blending example 14	Blending example 15	Blending example 16	Blending example 17	Blending example 18	Blending example	Blending example
Fluidity improver 1	0.02%						0.05%			
Fluidity improver 2				0.10%	0.05%	0.05%				0.02%
Fluidity improver 3		0.05%	0.05%					0.10%	0.05%	

Table 12

		Blending example 21	Blending example 22	Blending example 23	Blending example 24	Blending example 25	Blending example 26	Blending example 27	Blending example 28	Blending example 29	Blending example 30
Fuel oil base oil	Fuel oil base oil 1										
	Fuel oil base oil 2										
	Fuel oil base oil 3										
	Fuel oil base oil 4										
	Fuel oil base oil 5	Balance	Balance	Balance	Balance	Balance					
	Fuel oil base oil 6						Balance	Balance	Balance	Balance	Balance
Calcium salicylate	Calcium salicylate-diluted pro duct 3	0.10%					0.01%				
	Calcium salicylate-diluted pro duct 9		0.10%					0.01%			
	Calcium salicylate-diluted pro duct 11			0.05%	0.10%				0.005%	0.01%	
	Calcium salicylate-diluted pro duct 16					0.30%					0.01%

(continued)

		Blending example 21	Blending example 22	Blending example 23	Blending example 24	Blending example 25	Blending example 26	Blending example 27	Blending example 28	Blending example 29	Blending example 30
Antimicrobial or microbicide agent	Antimicrobial or microbicide agent 1				0.01%	0.01%			0.01%		
	Antimicrobial or microbicide agent 2	0.01%	0.01%							0.005%	0.01%
	Antimicrobial or microbicide agent 3			0.005%			0.01%	0.01%			
Rust inhibitor	Rust inhibitor 1	0.005%	0.002%	0.002%						0.005%	0.002%
	Rust inhibitor 2				0.001%	0.002%	0.001%	0.002%	0.002%		
Antioxidant	Antioxidant 1			0.01%					0.005%		
	Antioxidant 2	0.005%			0.005%		0.005%			0.01%	
	Antioxidant 3		0.01%			0.005%		0.005%			0.01%
Antiwear agent	Antiwear agent 1	0.04%		0.04%				0.04%			
	Antiwear agent 2		0.04%		0.01%		0.04%		0.04%		

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(continued)

		Blending example 21	Blending example 22	Blending example 23	Blending example 24	Blending example 25	Blending example 26	Blending example 27	Blending example 28	Blending example 29	Blending example 30
Fluidity improver	Antiwear agent 3					0.04%				0.04%	
	Fluidity improver 1			0.10%						0.02%	
	Fluidity improver 2	0.05%	0.05%					0.05%	0.10%		
	Fluidity improver 3				0.02%	0.05%	0.05%				0.05%

Table 13

	Blending example 31	Blending example 32	Blending example 33	Blending example 34	Blending example 35	Blending example 36	Blending example 37	Blending example 38	Blending example 39
Fuel oil base oil	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance
Fuel oil base oil 1									
Fuel oil base oil 2		Balance							
Fuel oil base oil 3			Balance						
Fuel oil base oil 4				Balance					
Fuel oil base oil 5						Balance	Balance		
Fuel oil base oil 6								Balance	Balance
Calcium salicylate-diluted product 3	0.10%					0.10%			
Calcium salicylate-diluted product 9		0.10%					0.30%		
Calcium salicylate-diluted product 11			0.05%	0.10%				0.05%	0.10%
Calcium salicylate-diluted product 16					0.10%				
Sorbitan ester 1	0.50%	0.50%	0.50%	1.0%	0.10%	1.00%	0.10%	1.0%	0.10%
Antimicrobial or microbicide agent 1			0.01%			0.01%	0.005%		
Antimicrobial or microbicide agent 2				0.01%	0.01%			0.01%	
Antimicrobial or microbicide agent 3	0.005%	0.01%							0.01%

(continued)

		Blending example 31	Blending example 32	Blending example 33	Blending example 34	Blending example 35	Blending example 36	Blending example 37	Blending example 38	Blending example 39
	Rust inhibitor 1	0.005%	0.002%	0.002%						0.005%
	Rust inhibitor 2				0.001%	0.002%	0.001%	0.002%	0.002%	
	Antioxidant 1	0.01%			0.005%				0.01%	
	Antioxidant 2		0.005%			0.01%	0.005%			0.01%
	Antioxidant 3			0.005%				0.005%		
	Antiwear agent 1	0.04%				0.04%		0.04%		0.04%
	Antiwear agent 2		0.01%		0.04%				0.04%	
	Antiwear agent 3			0.04%			0.01%			
	Fluidity improver 1	0.02%						0.05%		
	Fluidity improver 2				0.10%	0.05%	0.05%			
	Fluidity improver 3		0.05%	0.05%					0.10%	0.05%

Table 14

	Blending example 40	Blending example 41	Blending example 42	Blending example 43	Blending example 44	Blending example 45	Blending example 46	Blending example 47	Blending example 48
Fuel oil base oil	Fuel oil base oil 7	Balance	Balance	Balance	Balance	Balance			
	Fuel oil base oil 8					Balance			
	Fuel oil base oil 9						Balance	Balance	Balance
Calcium salicylate	Calcium salicylate-diluted product 3	0.10%				0.10%			
	Calcium salicylate-diluted product 9						0.30%		
	Calcium salicylate-diluted product 11		0.05%	0.10%				0.05%	0.10%
	Calcium salicylate-diluted product 16				0.10%				
Sorbitan ester	Sorbitan ester 1								
	Sorbitan ester 2								
	Sorbitan ester 3								
	Sorbitan ester 4								
Antimicrobial or microbicide agent	Antimicrobial or microbicide agent 1		0.01%			0.01%	0.005%		
	Antimicrobial or microbicide agent 2			0.01%	0.01%			0.01%	
	Antimicrobial or microbicide agent 3	0.005%	0.01%						0.01%

(continued)

		Blending example 40	Blending example 41	Blending example 42	Blending example 43	Blending example 44	Blending example 45	Blending example 46	Blending example 47	Blending example 48
	Rust inhibitor 1	0.005%	0.002%	0.002%	0.001%	0.002%	0.001%	0.002%		0.005%
	Rust inhibitor 2				0.005%			0.002%	0.01%	
	Antioxidant 1	0.01%					0.005%			
	Antioxidant 2		0.005%			0.01%				0.01%
	Antioxidant 3			0.005%				0.005%		
	Antiwear agent 1	0.04%				0.04%		0.04%		0.04%
	Antiwear agent 2		0.01%		0.04%				0.04%	
	Antiwear agent 3			0.04%			0.01%			
	Fluidity improver 1	0.02%						0.05%		
	Fluidity improver 2				0.10%	0.05%	0.05%			
	Fluidity improver 3		0.05%	0.05%					0.10%	0.05%

Table 15

	Blending example 49	Blending example 50	Blending example 51	Blending example 52	Blending example 53	Blending example 54	Blending example 55	Blending example 56	Blending example 57
Fuel oil base oil	Fuel oil base oil 7	Balance	Balance	Balance	Balance	Balance			
	Fuel oil base oil 8								
	Fuel oil base oil 9					0.10%		Balance	Balance
Calcium salicylate	Calcium salicylate-diluted product 3	0.10%				0.10%			
	Calcium salicylate-diluted product 9						0.30%		
	Calcium salicylate-diluted product 11		0.05%	0.10%				0.05%	0.10%
	Calcium salicylate-diluted product 16				0.10%				
Sorbitan ester	Sorbitan ester 1	0.50%			0.50%				0.50%
	Sorbitan ester 2					0.50%			
	Sorbitan ester 3		0.50%				0.50%		
	Sorbitan ester 4			0.50%				0.50%	
Antimicrobial or microbicide agent	Antimicrobial or microbicide agent 1		0.01%			0.01%	0.005%		
	Antimicrobial or microbicide agent 2			0.01%	0.01%			0.01%	
	Antimicrobial or microbicide agent 3	0.005%	0.01%						0.01%

(continued)

		Blending example 49	Blending example 50	Blending example 51	Blending example 52	Blending example 53	Blending example 54	Blending example 55	Blending example 56	Blending example 57
	Rust inhibitor 1	0.005%	0.002%	0.002%			0.001%	0.002%		0.005%
	Rust inhibitor 2				0.001%	0.002%		0.002%	0.002%	
	Antioxidant 1	0.01%			0.005%				0.01%	
	Antioxidant 2		0.005%			0.01%	0.005%			0.01%
	Antioxidant 3			0.005%				0.005%		
	Antiwear agent 1	0.04%				0.04%		0.04%		0.04%
	Antiwear agent 2		0.01%		0.04%				0.04%	
	Antiwear agent 3			0.04%			0.01%			
	Fluidity improver 1	0.02%						0.05%		
	Fluidity improver 2				0.10%	0.05%	0.05%			
	Fluidity improver 3		0.05%	0.05%					0.10%	0.05%

[0129] According to the present invention, there can be provided the fuel oil composition excellent in suppression of the deposition of sludge at the time of its storage or at the time of its use. In addition, according to the present invention, there can be further provided the fuel oil composition excellent in combustibility, storage stability, oxidation stability, wear resistance, uniformity, safety, environmental compatibility, startability, low-temperature fluidity, handleability, and the like.

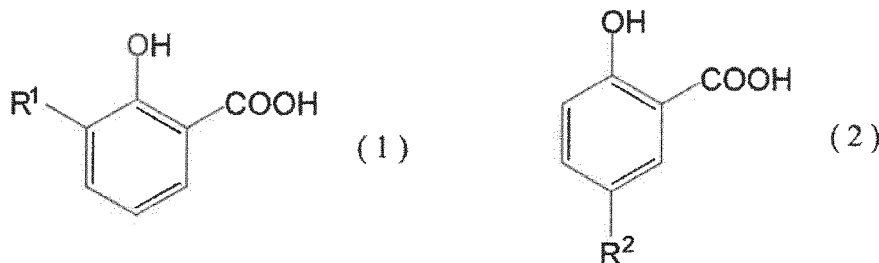
Claims

1. A fuel oil composition, comprising:

a fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass%; and
a calcium salicylate having a total base number of from 100 mgKOH/g to 1,200 mgKOH/g.

2. The fuel oil composition according to claim 1, wherein a content of the calcium salicylate is from 1 ppm by mass to 2,000 ppm by mass with respect to a total amount of the fuel oil composition in terms of calcium element content.

3. The fuel oil composition according to claim 1 or 2, wherein the calcium salicylate contains a calcium salt of an alkylsalicylic acid represented by the following general formula (1) or general formula (2):



where R¹ represents a hydrocarbon group having 4 to 32 carbon atoms, and R² represents a hydrocarbon group having 4 to 32 carbon atoms.

4. The fuel oil composition according to any one of claims 1 to 3, wherein a ratio between the sulfur element content in the fuel oil base oil and a calcium element content derived from the calcium salicylate is from 1,000:1 to 0.5:1 in terms of mass ratio.

5. The fuel oil composition according to any one of claims 1 to 4, wherein the fuel oil base oil has a kinematic viscosity at 40°C of from 1 mm²/s to 600 mm²/s.

6. The fuel oil composition according to any one of claims 1 to 5, further comprising a sorbitan ester.

7. The fuel oil composition according to any one of claims 1 to 6, wherein the fuel oil composition is a fuel oil composition for a ship.

8. A method of suppressing deposition of sludge in a fuel oil composition, comprising blending a fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass% with a calcium salicylate having a total base number of from 100 mgKOH/g to 1,200 mgKOH/g.

9. The method according to claim 8, wherein the fuel oil composition is a fuel oil composition for a ship.

10. A use of a calcium salicylate having a total base number of from 100 mgKOH/g to 1,200 mgKOH/g for suppressing deposition of sludge in a fuel oil composition comprising a fuel oil base oil having a sulfur element content of from 0.01 mass% to 0.50 mass%.

11. The use according to claim 10, wherein the fuel oil composition is a fuel oil composition for a ship.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/012671

A. CLASSIFICATION OF SUBJECT MATTER

C10L 1/189 (2006.01) i

FI: C10L1/189

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10L1/189

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-193074 A (ASAHI DENKA KOGYO KK.) 09.07.2003	1-7
Y	(2003-07-09) paragraphs [0053], [0059]	8-11
Y	JP 51-111807 A (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.) 02.10.1976 (1976-10-02) examples	8-11
Y	JP 63-312393 A (COSMO OIL CO., LTD.) 20.12.1988 (1988-12-20) examples	8-11
A	JP 50-3082 B1 (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V.) 31.01.1975 (1975-01-31)	1-11
A	JP 2007-146161 A (INFINEUM INTERNATIONAL LIMITED) 14.06.2007 (2007-06-14)	1-11



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
21 May 2020 (21.05.2020)Date of mailing of the international search report
16 June 2020 (16.06.2020)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application no.

PCT/JP2020/012671

5	Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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REFERENCES CITED IN THE DESCRIPTION

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