(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 116 779 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
18.07.2001 Bulletin 2001/29

(21) Application number: **99925327.1**

(22) Date of filing: **15.06.1999**

(51) Int Cl.[7]: **C10L 1/08**, C10L 1/22

(86) International application number:
PCT/JP99/03183

(87) International publication number:
WO 99/66010 (23.12.1999 Gazette 1999/51)

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **15.06.1998 JP 16650298**

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(54) FUEL OIL ADDITIVE AND FUEL OIL COMPOSITION

(57) Provided are a fuel oil additive comprising (a) an alkenylsuccinimide or alkylsuccinimide compound or its boron adduct, (b) a lubricant, and optionally (c) a low-temperature fluidability improver, and having a temperature per 90% recovered with distillation of 320°C or higher; and a fuel oil composition comprising fuel oil and the additive added thereto. The additive has excellent capabilities to enhance the lubricity in fuel injection pumps and to enhance the detergency in fuel injection nozzles, and it is especially favorable to low-sulfur gas oil.

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Printed by Jouve, 75001 PARIS (FR)

Description

TECHNICAL FIELD

[0001] The present invention relates to a fuel oil additive and a fuel oil composition. More precisely, it relates to a fuel oil additive especially to gas oil for diesel engines to be used in automobiles, ships, generators, etc., and to a fuel oil composition containing it.

BACKGROUND ART

[0002] To meet the recent exhaust gas control, reducing the sulfur content of gas oil for diesel engines is required. Since October 1997, the content has been controlled to be at most 0.05 % by weight. However, it has been known that deep desulfurization of gas oil bases for such sulfur content reduction degrades the lubricity of the resulting gas oil products. Specifically, it is reported that the components of fuel injection pumps for diesel engines lubricated by fuel gas oil of reduced lubricity are much worn, thereby causing some troubles such as engine rotation failure, drivability reduction, etc. It is believed that hydro-desulfurization for sulfur removal from gas oil will reduce the lubricity of gas oil since lubricant polar compounds such as nitrogen compounds, aromatic compounds and others will removed along with sulfur compounds through such hydro-desulfurization. To solve the problem of lubricity reduction in gas oil, the related hardware is being reformed and improved, while, on the other hand, it is required to modify and improve fuel itself. Many studies are being made for the latter, and various lubricants have been developed and added to fuel.

[0003] Low-sulfur gas oil used in diesel cars could reduce the sulfate particulate content of exhaust gas. In this connection, however, it is reported that the detergency reduction in fuel injection nozzles results in the increase in sulfate particulate exhaustion from engines. Therefore, various detergents have been investigated and added to fuel.

[0004] In general, lubricants improve the lubricity in fuel injection pumps, but do not contribute to the detergency in fuel injection nozzles. On the other hand, detergents contribute to the detergency in fuel injection nozzles, but little to improving the lubricity in fuel injection pumps. For example, Japanese Patent Laid-Open No. 272880/1997 discloses low-sulfur gas oil with a fatty acid ester of sorbitan added thereto, which, however, does not contribute to the detergency in fuel injection nozzles. Japanese Patent Laid-Open No. 255973/1997 discloses low-sulfur gas oil with a salt of a carboxylic acid and an aliphatic amine or the like added thereto. They say that it contributes both to the lubricity in fuel injection pumps and to the detergency in fuel injection nozzles, but its effect is not always satisfactory. International Patent Publication No. 513208/1998 (Exxon Chemical, WO96/23855, laid open on August 8, 1996) discloses a fuel oil composition comprising fuel oil not containing over 0.05 % by weight sulfur, of which the 95 % running point is not higher than 350°C, and an additive composition containing (a) an acylated nitrogen compound and (b) a carboxylic acid having from 2 to 50 carbon atoms or an ester of the carboxylic acid with an alcohol. They say that the additive composition comprising (a) and (b) enhances the lubricity of fuel oil and its solubility in fuel oil is improved. In that situation, desired are additives having excellent capabilities to improve the lubricity in fuel injection pumps and the detergency in fuel injection nozzles. Improving the lubricity in fuel injection pumps and the detergency in fuel injection nozzles is important also for gas oil not so much desulfurized.

[0005] The present invention has been made in consideration of the viewpoint mentioned above, and its object is to provide a fuel oil additive having excellent capabilities to improve the lubricity in fuel injection pumps and the detergency in fuel injection nozzles especially for fuel oil having a reduced sulfur content and having a temperature per 90% recovered with distillation of 320°C or higher, and also to provide a fuel oil composition containing the additive.

DISCLOSURE OF THE INVENTION

[0006] I, the inventor of the present invention, have assiduously studied and, as a result, have found that using an alkenylsuccinimide compound, alkylsuccinimide compound, a boron adduct of alkenylsuccinimide compound or a boron adduct of alkylsuccinimide compound as one component of an additive to fuel oil effectively attains the above-mentioned object of the invention, and have completed the invention.

[0007] Specifically, the invention is summarized as follows:

(1) A fuel oil additive comprising (a) an alkenylsuccinimide compound, alkylsuccinimide compound, a boron adduct of alkenylsuccinimide compound or a boron adduct of alkylsuccinimide compound, and (b) a lubricant, and having a temperature per 90% recovered with distillation of 320°C or higher.

(2) A fuel oil additive comprising (a) an alkenylsuccinimide compound, alkylsuccinimide compound, a boron adduct of alkenylsuccinimide compound or a boron adduct of alkylsuccinimide compound, (b) a lubricant, and (c) a low-temperature fluidability improver, and having a temperature per 90% recovered with distillation of 320°C or higher.

(3) The fuel oil additive of (1) or (2), wherein the lubricant is at least one of unsaturated fatty acids having from 4

to 22 carbon atoms or their dimer acids, or their esters.

(4) A fuel oil composition comprising fuel oil and a fuel oil additive of any of (1) to (3) added thereto.

(5) The fuel oil composition of (4), wherein the amount of the component (a) is from 20 to 1,500 ppm by weight based on the total of the fuel oil composition.

(6) The fuel oil composition of (4) or (5), wherein the amount of the component (b) is from 5 to 300 ppm by weight based on the total of the fuel oil composition.

(7) The fuel oil composition of any of (4) to (6), wherein the amount of the component (c) is from 50 to 500 ppm by weight based on the total of the fuel oil composition.

(8) The fuel oil composition of any of (4) to (7), wherein the fuel oil is diesel gas oil.

(9) The fuel oil composition of (8), wherein the sulfur content of diesel gas oil is from 0.001 to 0.05 % by weight.

(10) The fuel oil composition of (4), wherein the fuel oil has a temperature per 90% recovered with distillation of 320°C or higher.

(11) The fuel oil composition of (4), wherein the fuel oil has a temperature per 90% recovered with distillation of 330°C or higher.

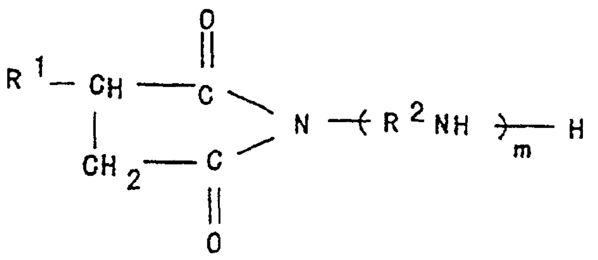
(12) The fuel oil composition of (4), wherein the fuel oil has a temperature per 90% recovered with distillation of 340°C or higher.

(13) The fuel oil composition of (4), wherein the fuel oil has a temperature per 90% recovered with distillation of 350°C or higher.

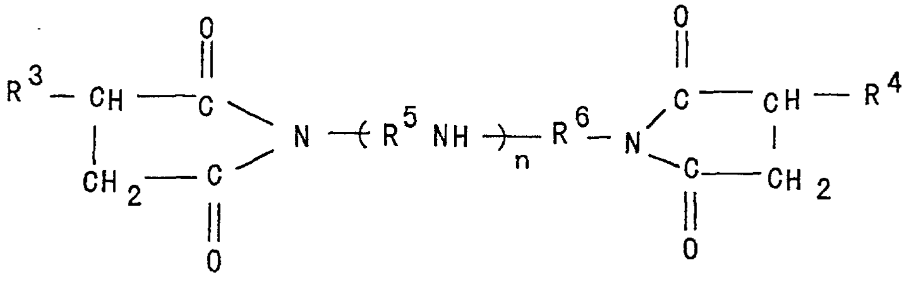
BEST MODES OF CARRYING OUT THE INVENTION

[0008] Embodiments of the invention are described below.

[0009] First described is the component (a) of the fuel oil additive of the first aspect of the invention, which is any of an alkenylsuccinimide or alkylsuccinimide compound or its boron adduct. The alkenylsuccinimide or alkylsuccinimide compound includes mono-compounds of the following general formula (1) and bis-compounds of the following general formula (2) :



(1)



· · · (2)

wherein R^1, R^3 and R^4 each represent an alkenyl or alkyl group having a number-average molecular weight of from 300 to 4, 000, and may be the same or different; R^5 and R^6 each represent an alkylene group having from 2 to 4 carbon atoms, and may be the same or different; m indicates an integer of from 1 to 10; and n indicates 0 or an integer of from 1 to 10.

[0010] In formulae (1) and (2), the number-average molecular weight of the alkenyl or alkyl group for R^1, R^3 and R^4 preferably falls between 500 and 2,000, more preferably between 500 and 1,000. The alkenyl group includes a polybutenyl group and an ethylene-propylene copolymer; and the alkyl group is derived from it through hydrogenation.

[0011] In the invention, usable is any of the above-mentioned mono-compounds and bis-compounds.

[0012] The alkenylsuccinimide and alkylsuccinimide compounds can be prepared generally through reaction of a polyalkenylsuccinic anhydride obtained by reacting a polyolefin with maleic anhydride, or a polyalkylsuccinic anhydride obtained by hydrogenating the polyalkenylsuccinic anhydride, with a polyamine. To prepare the above-mentioned mono-compounds and bis-compounds, the ratio of the polyalkenylsuccinic anhydride or polyalkylsuccinimide to the polyamine to be reacted therewith shall be varied. The olefin monomer to form the polyolefin may one or more of α-olefins having from 2 to 8 carbon atoms. The polyamine includes simple diamines such as ethylenediamine, propylenediamine, butylenediamine, pentylenediamine, etc.; and polyalkylenepolyamines such as diethylenetriamine, triethylenetetramine, tetraethylenepentamine, pentaethylenehexamine, di(methylethylene)triamine, dibutylenetriamine, tributylenetetramine, pentapentylenehexamine, etc.

[0013] The boron adduct of such an alkenylsuccinimide or alkylsuccinimide compound for use herein may be prepared in any ordinary manner. The boron content of the boron adduct preferably falls between 0.1 and 6 % by weight, more preferably between 0.1 and 4 % by weight.

[0014] One or more of the compounds mentioned above may be used for the component (a) either singly or as combined.

[0015] Next described is the lubricant for the component (b) in the first aspect of the invention. The lubricant for use in the invention is an additive to be incorporated in the composition for lowering the friction coefficient of the composition, and is not specifically defined. For this, however, preferred are unsaturated fatty acids having from 4 to 22 carbon atoms or their dimer acids, or their esters. Also preferred are mixtures of the acids and their esters. The unsaturated fatty acids may be linear or branched, including, for example, caproleic acid, linderic acid, tudic acid, myristoleic acid, oleic acid, codoic acid, erucic acid, linolic acid, linolenic acid, etc. Alcohols for esterifying the acids include methyl alcohol, ethyl alcohol, oleyl alcohol, glycerin, etc. The esters may be partial esters.

[0016] Other examples of the lubricant are amide compounds such as stearamide, oleamide, stearobis (polyethylene glycol) amide, etc.; amine compounds such as dodecylamine, aminostearic acid, dimethylstearic acid, cyclohexylamine, dodecylbis(diethylene glycol)amine, etc.; other amine compounds such as phenyl-α -naphthylamine, bisoctylphenylamine, bisnonylphenylamine, diphenyl-p-phenylenediamine, dipyridylamine, phenothiazine, N-methylphenothiazine, N-ethylphenothiazine, etc.; disulfides such as dibutyl disulfide, dioctyl disulfide, didodecyl disulfide, etc.; chlorinated hydrocarbons such as chlorinated paraffin wax, chlorinated naphthalene, chlorinated alkylbenzenes, etc.; phosphinates such as n-butyl-di-n-octyl phosphinate, etc.; phosphonates such as di-n-butylhexyl phosphonate, di-n-butylphenyl phosphonate, etc.; phosphates such as tributyl phosphate, tricresyl phosphate, trioleyl phosphate, di-2-ethylhexyl phosphate, etc.; phenols such as 2,6-di-t-butyl-p-cresol, 2,2'-methylenebis(4-methyl-6-t-butylphenol), 2,2'-methylenebis(4-ethyl-6-t-butylphenol), 2,5-di-t-amylhydroquinone, 2,5-di-t-butylhydroquinone, 4,4'-thiobis(6-t-butyl-m-cresol), octadecyl-3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate, diethyl-3,5 -di-t-butyl-4-hydroxybenzylphosphonate, triethylene glycol bis[3-(3-t-butyl-5-methyl-5-hydroxyphenyl)propionate], etc.

[0017] One or more of the compounds mentioned above may be used for the component (b) either singly or as combined.

[0018] The ratio of the component (a) to the component (b) preferably falls between 90/10 and 10/90 by weight. The fuel oil additive of the first aspect of the invention may be prepared by diluting a mixture of the components (a) and (b) with a diluent of kerosene gas oil and/or an aromatic solvent having from about 8 to 10 carbon atoms or the like, and optionally adding thereto other additives of antioxidant, metal deactivator, bactericide, anti-freezing agent, antistatic agent, corrosion inhibitor, anti-foaming agent, rust inhibitor, combustion improver, colorant, marker, etc., thereby controlling the total amount of the components (a) and (b) to fall preferably between 20 and 80 % by weight.

[0019] An additional component (c), low-temperature fluidability improver may be added to the fuel oil additive of the first aspect of the invention that comprises the components (a) and (b), by which the capability of the additive to improve the lubricity of fuel oil is much enhanced. The component (c), low-temperature fluidability improver is not specifically defined, but preferred for it are esters of a hydroxyl group-having nitrogen compound and a linear saturated fatty acid (Japanese Patent Laid-Open No. 1790993/1982), and polymers of the ester with one or more monomers selected from olefins, alkyl esters of ethylenic unsaturated carboxylic acids, and vinyl esters of saturated fatty acids (Japanese Patent Laid-Open No. 138791/1983). Other low-temperature fluidability improvers usable herein are ethylene-vinyl acetate copolymers, ethylene-alkyl alkylates, polyalkyl acrylates, alkenylsuccinic acid amides, etc.

[0020] One or more of the compounds mentioned above may be used for the component (c) either singly or as combined.

[0021] The ratio of the component (c) is preferably from 30 to 150 parts by weight to 100 parts by weight of the total of the components (a) and (b). The fuel oil additive comprising the components (a), (b) and (c) may be prepared by diluting a mixture of the components with a diluent of kerosene, gas oil or an aromatic solvent having from about 8 to

10 carbon atoms or the like, and optionally adding thereto other additives of antioxidant, metal deactivator, bactericide, anti-freezing agent, antistatic agent, corrosion inhibitor, anti-foaming agent, rust inhibitor, combustion improver, colorant, marker, etc., thereby controlling the total amount of the components (a), (b) and (c) to fall preferably between 20 and 80 % by weight.

[0022] The second aspect of the invention is a fuel oil composition comprising fuel oil and the above-mentioned fuel oil additive added thereto. Fuel oil to be in the composition includes various types of hydrocarbon-based fuel oils. In view of the required properties, however, preferred is gasoline or diesel gas oil, and more preferred is diesel gas oil. Diesel gas oil for the invention satisfies the Japan Industrial Standards (JIS K2204) with respect to its properties, preferably, its sulfur content falls between 0.001 and 0.05 % by weight. Also preferably, its kinematic viscosity at 30°C is at least 1.7 mm^2/sec. For example, usable herein are hydro-desulfurized gas oil (DGO), hydro-cracked gas oil (HCGO), etc., as well as their mixtures having a sulfur content within the defined range as above.

[0023] Preferably, the diesel gas oil composition of the invention has a sulfur content of from 0.001 to 0.05 % by weight. If its sulfur content oversteps the defined range, the effect of the fuel oil additive added to the composition will be poor.

[0024] Regarding its distillation characteristics, the fuel oil preferably has a temperature per 90% recovered with distillation of 320°C or higher, more preferably 330°C or higher, even more preferably 340°C or higher, most preferably 350°C or higher. The effect of the fuel oil additive, if added to fuel oil having a temperature per 90% recovered with distillation of lower than 320°C, will be poor.

[0025] Hydro-desulfurized gas oil (DGO) generally having a boiling point that falls between 140 and 390°C and having a density that falls between 0.80 and 0.90 may be suitably used in the invention. Such hydro-desulfurized gas oil (DGO) for use herein will generally have a sulfur content of falling between 0.005 and 0.5 % by weight, but its sulfur content is preferably at most 0.05 % by weight.

[0026] Hydro-desulfurized gas oil (DGO) for use herein may be obtained from a starting oil of straight-run light gas oil (LGO) by desulfurizing it in a hydro-desulfurizing apparatus. Concretely, LGO is desulfurized in the presence of a catalyst of, for example, Co-Mo/alumina, Ni-Mo/alumina or the like, under a pressure falling between 30 and 100 kg/cm^2G, preferably between 50 and 70 kg/cm^2G, at a temperature falling between 300 and 400°C, preferably between 330 and 360°C, and at a liquid-hourly space velocity (LHSV) falling between 0.5 and 5 hr^{-1}, preferably between 1 and 2 hr^{-1}, and thereafter processed with a stripper to remove hydrogen sulfide and naphtha from it.

[0027] Hydro-cracked gas oil (HCGO) for use herein may be obtained by hydro-cracking heavy gas oil (HGO), vacuum gas oil (VGO) or their mixture in the presence of a catalyst, and fractionating the cracked oil through distillation. The thus-obtained, hydro-cracked gas oil (HCGO) for use herein generally has a sulfur content falling between 0.0001 and 0.2 % by weight.

[0028] The gas oil base mentioned above may be optionally mixed with ordinary gas oil fractions such as straight-run light gas oil (LGO), by-product gas oil from fuel oil direct desulfurization process, desulfurized gas oil (DSGO), by-product gas oil from catalytic cracking process, light cycle oil (LCO), desulfurized LCO (DSLCO), by-product gas oil from indirect desulfurization process (VHLGO), dewaxed light gas oil (DWLGO), dewaxed desulfurized gas oil (DWD-GO), desulfurized kerosene fraction (DK), etc.

[0029] Regarding the amount of the fuel oil additive to be in the fuel oil composition, the components (a), (b) and (c) constituting it will be controlled as follows:

[0030] The amount of the component (a) preferably falls between 20 and 1, 500 ppm by weight, more preferably between 50 and 800 ppm by weight, based on the total of the composition. If it is smaller than 20 ppm by weight, the detergency in nozzles could be hardly enhanced; and if larger than 1, 500 ppm by weight, the detergency in nozzles could not be effectively enhanced.

[0031] The amount of the component (b) preferably falls between 5 and 300 ppm by weight, more preferably between 10 and 150 ppm by weight, based on the total of the composition. If it is smaller than 5 ppm by weight, the detergency in nozzles could be hardly enhanced; and if larger than 300 ppm by weight, the detergency in nozzles could not be effectively enhanced.

[0032] The amount of the component (c) preferably falls between 50 and 500 ppm by weight, more preferably between 100 and 400 ppm by weight, based on the total of the composition. If it is smaller than 50 ppm by weight, the synergistic effect with the component (b) will be poor and the detergency in nozzles could be hardly enhanced; and if larger than 300 ppm by weight, the synergistic effect with the component (b) will be poor and the detergency in nozzles could not be effectively enhanced.

[0033] To the fuel oil composition of the invention, if desired, other additives of antioxidant, metal deactivator, bactericide, anti-freezing agent, antistatic agent, corrosion inhibitor, anti-foaming agent, rust inhibitor, combustion improver, colorant, marker, etc., may be suitably added within the range not interfering with the effect of the invention. These additives may be added thereto separately from the above-mentioned fuel oil additive, but are generally in the form of fuel oil additive packages.

[Examples]

[0034] The invention is described more concretely with reference to the following Examples, which, however, are not intended to restrict the scope of the invention.

Examples 1 to 3; Comparative Examples 1 and 2; and Reference Example 1:

(1) Preparation of diesel gas oil composition of the Invention:

(i) Gas oil used:

[0035] Deep-desulfurized gas oil shown in the following Table 1 was used.

Table 1

Particulars		Data	Method of Measurement
Density (g/cm^3, 15°C)		0.8321	JIS K2249
Kinematic Viscosity (mm^2/sec, 30°C)		4.279	JIS K2283
Pour Point (°C)		-5.0	JIS K2269
Cloud Point (°C)		3.0	JIS K2269
Cetane number		55.1	JIS K2280
Clogging Temperature (°C)		1.0	JIS K2288
Sulfur Content (wt.%)		0.026	JIS K2541
Distillation Characteristics (°C)	10 vol.% point	222.0	JIS K2254
	50 vol.% point	288.5	
	90 vol.% point	352.0	

(ii) Additives:

[0036] The following additives were added to the gas oil in the ratio indicated in Table 2 to prepare gas oil compositions.

Succinimide for component (a)

[0037] Polybutene having a number-average molecular weight of 960 was added to maleic anhydride, to which was further added tetraethylenepentamine to prepare polybutenylsuccinimide. This was diluted with mineral oil having a viscosity at 40 °C of 32 mm^2/sec to prepare its dilution having a concentration of 64 % by weight.

Lubricant for component (b)

[0038] Its essential ingredient is a mixture of unsaturated fatty acids having 18 carbon atoms, linolic acid, oleic acid and linolic acid (in which the amount of each acid falls between 15 and 50 % by weight and the total of the acids is 90 % by weight) . This was diluted with an aromatic solvent having 10 carbon atoms to prepare its dilution having an effective ingredient content of 20 % by weight.

Low-temperature fluidability improver for component (c)

[0039] This is a mixture comprised of triethanolamine (25 % by weight), tribehenate (50 % by weight) and ethylene-vinyl acetate copolymer (25 % by weight) . This was diluted with an aromatic solvent having 10 carbon atoms to prepare its dilution having an effective ingredient content of 50 % by weight.

(2) Test for detergency in nozzles:

[0040] The gas oil compositions having been prepared in the above were tested for the detergency in nozzles, in the manner mentioned below.

[0041] Fueled with any of the gas oil composition, a 2,400 cc-class, ante-chamber-type, straight 4-cylinder diesel engine equipped with a slot nozzle was driven for 18 hours at an engine speed of 2,400 rpm and at a torque of 12.7 kg·m (load ratio of 80 %). After having been thus driven, the nozzle of the engine was checked for dirtiness. Concretely, the needle valve of the nozzle was lifted up to 0.6 mm, and 0.50 kg/cm^2 pressure air was applied to the injection port of the nozzle to measure the air flow rate through the nozzle by the use of an air flow meter. The air flow rate relative to the needle valve lift was calculated in terms of the area flow, and the data of the area flow before the test (fresh nozzle) were compared with those after the test, from which was derived the degree of dirtiness of the nozzle. The area flow retentiveness of 100 % before and after the test for area flow comparison relative to the needle valve lift indicates that the used nozzle is the same as the fresh nozzle, or that is, the used nozzle is not dirty at all. Contrary to this, the area flow retentiveness of 0 % indicates that the used nozzle is completely clogged, or that is, no fuel could be injected through it. The data obtained are given in Table 2.

(3) Test for lubricity:

[0042] Using a test apparatus of EU Committee's CEC-F-06-T94 HFRR (high frequency reciprocation wear rig), each oil composition was applied to a wear test ball. Regarding the test condition, the load was 200 g, the sample oil temperature was 60°C, the vibration frequency was 50 Hz, the test time was 75 minutes, and the sample amount was 2 ml. The worn mark profile on the test ball was inspected with a microscope in the direction of X (horizontal direction) and Y (vertical direction), and the values measured were averaged to obtain the wear rate (μm). The data are given in Table 2.

Table 2

	Example 1	Example 2	Example 3	Comp. Ex. 1	Comp. Ex. 2	Ref. Ex. 1
Amount of Succinimide added(*)	500	500	100	0	500	0
Amount of Lubricant added(*)	75	75	100	75	0	0
Amount of Low-temperature Fluidability Improver added(*)	0	275	275	0	0	0
Nozzle Area Flow Retentiveness (%)	70	72	50	35	54	35
HFRR Wear Rate (μm)	330	310	300	400	560	580

(Note) * ppm by weight.

[0043] As in Table 2, the nozzle area flow retentiveness of the gas oil compositions to which the additive of the invention had been added was high, and it is understood that the compositions enhanced the detergency in injection nozzles. In addition, the wear rate in the test where the compositions were used was small, and it is understood that the compositions enhanced the lubricity in injection nozzles.

Examples 4 and 5:

[PM reduction in exhaust gas and detergency in nozzles]

[0044] An engine, of which the particulars are shown in Table 3, was tested for PM (particulate matter) emission under the condition indicated in Table 4. Precisely, with any of the fuel of Table 1 (Example 4) or the fuel of Table 5 (Example 5), the engine of Table 3 was driven for 5000 km under the nozzle-soiling condition shown in Table 4 and then under the nozzle-deterging condition shown therein.

[0045] Next, the engine was further driven under the PM emission-measuring condition shown in Table 4, while its PM emission was measured by the use of a mini-dilution tunnel system (from Horiba Seisakusho). For this, referred to was the diesel car particulate emission test method, TRIAS-24-5-1993. The data obtained are given in Table 6.

Comparative Examples 3 and 4:

[0046] Fuel oil containing neither the succinimide nor the low-temperature fluidability improver was tested for PM emission in the same manner as in Examples 4 and 5. The data obtained are given in Table 7.

Table 3 -

Particulars of Engine Tested	
Particulars	Data
Cylinder configuration	straight 4-cylinder
Mode of combustion	swirl chamber type diesel engine
Total displacement (cc)	2,982
Compression ratio	21.2
Peak torque (N·m/rpm)	289/2000
Peak brake power (kW/rpm)	95.6/3600
Mode of injection pump	electronically-controlled distributor-injection system

Table 4 -

Condition for Engine Test			
	Nozzle-soiling Condition	Nozzle-deterging Condition	Condition for PM Emission Measurement
Engine rotation (rpm)	2000	2600	1500
Engine load (%)	80	25	80
Engine oil temperature (°C)	85	85	85
Engine water temperature (°C)	80	80	80
Intake temperature (°C)	25	25	25
Intake humidity (°C)	50	50	50
Fuel oil temperature (°C)	25	25	25
Driving time (hr)	up to 5000 km	8	0.5/test

Table 5 -

Particulars of Fuel Used			
Particulars		Data	Method of Measurement
Density (g/cm^3, 15°C)		0.8274	JIS K2249
Kinematic Viscosity (mm^2/sec, 30°C)		3.535	JIS K2283
Cetane number		57.0	JIS K2280
Sulfur Content (wt.%)		0.04	JIS K2541
Distillation Characteristics	10 vol.% point	204.0	JIS K2254
	50 vol.% point	283.0	
	90 vol.% point	330.0	

Table 6 -

PM Emission (Examples)		
	Example 4	Example 5
Amount of Succinimide added(*)	1000	1000
Amount of Lubricant added(*)	75	75
Amount of Low-temperature Fluidability Improver added(*)	275	275
PM emission (g/kWh)	0.834	0.965
Fuel used	Fuel of Table 1	Fuel of Table 5

(Note) * ppm by weight.

Table 7 -

PM Emission (Comparative Examples)		
	Comparative Example 3	Comparative Example 4
Amount of Succinimide added(*)	0	0
Amount of Lubricant added(*)	75	75
Amount of Low-temperature Fluidability Improver added(*)	0	0
PM emission (g/kWh)	1.155	1.254
Fuel used	Fuel of Table 1	Fuel of Table 5

(Note) * ppm by weight.

INDUSTRIAL APPLICABILITY

[0047] The invention provides a fuel oil additive having excellent capabilities to enhance the lubricity in fuel injection pumps and to enhance the detergency in fuel injection nozzles, and especially favorable to low-sulfur gas oil, and also provides a fuel oil composition containing it.

Claims

1. A fuel oil additive comprising (a) an alkenylsuccinimide compound, alkylsuccinimide compound, a boron adduct of alkenylsuccinimide compound or a boron adduct of alkylsuccinimide compound, and (b) a lubricant, and having a temperature per 90% recovered with distillation of 320°C or higher.

2. A fuel oil additive comprising (a) an alkenylsuccinimide compound, alkylsuccinimide compound, a boron adduct of alkenylsuccinimide compound or a boron adduct of alkylsuccinimide compound, (b) a lubricant, and (c) a low-temperature fluidability improver, and having a temperature per 90% recovered with distillation of 320°C or higher.

3. The fuel oil additive as claimed in claim 1 or 2, wherein the lubricant (b) is at least one of unsaturated fatty acids having from 4 to 22 carbon atoms or their dimer acids, or their esters.

4. A fuel oil composition comprising fuel oil and a fuel oil additive of any of claims 1 to 3 added thereto.

5. The fuel oil composition as claimed in claim 4, wherein the amount of the component (a) is from 20 to 1,500 ppm by weight based on the total of the fuel oil composition.

6. The fuel oil composition as claimed in claim 4 or 5, wherein the amount of the component (b) is from 5 to 300 ppm by weight based on the total of the fuel oil composition.

7. The fuel oil composition as claimed in any of claims 4 to 6, wherein the amount of the component (c) is from 50 to 500 ppm by weight based on the total of the fuel oil composition.

8. The fuel oil composition as claimed in any of claims 4 to 7, wherein the fuel oil is diesel gas oil.

9. The fuel oil composition as claimed in claim 8, wherein the sulfur content of diesel gas oil is from 0.001 to 0.05 % by weight.

10. The fuel oil composition as claimed in claim 4, wherein the fuel oil has a temperature per 90% recovered with distillation of 320°C or higher.

11. The fuel oil composition as claimed in claim 4, wherein the fuel oil has a temperature per 90% recovered with distillation of 330°C or higher.

12. The fuel oil composition as claimed in claim 4, wherein the fuel oil has a temperature per 90% recovered with distillation of 340°C or higher.

13. The fuel oil composition as claimed in claim 4, wherein the fuel oil has a temperature per 90% recovered with distillation of 350°C or higher.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/03183

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] C10L1/08, 1/22

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)
Int.Cl[6] C10L1/08, 1/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-1999
Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999

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.
Y	JP, 9-87641, A (Taiho Industries Co., Ltd.), 31 March, 1997 (31. 03. 97), Abstract ; Par. Nos. [0006], [0009] to [0012] (Family: none)	1-13
Y	JP, 38-915, B1 (California Research Corp.), 12 February, 1963 (12. 02. 63), Claims ; page 5, left column (Family: none)	1-13
A	JP, 55-38876, A (Mobil Oil Corp.), 18 March, 1980 (18. 03. 80), Claims ; page 3, lower left column & EP, 8953, A1	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 September, 1999 (30. 09. 99)	12 October, 1999 (12. 10. 99)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)