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Lubrication oil and internal-combustion engine fuel

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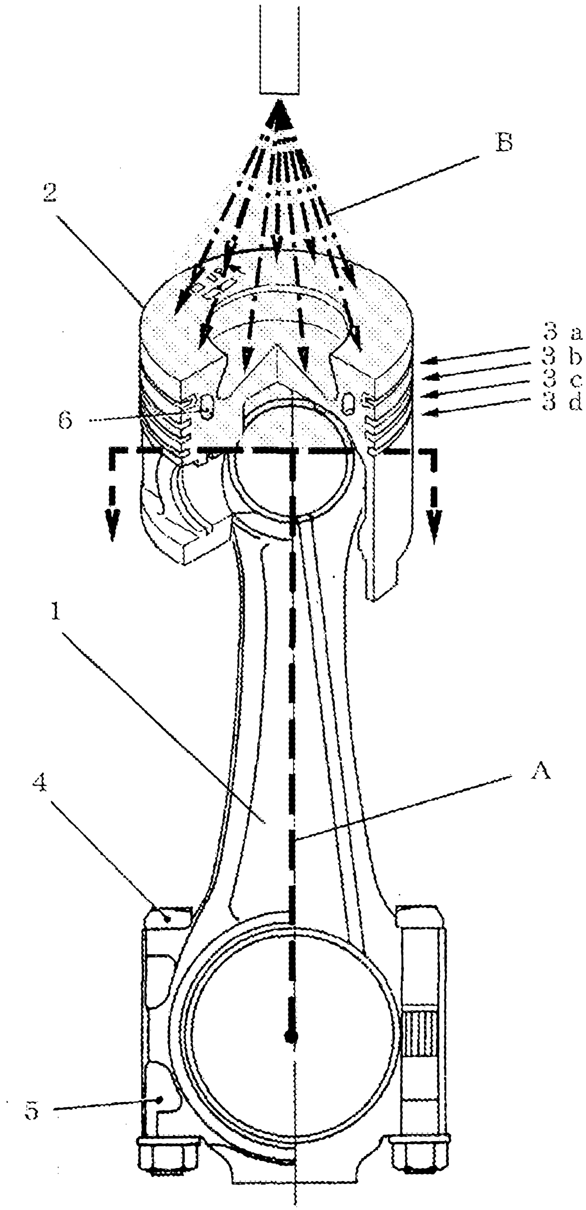
ABSTRACT

The objective is to provide lubrication oil and internal-combustion engine fuel for reducing the fuel consumption and for reducing carbon dioxide and other exhaust gas components.

The lubrication oil is injected with lubrication oil impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.01 to 1 volume% and desirably in the range from 0.1 to 0.5 volume%. Petroleum oil fuel is injected with fuel oil impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.5 to 1 volume%. The petroleum oil fuel is light oil, kerosene, gasoline, or Bunker A. Any one or both of these lubrication oil and petroleum oil fuel is/are used for an internal-combustion engine.

FIGURE

[FIG.1]



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LUBRICATION OIL AND INTERNAL-COMBUSTION ENGINE FUEL

Field of the Invention

[0001]

The present invention relates to lubrication oil. In particular, the present invention relates to internal-combustion engine lubrication oil and internal-combustion engine fuel.

Background Art

[0002]

Generally, it has been known that the global warming is influenced by the carbon dioxide caused by the combustion of petroleum oil fuel used in an internal-combustion engine.

[0003]

In the current economic situation, exchanging or improving various pieces of equipment such as a vehicle, a heavy machine, or a boiler is difficult but the reduction of carbon dioxide has been strongly required.

[0004]

In a machine such as an internal-combustion engine or a driving system, lubrication oil is used in order to reduce the friction caused during the operation of a gear or a piston. When lubrication oil is used in an internal-combustion engine or a driving system, the friction can be reduced to provide a smooth

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rotation of a gear or a piston for example, thus reducing the consumption amount of fuel (e.g., light oil, gasoline) and the emission amounts of carbon dioxide and other exhaust gas components caused in the combustion.

[0005]

On the other hand, lubrication oil is oxidized and deteriorated when subjected to the use for a long period of time. The oxidized lubrication oil causes acid substance, varnish, or sludge for example, thus promoting deterioration such as an increased acid number or an increased viscosity. There are various disadvantages where such an acid substance for example causes the worn parts of an internal-combustion engine or the wear or lubrication oil having an increased viscosity causes an increased power loss, which hinders the operation of the internal-combustion engine.

[0006]

The mechanical parts of the internal-combustion engine rust due to various causing factors such as water ingression by rain and wind for example. The rust causes an increased power loss, thus hindering the operation of the internal-combustion engine.

[0007]

By the way, lubrication oil is added with (a) copolymer having a number average molecular weight in the range higher than 6300 and lower than 1200 of octadecene 1 and maleic anhydride and (b) dispersant /VI improver additive agent including a

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succinimide reaction product prepared from polyamine and acyclic hydrocarbyl-substituted succinic acylating agents. As a result, resolving agent disperses the varnish and sludge components in the entire oil to thereby prevent the accumulation thereof, according to the disclosed invention (see Patent Publication 1 for example).

[0008]

Regarding petroleum oil fuel itself, it has been previously suggested to add, in a diesel engine, fuel additive substance to the petroleum oil fuel to provide a favorable combustion efficiency to thereby improve the fuel consumption (see Patent Publication 2 for example).

Related-art Publication

Patent Publication

[0009]

Patent Publication 1: Japanese Unexamined Patent Application Publication No. H09-176673

Patent Publication 2: Japanese Unexamined Patent Application Publication No. 2005-290254

[0009a]

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

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[009b]

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

Summary of the Invention

Problem to be Solved by the Invention

[0010]

However, the invention according to Patent Publication 1 uses the resolving agent to disperse sludge for example to suppress the oxidation and deterioration of lubrication oil. However, the dispersibility cannot be maintained for a long time, the suppression of the oxidation and deterioration of the lubrication oil is not so high, and the effect of reducing carbon dioxide is insufficient. Furthermore, the rust prevention effect for mechanical parts is not achieved.

[0011]

In the case of the technique as disclosed in Patent Publication 2 to include additive substance in petroleum oil fuel, to attach a fuel reduction apparatus, or to attach an exhaust gas reduction apparatus, carbon dioxide cannot be reduced. The complete combustion causes increased carbon dioxide and a fine-tuned engine causes increased carbon dioxide.

[0012]

On the other hand, the inventor has carried out the eco-drive education for saving fuel consumption for over ten years. However, the fuel consumption can be saved by about 1% to 2% only. Even when a digital tachograph is attached to manage the driver, there is no remarkable difference in fuel consumption between a vehicle attached with the digital tachograph and a vehicle driven by a highly-experienced driver performing eco-driving.

[0013]

In view of the above, the inventor has been researching how to reduce the carbon dioxide generation by using internal-combustion engine lubrication oil for a long time. Finally, the inventor has found an effect that eco-substance (dimethylalkyl tertiary amine) injected to lubrication oil can reduce the friction among the parts of the internal-combustion engine, prevent the oxidation and deterioration of the lubrication oil, and can reduce the wear to provide a longer life to various engines.

[0014]

The inventor also found that various engines can have a rust prevention effect, thus contributing to various engines having a longer life. Thus, the inventor was convinced that the reduction of carbon dioxide and the reduction of exhaust gas components (CO, HC, NOx gas) and the fuel consumption can be achieved, thus reaching the present invention.

[0015]

The inventor also found that, through a keen research for realizing internal-combustion engine fuel causing less carbon dioxide, eco-substance (dimethylalkyl tertiary amine) injected to petroleum oil fuel can effectively reduce carbon dioxide, other exhaust gas components, and fuel consumption.

[0016]

In other words, the fuel consumption in light oil, kerosene, gasoline, and Bunker A can be reduced, the amount of carbon dioxide in the exhaust gas can be reduced, and CO, HC, and NOx gas also can be reduced.

[0017]

It is an objective of this invention to provide internal-combustion engine lubrication oil that has reduced deterioration, a friction reduction effect, and a rust prevention effect as well as internal-combustion engine fuel that can reduce carbon dioxide, a fuel consumption amount, and all exhaust gas.

[0017a]

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

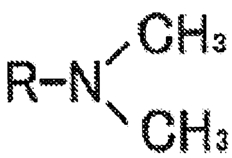
Means for Solving the Problem

[0017b]

According to a first aspect the invention provides lubrication oil for an internal combustion engine injected with impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.01 to 1 volume%;

wherein the lubrication oil is used in the internal-combustion engine together with internal-combustion engine fuel injected with the impregnating agent in the range from 0.1 to 1 volume%; and

wherein the dimethylalkyl tertiary amine is formed by oils of plants and animals and is represented by the general expression (1):



(1)

wherein R represents an alkyl group.

[0017c]

According to a second aspect the invention provides lubrication oil that is injected with impregnating agent consisting of dimethylalkyl tertiary amine in the range from 1 to 5 volume% and that is injected with thickener so that the resultant oil

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is jellylike.

[0017d]

According to a third aspect the invention provides internal-combustion engine fuel, wherein petroleum oil fuel is injected with fuel oil impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.5 to 1 volume%.

[0018]

In order to solve the above disadvantage, lubrication oil according to the present invention is injected with impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.01 to 1 volume%. The dimethylalkyl tertiary amine may be, for example, dimethyllaurylamin, dimethylmyristylamine, or dimethylcocoamine for example.

[0019]

According to this configuration, the impregnating agent (dimethylalkyl tertiary amine) is adsorbed to the metal surfaces of the respective parts of the internal-combustion engine or the driving system for example to reduce friction. Thus, rotating parts such as a gear or a bearing for example can have a reduced friction resistance, thus providing a smooth operation. Thus, an internal-combustion engine for example using this lubrication oil can have a reduced amount of fuel consumption and reduced carbon dioxide and other exhaust gas

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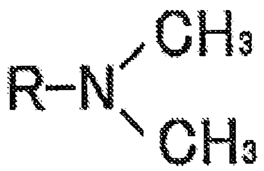
components (e.g., CO, HC, NOx, SOx, PM). The internal-combustion engine for example using this lubrication oil also can have suppressed wear of the gear or bearing for example, thus providing a longer life of various engines. Furthermore, since the lubrication oil impregnating agent can provide rust prevention acid neutralization, the oxidation and deterioration of the lubrication oil can be suppressed. Thus, the above-described fuel reduction effect or the effect of reducing carbon dioxide for example can be realized for a long time.

[0020]

The lubrication oil described in the present specification may have the dimethylalkyl tertiary amine represented by the general expression (1).

[0021]

[Chemical formula 1]



(1)

(R represents an alkyl group.)

[0022]

In the lubrication oil described in the present specification, the dimethylalkyl tertiary amine is desirably formed by oils of plants and animals for environmental friendliness.

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[0023]

In the lubrication oil described in the present specification, the impregnating agent is preferably injected in an amount of 0.1 to 0.5 volume% from the viewpoints of performance and cost.

[0024]

In the lubrication oil described in the present specification, the lubrication oil may be internal-combustion engine lubrication oil. The internal-combustion engine lubrication oil means engine oil for example. By using lubrication oil as engine oil, a reduced load can be applied to an engine, a main shaft, a clutch, a mission, a propeller shaft, a joint bearing, a differential gear, a rear shaft, a wheel bearing, a battery, or a starter for example. Thus, the respective parts can have reduced friction and can have remarkably-reduced fuel consumption, thus achieving the corresponding reduction of carbon dioxide and other types of exhaust gas. The lubrication oil also may be used, in addition to engine oil, for power steering oil, turbine oil, or gear oil for example.

[0025]

The lubrication oil described in the present specification may be used in internal-combustion engine together with internal-combustion engine fuel injected with the lubrication oil impregnating agent in the range from 0.1 to 1 volume%. According to this configuration, the internal-combustion engine fuel (e.g., gasoline) injected with the impregnating

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agent can provide, when being used together with the lubrication oil of the present invention, not only the effect by the lubrication oil but also a reduced fuel consumption by the internal-combustion engine fuel mixed with the impregnating agent, thus additionally achieving the effect of reducing carbon dioxide and other exhaust gas components. Even at a part to which the lubrication oil cannot reach (e.g., a top part of a con rod), an oil film is formed by jetted internal-combustion engine fuel. This oil film provides the same function as that of the lubrication oil to provide a smooth operation of various engines (see Fig. 1). This oil film also can prevent the seizure around a piston head for example.

[0026]

In the lubrication oil described in the present specification, impregnating agent composed of dimethylalkyl tertiary amine is injected in the range from 1 to 5 volume% and thickener is injected so that the resultant oil is jellylike. The jellylike lubrication oil means the one such as grease that is used by being coated on a bearing or a shaft for example. The thickener is injected in order to cause the lubrication oil to be semisolid and may be, for example, calcium, sodium, lithium, or aluminum for example. According to this configuration, the respective parts can have reduced friction thereamong, smooth operation can be obtained, reduced fuel consumption can be achieved, and the reduction of carbon dioxide and other exhaust gas components can be reduced. A rust prevention effect also can be obtained, thus providing a longer life to the machine. While the lubrication oil described in the present specification is mainly used in an internal-combustion engine (e.g., engine oil), the jellylike lubrication oil is mainly used for a bearing or a tire shaft for example. Thus, the impregnating agent can be used in a relatively-high amount.

[0027]

In the invention described in the present specification, petroleum oil fuel is injected with fuel oil impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.5 to 1 volume%. The dimethylalkyl tertiary amine may be amine DM12D, amine DM14D, or amine DM16D (product names used by LION AKZO Co., Ltd.).

[0028]

According to the invention described in the present specification, when the fuel is used in an internal-combustion engine, a fuel consumption amount is reduced, carbon dioxide and other exhaust gas components are reduced, and stability is achieved for a long period.

[0029]

When the fuel of described in the present specification is used as vehicle fuel, the engine noise is improved at the speed of about 20km and the exhaust gas temperature of 70 to 100 degrees C, showing a highly-efficient combustion. Since the fuel combusts at a low temperature, CO_2 is absorbed and the combustion reaction is promoted.

[0030]

In addition, the fuel oil impregnating agent (dimethylalkyl tertiary amine) can be adsorbed to a metal surface to provide friction reduction and rust prevention. Thus, the lubrication performance is improved qualitatively, a smooth engine rotation is provided, and the rust prevention acid neutralization is realized, thus preventing the oxidation and deterioration of engine oil. This effect is significant when the engine oil is oxidized and deteriorated.

[0031]

Furthermore, air pollutant such as sulfur oxide (SOx), black smoke, or particulate matter (PM) is reduced and CO, HC, or NOx is also reduced.

[0032]

As described in the present specification, the petroleum oil fuel composed of light oil, kerosene, gasoline, or Bunker A is effectively used.

[0033]

As described in the present specification, from the viewpoint of cost in particular, the fuel oil impregnating agent is desirably injected in an amount of 0.99 to 1 volume%.

Effect of the Invention

[0034]

As described above, according to the present invention, lubrication oil is injected with impregnating agent composed of dimethylalkyl tertiary amine in the range of 0.01 to 1 volume%. Thus, when the lubrication oil is used in an internal-combustion engine such as an automobile engine, various engines can have reduced friction resistance, the fuel consumption amount is reduced, and the carbon dioxide and other exhaust gas components are also reduced. The lubrication oil also provides a rust prevention effect, suppresses the oxidation and deterioration of the lubrication oil, suppresses the wear of the respective parts, and can provide the internal-combustion engine with a longer life.

[0035]

Petroleum oil fuel injected with fuel oil impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.5 to 1 volume% allows, when the petroleum oil fuel is used in an internal-combustion engine such as an automobile engine, the fuel consumption amount to be stably reduced for a long period and also allows carbon dioxide and other exhaust gas components to be reduced.

Brief Description of the Drawings

[0036]

Fig. 1 illustrates the flow of the lubrication oil in a piston

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and a con rod of an internal-combustion engine and the flow of fuel (injection).

Fig. 2 illustrates the result of the vehicle number 438 of the black smoke test using normal lubrication oil (conventional lubrication oil).

Fig. 3 illustrates the result of the vehicle number 438 of a black smoke test using new eco-friendly lubrication oil (the lubrication oil of the present invention).

Fig. 4 illustrates the result of the vehicle number 8003 of the black smoke test using normal lubrication oil.

Fig. 5 illustrates the result of the vehicle number 8003 of the black smoke test using the new eco-friendly lubrication oil.

Fig. 6A schematically illustrates the configuration of a test apparatus.

Fig. 6B illustrates one example of an eco-substance injection method.

Fig. 7 illustrates the result of the running test for confirming the effect in a high-octane gasoline vehicle injected with eco-substance.

Fig. 8 illustrates the result of the running test for confirming the effect in a regular gasoline vehicle injected with the eco-substance.

Fig. 9 illustrates the result of the running test for confirming the effect in a HINO 4t vehicle (kerosene) injected with the eco-substance.

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Fig. 10 illustrates the result of the running test for confirming the effect in a HINO 4t vehicle (clean heavy oil) injected with the eco-substance.

Fig. 11 illustrates the comparison in fuel consumption between a case where no eco-substance is injected and a case where the eco-substance is injected.

Fig. 12 illustrates, in a rust prevention experiment, the comparison regarding the rust occurrence between a case where normal lubrication oil is coated and a case where new eco-friendly lubrication oil is coated (as of September 16, 2010 at which the experiment was started).

Fig. 13 illustrates, in the rust prevention experiment, the comparison regarding the rust occurrence between a case where the normal lubrication oil is coated and a case where the new eco-friendly lubrication oil is coated (as of September 27, 2010).

Fig. 14 illustrates, in the rust prevention experiment, the comparison regarding the rust occurrence between a case where the normal lubrication oil is coated and a case where the new eco-friendly lubrication oil is coated (as of October 11, 2010).

Fig. 15 illustrates, in the rust prevention experiment, the comparison regarding the rust occurrence between a case where the normal lubrication oil is coated and a case where the new eco-friendly lubrication oil is coated (as of October 18, 2010).

Mode for Carrying Out the Invention

[0037]

The following section will describe an embodiment of the present invention with reference to the drawings and tables. The lubrication oil according to the present invention is obtained by injecting lubrication oil impregnating agent composed of dimethylalkyl tertiary amine (hereinafter referred to as eco-substance) to conventional lubrication oil. The eco-substance is injected in the range from 0.01 to 1 volume% and desirably in the range from 0.1 to 0.5 volume%. The reason is that the injection amount lower than 0.1 volume% prevents a sufficient effect from being provided and that the lubrication oil used in a machine such as an internal-combustion engine with the injection amount exceeding 0.5 volume% causes an insufficient effect not enough for a high price. It is confirmed that the lubrication oil injected with the impregnating agent within the above range can be used as general lubrication oil, according to a component analysis.

[0038]

It is also confirmed that the lubrication oil injected with the eco-substance can provide a desired effect as described later.

[0039]

The eco-substance may be, for example, dimethyllaurylamine, dimethylmyristylamine, dimethylcocoamine, dimethylpalmitinamine, dimethylbehenylamine, dimethylcocoamine, dimethyl palm stearin amine, or dimethyldesineamine. These eco-substances have different melting points, respectively, and are selectively used based on the application or the point of use of the lubrication oil for example. In this embodiment, the eco-substance is dimethyllaurylamine.

[0040]

First, lubrication oil is injected with the eco-substance (dimethyllaurylamine) at 0.1 volume%, 0.3 volume%, and 0.5 volume% to thereby manufacture the new eco-friendly lubrication oil having the respective concentrations. The new eco-friendly lubrication oil including the eco-substance at the respective concentrations (volume%) is manufactured, for example, by injecting into a tank including lubrication oil of 100 liters the eco-substance of 0.1 liter for the concentration of 0.1 volume%, the eco-substance of 0.3 liter for the concentration of 0.3 volume%, and the eco-substance of 0.5 liter for the concentration of 0.5 volume% to stir and mix the lubrication oil with the eco-substance.

[0041]

Next, the manufactured new eco-friendly lubrication oil was used to perform a running test and a black smoke test. These tests were performed in order to compare conventional lubrication oil with the new eco-friendly lubrication oil. In these tests, the lubrication oil was engine oil and the new eco-friendly lubrication oil was conventional engine oil injected with the above predetermined eco-substance.

[0042]

1. [Running test]

The vehicles (automobiles) used in the running test were: a diesel truck (a 4t vehicle, a 10t vehicle (gross weight of 20t), and a tractor (gross weight of 40t) for example), a diesel passenger vehicle ("SAFARI" (registered trademark)), a regular gasoline passenger vehicle ("BMW" (registered trademark) of 1600cc), and a high-octane gasoline passenger vehicle ("MERCEDES-BENZ" (registered trademark) of 6000cc). In these vehicles, light oil was used in the diesel truck and passenger vehicle and regular gasoline or high-octane gasoline was used in the gasoline vehicles. In order to provide uniform running conditions (e.g., a running speed, a running distance) as much as possible, the respective vehicles were driven by the same driver to run on the same route. In order to prevent an error, the consumption fuel was measured correctly and the running distance was measured correctly by a running distance meter. Then, the resultant fuel consumptions were compared.

[0043]

(1) New eco-friendly lubrication oil including 0.1 volume% of eco-substance

Table 1 to Table 5 show the result of the running tests using the new eco-friendly lubrication oil including 0.1 volume% of the eco-substance. Table 1 and Table 2 are tables showing the result of the running test for the comparison in the fuel consumption for the respective diesel trucks using light oil as fuel between a case where the conventional engine oil was used and a case where the new eco-friendly lubrication oil was used. The tables show, from the left side, the vehicle information, the destination, the stopover point, the running distance, and the consumption fuel for example when the conventional engine oil (normal lubrication oil) was used, and the destination, the stopover point, the running distance, and the consumption fuel for example when the new eco-friendly lubrication oil was used. The rightmost section shows how much fuel consumption was reduced and how much average fuel consumption was reduced for the respective vehicles by the use of the new eco-friendly lubrication oil from the fuel consumption amount of the normal lubrication oil. The lowermost section shows how much average fuel consumption was reduced for all of the vehicles.

[0044]

[Table 1]

[0045]

[Table 2]

The comparison in the fuel consumption <New eco-friendly lubrication oil (including 0.1 volume % of eco-substance)>

February～March

February～March		<Normal> 2009/4/13 ~ 2010/2										<New eco-friendly lubrication oil (including 0.1 volume % of eco-substance)> 2010/2 ~ 2010/3										[illegible]	Notes	[illegible]
vehicle information		to		[illegible]	from		[illegible]	Dates	Running distance	[illegible]	[illegible]	to			from		[illegible]	Dates	Running distance	[illegible]	[illegible]			
No.	Kobe-88-Ka-3714	[illegible]CHEMICA	Chiba	2,020	[illegible]	Chiba	11,040	2010/1/27-29	1,422	490	2.90	[illegible]CHEMICA	Chiba	5,300	[illegible]	Chiba	11,100	2010/2/10-20	1,303	432	3.02	-4%		
Type	ISUZU P-CXM[illegible]																							
Engine	10PC1 [illegible] 1994	SK	Kawaguchi	10,070	TOKUOKA	Tokyo	10,760	[illegible]	1,171	443	2.64	SK	Kawaguchi	★8730	TOKUOKA	Tokyo	10,430	[illegible]	1,078	375	2.87	-8%	[illegible]	
[illegible]	19,550kg																							
																								-4%
No.	Kobe-88-Ka-4112	[illegible]	Toyama	10,100	-	-	-	2010/1/26-?	934	310	3.01	[illegible]	Toyama	10,170	–			[illegible]	1,031	317	3.25	-7%		
Type	ISUZU P-CXM[illegible]											[illegible]	Toyama	10,210	–			[illegible]	1,014	320	3.17	-5%		
Engine	10PC1 [illegible] 1989																	Ave	1,023	319	3.21	-6%		
[illegible]	19,825kg	[illegible]	Ishikawa	10,770	-	-	-	[illegible]	706	215	3.22	[illegible]	Ishikawa	10,670	-	-	-	[illegible]	578	200	3.32	-7%		
																								-6%
No.	Fukui-800-Ka-257	SK	Kawaguchi	8,220	[illegible]	Shizuoka	10,600	2009/9/4-9	1,320	427	3.09	SK	Kawaguchi	★6370	[illegible]	Shizuoka	10,300	2010/2/2-3	1,280	358	3.57	-9%		
Type	NISSAN P-CD45NC[illegible]																							
Engine	PE6 [illegible] 1989																							
[illegible]	19,270kg																							
																								-9%
No.	Fukui-800-Ka-328	[illegible]	Ishikawa	10,500	-	—	—	2010/2/6-8	704	235	3.00	[illegible]	Ishikawa	10,710	-	-	—	[illegible]	672	206	3.26	-8%		
Type	[illegible]	[illegible]	Ishikawa	10,070	-	---	---	2009/2/9-10	666	190	3.51													
Engine	6D22 [illegible] 1995							Ave	685	213	3.23													
[illegible]	20,540kg																							
																								-8%
																		Average of all vehicles				-6%		

conditions
- loading : 4 ~ 500kg
- Utilization of the highway : 5 ~ 10%
- Tank cleaning
- Driver
- [illegible] the points of loading and unloading
- direct delivery from factories

comparison in the fuel consumption <New eco-friendly lubrication oil (including 0.1 volume % of eco-substance)>

March～July

March～July		<Normal> ～ 2010/4/1										<New eco-friendly lubrication oil (including 0.1 volume % of eco-substance)> 2010/4/1 ～								
The vehicle information		to		load [illegible]	from		load [illegible]	Dates	[illegible]	[illegible]	[illegible]	to		from	load [illegible]	Dates	[illegible]	[illegible]	[illegible]	Reduction rate from [illegible]
No.	Kobe-88-Ka-4112	SK	Saitama	10,000	TOUSHIN	Nagano	10,210	2009/10/17-21	1,215	432	2.82	SK	9,450	TOUSHIN	10250	2010/5/17-18	1,188	345	3.44	-18%
Type	ISUZU P-CXM19P rev																			
Engine	10PC1 [illegible] 1985																			
[illegible]	19,385kg								--											
																				-18%
No.	Kobe-88-Ka-4112	[illegible]	Iizuka	9,800	empty	-	-	2009/9/23-24	1,250	370	3.38	[illegible]	9,900	empty		2010/4/18-20	1,232	335	3.68	-4%
Type	MITSUBISHI P-FU415N rev	[illegible]	Iizuka	9,800	empty	-	-	2009/11/20-21	1,320	360	3.87	[illegible]	9,900	empty		2010/4/26-28	1,235	343	3.60	-2%
Engine	8DC9 [illegible] 1986							Ave	1,285	365	3.52	[illegible]	9,900	empty		2010/5/6-7	1,213	337	3.61	-2%
[illegible]	19,715kg											[illegible]	9,900	empty		2010/5/24-25	1,213	332	3.65	-4%
												[illegible]	9,900	empty		[illegible]	1,220	325	3.75	-9%
												[illegible]	9,900	empty		2010/6/28-29	1,221	340	3.59	-2%
																Ave	1,223	335	3.66	-4%
																				-4%
No.	Fukui-800-Ka-357	KOGUNIS	Kitatone	7,460	MARUOU	Sendai	10,270	[illegible]	1,890	548	3.46	KOGUNIS	6,310	MARUOU	10,570	[illegible]	1,930	509	3.79	-9%
Type	NISSAN P-CD45NC rev								--											
Engine	PE6 [illegible] 1989																			
[illegible]	10,870kg																			
																				-9%
																Average of all vehicles				-10%

conditions
・loadage : [illegible]～500kg ・Tank cleaning ・Driver
・Utilization of the highway : [illegible]～10% ・using the power of loading and unloading ・direct delivery from [illegible]

[0046]

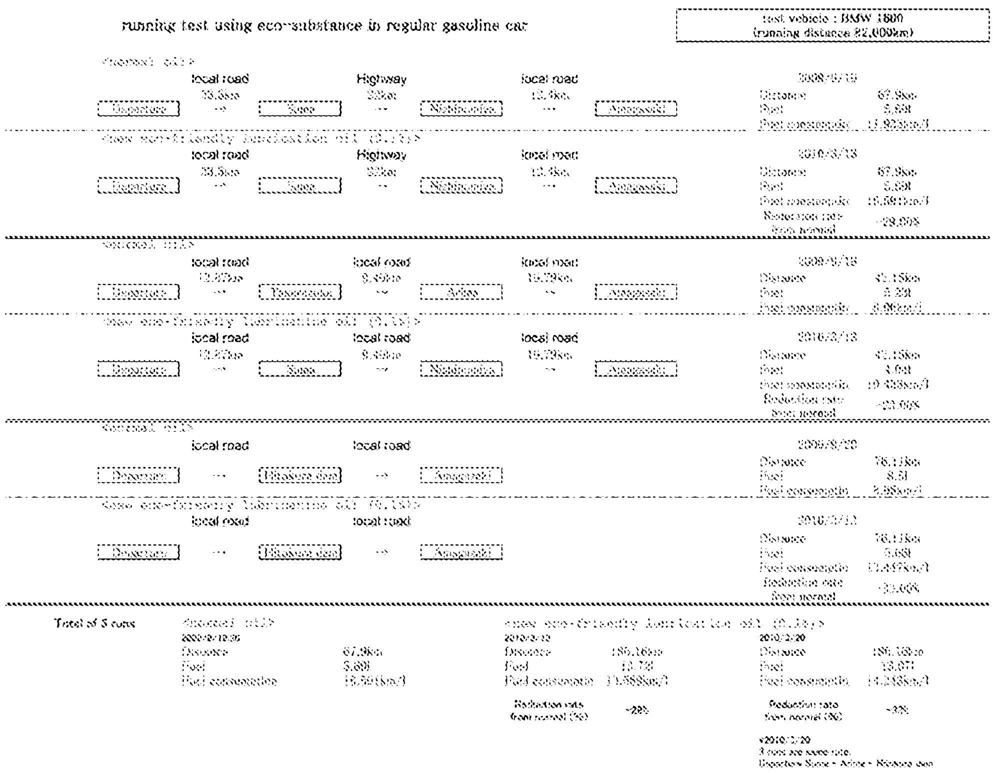
As can be seen from these results, the fuel consumption performance is improved by the use of new eco-friendly lubrication oil when compared with a case where the normal lubrication oil is used. The improved fuel consumption provides the reduction of emitted carbon dioxide and other exhaust gas components.

[0047]

Table 3 and Table 4 are tables showing, with regard to the respective vehicles using gasoline (regular or high-octane) as fuel, the result of the running test for the comparison of the fuel consumption between a case where the conventional engine oil was used and a case where the new eco-friendly lubrication oil was used. These tables show the destinations of the respective routes, the stopover points, the respective distances, the total running distances, the fuel consumption amounts, the fuel consumption, and how much fuel consumption was reduced by the use of the new eco-friendly lubrication oil from the fuel consumption amount of the normal lubrication oil. The lowermost section shows how much average fuel consumption was reduced for all of the routes. In the table, the term "new eco-friendly oil" means the new eco-friendly lubrication oil.

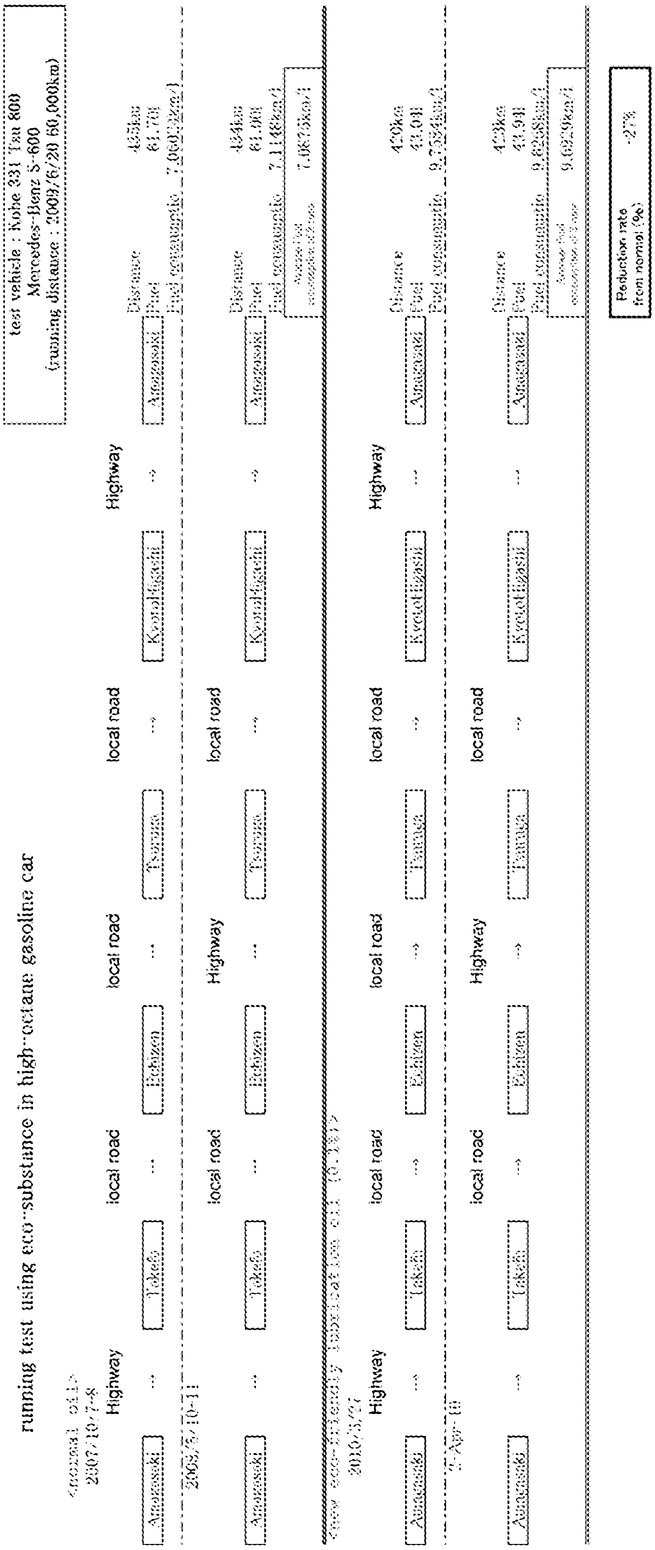
[0048]

[Table 3]


running test using eco-substance in regular gasoline car
test vehicle : BMW 1800
(running distance 82,000km)
local road
Highway
local road
Departure
Nishinomiya
Amagasaki
Distance
67.9km
Fuel
Fuel consumption
Total of 3 runs
Reduction rate from normal (%)

[0049]

[Table 4]



[0050]

As can be seen from these results, the fuel consumption performance is improved, also in the gasoline vehicle, by the use of new eco-friendly lubrication oil when compared with a case where the normal lubrication oil is used.

[0051]

From the above description, it is understood that the fuel consumption performance is improved, both in the diesel trucks and the gasoline vehicles, by the use of new eco-friendly lubrication oil including 0.1 volume% of the eco-substance.

[0052]

Table 5 shows the comments by the driver regarding the change from the normal lubrication oil to the new eco-friendly lubrication oil. The comments at least did not include any answer showing bad fuel consumption or vehicle.

[0053]

[Table 5]

running test using new eco-friendly lubrication oil in high-octane gasoline car

car No.	engine type	displacement	date of mixing oil	eco-substance	running distance	running distance after changing oil	amount of oil	eco-substance	comment of driver			date of changing oil
357	PE-8	11870cc	2010/1/20	0.10%	1,652,978km	3,000km	27L	27cc	fuel consumption: GOOD	condition: GOOD	power: GOOD	2010/3/18
4914	8DC9		2010/2/1	0.10%	549,739km	20,000km	28L	28cc	fuel consumption: GOOD	condition: GOOD	power: GOOD	
3387	10PC1	15010cc	2010/2/6	0.10%	1,505,201km	3,000km	30L	30cc	fuel consumption: GOOD	condition: GOOD	power: GOOD	2010/2/6
5211	TD42	4169cc	2010/3/1	0.10%	101,734km	700km	9L	9cc	fuel consumption: GOOD	condition: GOOD	power: GOOD	2010/3/1

car No.	engine type	displacement	date of mixing oil	eco-substance	running distance	running distance after changing oil	amount of oil	eco-substance	comment of driver			something wrong
4397	8DC9	16030cc	2010/2/14	0.10%	1,236,666km	14,586km	28L	28cc	fuel consumption: GOOD	condition: GOOD	power: GOOD	nothing
428	6D22	11140cc	2010/2/14	0.10%	1,052,103km	2,103km	26L	26cc	fuel consumption: GOOD	condition: GOOD	power: GOOD	nothing
4113	10PC1	15010cc	2010/2/14	0.10%	1,693,635km	6,385km	30L	30cc	fuel consumption: unknown	condition: unknown	power: unknown	nothing
4914	8DC9	16030cc	2010/2/22	0.10%	549,739km	0	28L	28cc	fuel consumption: GOOD	condition: GOOD	power: GOOD	nothing

[0054]

(2) New eco-friendly lubrication oil including 0.3 volume% of eco-substance

Table 6 to Table 12 show the result of the running tests using the eco-friendly lubrication oil including 0.3 volume% of the eco-substance. Table 6 and Table 7 show, as in Table 1 and Table 2, the result of the running test for the comparison in the fuel consumption for the respective diesel trucks (10t vehicles) using light oil as fuel between a case where the conventional engine oil was used and a case where the new eco-friendly lubrication oil was used. Table 8 shows the data for the running test regarding the diesel truck (10t vehicle) having the vehicle number 353. The 353 vehicle was caused to run on generally the same route for many times.

[0055]

[Table 6]

[0056]

comparison in the fuel consumption <New eco-friendly lubrication oil (including 0.3 volume % of eco-substance)> **April～July**

April～July		<Normal> ～ 2010/4/20										<New eco-friendly lubrication oil (including 0.1 volume % of eco-substance)> 2010/4/20 ～								
vehicle information		to		Load (kg)	from		Load (kg)	Dates	Running distance(km)	fuel consumption amount(l)	fuel consumption (km/l)	to		from	Load (kg)	Dates	Running distance(km)	fuel consumption amount(l)	fuel consumption (km/l)	Reduction rate from normal (%)
No.	Kobe-88-Ka-3887	KOGUNIS	Kitabono	8,320	NIIGATA CHEMICAL	Niigata	11,480	2008/4/22-25	1,405	503	2.79	KOGUMIS	7,530	NIIGATA CHEMICAL	11850	2010/4/23-27	1,405	448	3.14	-11%
Type	ISUZU P-CXM19P rev																			
Engine	10PC1 [illegible] 1984																			
[illegible]	19,975kg																			
																				-11%
No.	Kobe-88-Ka-3900	SK	Kawaguchi	5,560	TOUSHIN	Nagano	10,520	2008/4/24-26	1,353	478	2.83	SK	8,720	TOUSHIN	10050	2010/4/20-22	1,336	416	3.21	-10%
Type	ISUZU P-CXM19P rev	SK	Kawaguchi	5,350	TOUSHIN	Nagano	9940	2008/7/20-21	1,353	461	2.93									
Engine	10PC1 [illegible] 1984							Ave	1,353	470	2.88									
[illegible]	19,835kg																			
																				-10%
																Average of all vehicles				-10%

conditions
・loadage : +---500kg ・Tank cleaning ・Driver
・Utilization of the highway : 5～10% ・using the power at loading and unloading ・direct delivery from fuelmakers

[Table 7]

mparison in the fuel consumption <New eco-friendly lubrication oil (including 0.3 volume % of eco-substance)> **April～August**

April～August		<Normal> ～ 2010/4/20										<New eco-friendly lubrication oil (including 0.1 volume % of eco-substance)> 2010/4/20 ～								[illegible]
vehicle information		to		[illegible]	from		[illegible]	Dates	[illegible]	[illegible]	[illegible]	to		from	[illegible]	Dates	[illegible]	[illegible]	[illegible]	
No.	Kobe-88-Ka-S714	KOGUNIS	Kitatone	3,200	[illegible]	Niigata	10,100	2009/5/23-28	1,575	555	2.84	KOGUNIS	7,510	[illegible]	10270	2010/8/8-11	1,576	538	2.93	-3%
Type	ISUZU P-CXM19P rev																			
Engine	10PC1 [illegible] 1984																			
[illegible]	19,550kg								–											
																			Avg	-3%
No.	Kobe-89-Ka-S987	KOGUNIS	Kitatone	9,320	[illegible]	Niigata	11,460	2009/4/22-25	1,495	503	2.78	KOGUNIS	7,630	[illegible]	11850	2010/4/23-27	1,405	448	3.14	-11%
Type	ISUZU P-CXM19P rev																			
Engine	10PC1 [illegible] 1984																			
[illegible]	19,575kg																			
																			Avg	-11%
No.	Kobe-88-Ka-S900	SK	Kawaguchi	5,580	TOUSHIN	Nagano	10,520	2009/9/24-26	1,353	476	2.83	SK	8,720	TOUSHIN	10,050	[illegible]	1,336	416	3.21	-10%
Type	ISUZU P-CXM19P rev	SK	Kawaguchi	5,250	TOUSHIN	Nagano	9,980	2009/7/29-31	1,353	461	2.83									
Engine	10PC1 [illegible] 1984							Avg	1,353	470	2.88									
[illegible]	19,535kg																			
																			Avg	-10%
																Average of all vehicles				-8%

conditions ·loadage : 4～500kg ·Tank cleaning ·Driver ·Utilization of the highway : 5～10% ·using the power of loading and unloading ·direct delivery from fuelmakers

[0057]

[Table 8]

[0058]

Transport running test (vehicle No.353)

Destination : YASHIROIGA (Iga-shi, Mie) - NICHIHAKU (Amagasaki-shi)
Condition : same driver, same load

using normal oil

month	service frequency	running distance per a service(km)	total transport tonnage (t)	transport tonnage one service (t)	average fuel per one service	running distance (km)	fuel (l)	fuel consumption (km/l)
Jan	14	272	105.920	7.566	74.14	3,812	1,038	3.67
Feb	16	253	120.080	7.505	60.25	4,048	964	4.20
Mar	16	251	120.480	7.53	67.38	4,019	1,078	3.73
Apr	16	252	120.340	7.521	75.88	4,028	1,214	3.32
May	14	249	104.370	7.455	73.29	3,492	1,026	3.40
Jun	18	252	135.400	7.522	57.56	4,531	1,036	4.37
Jul	26	260	203.000	7.806	67.27	6,761	1,749	3.87
total	120	1789	909.590	52.907	475.77	30,691	8,105	26.56
average	17	256	129.941	7.56	67.54	4384	1,158	3.79

using new eco-friendly lubrication oil 2010/8/18-

month	service frequency	running distance per a service(km)	total transport tonnage (t)	transport tonnage one service (t)	average fuel per one service	running distance (km)	fuel (l)	fuel consumption (km/l)	Reduction rate from normal (%)
9/9-15	6	250	45.060	7.51	62.5	1,502	375	4.01	-5.50%
9/16-22	6	253	44.980	7.497	67	1,516	402	3.77	0.40%
9/23-29	6	251	44.820	7.47	65	1,504	390	3.86	-1.80%
9/30-10/6	6	249	45.350	7.558	63.83	1,491	383	3.89	-2.70%
10/7-13	6	248	45.390	7.565	62.5	1,490	375	3.97	-4.70%
10/14-18	4	248	29.960	7.495	62.75	992	251	3.95	-4.20%
total	34	1499	255.580	45.095	383.58	8,495	2,176	23.45	
average	5.7	250	42.597	7.516	63.93	1416	363	3.91	-3.00%

Reduction rate from normal (%)
-5.20%

As can be seen from these results, the fuel consumption performance is improved, in the diesel trucks using light oil, by the use of new eco-friendly lubrication oil including 0.3 volume% of eco-substance when compared with a case where the normal lubrication oil is used.

[0059]

Table 9 shows the test result when the new eco-friendly lubrication oil including 0.3 volume% of the eco-substance was used in the diesel trucks (4t vehicle) using light oil as fuel. Table 10 shows the test result for the diesel passenger vehicle using light oil as fuel.

[0060]

[Table 9]

[0061]

running test using new eco-friendly lubrication oil in 4t car

(conditions : same time zone, same route)

new eco-friendly lubrication oil : mixing 1.2l engine oil and 0.3 volume % (36cc) eco-substance

test vehicle	engine	displacement	total weight	vehicle weight	loading capacity	load
NISSAN	FE6	5920cc	7590kg	4180kg	3700kg	1500kg (50%)
HINO	H07D	7410cc	7545kg	5530kg	2250kg	unic vehicle weight : 50%

2010/4/29 <0% new eco-friendly lubrication oil (using normal diesel fuel)>

Garage → (local road) → Suma → (Highway) → Nishinomiya → (local road) → Garage

Garage → (local road) → Amagasaki → (Highway) → Kameyama → (local road) → Yokkaichi → (local road) → Kameyama → (Highway) → Amagasaki → (local road) → Garage

Garage → (local road) → Arima → (local road) → Garage

test vehicle	total running distance(AVE)	oiling quantity	fuel consumption
NISSAN	429.5km	58.22l	7.377km/l
HINO	429.5km	62.53l	6.889km/l

2010/5/1 <0.3% new eco-friendly lubrication oil in engine oil (using normal diesel fuel)>

Garage → (local road) → Suma → (Highway) → Nishinomiya → (local road) → Garage

Garage → (local road) → Amagasaki → (Highway) → Kameyama → (local road) → Yokkaichi → (local road) → Kameyama → (Highway) → Amagasaki → (local road) → Garage

Garage → (local road) → Arima → (local road) → Garage

test vehicle	total running distance(AVE)	oiling quantity	fuel consumption	Reduction rate from normal (%)
NISSAN	425.5km	55.28l	7.770km/l	-5.05%
HINO	429.5km	59.44l	7.220km/l	-4.94%

[Table 10]

running test using new eco-friendly lubrication oil

test vehicle : NISSAN SAFARI
conditions : load +-30kg, same vehicle, same driver, fuel tolerance 100cc

	Normal oil			new eco-friendly lubrication oil (including 0.3 volume % of eco-substance)					
month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
working days	18days	24days	25days	21days	22days	25days	23days	23days	24days
running distance per month	101734km	102090km	102445km	102778km	103205km	103744km	104413km	104946km	105455km
main destination & running distance	Nishinomiya 12km Ishimichi 48km Hitokura 61km Nada 36km	Hitokura dam 61km Hitokura dam 61km Nada 36km	Nishinomiya 12km Ishimichi 48km Nada 36km	Osaka 50km Hitokura dam 61km Hitokura dam 61km Nada 36km	Sakai 70km Hitokura dam 61km Sakai 35km Nada 36km	Sanda 58km Suma 80km Nada 36km	Sanda 93km Nada 36km	Hitokura dam 61km Ishimichi 48km Nada 36km Hitokura dam 61km	Hitokura dam 61km Nishinomiya 12km Izumi-shi 120km Nada 36km Kobe 61km Morinomiya 40km Izumisano 90km KobeMaya 42km
total running distance	157km	158km	96km	208km	202km	204km	129km	206km	461km
comuting (2km), less than 10km per service	199km	197km	237km	219km	337km	465km	404km	303km	351km
running distance	356km	355km	333km	427km	539km	669km	533km	509km	812km
amount used fuel	67.8l	64.23l	61.92l	66.54l	83.14l	93.28l	78.18l	74.24l	108.35l
fuel consumption	5.251km/l	5.527km/l	5.378km/l	6.417km/l	6.483km/l	7.172km/l	6.818km/l	6.856km/l	7.494km/l
average of fuel consumption (normal oil, 3months)			5.385						
Reduction rate from normal (%)				-18%	-17%	-25%	-21%	-21%	-28%
				average of fuel consumption (new eco-friendly lubrication oil, 5months)		6.873	Reduction rate from normal (%)	-22%	

[0062]

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As can be seen from these results, the fuel consumption performance is improved, also in the diesel truck (4t vehicle) and the diesel passenger vehicle using light oil, by the use of the new eco-friendly lubrication oil including 0.3 volume% of the eco-substance when compared with a case where the normal lubrication oil is used.

[0063]

Table 11 and Table 12 show, as in Table 3 and Table 4, the result of the running test for the comparison in the fuel consumption for the respective vehicles using gasoline (regular and high-octane) as fuel between a case where the conventional engine oil was used and a case where the new eco-friendly lubrication oil was used.

[0064]

[Table 11]

[0065]

running test using the eco-substance in regular gasoline car

test vehicle : BMW 1600
(running distance 82,000km)

<normal oil>

Departure → (local road 33.5km) → Suma → (Highway 22km) → Nishinomiya → (local road 12.4km) → Amagasaki

2009/9/19
Distance 67.9km
Fuel 5.69l
Fuel consumption 11.933km/l

<new eco-friendly lubrication oil (0.3%)>

Departure → (local road 33.5km) → Suma → (Highway 22km) → Nishinomiya → (local road 12.4km) → Amagasaki

2010/8/11
* traffic jam 40minutes
* using air conditioner

2010/8/21
* traffic jam 0minutes
* using air conditioner

<normal oil>

Departure → (local road 12.87km) → Takarazuka → (local road 9.49km) → Arima → (local road 19.79km) → Amagasaki

2009/9/19
Distance 42.15km
Fuel 5.23l
Fuel consumption 8.06km/l

<new eco-friendly lubrication oil (0.3%)>

Departure → (local road 12.87km) → Suma → (local road 9.49km) → Nishinomiya → (local road 19.79km) → Amagasaki

2010/8/11
* traffic jam 40minutes
* using air conditioner

2010/8/21
* traffic jam 0minutes
* using air conditioner

<normal oil>

Departure → (local road) → Hitokura dam → (local road) → Amagasaki

2009/9/20
Distance 76.11km
Fuel 8.5l
Fuel consumption 8.95km/l

<new eco-friendly lubrication oil (0.1%)>

Departure → (local road) → Hitokura dam → (local road) → Amagasaki

2010/8/11
* traffic jam 40minutes
* using air conditioner

2010/8/21
* traffic jam 0minutes
* using air conditioner

	<normal oil> 2009/9/19.20	<new eco-friendly lubrication oil (0.1%)> 2010/8/11	2010/8/21
Distance	186.16km	186.16km	186.16km
Fuel	19.42l	17.45l	14.95l
Fuel consumption	9.585km/l	10.668km/l	12.452km/l
Reduction rate from normal (%)		-10%	-23%

[Table 12]

running test using the eco-substance in high-octane gasoline car

test vehicle : Kobe 331 Tsu 800
Mercedes-Benz S-600
(running distance : 2009/6/20 60,000km)

<normal oil>

2007/10/7-8

Amagasaki		Takefu		Echizen		Tsuruga		KyotoHigashi		Amagasaki		
	Highway →		local road →		local road →		local road →		Highway →		Distance	435km
											Fuel	61.70l
											Fuel consumptio	7.05024km/l

2008/5/10-11

Amagasaki		Takefu		Echizen		Tsuruga		KyotoHigashi		Amagasaki		
	→		local road →		Highway →		local road →		→		Distance	434km
											Fuel	61.00l
											Fuel consumptio	7.1148km/l
											Average Fuel consumption of 2 runs	7.0875km/l

<new eco-friendly lubrication oil (0.3 volume% eco-substance)>

2010/5/8-9

Amagasaki		Takefu		Echizen		Tsuruga		KyotoHigashi		Amagasaki		
	Highway →		local road →		local road →		local road →		Highway →		Distance	420km
											Fuel	43.76l
											Fuel consumptio	9.5978km/l

2010/5/22-23

Amagasaki		Takefu		Echizen		Tsuruga		KyotoHigashi		Amagasaki		
	→		local road →		Highway →		local road →		→		Distance	420km
											Fuel	43.21l
											Fuel consumptio	9.7200km/l
											Average Fuel consumption of 2 runs	9.6589km/l

Reduction rate from normal (%)	-26.6%

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[0066]

As can be seen from these results, the fuel consumption performance is improved, also in the gasoline vehicles, by the use of the new eco-friendly lubrication oil including 0.3 volume% of the eco-substance when compared with a case where the normal lubrication oil is used.

[0067]

As can be seen from the above, the fuel consumption performance is improved, also in any of the diesel truck and the passenger vehicle using light oil as fuel and the gasoline vehicle, by the use of the new eco-friendly lubrication oil including 0.3 volume% of the eco-substance.

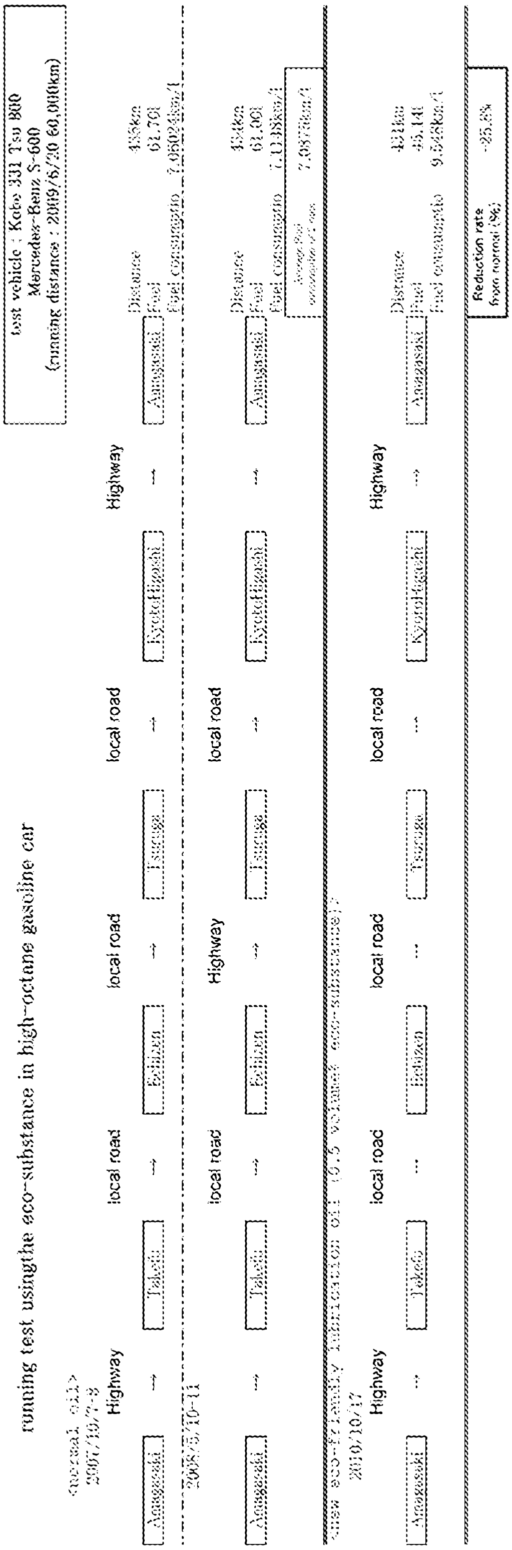
[0068]

(3) New eco-friendly lubrication oil including 0.5 volume% of eco-substance

Table 13 to Table 15 show the result of the running tests using the eco-friendly lubrication oil including 0.5 volume% of the eco-substance regarding the gasoline vehicle using high-octane gasoline, the gasoline vehicle using regular gasoline, and the diesel passenger vehicle using light oil as fuel. Table 13 shows the test result for high-octane gasoline. Table 14 shows the test result for regular gasoline. Table 15 shows the test result for light oil as fuel.

[0069]

[Table 13]



[0070]

[Table 14]

[0071]

[Table 15]

running test using new eco-friendly lubrication oil in regular gasoline car

test vehicle : BMW 1600

test-day : 2010/10/11 weather : fine

Departure	→	Suma	→	Nishinomiya	→	Amagasaki	68.87km		
Departure	→	Hitokura dam	→	Amagasaki			63.23km		
Departure	→	Takarazuka	→	Arima	→	Amagasaki	48.11km		
							total : 180.21km		

2010/10/11

Distance	180.21km
Fuel	11.63l
Fuel consumption	15.495km/l

Departure	→	Suma	→	Nishinomiya	→	Amagasaki
Departure	→	Hitokura dam	→	Amagasaki		
Departure	→	Takarazuka	→	Arima	→	Amagasaki

<normal oil>

2009/9/19,21

Distance	186.16km
Fuel	19.42l
Fuel consumption	9.586km/l

Reduction rate from normal (%)	-10%

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running test using new eco-friendly lubrication oil

test vehicle : NISSAN SAFARI

(conditions : load +-30kg, same vehicle, same driver, fuel tolerance 100cc)

	Normal oil			new eco-friendly lubrication oil (0.5 volume% eco-substance)
month	Jan	Feb	Mar	Oct
working days	18days	24days	25days	24days
running distance per month	101734km	102090km	102445km	106267km
main destination & running distance	Nishinomiya 12km Ishimichi 48km Hitokura 61km Nada 36km	Hitokura dam 61km Hitokura dam 61km Nada 36km	Nishinomiya 12km Ishimichi 48km Nada 36km	Hitokura 61km Hitokura 61km Nada 36km
total running distance	157km	158km	96km	158km
comuting (2km), less than 10km per service	199km	197km	237km	237km
running distance	356km	355km	333km	395km
amount used fuel	67.8l	64.23l	61.92l	59.09l
fuel consumption	5.251km/l	5.527km/l	5.378km/l	6.685km/l
average of fuel consumption (normal oil, 3months)			5.385	
Reduction rate from normal (%)				-19%

[0072]

As can be seen from these results, the fuel consumption performance is improved, at least in the passenger vehicle using gasoline and light oil as fuel, by the use of new eco-friendly lubrication oil including 0.5 volume% of eco-substance when compared with a case where the normal lubrication oil is used.

[0073]

2. [Black smoke test]

The respective vehicles were black smoke test in order to compare the new eco-friendly lubrication oil including 0.3 volume% of the eco-substance with the normal lubrication oil regarding the black smoke concentration.

[0074]

In the black smoke test, a probe (a exhaust gas extraction sheet of a black smoke measuring instrument) was inserted to an exhaust pipe by about 20cm to allow the exhaust gas to pass through the probe. Then, the probe on which impurities were attached was placed in the black smoke measuring instrument to measure the black smoke concentration. The blacker the probe is, the more impurities are attached thereto, thus resulting in a higher black smoke concentration.

[0075]

(i) In the black smoke test, the vehicle was stopped and the change gear was at a neutral position.

(ii) A motor was operated under no load. Then, an accelerator pedal was pushed down rapidly until the highest rotation number was reached. Then, the accelerator pedal was released until the no-load running is reached. The above operation was repeated 2 or 3 times.

(iii) Next, the no-load running was performed for about 5 seconds and the accelerator pedal was pushed down rapidly to retain this state for about 4 seconds. Thereafter, the accelerator pedal was released and this state was retained for about 11 seconds. The above operation was repeated 2 or 3 times

(iv) The extraction of black smoke was started when the accelerator pedal was pushed down in (iii). The probe was purged (to scavenge any remaining black smoke) just before the extraction of black smoke.

(v) The above steps of (i) to (iv) were repeated 3 times. Then, the resultant average value was determined as a black smoke concentration.

[0076]

Table 16 shows the list of the results of the black smoke test for the respective vehicles. The left side shows the result for the normal lubrication oil. The right side shows the result for the new eco-friendly lubrication oil including 0.3 volume% of the eco-substance. Fig. 2 to Fig. 5 are an example showing the result of the actually-performed black smoke test (regarding the vehicle numbers 438 and 8003).

[0077]

[Table 16]

Black Smoke Test

Comparison of normal oil and new eco-friendly lubrication oil including 0.3 volume% eco-substance

	normal oil (RIMULA SUPER)						new eco-friendly lubrication oil including 0.3 volume% eco-substance (RIMULA SUPER)						comparison result		notes
car No.	running distance (km)	test-day	1st (%)	2nd (%)	3rd (%)	average (%)	running distance (km)	test-day	1st (%)	2nd (%)	3rd (%)	average (%)	reducation value of black smoke	reducation rate of black smoke	
438	399,435	2010/7/24	18	16	18	17.3	411,922	2010/10/5	14	18	18	16.7	-0.67	-3.80%	
358	1,638,971	2010/8/31	18	30	34	27.3	1,845,835	2010/10/7	20	30	24	24.7	-2.67	-9.80%	
428	1,091,454	2010/8/31	22	24	24	23.3	1,097,929	2010/10/7	24	22	26	24	0.67	2.90%	
8003	502,868	2010/8/31	2	2	2	2	506,248	2010/10/6	1	1	1	1	-1	-50.00%	
4397	1,272,953	2010/9/6	26	26	30	28	1,279,810	2010/10/8	18	20	26	21.3	-6.67	-23.80%	
4112	1,729,429	2010/9/9	34	20	14	22.7	1,735,222	2010/10/7	22	26	26	23.3	0.67	2.90%	

[0078]

As can be seen from the above, the use of the new eco-friendly lubrication oil including 0.3 volume% of the eco-substance can reduce black smoke, thus improving the performance. Furthermore, less emitted black smoke also achieves environmental friendliness.

[0079]

Table 17 to Table 19 show the comments by the drivers of the respective vehicles regarding the behavior and horsepower of the engine, the fuel consumption, and exhaust gas smoke for example.

[0080]

[Table 17]

resarch table of car condition

car No. 9092	driver	YAHARI						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/16	
good		good		little		little		tractor / gross weight / 40t	
unknown	*	unchanged	*	unchanged	*	unchanged	*		
bad		bad		much		much		sign:MAKITA	sign:YAHARI

resarch table of car condition

car No. 3987	driver	TSUGAWA						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/16	
good	*	good	*	little	*	little		large-sized-car / 20t	
unknown		unchanged		unchanged		unchanged	*		
bad		bad		much		much		sign:MAKITA	sign:TSUGAWA

resarch table of car condition

car No. 3714	driver	SEKIGUCHI						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/17	
good		good		little	*	little		large-sized-car / 20t	
unknown	*	unchanged		unchanged		unchanged	*		
bad		bad	*	much		much		sign:MAKITA	sign:SEKIGUCHI

resarch table of car condition

car No. 3906	driver	INOUE						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/16	
good	*	good		little	*	little	*	large-sized-car / 20t	
unknown		unchanged	*	unchanged		unchanged		engine is smooth	
bad		bad		much		much		sign:MAKITA	sign:INOUE

resarch table of car condition

car No. 4914	driver	TUKANO						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/16	
good	*	good	*	little	*	little		large-sized-car / 20t	
unknown		unchanged		unchanged		unchanged	*		
bad		bad		much		much		sign:MAKITA	sign:TUKANO

resarch table of car condition

car No. 9001	driver	SUGA						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/18	
good		good	*	little		little	*	large-sized-car / 20t	
unknown	*	unchanged		unchanged	*	unchanged			
bad		bad		much		much		sign:MAKITA	sign:SUGA

resarch table of car condition

car No. 357	driver	TAKEDA						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/17	
good	*	good		little	*	little		large-sized-car / 20t	
unknown		unchanged	*	unchanged		unchanged	*	oil consumption amount decreas	
bad		bad		much		much		sign:MAKITA	sign:TAKEDA

resarch table of car condition

car No. 353	driver	Shin YAMADA						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/21	
good		good		little		little		large-sized-car / 20t	
unknown	*	unchanged		unchanged	*	unchanged	*	smoke amount decrease	
bad		bad	*	much		much		sign:MAKITA	sign:YAMADA

[0081]

[Table 18]

[0082]

resarch table of car condition

car No. 348	driver	ARATANI						notes
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/10/13
good	*	good		little		little		I feel that
unknown		unchanged	*	unchanged	*	unchanged	*	the condition of engine is good
bad		bad		much		much		sign:ARATANI

resarch table of car condition

car No. 428	driver	Tadashi YAMADA						notes
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/10/1
good	*	good	*	little	*	little		
unknown		unchanged		unchanged		unchanged	*	
bad		bad		much		much		sign:YAMADA

resarch table of car condition

car No. 4112	driver	HARUNA						notes
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/30
good	*	good		little	*	little	*	
unknown		unchanged	*	unchanged		unchanged		
bad		bad		much		much		sign:HARUNA

resarch table of car condition

car No. 4397	driver	YAMAGUCHI						notes
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/9/30
good	*	good		little	*	little	*	I feel unchanged
unknown		unchanged	*	unchanged		unchanged		
bad		bad		much		much		sign:YAMAGUCHI

[Table 19]

resarch table of car condition

car No. 8003	driver	GOTOU						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/10/1	
good		good	*	little		little		I feel that	
unknown	*	unchanged		unchanged	*	unchanged	*	engine is good in uphill	
bad		bad		much		much			sign:GOTOU

resarch table of car condition

car No. 427	driver	UMEDA						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/10/7	
good	*	good		little		little	*		
unknown		unchanged	*	unchanged	*	unchanged			
bad		bad		much		much			sign:UMEDA

resarch table of car condition

car No. 358	driver	MIYAZU						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/10/1	
good		good	*	little	*	little		I feel that	
unknown	*	unchanged		unchanged		unchanged	*	horsepower is slightly stronger	
bad		bad		much		much			sign:MIYAZU

resarch table of car condition

car No. 438	driver	MUKAI						notes	
engine	feeling	horsepower	feeling	fuel	feeling	smoke	feeling	2010/10/1	
good		good		little		little		it is quiet during	
unknown	*	unchanged	*	unchanged	*	unchanged	*	rotation of the engine is raised	
bad		bad		much		much			sign:MUKAI

[0083]

As can be seen from these comments, according to the comments by the drivers, the use of the new eco-friendly lubrication oil provides, when compared with the use of the conventional lubrication oil, at least equal or improved engine behavior, fuel consumption, and exhaust gas smoke amount.

[0084]

3. [Internal-combustion engine fuel]

Next, the following section will describe an embodiment of the internal-combustion engine fuel injected with eco-substance with reference to the drawings.

[0085]

The internal-combustion engine fuel according to the present invention is obtained by injecting (or adding) fuel oil impregnating agent composed of dimethylalkyl tertiary amine (hereinafter referred to as eco-substance) to petroleum oil fuel. The eco-substance is injected in the range from 0.5 to 1 volume% and desirably in the range from 0.99 to 1 volume%. The reason is that the injection amount lower than 0.5 volume% prevents a sufficient effect from being provided and that the injection amount exceeding 1 volume% causes an insufficient effect not enough for a high price. It is confirmed that light oil, kerosene, gasoline, or Bunker A injected with the fuel oil impregnating agent within the above range is handled as light oil, kerosene, gasoline, or Bunker A, according to a component analysis.

[0086]

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The petroleum oil fuel is light oil, kerosene, gasoline, or Bunker A and can provide, by being injected with the eco-substance, a desired effect as described later.

[0087]

The eco-substance may be amine DM12D, amine DM14D, or amine DM16D (product name used by LION AKZO Co., Ltd.).

[0088]

Next, as shown in Fig. 6(a), the heat-resistant hose 14 was used to send the exhaust gas from the exhaust pipe 12 of the automobile engine 11 via the hot filter 13 into the general-purpose engine exhaust gas measurement apparatus 15 (EXSA-1500 HORIBA Ltd). Then, the increase-decrease rate of the concentration of an exhaust gas component (e.g., CO_2) was measured with a different engine rotation number for light oil, regular gasoline, kerosene, and Bunker A for a case where the eco-substance was not injected and a case where the eco-substance of 1% was injected, the result of which is shown in Tables 20 to 23. The reference numeral 16 denotes an input apparatus for setting test conditions (e.g., a personal computer). The reference numeral 17 denotes an output apparatus for outputting the test result (e.g., a pen recorder).

[0089]

In this test, as shown in Fig. 6(b), the round tank 18 including 500 to 1500 liters of the remaining oil injected with the eco-substance was injected with such solution from the storage tank 19 that is obtained by injecting 80 liters of the eco-substance to 120 liters of petroleum oil. Then, the resultant mixture in the lower part of the tank was stirred and mixed by the pump 20. Thereafter, in order so that the concentration of the entirety is 1% for example, fuel not injected with the eco-substance was inputted to the tanker lorry 21, thereby preparing internal-combustion engine fuel as a sample.

[0090]

In Table 20 to Table 36, DLMA is the amine DM12D and DMMA is the amine DM16D.

[0091]

[Table 20]

[car A / diesel fuel --- air temperature 9 degrees / humidity 50% at the time of measurement]

DMLA - adding amount		density of exhaust constituent (ppm)			
	engine speed	idling	1000 rpm	1500 rpm	2000 rpm
0%	CO	168	230	234	262
	CO2	12,775	13,725	16,550	20,400
1%	CO (rate of change)	136 (-19%)	197 (-14%)	188 (-20%)	244 (-7.0%)
	CO2 (rate of change)	11,375 (-11%)	13,125 (-4.4%)	15,175 (-8.3%)	20,050 (-1.7%)
2%	CO (rate of change)	124 (-26%)	169 (-27%)	189 (-19%)	227 (-13%)
	CO2 (rate of change)	10,525 (-18%)	12,500 (-8.9%)	15,850 (-4.2%)	18,725 (-8.2%)
4%	CO (rate of change)	115 (-32%)	158 (-31%)	178 (-24%)	228 (-23%)
	CO2 (rate of change)	11,075 (-13%)	12,975 (-5.5%)	16,150 (-2.4%)	19,900 (-2.5%)

[0092]

[Table 21]

[car A / diesel fuel --- air temperature 9 degrees / humidity 50% at the time of measurement]

DMMA - adding amount	engine speed	density of exhaust constituent (ppm) idling	1000 rpm	1500 rpm	2000 rpm
0%	CO	168	230	234	262
	CO2	12,775	13,725	16,550	20,400
1%	CO (rate of change)	111 (-34%)	158 (-31%)	188 (-20%)	235 (-10%)
	CO2 (rate of change)	10,500 (-18%)	12,825 (-6.6%)	15,150 (-8.5%)	18,625 (-8.7%)
2%	CO (rate of change)	122 (-27%)	168 (-27%)	200 (-15%)	239 (-8.8%)
	CO2 (rate of change)	10,875 (-15%)	12,175 (-11%)	14,550 (-12%)	18,250 (-11%)
4%	CO (rate of change)	122 (-27%)	171 (-26%)	199 (-15%)	256 (-3.3%)
	CO2 (rate of change)	10,900 (-15%)	12,225 (-11%)	14,575 (-12%)	18,450 (-9.6%)

[0093]

[Table 22]

[car B / diesel fuel --- air temperature 17 degrees / humidity 45% at the time of measurement]

DMLA - adding amount	engine speed	density of exhaust constituent (ppm) idling	1000 rpm	1500 rpm	2000 rpm
0%	CO	134	147	171	213
	CO2	11,400	13,725	18,300	23,100
	HC	262	272	302	326
1%	CO (rate of change)	121 (-10%)	137 (-6.8%)	160 (-6.4%)	200 (-6.1%)
	CO2 (rate of change)	11,250 (-1.3%)	13,800 (+0.5%)	16,700 (-8.7%)	21,200 (-8.2%)
	HC (rate of change)	226 (-14%)	236 (-13%)	264 (-13%)	310 (-4.9%)
2%	CO (rate of change)	139 (+3.7%)	138 (-6.1%)	166 (-2.9%)	201 (-6.6%)
	CO2 (rate of change)	11,375 (-0.2%)	13,575 (-1.1%)	17,625 (-3.7%)	21,425 (-7.3%)
	HC (rate of change)	206 (-21%)	216 (-21%)	240 (-21%)	255 (-22%)
4%	CO (rate of change)	128 (-4.5%)	134 (-8.8%)	159 (-7.0%)	193 (-9.4%)
	CO2 (rate of change)	11,350 (-0.4%)	13,450 (-2.2%)	17,100 (-6.6%)	21,375 (-7.5%)
	HC (rate of change)	203 (-23%)	213 (-22%)	235 (-22%)	244 (-25%)

[0094]

[Table 23]

[car C / diesel fuel --- air temperature 25 degrees / humidity 60% at the time of measurement]

DMLA - adding amount	engine speed	density of exhaust constituent (ppm) idling	1000 rpm	1500 rpm	2000 rpm
0%	CO	90	117	167	224
	CO2	13,500	14,350	16,600	22,350
	HC	74	92	139	218
2%	CO (rate of change)	23 (-74%)	32 (-73%)	16 (-54%)	138 (-40%)
	CO2 (rate of change)	13,200 (-2.2%)	14,200 (-1.0%)	15,875 (-4.4%)	18,475 (-17%)
	HC (rate of change)	59 (-20%)	74 (-20%)	120 (-14%)	172 (-21%)
4%	CO (rate of change)	29 (-68%)	23 (-80%)	70 (-58%)	124 (-45%)
	CO2 (rate of change)	13,125 (-2.8%)	14,150 (-1.4%)	16,000 (-3.6%)	18,600 (-17%)
	HC (rate of change)	63 (-15%)	74 (-20%)	118 (-15%)	168 (-23%)
7.5%	CO (rate of change)	20 (-78%)	17 (-85%)	50 (-70%)	106 (-53%)
	CO2 (rate of change)	13,050 (-3.3%)	13,725 (-4.4%)	15,725 (-5.3%)	18,525 (-17%)
	HC (rate of change)	55 (-26%)	65 (-29%)	101 (-27%)	148 (-32%)
10%	CO (rate of change)	10 (-89%)	13 (-89%)	39 (-77%)	91 (-59%)
	CO2 (rate of change)	13,500 (-0%)	13,950 (-2.8%)	15,075 (-9.2%)	18,075 (-19%)
	HC (rate of change)	45 (-39%)	64 (-30%)	94 (-32%)	137 (-37%)

[0095]

[Table 24]

[car D / diesel fuel --- air temperature 22 degrees / humidity 50% at the time of measurement]

DMLA - adding amount	engine speed	density of exhaust constituent (ppm) idling	1000 rpm	1500 rpm	2000 rpm	2500 rpm
0%	CO	158	164	174	236	302
	CO2	16,800	17,200	18,750	23,300	28,250
	NOX	157	134	125	189	369
2%	CO (rate of change)	28 (-82%)	49 (-70%)	96 (-45%)	152 (-36%)	212 (-30%)
	CO2 (rate of change)	16,425 (-2.2%)	16,975 (-1.3%)	17,275 (-7.9%)	22,600 (-3.0%)	27,350 (-3.2%)
	NOX (rate of change)	142 (-10%)	107 (-20%)	95 (-24%)	148 (-22%)	292 (-21%)

[0096]

[Table 25]

[car D / diesel fuel --- air temperature 25 degrees / humidity 75% at the time of measurement]

DMLA - adding amount	engine speed	density of exhaust constituent (ppm) idling	1000 rpm	1500 rpm	2000 rpm	2500 rpm
0%	CO	167	172	200	262	338
	CO2	22,150	20,250	24,100	28,050	34,850
	NOX	109	116	103	153	316
2%	CO (rate of change)	102 (-39%)	97 (-44%)	152 (-24%)	218 (-17%)	255 (-25%)
	CO2 (rate of change)	19,475 (-12%)	19,750 (-2.5%)	22,400 (-7.1%)	26,750 (-4.6%)	32,850 (-5.7%)
	NOX (rate of change)	121 (+11%)	101 (-13%)	73 (-29%)	114 (-25%)	234 (-26%)

[0097]

[Table 26]

{car D / diesel fuel --- air temperature 23 degrees / humidity 46% at the time of measurement }

DMMA - adding amount	engine speed	density of exhaust constituent (ppm)				
		idling	1000 rpm	2000 rpm	2500 rpm	accelerator MAX
0%	CO	124	143	213	278	195
	CO2	17,600	17,450	22,600	28,600	27,100
	NOX	167	124	152	284	144
2%	CO (rate of change)	59 (-52%)	68 (-52%)	177 (-17%)	240 (-14%)	161 (-17%)
	CO2 (rate of change)	17,075 (-3.0%)	16,525 (-5.3%)	21,150 (-6.4%)	27,025 (-5.5%)	24,275 (-10%)
	NOX (rate of change)	137 (-18%)	104 (-16%)	126 (-17%)	256 (-10%)	126 (-12%)

[0098]

[Table 27]

{car D / diesel fuel --- air temperature 30 degrees / humidity 50% at the time of measurement }

DMMA - adding amount	engine speed	density of exhaust constituent (ppm)				
		idling	1000 rpm	2000 rpm	2500 rpm	accelerator MAX
0%	CO	133	150	209	251	184
	CO2	18,200	18,650	24,450	31,500	27,850
	NOX	154	115	153	339	153
2%	CO (rate of change)	102 (-23%)	129 (-14%)	196 (-6.2%)	239 (-4.8%)	153 (-17%)
	CO2 (rate of change)	17,850 (-2.0%)	18,050 (-3.2%)	22,550 (-7.8%)	28,200 (-10%)	26,200 (-5.9%)
	NOX (rate of change)	123 (-20%)	118 (+2.6%)	127 (-17%)	253 (-25%)	152 (-0.7%)

[0099]

[Table 28]

{car D / diesel fuel --- air temperature 30 degrees / humidity 50% at the time of measurement }

DMLA - adding amount	engine speed	density of exhaust constituent (ppm)				
		idling	1000 rpm	1500 rpm	2000 rpm	2500 rpm
0%	CO	133	150	160	209	251
	CO2	18,200	18,650	19,900	24,450	31,500
	NOX	154	115	108	153	339
7.5%	CO (rate of change)	107 (-20%)	116 (-23%)	141 (-12%)	170 (-19%)	208 (-17%)
	CO2 (rate of change)	17,800 (-2.2%)	17,300 (-7.2%)	19,400 (-2.5%)	22,300 (-8.8%)	27,700 (-12%)
	NOX (rate of change)	133 (-14%)	106 (-8.6%)	85 (-21%)	130 (-15%)	266 (-2.2%)
10%	CO (rate of change)	54 (-59%)	48 (-68%)	108 (-33%)	158 (-24%)	188 (-25%)
	CO2 (rate of change)	18,300 (+0.5%)	16,900 (-9.4%)	18,250 (-8.3%)	21,300 (-13%)	26,000 (-17%)
	NOX (rate of change)	163 (+5.8%)	112 (-2.6%)	89 (-18%)	123 (-20%)	272 (-20%)

[0100]

[Table 29]

[car E / diesel fuel --- air temperature 17 degrees / humidity 60% at the time of measurement]

DMMA		density of exhaust constituent (ppm)				
- adding amount	engine speed	idling	1000 rpm	1500 rpm	2000 rpm	2500 rpm
0%	CO	98	83	139	228	299
	CO2	24,125	21,850	22,250	24,850	27,875
1%	CO (rate of change)	89 (-9.2%)	72 (-13%)	106 (-24%)	162 (-29%)	188 (-37%)
	CO2 (rate of change)	23,350 (-3.2%)	20,850 (-4.6%)	20,800 (-6.5%)	22,450 (-9.7%)	26,850 (-3.7%)
2%	CO (rate of change)	106 (+8.2%)	74 (-11%)	95 (-32%)	164 (-28%)	206 (-31%)
	CO2 (rate of change)	24,075 (-0.2%)	21,425 (-1.9%)	21,800 (-2.0%)	23,225 (-6.5%)	26,800 (-3.9%)

[0101]

[Table 30]

[car F / diesel fuel --- air temperature 9 degrees / humidity 60% at the time of measurement]

DMMA		density of exhaust constituent (ppm)				
- adding amount	engine speed	idling	1000 rpm	1500 rpm	2000 rpm	2200 rpm
0%	CO	170	192	207	246	348
	CO2	12,000	12,800	15,450	18,100	24,950
1%	CO (rate of change)	138 (-19%)	178 (-7.3%)	229 (+11%)	229 (-7.0%)	337 (-3.2%)
	CO2 (rate of change)	11,675 (-2.7%)	12,625 (-1.4%)	14,775 (-4.4%)	17,625 (-2.6%)	22,525 (-9.7%)
2%	CO (rate of change)	122 (-28%)	157 (-18%)	205 (-1.0%)	231 (-6.1%)	325 (-6.6%)
	CO2 (rate of change)	11,300 (-5.8%)	12,400 (-3.1%)	13,850 (-10%)	16,250 (-10%)	21,200 (-15%)
4%	CO (rate of change)	107 (-37%)	161 (-16%)	200 (-4.4%)	225 (-8.5%)	325 (-6.6%)
	CO2 (rate of change)	11,125 (-7.7%)	12,028 (-6.1%)	14,500 (-6.1%)	16,500 (-8.8%)	22,125 (-11%)

[0102]

[Table 31]

[car A / fuel oil A --- air temperature 9 degrees / humidity 60% at the time of measurement]

DMLA		density of exhaust constituent (ppm)				
- adding amount	engine speed	idling	1000 rpm	1500 rpm	2000 rpm	2500 rpm
0%	CO2	11,400	12,850	16,200	18,375	24,150
2%	CO2 (rate of change)	11,300 (-0.9%)	12,750 (-0.8%)	15,600 (-3.7%)	17,900 (-2.6%)	23,100 (-4.3%)
4%	CO2 (rate of change)	11,150 (-2.2%)	12,250 (-4.7%)	14,100 (-13%)	17,950 (-2.2%)	23,100 (-4.3%)

[0103]

[Table 32]

[car E / fuel oil A --- air temperature 17 degrees / humidity 60% at the time of measurement]

DMLA - adding amount	density of exhaust constituent (ppm)				
	engine speed	idling	1000 rpm	1500 rpm	2000 rpm
0%	CO2	25,500	23,050	23,400	25,255
1%	CO2 (rate of change)	24,800 (-2.7%)	22,600 (-2.0%)	22,625 (-3.3%)	25,175 (-0.3%)
2%	CO2 (rate of change)	24,525 (-3.8%)	23,050 0%	22,425 (-4.2%)	24,250 (-4.0%)
4%	CO2 (rate of change)	24,275 (-4.8%)	22,025 (-4.4%)	22,475 (-4.0%)	25,125 (-0.5%)

[0104]

[Table 33]

[car B / fuel oil A --- air temperature 17 degrees / humidity 45% at the time of measurement]

DMLA - adding amount		density of exhaust constituent (ppm)				
	engine speed	idling	1000 rpm	1500 rpm	2000 rpm	2200 rpm
0%	CO	215	243	298	376	383
	CO2	11,725	13,950	18,050	22,350	27,350
	HC	312	348	378	361	357
1%	CO (rate of change)	174 (-19%)	216 (-11%)	270 (-9.4%)	351 (-6.6%)	366 (-4.4%)
	CO2 (rate of change)	11,350 (-3.2%)	14,000 (+0.4%)	17,800 (-1.4%)	22,600 (+1.1%)	24,500 (-10%)
	HC (rate of change)	288 (-7.7%)	309 (-11%)	336 (-11%)	315 (-13%)	318 (-11%)
2%	CO (rate of change)	195 (-9.3%)	228 (-6.2%)	280 (-6.0%)	351 (-6.6%)	352 (-8.1%)
	CO2 (rate of change)	11,450 (-2.3%)	13,400 (-3.9%)	16.150 (+0.6%)	21,050 (-5.8%)	24,700 (-9.7%)
	HC (rate of change)	292 (-6.4%)	319 (-8.3%)	346 (-8.5%)	328 (-9.1%)	327 (-8.4%)

[0105]

[Table 34]

[car G / regular gasoline --- air temperature 8 degrees / humidity 65% at the time of measurement]

DMLA - adding amount	density of exhaust constituent (ppm)				
	engine speed	idling	1000 rpm	1500 rpm	2000 rpm
0%	CO2	38,319	108,494	114,981	125,344
1%	CO2 (rate of change)	33,900 (-12%)	96,650 (-11%)	113,950 (-0.9%)	123,825 (-1.2%)
2%	CO2 (rate of change)	32,950 (-14%)	98,250 (-9.4%)	103,375 (-10%)	124,650 (-0.6%)
4%	CO2 (rate of change)	32,425 (-15%)	96,225 (-11%)	109,525 (-4.7%)	118,775 (-5.2%)

[0106]

[Table 35]

[car A / kerosene --- air temperature 7 degrees / humidity 60% at the time of measurement]

DMLA - adding amount		density of exhaust constituent (ppm)				
	engine speed	idling	1000 rpm	1500 rpm	2000 rpm	2300 rpm
0%	CO	154	230	344	521	832
	CO2	14,810	15,010	18,050	22,030	26,430
	HC	176	182	210	311	440
1%	CO (rate of change)	141 (-8.4%)	196 (-15%)	302 (-12%)	456 (-12%)	710 (-15%)
	CO2 (rate of change)	14,000 (-5.5%)	14,750 (-1.7%)	16,050 (-11%)	19,900 (-9.7%)	24 000 (-9.2%)
	HC (rate of change)	142 (-19%)	164 (-9.9%)	196 (-6.7%)	281 (-9.6%)	383 (-13%)
2%	CO (rate of change)	137 (-11%)	197 (-14%)	323 (-6.1%)	475 (-8.8%)	668 (-20%)
	CO2 (rate of change)	14,050 (-5.1%)	14,800 (-1.4%)	16,200 (-10%)	21,200 (-3.8%)	24,500 (-7.3%)
	HC (rate of change)	139 (-21%)	161 (-12%)	202 (-3.8%)	289 (-7.1%)	374 (-15%)

[0107]

[Table 36]

[car C / kerosene --- air temperature 7 degrees / humidity 60% at the time of measurement]

DMLA - adding amount		density of exhaust constituent (ppm)				
	engine speed	idling	1000 rpm	1500 rpm	2000 rpm	2300 rpm
0%	CO	78	170	383	517	393
	CO2	13,650	12,550	14,810	18,400	22,275
	HC	192	206	330	467	443
1%	CO (rate of change)	33 (-58%)	62 (-64%)	221 (-42%)	441 (-15%)	313 (-20%)
	CO2 (rate of change)	13,600 (-0.4%)	12,375 (-1.4%)	14,400 (-2.8%)	18,400 0%	21 700 (-3.6%)
	HC (rate of change)	121 (-37%)	167 (-19%)	275 (-17%)	380 (-19%)	308 (-31%)
2%	CO (rate of change)	45 (-42%)	103 (-39%)	211 (-45%)	406 (-21%)	348 (-11%)
	CO2 (rate of change)	12,850 (-5.9%)	12,850 (+2.4%)	14,025 (-5.3%)	16,725 (-9.1%)	21,775 (-2.2%)
	HC (rate of change)	117 (-39%)	166 (-19%)	253 (-23%)	368 (-21%)	294 (-34%)
4%	CO (rate of change)	48 (-38%)	110 (-35%)	234 (-39%)	364 (-30%)	326 (-17%)
	CO2 (rate of change)	13,650 0%	12,550 0%	14,550 (-1.8%)	16,975 (-7.7%)	21,025 (-5.6%)
	HC (rate of change)	110 (-43%)	153 (-26%)	241 (-27%)	339 (-27%)	300 (-32%)

[0108]

As can be seen from the result shown in the above tables, the light oil, kerosene, gasoline, or Bunker A injected with the eco-substance can reduce CO_2 when compared with fuel not injected with the eco-substance. The light oil, kerosene, gasoline, or Bunker A injected with the eco-substance also can reduce sulfur oxide (SOx), black smoke, and particulate matter (PM) as an air pollutant and can reduce CO, HC, and NOx.

[0109]

Then, Fig. 7 to Fig. 10 show the result of the running test when the petroleum oil fuel is high-octane gasoline, regular gasoline, kerosene, and clean Bunker A for the comparison between a case where these types of fuel are not injected with the eco-substance and a case where these types of fuel are injected with the eco-substance. In order to provide uniform running conditions (e.g., a running speed, a running time) as much as possible, the running test was performed by the same driver. In order to prevent an error, the petroleum oil fuel and the eco-substance were measured correctly.

[0110]

The result was that any of the high-octane gasoline, regular gasoline, kerosene, and clean Bunker A showed a reduced consumption fuel, resulting in the reduction rate of 5% to 21%. In particular, gasoline showed a reduction rate of 9.5% to 21% and kerosene and Bunker A showed a reduction rate of 5% to 9%. This shows that a significant reduction effect is obtained when the fuel is gasoline.

[0111]

Fig. 11 and Table 37 show the comparison between the petroleum oil fuel of light oil not injected with the eco-substance and the petroleum oil fuel of light oil injected with the eco-substance by performing the running test to measure the running distance by a tachometer.

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[0112]

As in the high-octane gasoline, regular gasoline, kerosene, and clean Bunker A, light oil injected with the eco-substance shows a reduced consumption fuel, thus improving the fuel consumption.

[0113]

Table 37 to Table 54 show the result of the test to further confirm the fuel consumption.

[0114]

[Table 37]

base period : 2008.Jan ~ 2009.Mar
confirming the fuel consumption of injecting no eco-substance into fuel
study period : 2009.Apr. 13 ~ 2009. Sep. 30
confirming the fuel consumption of injecting eco-substance into fuel

		running distance of all vehicles	fuel consumption amounts of all vehicles	fuel consumption of all vehicles	reduction rate (%)
2008	Apr	102,214	34,778	2.94	
	May	99,354	32,725	3.04	
	Jun	85,280	28,312	3.01	
	Jul	102,597	36,288	2.83	
	Aug	70,338	22,661	3.10	
	Sep	101,246	35,744	2.83	
	total	561,029	190,508	2.96	
2009	Apr	70,944	22,720	3.12	-5.9%
	May	67,260	21,071	3.19	-4.9%
	Jun	86,370	27,494	3.14	-4.1%
	Jul	78,478	26,179	3.00	-5.7%
	Aug	70,100	21,645	3.24	-4.2%
	Sep	85,606	26,145	3.27	-13.5%
	total	458,758	145,254	3.16	-6.4%

		running distance of 10t vehicle	fuel consumption amounts of 10t vehicle	fuel consumption of 10t vehicle	reduction rate (%)
2008	Apr	94,336	31,224	3.02	
	May	90,804	29,182	3.11	
	Jun	78,121	24,772	3.15	
	Jul	93,603	32,299	2.90	
	Aug	63,450	19,726	3.22	
	Sep	92,320	31,856	2.90	
	total	512,643	169,059	3.05	
2009	Apr	67,339	20,823	3.23	-6.6%
	May	63,279	19,269	3.28	-5.2%
	Jun	78,406	24,393	3.21	-1.9%
	Jul	70,572	22,797	3.10	-6.4%
	Aug	62,774	18,305	3.43	-6.2%
	Sep	71,190	20,693	3.44	-15.8%
	total	413,560	126,280	3.28	-7.1%

test vehicles : 10t car * 13 (including onboard cars)
[trailer] Apr ~ Jun : 2 cars, Jul ~ Sep : 3 cars

[0115]

As can be seen from Table 37, all of the vehicles show an average reduction rate of -6.4% and the 10t vehicle shows an average reduction rate of -7.1%.

[0116]

[Table 38]

No	Kobe-58-Ka-4387		
Type	MITSUBISHI P-FU415N rev		
Engine	8DC9	Registration	1986
Total weight	19715kg		

destination data loading point : Kobe-shi, Hyogo
unloading point : Iizuka-shi, Hukuoka

The comparison in the fuel amounts & the fuel consumption
From 13 April to 31 October

<Normal> ~ 2009/4/13

to			from			Dates	[illegible]	[illegible]	[illegible]
		Load (kg)			Load (kg)				
[illegible]	Iizuka	9,900	empty	–	–	2008/9/23-24	1,250	370	3.38
[illegible]	Iizuka	9,900	empty	–	–	2008/11/20-21	1,320	360	3.67
						Ave	1285	365	3.52

<injecting 0.98～1 volume % of eco-substance)> 2009/4/13 ~

to			from			Dates	[illegible]	[illegible]	[illegible]	[illegible]	Notes	[illegible]
					Load (kg)							
[illegible]	Iizuka	9,900	empty	–	–	2009/5/15-18	1,218	340	3.58	-2%		-5%
[illegible]	Iizuka	9,900	empty	–	–	2009/5/15-18	1,351	340	3.97	-11%		
[illegible]	Iizuka	9,900	empty	–	–	2009/6/8-9	1,224	330	3.71	-5%		
[illegible]	Iizuka	9,900	empty	–	–	2009/7/28-29	1,223	335	3.65	-2%		
[illegible]	Iizuka	9,900	empty	–	–	2009/8/24-25	1,316	345	3.81	-8%		
[illegible]	Iizuka	9,900	empty	–	–	2009/10/14-15	1,225	335	3.58	-4%		
[illegible]	Iizuka	9,900	empty	–	–	2009/10/22-23	1,222	330	3.70	-5%		
[illegible]	Iizuka	9,900	empty	–	–	2009/10/26/27	1,214	330	3.68	-4%		
						Ave	1,249	336	3.72	-5%		

conditions
・loadage [illegible]
・Utilization of the highway : 5～10%
・Tank cleaning ・Driver
・using the power of loading and unloading ・direct delivery from fuelmakers

[0117]

Table 38 shows that an average reduction rate of -5% is achieved in 8 running tests for which the loading place is Kobe-shi of Hyogo ken and the unloading place is Iizuka-shi of Fukuoka ken.

[0118]

[Table 39]

[0119]

[Table 40]

destination data

to	loading point :	Amagasaki-shi, Hyogo
	unloading point :	Kawaguchi-shi, Saitama
from	loading point :	Ueda-shi, Nagano
	unloading point :	Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

No.	Kobe-58-Na-4112		
Type	ISUZU P-CXM19P rev		
Engine	10PC1	Registration	1985
Total weight	13,085kg		

<Normal> ~ 2009/4/13									
to			from			Dates	[illegible]	[illegible]	[illegible]
		Load (kg)			Load (kg)				
SK	Kawaguchi	10,100	TOUSHIN	Nagano	10,200	2008/10/17-21	1,219	432	2.82

<injecting 0.99~1 volume % of eco-substance> 2009/4/13 ~										[illegible]	Notes	[illegible]
to			from			Dates	[illegible]	[illegible]	[illegible]			
					Load (kg)							
SK	Kawaguchi	10,100	TOUSHIN	Nagano	10,300	2009/5/14-18	1,213	415	2.92	−3%		−17%
SK	Kawaguchi	10,100	TOUSHIN	Nagano	10,300	2009/10/27-29	1,207	405	2.98	−6%		
						Ave	1,210	410	2.95	−4%		

conditions

・loadage : 0~500kg ・Tank cleaning ・Driver
・Utilization of the highway : 5~10% ・using the power of loading and unloading ・direct delivery from fuelmakers

[0120]

No.	Fukui-920-Ka-357
Type	NISSAN P-CD45MC rev
Engine	PE6 / Registration 1993
Total weight	19,970kg

destination data

to loading point : Amagasaki-shi, Hyogo
unloading point : Kawaguchi-shi, Saitama

from loading point : Ueda-shi, Nagano
unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

<Normal> ~ 2009/4/13										<injecting 0.99~1 volume % of eco-substance> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to			from			Dates	Running distance (km)	fuel consumption amounts (l)	fuel consumption (km/l)	to			from			Dates	Running distance (km)	fuel consumption amounts (l)	fuel consumption (km/l)			
		Load (kg)			Load (kg)										Load (kg)							
SK	Kawaguchi	6,320	TOUSHIN	Nagano	10,750	2008/4/3-5	1,220	419	2.91	SK	Kawaguchi	8,700	TOUSHIN	Nagano	19,600	2009/9/29-10/1	1,220	338	3.61	-17%		-12%
SK	Kawaguchi	8,050	TOUSHIN	Nagano	10,300	2008/5/12-14	1,220	390	3.13													
SK	Kawaguchi	10,000	TOUSHIN	Nagano	10,250	2008/3/25-27	1,220	400	3.05													
						Ave	1230	403	3.03													

conditions
·loadage : 4~~309kg
·Utilization of the highway : 5~15%
·Tank cleaning
·Driver
·using the power of loading and unloading
·direct delivery from tankmakers

[Table 41]

No.	Fukui-800-Ka-358		
Type	NISSAN P-CD48NG rev		
Engine	PE6	Registration	1989
Total weight	19,370kg		

destination data

to	loading point :	Amagasaki-shi, Hyogo
	unloading point :	Kawaguchi-shi, Saitama
from	loading point :	Ueda-shi, Nagano
	unloading point :	Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

<Normal> ~ 2009/4/13										<injecting 0.39~1 volume % of eco-substance> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to		Load (kg)	from		Load (kg)	Dates	Running distance(km)	fuel consumption amount (L)	fuel consumption (km/L)	to		Load (kg)	from		Load (kg)	Dates	Running distance(km)	fuel consumption amount (L)	fuel consumption (km/L)			
SK	Kawaguchi	6,380	TOUSHIN	Nagano	11,030	2008/5/20-22	1,310	445	2.94	SK	Kawaguchi	9,200	TOUSHIN	Nagano	10,800	2009/5/18-20	1,270	370	3.43	-14%		-12%

conditions

・Package : 4~200kg ・Tank cleaning ・Driver

・Utilization of the highway : 5~10% ・using the power of loading and unloading ・direct delivery from fishmakers

[0121]

Table 39 to Table 41 show that an average reduction rate of -12% is achieved in 4 running tests for the outward path (loading place: Amagasaki-shi of Hyogo ken, unloading place: Kawaguchi-shi of Saitama ken) and the return path (loading place: Ueda-shi of Nagano ken, unloading place: Amagasaki-shi of Hyogo ken).

[0122]

[Table 42]

destination data loading point : Wajima, Ishikawa
unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption
From 13 April to 31 October

No.	Kobe-88-Ko-4914		
Type	MITSUBISHI P-FU419N (?)		
Engine	9C?3	Registration	1988
Fuel weight	20680kg		

<Normal> ~ 2009/4/13										<Injecting 0.99~1 volume % of eco-substance> 2009/4/13 ~												
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
		Load (kg)			Load (kg)										Load (kg)							
YONESHO	Ishikawa	10,400	empty	-	-	2009/2/4-5	670	230	2.91	YONESHO	Ishikawa	10,800	empty	-	-	2009/5/14-15	675	206	3.29	-12%		-13%
										YONESHO	Ishikawa	10,700	empty	-	-	2009/5/22-23	687	206	3.33	-10%		
																Ave	681	206	3.27	-11%		

conditions
・loadage : 4~500kg
・Utilization of the highway : 5~10%
・Tank cleaning
・using the power of loading and unloading
・Driver
・direct delivery from fisherman

[0123]

[Table 43]

No.	Fukui-800-Ka-438		
Type	MITSUBISHI P-FU419N rev		
Engine	8DC9	Registration	1985
Total weight	20840kg		

destination data loading point : Wajima, Ishikawa

unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

<Normal> ~ 2008/4/13										<injecting 0.99~1 volume % of eco-substance> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
YONESHO	Ishikawa	10,500	empty	-	-	2008/2/27~28	660	235	2.81	YONESHO	Ishikawa	10,200	empty	-	-	2009/4/17~20	660	200	3.30	-12%		-13%
YONESHO	Ishikawa	10,500	empty	-	-	2008/7/31-8/1	650	216	3.01	YONESHO	Ishikawa	10,800	empty	-	-	2009/6/4-5	650	181	3.59	-19%		
						Ave	655	226	2.90	YONESHO	Ishikawa	10,500	empty	-	-	2009/9/11-12	651	196	3.31	-12%		
																Ave	657	194	3.39	-14%		

conditions ·loadage : 4~500kg ·Utilization of the highway : 9~10% ·Tank cleaning ·Driver ·using the power of loading and unloading ·direct delivery from fuelmakers

[0124]

Table 42 and Table 43 show that an average reduction rate of

-13% is achieved in 5 running tests for which the loading place is Wajima of Ishikawa ken and the unloading place is Amagasaki-shi of Hyogo ken.

[0125]

[Table 44]

[0126]

destination data

loading point : Nakaniikawa-gun, Toyama

unloading point : Takasago-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

No.	Kobe-88-Ka-4914		
Type	MITSUBISHI P-FU415N rev		
Engine	8DC9	Registration	1988
Total weight	20,000kg		

<Normal> ~ 2008/4/13									
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)
		Load (kg)			Load (kg)				
TATEYAMA ~KANEKA	Toyama	10,200	empty	--	--	2008/2/26-27	998	297	3.36
TATEYAMA ~KANEKA	Toyama	10,400	empty	--	--	2008/12/11-12	998	305	2.82
						Ave	998	286	3.12

<Injecting 0.98~1 volume % of eco-substance)> 2009/4/13 ~												
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
					Load (kg)							
TATEYAMA ~KANEKA	Toyama	10,400	empty	--	--	2009/5/28-29	999	251	3.98	-13%		
TATEYAMA ~KANEKA	Toyama	10,400	empty	--	--	2009/6/1-2	980	270	3.30	-6%		
TATEYAMA ~KANEKA	Toyama	10,500	empty	--	--	2009/6/3-4	981	290	3.47	-10%		
TATEYAMA ~KANEKA	Toyama	10,400	empty	--	--	2009/7/1-2	899	272	3.29	-5%		
						Ave	990	283	3.40	-8%		-12%

conditions

・loadage : +---500kg
・Utilization of the highway : 5~10%
・Tank cleaning ・Driver
・using the power of loading and unloading
・direct delivery from fuelmakers

[Table 45]

destination data

loading point : Nakaniikawa-gun, Toyama

unloading point : Takasago-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

No.	Fukui-800-Ka-428		
Type	MITSUBISHI P-FU418N rev		
Engine	6D2?	Registration	1995
Total weight	20840kg		

<Normal> ~ 2009/4/13									
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)
		Load (kg)			Load (kg)				
[illegible]	Toyama	10,190	empty	--	--	2008/ 11/4-5	914	277	3.30
[illegible]	Toyama	10,300	empty	--	--	2009/ 1/7-8	896	250	3.59
						Ave	905	264	3.42

<Injecting 0.98~1 volume % of eco-substance)> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
					Load (kg)							
[illegible]	Toyama	10,190	empty	--	-	2009/ 6/10-11	879	250	3.51	-3%		
[illegible]	Toyama	10,280	empty	[illegible]		2009/ 6/17-18	918	230	4.08	-15%		
[illegible]	Toyama	10,380	empty	--	-	2009/ 7/13-14	910	258	3.53	-3%		
[illegible]	Toyama	10,250	empty	--	-	2009/ 8/27-28	880	240	3.67	-7%		
						Ave	902	245	3.69	-7%		-12%

conditions

·loadage : + -500kg ·Tank cleaning ·Driver

·Utilization of the highway 5~10% ·using the power of loading and unloading ·direct delivery from fuel tankers

[0127]

[Table 46]

destination data loading point : Nakaniikawa-gun, Toyama unloading point : Takasago-shi, Hyogo

comparison in the fuel amounts & the fuel consumption
From 13 April to 31 October

No.	Fukui-200-Ka-438		
Type	NISSAN U-CD450HC rev		
Engine	PE6	Registration	1993
Total weight	19810kg		

<Normal> ~ 2009/4/13									
to			from			Dates	Running distance (km)	fuel consumption amounts (l)	fuel consumption (km/l)
		Load (kg)			Load (kg)				
TATEYAMA ~KAKEKA	Toyama	10,110	empty	--	-	2009/ 2/11~13	1,016	318	3.19
TATEYAMA ~KAKEKA	Toyama	10,390	empty	-	-	2009/ 3/12~13	990	383	2.58
						Ave	1,003	351	2.88

<injecting 0.98~1 volume % of eco-substance)> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to			from			Dates	Running distance (km)	fuel consumption amounts (l)	fuel consumption (km/l)			
					Load (kg)							
TATEYAMA ~KAKEKA	Toyama	10,110	empty	--	-	2009/ 10/14~15	980	274	3.61	-20%		-12%

conditions ·Tankage : 4~500kg ·Utilization of the highway : 5~10% ·Tank cleaning ·using the power of loading and unloading ·Driver ·direct delivery from fuelmakers

[0128]

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Table 44 to Table 46 show that an average reduction rate of -12% is achieved in 9 running tests for which the loading place is Nakaniikawa-gun of Toyama ken and the unloading place is Takasago-shi of Hyogo ken.

[0129]

[Table 47]

[0130]

destination data

loading point : Noto, Ishikawa

unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

No.	Kobe-88-Ko-4814		
Type	MITSUBISHI P-FU419N		
Engine	8DC9	Registration	1988
Total weight	20000kg		

<Normal> ～ 2009/4/13										<injecting 0.99～1 volume % of one substance)> 2009/4/13 ～										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to		Load (kg)	from		Load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to		Load (kg)	from		Load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
ISHIKAWA SANY	Ishikawa	10,300	empty	-	-	2009/1/5-8	729	273	2.67	ISHIKAWA SANY	Ishikawa		empty	-	-	2009/6/19-22	730	216	3.38	-20%		-14%

conditions

·loadage : 4～800kg ·Tank cleaning ·Driver

·Utilization of the highway : 5～10% ·using the power of loading and unloading ·direct delivery from fuelmakers

[Table 48]

destination data loading point : Noto, Ishikawa
unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption
From 13 April to 31 October

No.	Fukui-800-ha-428		
Type	MITSUBISHI P-FU419N rev		
Engine	6D22	Registration	1995
Total weight	20640kg		

<Normal> ~ 2009/4/13										<Injecting 0.99~1 (volume % of eco-substance)> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
		Load (kg)			Load (kg)							Load (kg)			Load (kg)							
ISHIKAWA SANY	Ishikawa	10,000	empty	-	-	2009/3/12-13	720	215	3.35	ISHIKAWA SANY	Ishikawa	10,000	empty	-	-	2009/4/22-23	720	190	3.79	-12%		-14%
ISHIKAWA SANY	Ishikawa	7,800	empty	-	-	2009/3/16-17	693	190	3.64	ISHIKAWA SANY	Ishikawa	8,000	empty	-	-	2009/5/26-27	693	183	3.78	-4%		

conditions ·loadage : 4~8000kg ·Tank cleaning ·Driver
·Utilization of the highway : 5~10% ·using the power of loading and unloading ·direct delivery from fuelmakers

[0131]

Table 47 and Table 48 show that an average reduction rate of -14% is achieved in 3 running tests for which the loading place is Noto of Isikawa ken and the unloading place is Amagasaki-shi of Hyogo ken.

[0132]

[Table 49]

[0133]

[Table 50]

No.	Fukui-800-Ka-357		
Type	NISSAN P-CD42NC rev		
Engine	PE6	Registration	1989
Total weight	19,870kg		

destination data

to loading point : Amagasaki-shi, Hyogo
unloading point : Kitatone, Ibaraki
from loading point : Sano-shi, Tochigi
unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption
From 13 April to 31 October

<Normal> ~ 2009/4/13										<injecting 0.99~1 volume % of eco-substance1> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to		Load (kg)	from		Load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to		Load (kg)	from		Load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
KOGUNIS	Kitatone	8,300	YOSHIKAWA	Tochigi	10,600	2008/ 8/17-18	1,270	405	3.14	KOGUNIS	Kitatone	9,200	YOSHIKAWA	Tochigi	10,600	2009/ 6/13-17	1,270	409	3.12	-5%		-5%
KOGUNIS	Kitatone	8,300	YOSHIKAWA	Tochigi	10,200	2008/ 8/23-25	1,270	411	3.09	KOGUNIS	Kitatone	9,320	YOSHIKAWA	Tochigi	10,400	2009/ 5/22-24	1,270	404	3.14	-4%		
KOGUNIS	Kitatone	8,100	YOSHIKAWA	Tochigi	10,400	2008/ 7/5-9	1,270	440	2.89							Ave	1,270	407	3.13	-4%		
						Ave	1270	419	3.03													

conditions
・loadage : [illegible]
・Utilization of the highway : 5~10%
・Tank cleaning
・Driver
・using the power of loading and unloading
・direct delivery from factories

No.	Fukui-800-Ka-478		
Type	NISSAN U-CD450RC rev		
Engine	FE6	Registration	1993
Total weight	19810kg		

destination data

to loading point : Amagasaki-shi, Hyogo
unloading point : Kitatone, Ibaraki
from loading point : Sano-shi, Tochigi
unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption
From 13 April to 31 October

<Normal> ~ 2009/4/13									
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)
		Load (kg)			Load (kg)				
KOGUNIS	Kitatone	8,350	YOSHIKAWA	Tochigi	10,400	2008/12/1-3	1,236	474	2.60

<injecting 0.89~1 volume % of eco-substance> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
					Load (kg)							
KOGUNIS	Kitatone	★7500	YOSHIKAWA	Tochigi	10,800	2009/6/3-5	1,328	407	3.28	-14%		-8%

conditions
・loadage : 4~500kg ・Tank cleaning ・Driver
・Utilization of the highway 5~10% ・using the power of loading and unloading ・direct delivery from fuelmakers

[0134]

Table 49 and Table 50 show that an average reduction rate of

-9% is achieved in 3 running tests for the outward path (loading place: Amagasaki-shi of Hyogo ken, unloading place: Kitatone of Ibaragi ken) and the return path (loading place: Sano-shi of Tochigi ken, unloading place: Amagasaki-shi of Hyogo ken).

[0135]

[Table 51]

[0136]

[Table 52]

destination data	
to	loading point : Izumisano-shi, Osaka
	unloading point : Echizen-shi, Fukui
from	loading point : Nakaniikawa-gun, Toyama
	unloading point : Takasago-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

No.	Fukui-800-Ka-351		
Type	ISUZU P-EKG23M rev		
Engine	6SD1	[illegible]	1986
Total weight	19520kg		

<Normal> ~ 2009/4/13										<Injecting 0.99~1 volume % of eco-substance)> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
		[illegible]			Load (kg)										Load (kg)							
[illegible]	Fukui	10,000	[illegible]	Toyama	10,300	2009/1/27~29	1,002	275	3.65	[illegible]	Fukui	10,300	[illegible]	Toyama	10,000	2009/5/27~29	1,064	282	3.77	~3%		~8%

<u>conditions</u>

·loadage : 4~500kg
·Utilization of the highway : 5~10%
·Tank cleaning
·using the power of loading and unloading
·Driver
·[illegible]

No.	Fukui-800-Ka-439		
Type	MITSUBISHI P-FU419N rev		
Engine	8DC2	Production	1995
Total weight	20640kg		

destination data

to	loading point :	Izumisano-shi, Osaka
	unloading point :	Echizen-shi, Fukui
from	loading point :	Nakaniikawa-gun, Toyama
	unloading point :	Takasago-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

<Normal> ~ 2009/4/13										<injecting 0.98~1 volume % of eco-substance)> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
[illegible]	Fukui	10,000	[illegible]	Toyama	10,100	2008/7/26-26	973	314	3.10	[illegible]	Fukui	10,030	[illegible]	Toyama	10,200	2009/8/11-13	979	292	3.35	-8%		-8%
										[illegible]	Fukui	10,030	[illegible]	Toyama	10,100	2009/8/1-3	979	285	3.43	-11%		
										[illegible]	Fukui	10,030	[illegible]	Toyama	10,200	2009/9/19-20	977	250	3.91	-20%		
										[illegible]	Fukui	10,030	[illegible]	Toyama	10,200	2009/9/15-16	1,024	300	3.41	-10%		
																Ave	989	281	3.52	-13%		

conditions
·loadage : 4~~500kg
·Utilization of the highway : 5~10%
·Tank cleaning
·Driver
using the power of loading and unloading
·direct delivery from factories

[0137]

Table 51 and Table 52 show that an average reduction rate of

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-8% is achieved in 5 running tests for the outward path (loading place: Izumisano-shi of Osaka-fu, unloading place: Echizen-shi of Fukui ken) and the return path (loading place: Nakaniikawa-gun of Toyama ken, unloading place: Takasago-shi of Hyogo ken).

[0138]

[Table 53]

[0139]

destination data

loading point : Amagasaki-shi, Hyogo

unloading point : Yokkaichi-shi, Aichi

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

<Tractor>

No.	Kobe 130 A 8802		
Type	VOLVO Tractor		
Engine	D12	Registration	2003
Total weight	39920kg		

<Normal> ~ 2009/4/13										<Injecting 0.99~1 volume % of eco-substance> 2009/4/13 ~												
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
		Load (kg)			Load (kg)										Load (kg)							
JSR	Yokkaichi	15,100	empty	~	~	2009/1/6-7	307	150	2.05	JSR	Yokkaichi	15,100	empty	~	~	2009/4/17-20	310	144	2.15	-5%	[illegible]	-6%
JSR	Yokkaichi	15,100	empty	~	~	2009/1/9-12	310	157	1.97	JSR	Yokkaichi	15,100	empty	~	~	2009/5/26-27	308	142	2.17	-10%	[illegible]	
JSR	Yokkaichi	15,100	empty	~	~	2009/3/27-3/2	294	155	1.90	JSR	Yokkaichi	15,100	empty	~	~	2009/6/26-29	310	152	2.04	-3%	[illegible]	
						Ave	304	154	1.97							Ave	309	146	2.12	-7%		

conditions
- Haulage : 4~500kg
- Utilization of the highway : 5~10%
- Tank cleaning
- using the power of loading and unloading
- Driver
- direct delivery from fuelmakers

[Table 54]

<Trailer>

No.	Kobe-130-A-8003
Type	VOLVO Tractor
Engine	D12C / Registration 2003
Total weight	35920kg

destination data loading point : Amagasaki-shi, Hyogo
unloading point : Yokkaichi-shi, Aichi

comparison in the fuel amounts & the fuel consumption
From 13 April to 31 October

<Normal> ~ 2009/4/13										<injecting 0.99~1 volume % of eco-substance)> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
JSR	Yokkaichi	15,000	empty	-	-	2009/4/16-17	310	160	1.94	JSR	Yokkaichi	15,100	empty	-	-	2009/4/22-23	310	150	2.07	-6%		-5%
										JSR	Yokkaichi	15,110	empty	-	-	2009/10/1-2	310	156	1.99	-3%		
										JSR	Yokkaichi	15,050	empty	-	-	2009/10/13-14	307	156	1.97	-2%		
										JSR	Yokkaichi	15,030	empty	-	-	2009/10/17-18	321	166	1.94	0%	[illegible]	
										JSR	Yokkaichi	15,030	empty	-	-	2009/10/19-20	303	141	2.15	-9%		
										JSR	Yokkaichi	15,170	empty	-	-	2009/10/20-21	308	150	2.04	-5%		
										JSR	Yokkaichi	15,000	empty	-	-	2009/10/21-22	294	138	2.13	-9%	[illegible]	
										JSR	Yokkaichi	15,000	empty	-	-	2009/10/22-23	313	155	2.02	-4%	Fri.~ Mon.	
																Ave.	309	152	2.03	-5%		

conditions
*loadage : 4~15,000kg *Utilization of the highway : 3~10% *Tank cleaning *using the owner of loading and unloading *Driver *direct delivery from fuelmakers

[0140]

Table 53 and Table 54 show that an average reduction rate of -6% is achieved in 11 running tests for which the loading place is Amagasaki-shi of Hyogo ken and unloading place is Noto of Isikawa ken.

[0141]

[Table 55]

[0142]

destination data

loading point : Yokkaichi-shi, Aichi

unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

No.	Kobe-88-Ka-3714		
Type	ISUZU P-CXM19P rev.		
Engine	19PC1	Registration	1984
Total weight	19950kg		

<Normal> ~ 2009/4/13										<injecting 0.99~1 volume % of eco-substance)> 2009/4/13 ~										Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to			from			Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)			
		Load (kg)			Load (kg)										Load (kg)							
[illegible]	Yokkaichi	8,100	empty	-	-	2009/4/3	340	115	2.96	[illegible]	Yokkaichi	8,040	empty	-	-	2009/4/12	340	100	3.40	-13%		
																						-17%

conditions

・Loadage : 4~5000kg ・Utilization of the highway : 5~10%

・Tank cleaning ・using the power of loading and unloading

・Driver ・direct delivery from [illegible]

[Table 56]

destination data

loading point : Yokkaichi-shi, Aichi

unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

No.	Kobe-88-Ka-3800		
Type	ISUZU P-CXM13P rev.		
Engine	10PC1	Registration	1984
Total weight	19635kg		

<Normal> ~ 2009/4/13										<injecting 0.89~1 volume % of eco-substance)> 2009/4/13 ~												
to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amount (l)	fuel consumption (km/l)	Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
[illegible]	Yokkaichi	8,000	empty	-	-	2008/10/20	342	112	3.05	[illegible]	Yokkaichi	8,100	empty	-	-	2009/4/15	387				for two days in a row	-17%
										[illegible]	Yokkaichi	8,000	empty	-	-	2009/4/16	383	207	3.50	-13%		
										[illegible]	Yokkaichi	8,000	empty	-	-	2009/5/26	382	100	3.82	-18%		
										[illegible]	Yokkaichi	8,100	empty	-	-	2009/5/27	387	106	3.47	-11%		
																Ave	387	103	3.51	-15%		

conditions

- loadage : 4~500kg
- Utilization of the highway : 5~10%
- Tank cleaning
- Driver
- using the power of loading and unloading
- direct delivery from fuelmakers

[0143]

[Table 57]

No.	Kobe-811-Ka-4112
Type	ISUZU P-CXM19P rev.
Engine	10PC1 / Registration 1985
Total weight	19825kg

destination data loading point : Yokkaichi-shi, Aichi

unloading point : Amagasaki-shi, Hyogo

comparison in the fuel amounts & the fuel consumption

From 13 April to 31 October

<Normal> ~ 2009/4/13

to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amounts (l)	fuel consumption (km/l)
[illegible]	Yokkaichi	8,000	empty	-	-	2008/12/3			
[illegible]	Yokkaichi	8,000	empty	-	-	2008/12/4	671	272	2.47
						Ave	336	136	2.47

<injecting 0.89~1 volume % of eco-substance)> 2009/4/13 ~

to		load (kg)	from		load (kg)	Dates	Running distance (km)	fuel consumption amounts (l)	fuel consumption (km/l)	Reduction rate from normal (%)	Notes	average of reduction rate from normal (%)
[illegible]	Yokkaichi	8,100	empty	-	-	2009/5/11	337				for two days in a row	-17%
[illegible]	Yokkaichi	8,000	empty	-	-	2009/5/13	346	235	2.96	-15%		
[illegible]	Yokkaichi	8,000	empty	-	-	2009/5/19					for two days in a row	
[illegible]	Yokkaichi	8,100	empty	-	-	2009/5/20	685	215	3.17	-22%		
						Ave	342	113	3.03	-18%		

conditions ·loadage : [illegible]~500kg ·Utilization of the highway : 5~10% ·Tank cleaning ·Driver ·using the power of loading and unloading ·direct delivery from fuelmakers

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[0144]

Table 55 to Table 57 show that an average reduction rate of -17% is achieved in 9 running tests for which the loading place is Yokkaichi-shi of Aichi ken and unloading place is Amagasaki-shi of Hyogo ken.

[0145]

As is clear from these results, the fuel consumption performance can be improved. The fuel consumption performance is improved when the injection amount of the eco-substance is about 0.5 volume%.

[0146]

4. [Running test when the eco-fuel is used in combination]

Next, the running test was performed for a case where the eco fuel obtained by injecting the eco-substance to the internal-combustion engine fuel (light oil, gasoline for example) was used with the new eco-friendly lubrication oil, the result of which is shown in Table 58 to Table 60. In Table 58 and Table 59, with regard to a diesel truck using light oil, the left side shows the result when the normal fuel and the normal lubrication oil were used, the middle side shows the result when the eco fuel and the normal lubrication oil were used, and the right side shows the result when the eco fuel and the new eco-friendly lubrication oil were used. Table 60 shows the result for a passenger vehicle using regular gasoline.

[0147]

[Table 58]

comparison in the fuel consumption <New eco-friendly lubrication oil (including 5.3 volume % of eco-substance)>

September

September	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[0148]

[Table 59]

comparison in the fuel consumption <New eco-friendly lubrication oil (including 0.3 volume % of eco-substance)>

October

October	<Normal> ~ 2009. 4/13	<eco-fuel (including 1.0 volume % of eco-substance)> 2009. 4/13 ~ 2010. 3/30	<eco-fuel (including 0.3 volume % of eco-substance)> + <New eco-friendly lubrication oil (including 0.3 volume % of eco-substance)> 2010. 4/1 ~	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[0149]

[Table 60]

running test using new eco-friendly lubrication oil in regular gasoline car

test vehicle : BMW 1600

test date : 2010/10/11 weather : fine

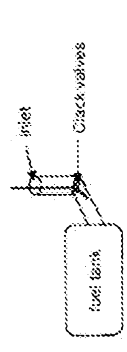
Departure → Suma → Nishinomiya → Amagasaki

Departure → Hitokura dam → Amagasaki

Departure → Takarazuka → Arima → Amagasaki

<normal oil>	<eco-fuel (including 1% of eco-substance)>	<eco-fuel (including 1% of eco-substance) + New eco-friendly lubrication oil (including 0.1% of eco-substance)>	
2009/9/19.27	2010/9/21.27	2010/3/13	2010/3/20
Distance: 186.16km	Distance: 186.16km	Distance: 186.16km	Distance: 186.16km
Fuel: 19.42l	Fuel: 15.82l	Fuel: 13.72l	Fuel: 13.07l
Fuel consumption: 9.586km/l	Fuel consumption: 11.767km/l	Fuel consumption: 13.569km/l	Fuel consumption: 14.243km/l
		(Ave 13.906km/l)	

we put steel bars inside Clack valves and release air.
in order to take an accurate measurement of fuel consumption amount.



Reduction rate of eco-fuel (%) :	-24%
Reduction rate of eco-fuel + New eco-friendly lubrication oil (%)	-10%

[0150]

As can be seen from the above, the combination of the eco

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fuel and the new eco-friendly lubrication oil can further improve the fuel consumption performance.

[0151]

The reason why the combination of the eco fuel and the new eco-friendly lubrication oil can improve the fuel consumption performance is that the eco fuel injected with the eco-substance itself has an effect of reducing the fuel consumption and also functions like lubrication oil partially in the mechanical parts. Thus, the eco-substance included in the fuel provides the effect.

[0152]

Specifically, in the piston 2 and the con rod 1 shown in Fig. 1 for example, the lubrication oil flows from the lower side to the upper side of the con rod 1. Then, since the concave section 3d of the piston 2 generally includes an oil ring (not shown), the lubrication oil flowed to the upper side passes through the oil hole 6 and is returned to the lower side by the oil ring of the concave section 3d (arrow A). The reason is that the lubrication oil at the upper side than the concave section 3d causes the PM black smoke or carbon generation, thus deteriorating the engine performance.

[0153]

On the other hand, the non-existence of an oil film at the upper side than the concave section 3d of the piston 2 undesirably causes metal attack. However, in an actual case, the fuel injected from the upper side of the piston 2 forms a thin oil film (arrow B) to suppress the metal attack at the upper side of the piston 2, thus allowing the fuel to function like lubrication oil.

[0154]

When the fuel includes the eco-substance at this stage, friction is reduced compared with the conventional case and the oxidation and deterioration of the fuel as lubrication oil can be suppressed. It is also effective to prevent the rust of the piston 2.

[0155]

5. [Rust prevention experiment]

Next, a rust prevention experiment was performed to investigate the rust prevention effect of the new eco-friendly lubrication oil. The rust prevention experiment was performed in the manner as described below. Specifically, the respective parts coated with normal lubrication oil and the respective parts coated with the new eco-friendly lubrication oil were left outside. Then, the rust states of the respective parts after the passage of a predetermined period were visually inspected.

[0156]

Fig. 12 to Fig. 15 show the rust states from September 16, 2010 to October 18, 2010. In Fig. 12 to Fig. 15, the upper side shows the result for the new eco-friendly lubrication oil and the lower side shows the result for the normal lubrication oil.

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[0157]

The parts coated with the normal lubrication oil were significantly oxidized and showed a high amount of red rust. On the other hand, the parts coated with the new eco-friendly lubrication oil showed a very small amount of red rust. This clearly shows that the new eco-friendly lubrication oil has a rust prevention effect

[0158]

As described above, the new eco-friendly lubrication oil injected with the eco-substance can reduce, when being used in an internal-combustion engine such as an automobile engine, the friction resistance in various engines, can reduce the fuel consumption amount, and can reduce carbon dioxide and other exhaust gas component. The new eco-friendly lubrication oil injected with the eco-substance also provides a rust prevention effect, suppresses the oxidation and deterioration of lubrication oil, suppresses the wear of the respective parts, thus providing a longer life to the internal-combustion engine.

[0159]

6. [Jellylike lubrication oil]

The lubrication oil used for a grease application is manufactured by injecting the eco-substance (dimethyllaurylamine) of 1 to 5 volume% to conventional lubrication oil to subsequently inject thickener (e.g., calcium, sodium, lithium, aluminum, fatty acid salt) to uniformly disperse the thickener to thereby obtain a jellylike form. Then, the resultant jellylike lubrication oil can be used for a thrust bearing, an intermediate bearing, or a tire shaft for example to thereby reduce the friction resistance, to reduce the fuel consumption amount, and to reduce carbon dioxide and other exhaust gas components. Since this lubrication oil also has a rust prevention effect, this lubrication oil can suppress the oxidation and deterioration of the respective parts, thus providing a longer life to various engines. The jellylike lubrication oil also can be used not only for the above applications but also for respective parts of other various machines or equipment for example.

[0160]

As described above, an embodiment of the present invention has been described with reference to the drawings and tables. However, various additions, changes, or deletions are possible within the scope not deviating from the intention of the present invention. In particular, the eco-substance is not limited to dimethyllaurylamine and also may be other dimethylalkyl tertiary amine. The eco-substance can be used as engine oil in an internal-combustion engine and also can be used as power steering oil, turbine oil, or gear oil and also can be used as lubrication oil for a driving system. Thus, such modifications are also included in the scope of the present invention.

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Description of the Reference Numerals

[0161]

1 Con rod

2 Piston

3a to 3d Concave section

4 Con rod bolt

5 Con rod cap

6 Oil hole

A Lubrication oil flow

B Fuel injection flow

11 Engine

12 Exhaust pipe

13 Hot filter

14 Heat-resistant hose

15 Exhaust gas measurement apparatus

16 Input apparatus

17 Output apparatus

18 Round tank

19 Storage tank

20 Pump

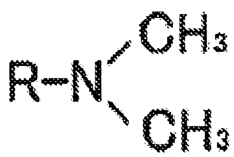
21 Tanker lorry

What is claimed is:

1. Lubrication oil for an internal combustion engine injected with impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.01 to 1 volume%;

wherein the lubrication oil is used in the internal-combustion engine together with internal-combustion engine fuel injected with the impregnating agent in the range from 0.1 to 1 volume%; and

wherein the dimethylalkyl tertiary amine is formed by oils of plants and animals and is represented by the general expression (1):



(1)

wherein R represents an alkyl group.

2. The lubrication oil according to claim 1, wherein the impregnating agent is injected in an amount of 0.1 to 0.5 volume%.

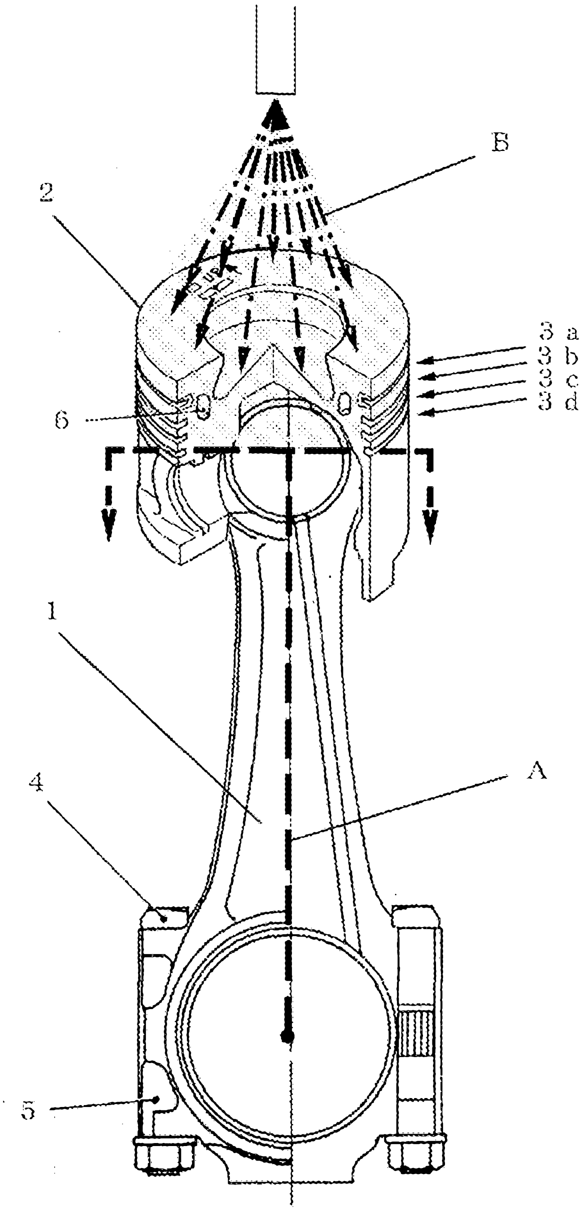
3. The lubrication oil according to any one of claims 1 to 3, wherein the impregnating agent is injected in an amount of 0.1 to 0.5 volume%.

4. Lubrication oil that is injected with impregnating agent consisting of dimethylalkyl tertiary amine in the range from 1 to 5 volume% and that is injected with thickener so that the resultant oil is jellylike.

5. Internal-combustion engine fuel, wherein petroleum oil fuel is injected with fuel oil impregnating agent composed of dimethylalkyl tertiary amine in the range from 0.5 to 1 volume%.

FIGURE

[FIG.1]



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[FIG.2]

Messrs. MAKITA UNSO Kabusikikaisha

List of result
(black smoke test)

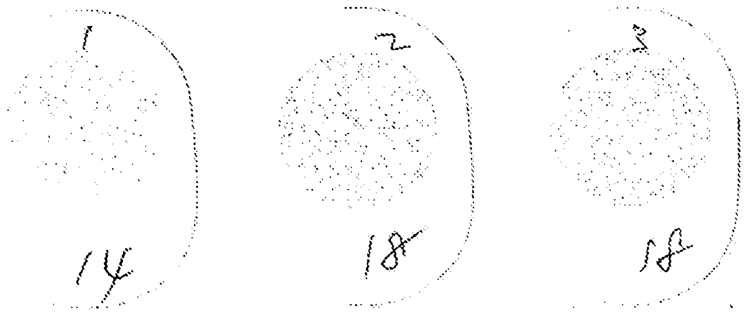
Registration number : Hukui-800-Ka-438

Car number : CD450NC-00441

Test day : 2010.10.05

Running distance at test day : 411,992 km

Measurement company : Kabushikikaisha HUSO automobile maintenance



Average: 16 %

[FIG.3]

Messrs. MAKITA UNSO Kabusikikaisha

List of result
(black smoke test)

Registration number : Hukui-800-Ka-438

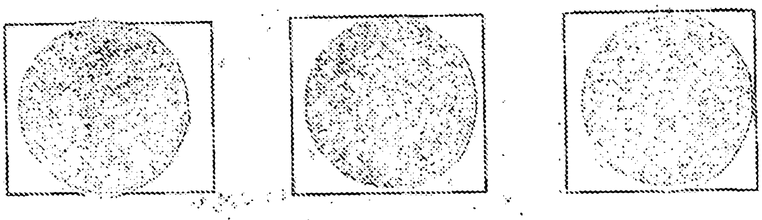
Car number : CD450NC-00441

Test day : 2010.07.24

Running distance at test day : 399,433 km

Measurement company : Kabushikikaisha HUSO automobile maintenance

first time: 18% second time: 18% third time: 16%



Average: 17.3%

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[FIG.4]

Messrs. MAKITA UNSO Kabusikikaisha

List of result
(black smoke test)

Registration number : Kobe-130-A-8003

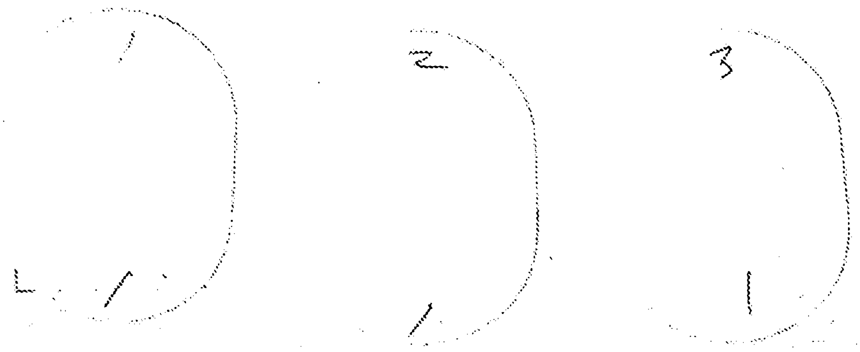
Car number : YV2A4DAA41A523773

Test day : 2010.10.06

Running distance at test day : 506,248 km

Measurement company : Kabushikikaisha HUSO automobile maintenance

first time: / % second time: / % third time: / %



Average: / %

[FIG.5]

Messrs.MAKITA UNSO Kabusikikaisha

List of result
(black smoke test)

Registration number : Kobe-130-A-8003

Car number : YV2A4CFA92A54

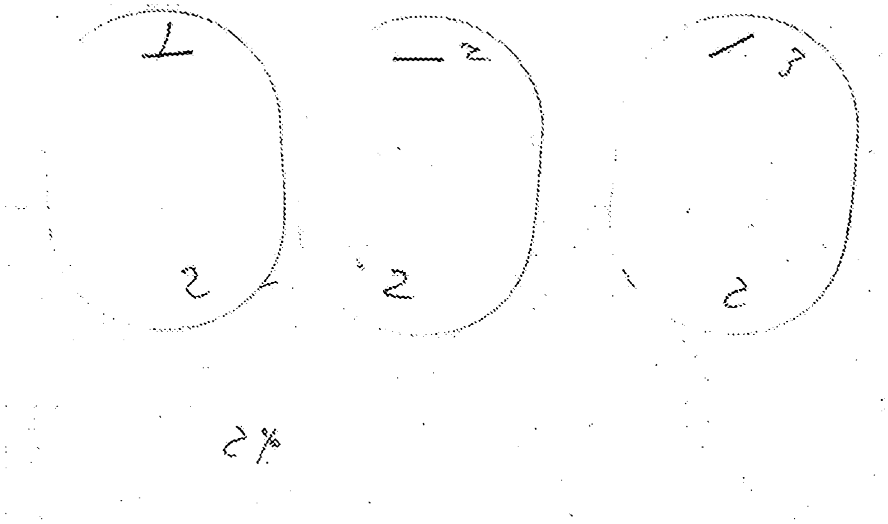
Test day : 2010.08.31

Running distance at test day : 502,888 km

Measurement company : Kabushikikaisha HUSO automobile maintenance

Average: 2%

first time: second time: third time:



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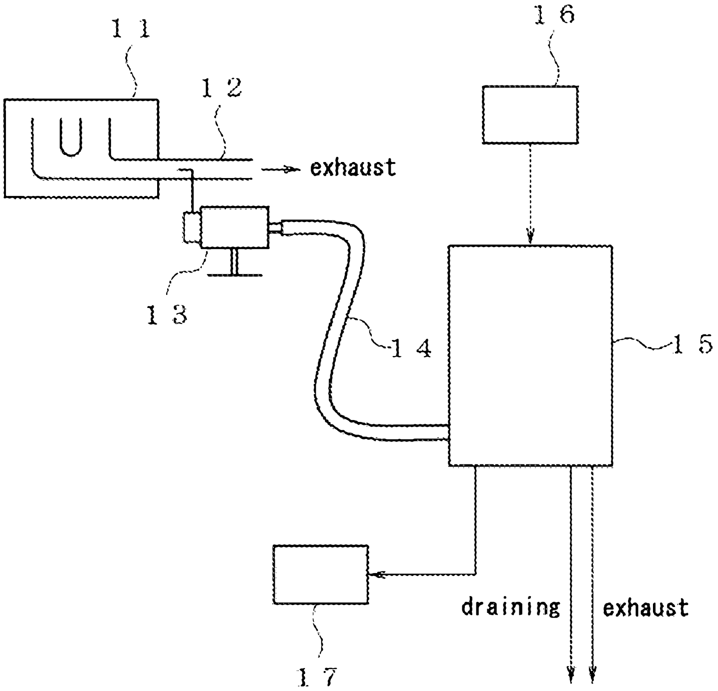
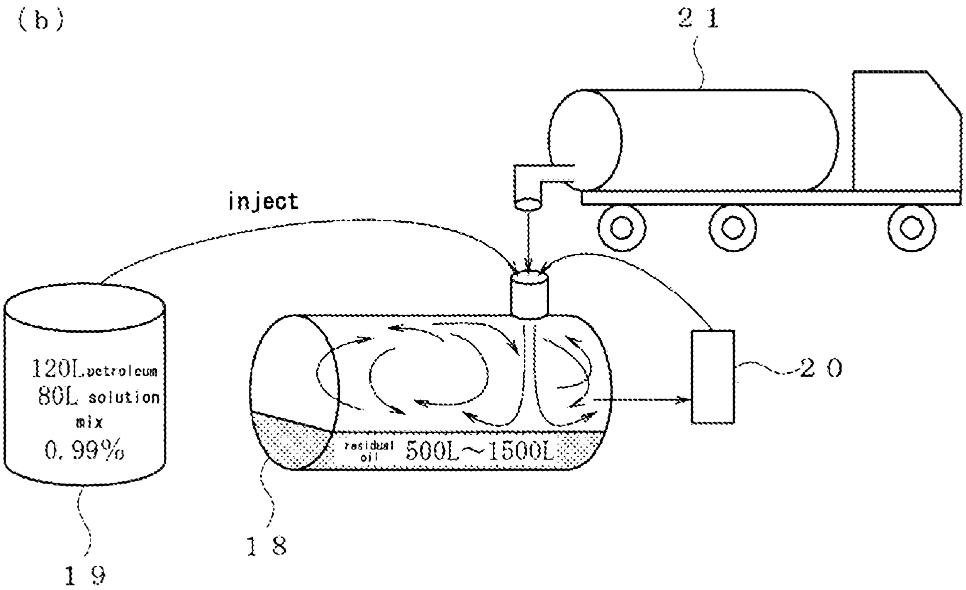
[FIG.6]

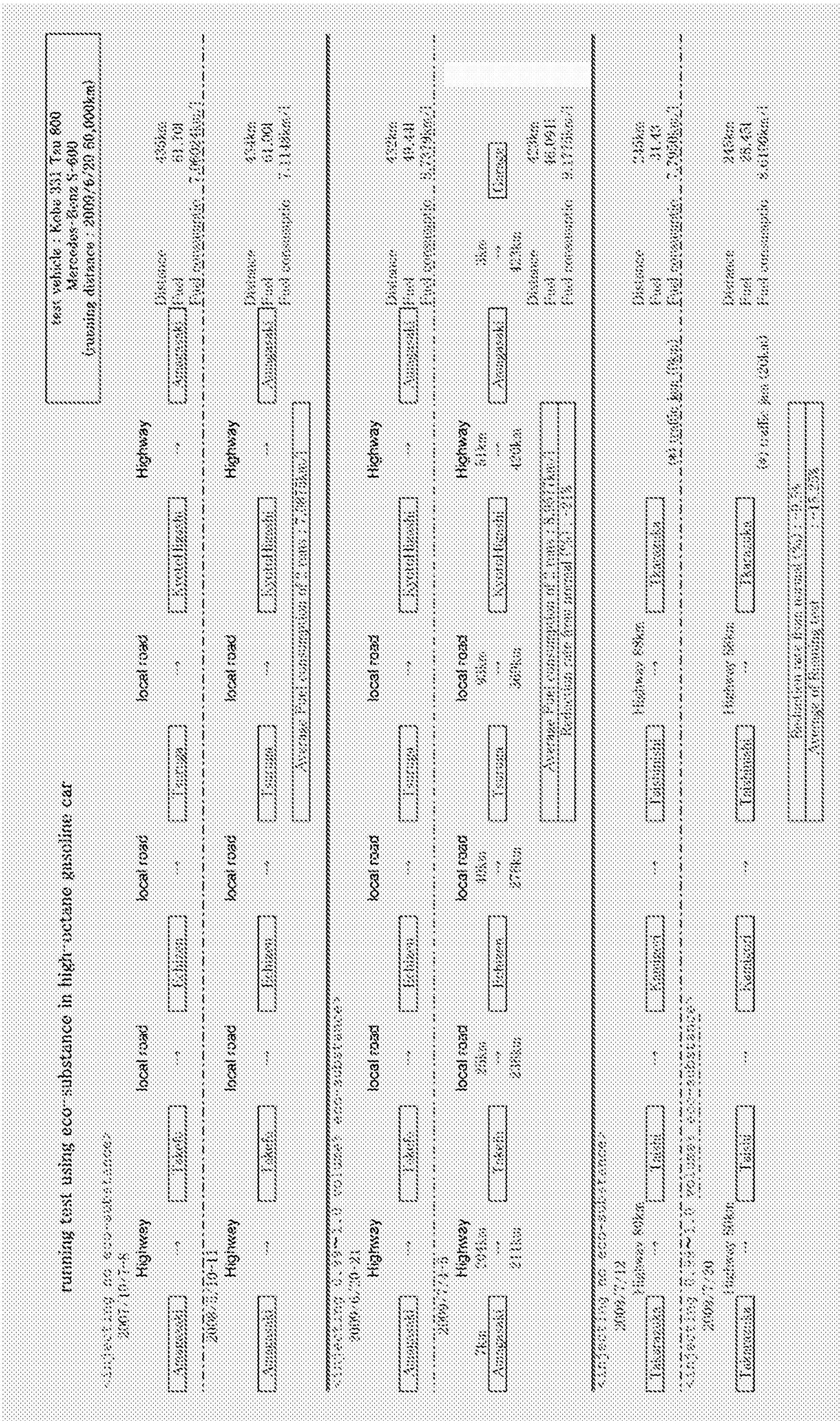
(a)



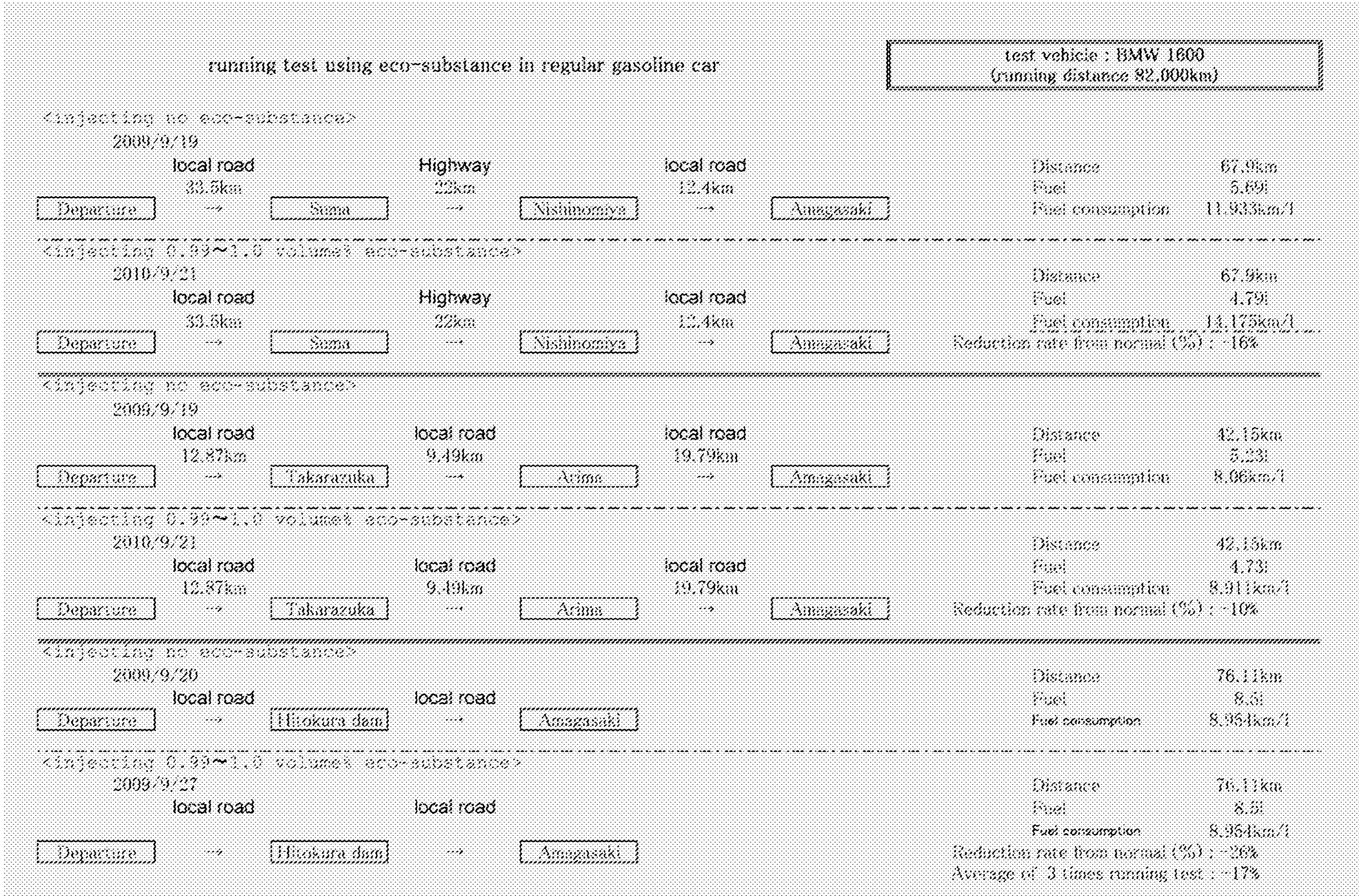
(b)



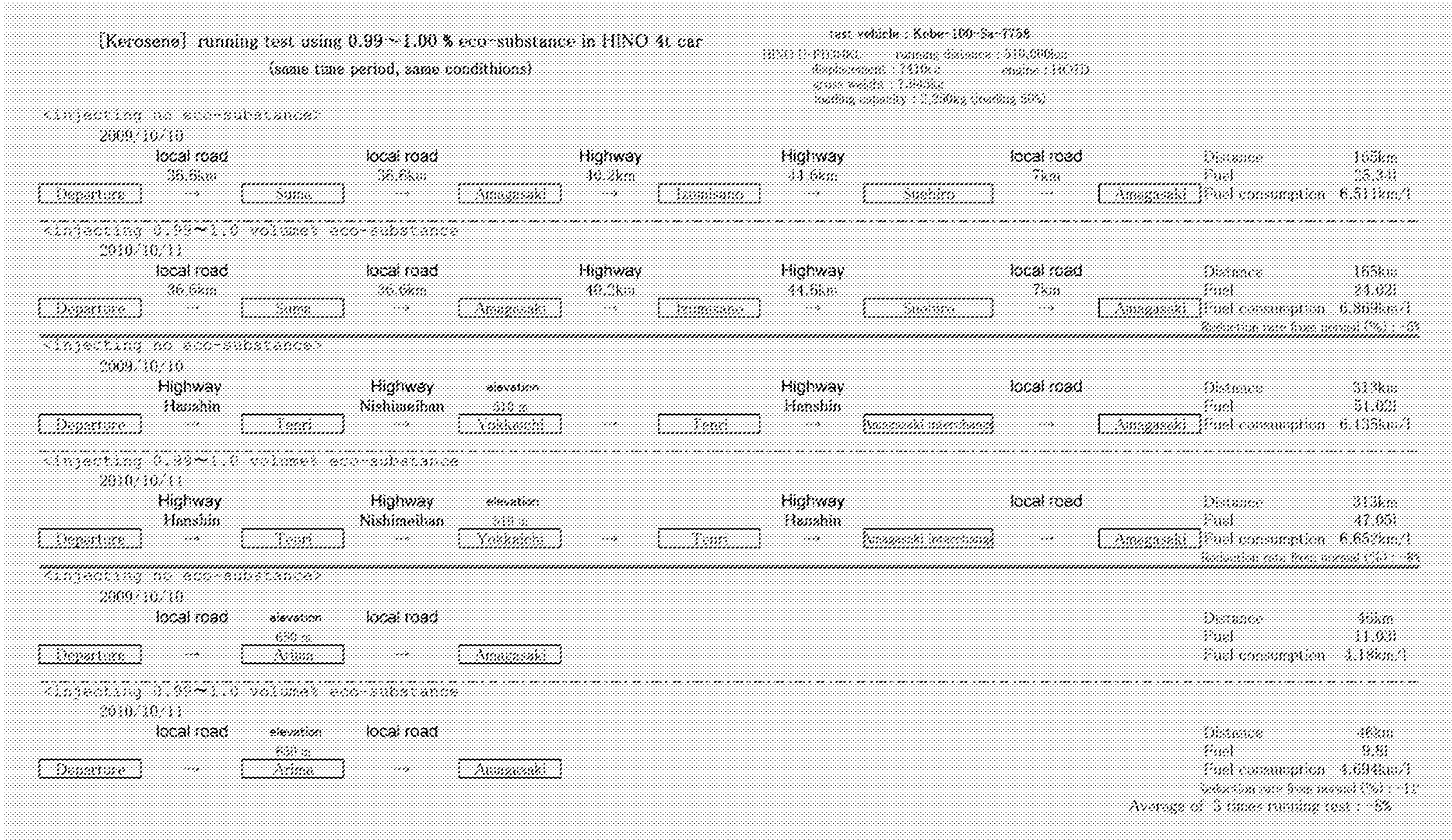
[FIG.7]



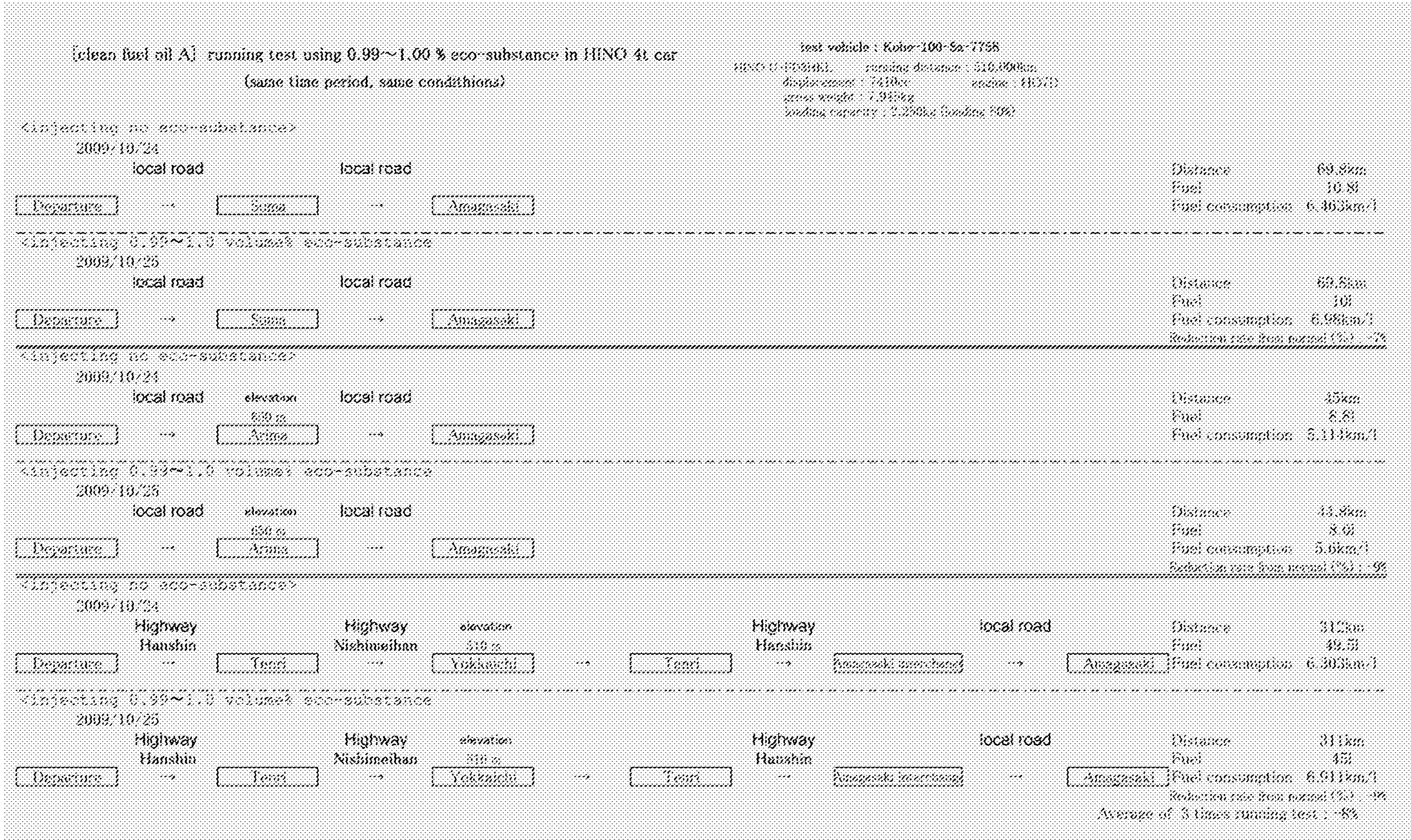
[FIG.8]


running test using eco-substance in regular gasoline car
test vehicle : BMW 1600
(running distance 82,000km)
<injecting no eco-substance>
2009/9/19
local road
33.5km
Highway
22km
local road
12.4km
Departure
Suma
Nishinomiya
Amagasaki
Distance 67.9km
Fuel 5.69l
Fuel consumption 11.933km/l
<injecting 0.99~1.0 volume% eco-substance>
2010/9/21
local road
33.5km
Highway
22km
local road
12.4km
Departure
Suma
Nishinomiya
Amagasaki
Distance 67.9km
Fuel 4.79l
Fuel consumption 14.175km/l
Reduction rate from normal (%) : -16%
<injecting no eco-substance>
2009/9/19
local road
12.87km
local road
9.49km
local road
19.79km
Departure
Takarazuka
Arima
Amagasaki
Distance 42.15km
Fuel 5.23l
Fuel consumption 8.06km/l
<injecting 0.99~1.0 volume% eco-substance>
2010/9/21
local road
12.87km
local road
9.49km
local road
19.79km
Departure
Takarazuka
Arima
Amagasaki
Distance 42.15km
Fuel 4.73l
Fuel consumption 8.911km/l
Reduction rate from normal (%) : -10%
<injecting no eco-substance>
2009/9/20
local road
local road
Departure
Hitokura dam
Amagasaki
Distance 76.11km
Fuel 8.5l
Fuel consumption 8.954km/l
<injecting 0.99~1.0 volume% eco-substance>
2009/9/27
local road
local road
Departure
Hitokura dam
Amagasaki
Distance 76.11km
Fuel 8.5l
Fuel consumption 8.954km/l
Reduction rate from normal (%) : -26%
Average of 3 times running test : -17%

[FIG.9]


[Kerosene] running test using 0.99~1.00 % eco-substance in HINO 4t car
(same time period, same conditions)
test vehicle : Kobe-100-Sa-7758
<injecting no eco-substance>
2009/10/10
local road
35.6km
local road
36.6km
Highway
40.2km
Highway
41.6km
local road
7km
Departure
Suma
Amagasaki
Izumisano
Suehiro
Amagasaki
Distance 165km
Fuel 25.33l
Fuel consumption 6.511km/l
<injecting 0.99~1.0 volume% eco-substance>
2010/10/11
local road
36.6km
local road
36.6km
Highway
40.2km
Highway
41.6km
local road
7km
Departure
Suma
Amagasaki
Izumisano
Suehiro
Amagasaki
Distance 165km
Fuel 24.02l
Fuel consumption 6.869km/l
<injecting no eco-substance>
2009/10/10
Highway
Hanshin
Highway
Nishimeihan
elevation
Departure
Tenri
Yokkaichi
Tenri
Highway
Hanshin
local road
Amagasaki
Distance 313km
Fuel 51.02l
Fuel consumption 6.135km/l
<injecting 0.99~1.0 volume% eco-substance>
2010/10/11
Highway
Hanshin
Highway
Nishimeihan
elevation
Departure
Tenri
Yokkaichi
Tenri
Highway
Hanshin
local road
Amagasaki
Distance 313km
Fuel 47.05l
Fuel consumption 6.652km/l
<injecting no eco-substance>
2009/10/10
local road
elevation
local road
Departure
Arima
Amagasaki
Distance 46km
Fuel 11.03l
Fuel consumption 4.18km/l
<injecting 0.99~1.0 volume% eco-substance>
2010/10/11
local road
elevation
local road
Departure
Arima
Amagasaki
Distance 46km
Fuel 9.8l
Fuel consumption 4.694km/l
Average of 3 times running test : -8%

[FIG.10]


[clean fuel oil A] running test using 0.99~1.00 % eco-substance in HINO 4t car
(same time period, same conditions)
<injecting no eco-substance>
local road
local road
Departure
Suma
Amagasaki
Distance 69.8km
Fuel 10.8l
Fuel consumption 6.463km/l
<injecting 0.99~1.0 volume% eco-substance
local road
local road
Departure
Suma
Amagasaki
Distance 69.8km
Fuel 10l
Fuel consumption 6.98km/l
<injecting no eco-substance>
local road
local road
Departure
Arima
Amagasaki
Distance 45km
Fuel 8.8l
Fuel consumption 5.114km/l
<injecting 0.99~1.0 volume% eco-substance
local road
local road
Departure
Arima
Amagasaki
Distance 44.8km
Fuel 8.0l
Fuel consumption 5.6km/l
Reduction rate from normal (%) : -9%
<injecting no eco-substance>
Highway
Hanshin
Highway
Nishimeihan
Highway
Hanshin
local road
Departure
Tenri
Yokkaichi
Tenri
Amagasaki
Distance 312km
Fuel 49.5l
Fuel consumption 6.303km/l
<injecting 0.99~1.0 volume% eco-substance
Highway
Hanshin
Highway
Nishimeihan
Highway
Hanshin
local road
Departure
Tenri
Yokkaichi
Tenri
Amagasaki
Distance 311km
Fuel 45l
Fuel consumption 6.911km/l
Reduction rate from normal (%) : -9%
Average of 3 times running test : -8%

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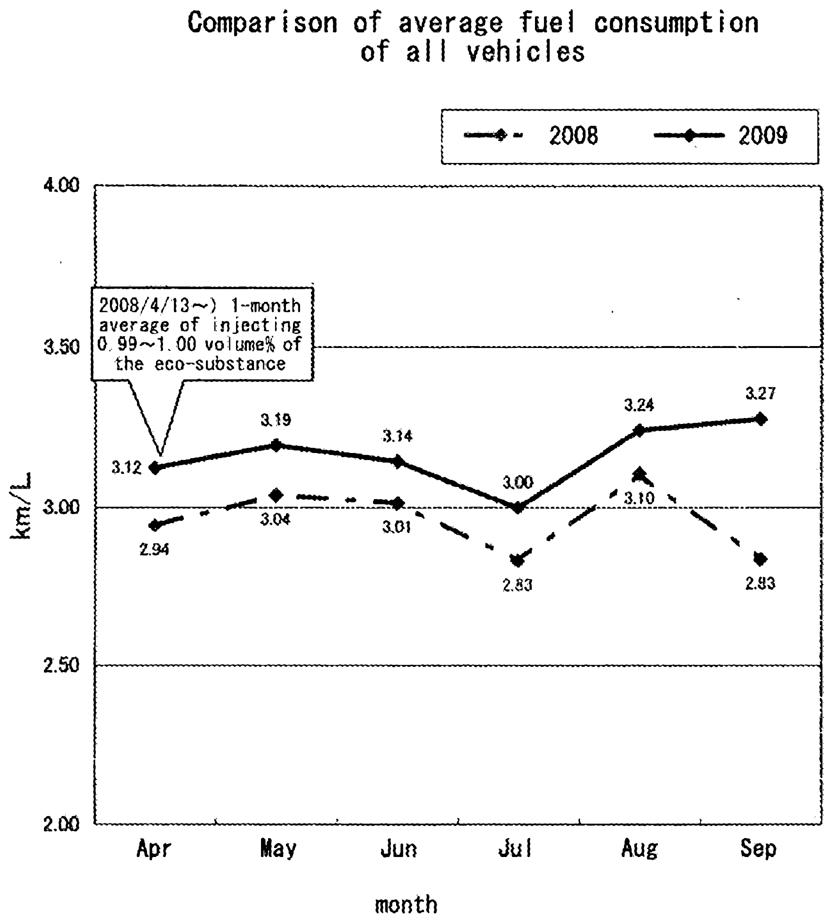
[FIG.11]



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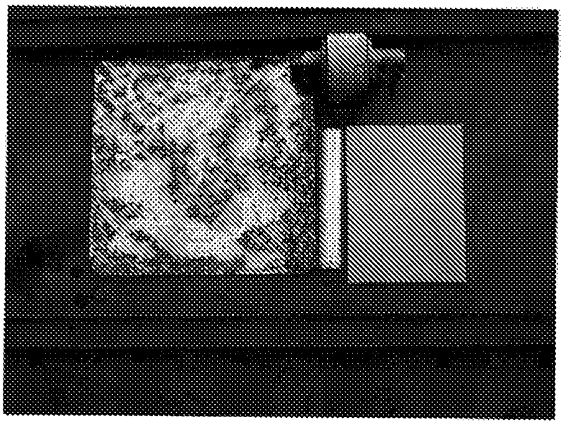
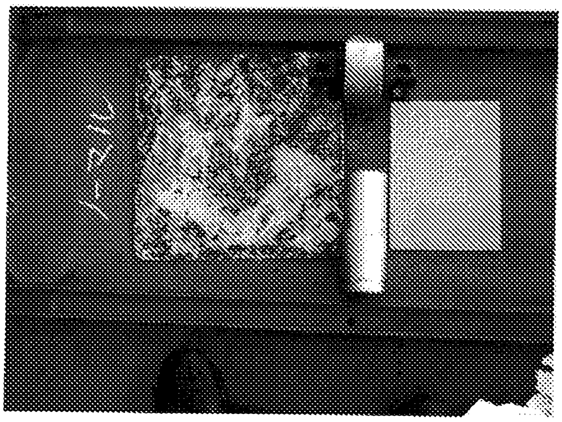
[FIG.12]

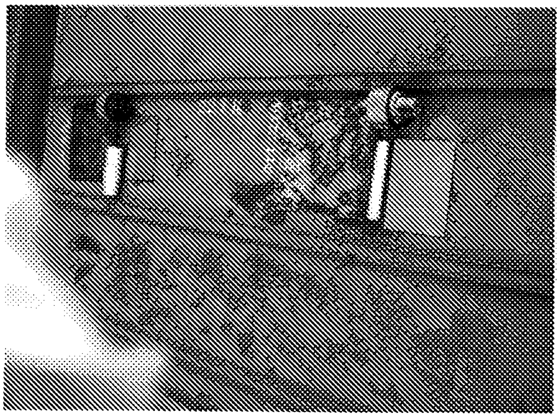


H22.9.16

DM



NORMAL



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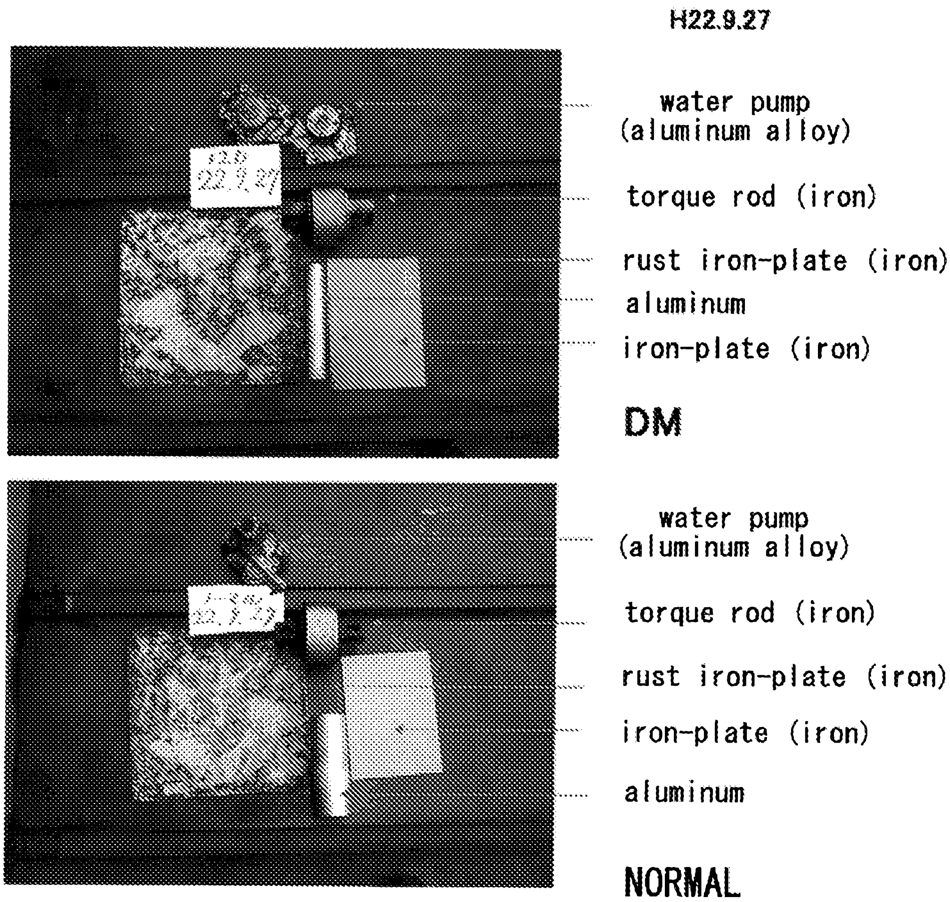
[FIG.13]



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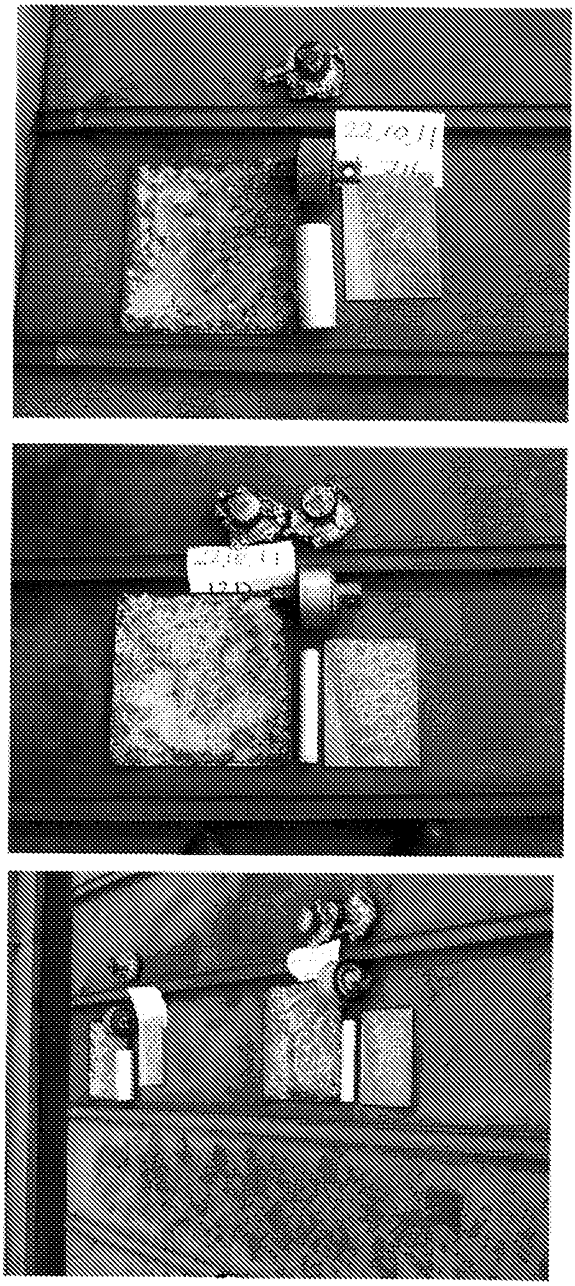
[FIG.14]

H22.10.11

NORMAL

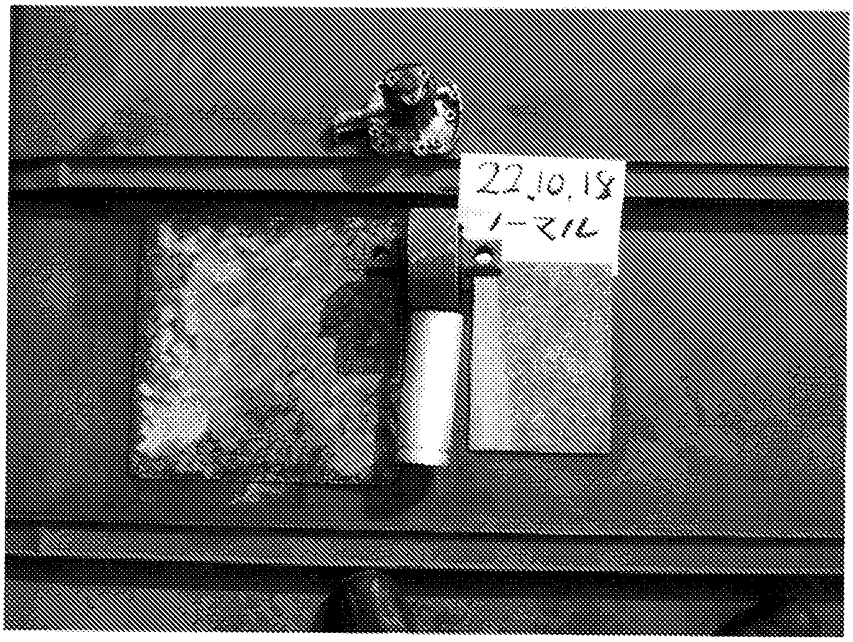
DM



[FIG.15]

H22.10.18

DM



NORMAL