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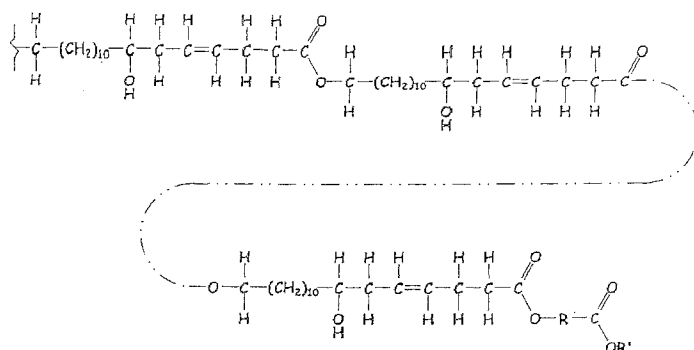
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- (71) Applicant (for all designated States except US): **C.M. INTELLECTUAL PROPERTY AND RESEARCH, INC.** [US/US]; 28030 County Highway, #34, Callaway, MN 56521 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **RITTER, Clyde** [US/US]; 127 Hunter's Way, Bozeman, MT 59718 (US). **WALTHER, Michael** [US/US]; 28030 County Hwy., #34, Callaway, MN (US).

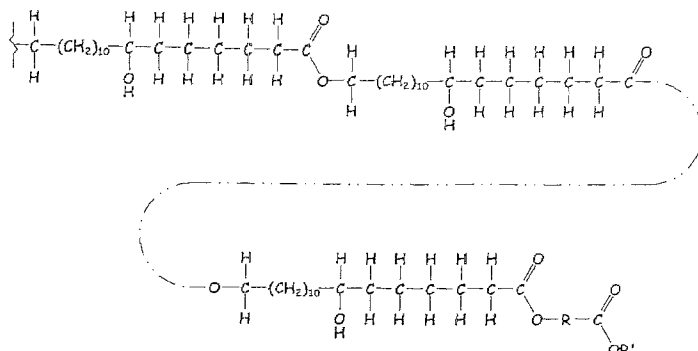
- (74) Agents: **PEDERSEN, Ken, J.** et al.; PEDERSEN & COMPANY, PLLC, P.O. Box 2666, Boise, ID 83701 (US).
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(54) Title: FUEL AND LUBRICANT ADDITIVES AND METHODS FOR IMPROVING FUEL ECONOMY AND VEHICLE EMISSIONS



POLYMER ESTER OF RICINOLEIC ACID



POLYMER ESTER OF 12 - HYDROXY STEARIC ACID

(57) Abstract: An additive includes a calcium source, a suspension agent, a castor oil, and optionally a castor supplement/replacement. In many embodiments, polyalphaolefin is included. The preferred suspension agents are fatty acid esters, triglycerides or other, with a pour point/melt point from about 5 degrees C to about 50 degrees C. Suspension agents of particular interest are: 1) polymerized ester(s) of ricinoleic acid (polymerized ester(s) of 12-Hydroxy Oleic Acid), 2) polymerized ester(s) of 12-Hydroxy Stearic Acid, 3) waxy esters of ricinoleic acid, 4) palm oil, 5) palm-olein, 6) coconut oil, and 7) jojoba oil. The waxy esters may result from polymerization of shorter carboxylic acid monomers. The additive may be used in fuels to improve combustion engine performance in terms of efficiency and emissions. Polyalphaolefin may be important, especially in additive formulations for diesel fuels, for NOx reduction. The additive may be used in lubricants that improve performance of both ferrous and non-ferrous metal components of engines, guns, or other machinery. The additive also may be used in cutting fluids for machining and fabrication. Used in conjunction with other additives, embodiments of the invention may be used to lower pour points in oils, esters and other similar products.

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FUEL AND LUBRICANT ADDITIVES AND METHODS
FOR IMPROVING FUEL ECONOMY AND VEHICLE EMISSIONS

DESCRIPTION

This application claims priority of U.S. Patent Application No. 60/702,420, filed July 25, 2005, and U.S. Patent Application No. 60/782,091, filed March 13, 2006.

FIELD OF THE INVENTION

The invention relates to additives for motor fuels that improve combustion engine performance, especially in terms of efficiency and emissions. The invention also relates to additives for lubricants that improve performance of both ferrous and non-ferrous metal components of engines, guns, or other machinery. The invention may also relate to additives for cutting fluids used in machining and fabricating, as well as mining and other similar cutting, shearing, and grinding applications that benefit from ease of cutting and lower temperatures. The invention may also relate to additives for pour point depressants. The invention may find other applications in various fuels, oils, esters, grease, pasty compounds such as cosmetics, as well as other fluids and semi-solids.

BACKGROUND

Ritter, in U.S. Patent 5,505,867 (issued April 9, 1996), discloses compositions of matter for inclusion in fuels and lubricants that include overbased sulfonates, jojoba oil, and castor oil. A combination of these components, when added to lube oils for metals, was found to provide superior lubrication performance. A combination of these components, when added to automotive diesel fuel, was found to provide superior power, lower fuel consumption, and lower smoke emissions. A combination of these components, when added to 95 Research Octane gasoline, allowed a single-engine aircraft engine to perform without incipient detonation even while "leaning" the fuel by 20 – 25 %.

Many other patents and products attempt to improve engine performance and lube oil performance, with varying success. Many commercial products are available from the major oil companies and from smaller specialty producers that tout improved engine performance and life due to removal of deposits, prevention of deposits, lubrication of engine metal surfaces, removal of water droplets in fuel, or rust inhibition.

Still, the present inventors believe that improvement in fuel additives and lubricants is needed. Embodiments of the present invention meet this and other needs.

SUMMARY OF THE INVENTION

Objects of the invention include improving the combustion performance of fuels, so that fuel economy is increased and harmful emissions are reduced. Further objects of the present invention include improving the lubricating value of fuels, and improving performance of lubricants in high velocity contact of metals. Other objects of some embodiments of the invention include enhancing pour point depression in diesel fuels. Invented compositions of matter are provided as additives for fuels and lubricants, wherein said additives enhance said combustion performance and lubrication, and fulfill some or all of the above objects.

The additives of the invention comprise a calcium-containing component, castor oil, a suspension agent, an optional castor supplement/partial replacement, and, in many embodiments, a polyalphaolefin component. Preferred calcium-containing components are overbased calcium sulfonate, calcium carbonate, and other liquids and powders containing calcium sulfonate and/or calcium carbonate. Preferred suspension agents (also called herein "bonding agents") are fatty acid esters, triglycerides or other, with a pour point/melt point between about 5 degrees C and 50 degrees C. Especially-preferred suspension agents are waxy esters of ricinoleic acid, palm oil, palm-olein, coconut oil, and jojoba oil. Preferred castor supplement/partial-replacements include sulfated castor oil, soy methyl ester, canola oil, and pour point depressant.

In embodiments used with fuels, the invented additives may be formulated from components only from the above lists, or may include other components such as conventional fuel additive packages, and the additives may be used with fuels that themselves include other additive packages. In embodiments used with lubricants or as lubricants, the invented additives may be formulated from components only from the above lists, or may include other components such as conventional lubricant additive packages, and the additives may be used with lubricants that themselves include other additive packages. In embodiments used with pour point depressants, the invented additives may be formulated from components only from the above lists, or may include other components; the invented additives may be used to enhance pour point depressants used with biodiesel fuel or diesels containing biodiesel, and

most preferably, the invented additive is mixed with the pour point depressant before the mixture is added to a biodiesel or biodiesel-containing fuel.

While particular uses of the invented additives are described herein, other uses may become apparent over time. Further, particular preferred formulations are described here, but other formulations according to the invention may be effective within the broad scope of this disclosure or within the broad scope of the priority documents for this application, specifically U.S. Patent Application No. 60/702,420, filed July 25, 2005, and U.S. Patent Application No. 60/782,091, filed March 13, 2006, which are incorporated herein by this reference.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the invented composition may be formulated for use alone, blended into fuels, lubricants, treatments, or cutting oils, or blended into additives or pour point depressants for said fuel, lubricants, treatments, or cutting fluids. Embodiments of the invented composition may improve combustion and/or operation of combustion engines, resulting in improved miles per gallon and/or improved emissions. Embodiments of the invented additives may improve fuel lubricity, resulting in less engine wear and increased engine efficiency. Additives according to the invention comprise a calcium-containing component; castor oil; a suspension agent; an optional castor supplement/partial replacement, and, in many embodiments, a polyalphaolefin component.

The calcium component may be calcium sulfonate, preferably an overbased calcium sulfonate, but the inventors have also found that calcium carbonate may be effective, in place of, or in addition to, calcium sulfonate. Many calcium sulfonates and overbased calcium sulfonates are known (see, for example, U.S. Patent 5,505,867 Related Art), and are available commercially, for example, from Crompton Corporation/Great Lakes Corporation (Chemtura). Particularly preferred calcium sources are C-400™ or C-400-C™ or C-400-CLR™ overbased calcium sulfonates from Crompton Corporation/Great Lakes Corporation (Chemtura). Crompton C-400™ or C-400-C™ or C-400-CLR™ have been found to be excellent calcium sources in the form of liquids that do not exhibit calcium particle size problems by plugging fuel filters.

The inventors have experimented with magnesium sulfonates, and have found them to be effective, except that they typically leave deposits in combustion chambers on the head, valves, spark plugs, etc., to the point that the deposits on the spark plugs “ground out” the

spark plugs. Therefore, including magnesium sulfonates instead of, or in addition to, calcium sulfonates may not be practical and are therefore not preferred. The inventors have experimented with barium sulfonates, but have not found them to be effective, for example, because they appear to decompose at the temperatures of interest in combustion engines to produce undesirable emissions. In preferred embodiments, therefore, only calcium-
5 containing components are used, rather than other alkaline earth components and rather than other alkaline earth sulfonates.

The inventors believe that many, if not all, polyalphaolefin compounds will be effective in the preferred additives. The polyalphaolefins are preferably not hydrogenated for use in the preferred additives. Specific examples of preferred polyalphaolefin compounds that
10 have been effective in the below-described tests and examples are SYNTON™ PAOs (such as SYNTON-40™ and SYNTON-80™) available from Crompton Corporation/Great Lakes Corporation (Chemtura), and DURASYN™ PAO's available from BP Amoco.

The suspension agents, sometimes called "bonding agents" by the inventors, are believed to be critical in keeping the calcium-containing component, whether calcium
15 organic (example: sulfonate) or inorganic (example: carbonate) salt, in suspension in the vegetable oils of the preferred additives, and also in the final fuel-additive blends and the final lubricant-additive blends. The inventors note, in the case of overbased calcium sulfonate being suspended in additive-fuel or additive-lubricant mixtures of the invention, that both
20 inorganic (the carbonate "overbased" portion of the overbased calcium sulfonate) and organic (the sulfonate portion of the overbased calcium sulfonate) calcium are being suspended. Because the effectiveness of the suspension agents has been so remarkable, it has appeared to the inventors that the suspension agent seems to nearly "bind" the calcium to the other
25 components to keep the calcium in suspension, and, hence, the name "bonding agent." The inventors do not necessarily believe that the calcium is covalently bound to the "bonding agent" or to the castor oil, castor supplement/replacement, or the PAO, but they use this "bonding agent" terminology as indicative of the surprising results achievable by using the suspension agents.

The preferred suspension agents comprise one or more of the following: 1)
30 polymerized ester(s) of ricinoleic acid (polymerized ester(s) of 12-Hydroxy Oleic Acid), 2) polymerized ester(s) of 12-Hydroxy Stearic Acid, 3) palm oil 4) palm-olein, 5) coconut oil, and 6) jojoba oil. Particularly preferred suspension agents are:

Acme Wax 224TM from Acme Hardesty Co. (an example of item no. 1 above);
Acme Wax 225TM from Acme Hardesty Co. (an example, of items no. 2 above,
having a 45 degree Centigrade melting point);

5 palm oil #701 (41 degrees C melting point), #710 (41 degrees C melting point), #720,
and #730 (28 degrees C melting point) from Columbus Foods;
palm-olein #725 (21 degrees C melting point); and
coconut oils #92 (34 degrees C melting point) and #76 (26 degrees C melting point)
also from Columbus Foods.

10 A less preferred suspension agent is jojoba oil (preferably only cis-jojoba, that
naturally occurring jojoba, with about 7 degrees C melting point), wherein it is less-preferred
particularly because of its cost and low availability.

A representation of the general chemical structure of Acme Wax 224TM is portrayed
in Figure 1, wherein one may see the unsaturation in the structure (that is, the carbon=carbon
15 double bonds in each of the monomers) and the plurality of hydroxy groups bonded to the
carbon chains (here, one per monomer). Acme Wax 224TM wax ester may comprise dimers,
trimers, and oligmers, with the chain lengths being greater than 30 carbons (dimers and
higher numbers of polymerized monomers), and typically greater than 40 carbons (trimers
and higher numbers of polymerized monomers).

20 A representation of the general chemical structure of Acme Wax 225TM is portrayed
in Figure 2, wherein one may see the saturation in the structure (that is, the carbon-carbon
single bonds throughout each of the polymerized monomers) and the plurality of hydroxy
groups bonded to the carbon chains (here, one per monomer). Acme Wax 225TM wax ester
may comprise dimers, trimers, and oligmers, with the chain lengths being greater than 30
25 carbons (dimers and higher numbers of polymerized monomers), and typically greater than
40 carbons (trimers and higher numbers of polymerized monomers).

One may note the 18-carbon-chain monomers in both Acme Wax 224TM and 225TM,
each with a carboxyl (COO-) groups.

30 Regarding the castor oil component, conventional castor oil, as available from many
commercial sources, is effective. The castor oil component optionally may be supplemented,
or a portion but not all of the castor oil may be replaced, with one or more of the castor
supplement/partial replacement components. The preferred castor supplement/partial
replacement components are sulfated castor oil, canola oil, soy methyl ester, and pour point

depressant (preferably a plant-oil-based pour point depressant, such as Rho-Max 10 – 310™, currently available from RHOMAX in Montreal, and reported to be a rapeseed oil derivative being the one preferred by the inventors). Sulfated castor oil (for example, “75% sulfated”) is preferred, and is also available from Acme Hardesty Co., Blue Bell, PA, U.S.A.

5 A wide range of formulations are expected to be effective for the additive, for example, a “three group” formulation (noting that in such formulations polyalphaolefins are not added) may be within the following ranges:

Group 1: Calcium component, 10 – 50 LV-%, including calcium sulfonate and/or calcium carbonate;

10 Group 2: Polyalphaolefin, 0 LV-%;

Group 3: Castor oil, including optional castor supplement/partial replacement: 10 – 60 LV-%; and

Group 4: Suspension Agent, 1 – 25 LV-%.

15 The ranges for a “four group” formulation, listed below, have been found to be effective in many different environments:

Group 1: Calcium component, 10 - 50 LV-%, such as calcium sulfonate and/or calcium carbonate;

Group 2: Polyalphaolefin, 15 – 75 LV-%;

20 Group 3: Castor oil, including optional castor supplement/partial replacement, 10 – 60 LV-%;

Group 4: Suspension Agent, 1 – 20 LV-%; and

25 When components from three groups are blended together to form 100 liquid-volume-% of the additive (leaving out Group 2), it is referred to as the “three-group additive” composition. When four groups are blended together to form 100 liquid-volume-% of the additive (including Group 2), it is referred to as the “four-group additive.”

30 The blending process is best done by adding Group 4 to the Group 1 component(s), and blending these two components/groups very well before adding any other groups. After blending the Groups 1 and 4, Group 3 and optionally Group 2 component(s) may be added. A thorough blending of components from Groups 1 and 4, before any other components are added, is believed by the inventors to be very important to keeping all the components of the additive in solution/suspension, and in keeping the additive in proper solution/suspension with the oil, fuel, or lubricant into which the additive is placed. While the components may

be at a range of temperatures during the blending process, it is preferred that the components be blended at about room temperature up to about 100 – 140 degrees F.

The terms “blend” and “mixture” and “add” herein may be done with various methods and various equipment, and is not intended to require a particular method, particular equipment, or duration of mixing. In the claims, multiple of these terms may be used in a single claim, which is for clarity in explaining different steps, but is not intended to imply that the steps require different mixing techniques or equipment. In some embodiments, however, the blending/mixing/adding of the various components of the preferred additives with each other, or of the additive to the fuel or lubricant, may need to be done with a high speed, high shear, or otherwise energetic mixing technique of equipment, as will be apparent to one of average skill in the art without undue experimentation.

The preferred three-group additive may consist only of said three groups, and the preferred four-group additive may consist only of said four groups. Alternatively, the preferred three-group additive or four-group additive may be blended with additional components, for example, additive packages such as those available commercially, to arrive at a “blended additive.” A blended additive may consist of, for example, 80 – 99.99 LV-% of the three group combination and 20 – 0.01 LV-% of “additional components.” Or, a blended additive may consist of, for example, 80 – 99.99 LV-% of the four group combination and 20 – 0.01 LV-% of “additional components.” Thus, the “additional components” may range from a significant portion of the product (at about 20 LV-%, for example) to a very small portion of the product (at about 0.01 LV-%, for example). Examples of components that may be added to the “three-group additive” or “four-group additive” to form a “blended additive” include, but are not limited to, a pour point suppressant, wintergreen oil, dyes, oil, various esters, and/or various conventional additive packages for fuels or for lubricants. Further, the three-group or four-group additive or the blended additive may be added/blended with other materials, preferably lube oil or fuels, which themselves may already contain other “additives.”

Effective concentrations of the three-group or four-group additive, or the blended additive, in conventional lube oils are believed to be 0.002– 20.0 LV-% four-group or five-group or blended additive (0.03 – 20 LV-% being typical) with 99.998 – 80 LV-% lube oil (99.97 – 80 LV-% being typical), for example. Effective concentrations of the three-group or four-group additive, or the blended additive, in combustion engine fuels are believed to be

0.002 – 5.0 LV-% three-group or four-group or blended additive (0.03 – 5 LV-% being typical) with 99.998 – 95 LV-% fuel (99.97 – 95 LV-% being typical), for example.

5 The inventor envisions use of a wide range of concentrations of the three or four-group additive or the blended additive in lube oils, fuels, cutting oils, treatment oils, and that the more important issue is that components from at least the three required groups be present in the lube or fuel, with or without other conventional or unconventional additive components.

10 In the following Examples, additives according to embodiments of the invention are described. Data associated therewith illustrates emissions improvement, fuel mileage (miles per gallon) improvement, and lubricity and metals treatment improvement.

EXAMPLE I

Emissions Testing

Additive (according to one embodiment of the invention):

15 40 LV-% C-400 Calcium Sulfonate
20 LV-% Polyalphaolefin
20 LV-% Castor Oil
2 LV-% Jojoba Oil
18 LV-% Canola Oil

20 Equaling 100 LV-% additive.

This formulation was blended by the methods described above, added to diesel fuel and to gasoline, and run in a variety of engines, as noted in the table below.

Procedures:

25 Tests 1 – 9 were performed under no-load conditions, with diesel fuel plus the additive (in a concentration of 1 ounce of additive in 12 gallons of conventional, commercial diesel fuel) compared to the same engine operating on only the diesel fuel. Tests 10 and 11 were performed under no-load conditions, with gasoline plus the additive (in a concentration of 1 ounce of additive in 18 gallons of conventional 87 octane, commercial gasoline)
30 compared to the same engine operating with only the gasoline. All emissions results were obtained by means of an analyzer in the vehicle tailpipe, such as a Ferret™, Sun™, or ECOM™ analyzer.

Results:

The results of this testing are shown below as percent change in emissions when going from the diesel-only or gasoline-only performances to the “diesel plus additive” or the “gasoline plus additive” performance, respectively.

In Tests 1, 3-9 (no data available for Test No. 2): when additive was included, O₂ increased by an average of 3%, while NO_x decreased by an average of approximately 18%, carbon monoxide decreased by an average of approximately 27 %, and carbon dioxide decreased by an average of approximately 8 %. When additive was included, NO₂ decreased by an average of approximately 19 %, and NO decreased by an average of approximately 17 %. Therefore, significant and surprising improvements in each of these emissions were seen in the diesel plus additive operations. In Test 10 and 11: when additive was included, hydrocarbon ppm emissions dropped by very large percentages, namely, approximately 100 % and 67 %, for an average of an 83.5 % decrease. Therefore, significant and surprising improvement in emissions was seen in the gasoline plus additive operations.

OVERVIEW OF
EMISSIONS Test
Sequence A

VEHICLE	#1	JOHN DEERE		4850	Diesel
	#2	JOHN DEERE		4650	Diesel
	#3	JOHN DEERE		8300	Diesel
	#4	CASE STIEGER		9390	Diesel
	#5	FORD		1900	Diesel
	#6	NEW HOLLAND		LX665	Diesel
	#7	BOBCAT			Diesel
	#8	FREIGHTLINER		CAT	Diesel
	#9	DODGE RAM ½ TON			Diesel
	#10	96 JEEPCHEROKEE 4.0			Gas
	#11	2000 PONTIAC BONNEVILLE 3.8			Gas

DIESEL									AVERAGE
VEHICLE	#1	#3	#4	#5	#6	#7	#8	#9	
O2	+13%	+1%	+1%	+5%	+2%	+1.1%	+1%	+0.3%	3%
NOX	-20%	-14%	-15%	16%	-12%	-23%	-18%	-21%	-18.25%
CO	-20%	-21%	-18%	49%	-19%	-47%	-25%	-21%	-27.50%
CO2	-35%	0%	-3%	14%	-5%	-14%	-5%	-4.80%	-8.22%
NO2	-20%	-25%	-10%	-9%	-10%	-41%	-20%	19.30%	-19.28%
NO	-26%	-7%	-18%	17%	-12%	-18%	-18%	24.90%	-17.61%

(Continued)

GAS									AVERAGE
VEHICLE			#10	#11					
% DROP									
HC PPM			100%	67%					-83.50%

EXAMPLE II

Emissions Testing

Additive (according to one embodiment of the invention):

- 5 30 LV-% C-400-C Calcium Sulfonate (Crompton Corporation/Great Lakes Corporation (Chemtura))
- 30 LV-% Polyalphaolefin
- 20 LV-% Castor Oil
- 2 LV-% Jojoba Oil
- 10 18 LV-% Canola Oil
- Equaling 100 LV-% additive.

Procedures:

Testing was done in a Cummins B Series Turbo Diesel, starting with conventional, commercial #2 diesel (Test No. 1), followed by: the same diesel combined with additive (Test No. 2), diesel with 2% biodiesel additive and 1 ounce/10 gallons additive (Test No. 3), diesel with 5% biodiesel additive and 1 ounce/10 gallons additive (Test No. 4), and the fuel of Test No. 4 with an additional 1 ounce of additive per 10 gallons of fuel.

Results:

Testing was done at various engine rpm with no load, and at various road speeds (“with load”). Emissions were reported as shown in the table below, in the form of percent change from the base test, that is, Test No. 1. The data shows substantial and surprising improvement in NO_x with the addition of additive and additive combined with biodiesel. For example, NO_x decreased about 7 – 14 % at 2500 rpm, no load; 8 – 31% at 30 mph; 3 – 21% at 50 mph; and 4 – 8 % at 70 mph.

Vehicle:

Dodge 2001 pickup, VIN# 387K23601G735111

Engine: Cummins B series Turbo Diesel

Fuels:

- 1. #2 diesel fuel
- 2. #2 diesel fuel with Additive in proportion of 1 fluid ounce per 10 gallons diesel fuel
- 3. #2 diesel fuel plus 2% biodiesel, with Additive in proportion of 1 fluid ounce per 10 gallons diesel fuel
- 4. #2 diesel fuel plus 5% biodiesel, with Additive in proportion of 1 fluid ounce per 10 gallons diesel fuel
- 5. the mixed fuel from no. 4 above, plus an additional 1 ounce of Additive per 10 gallons fuel.

Note: O₂=% CO=ppm NO_x=ppm CO₂=%

Change=Difference from condition #1 data

800 RPM with No Load

Test Condition	O ₂	CO	NOx	CO ₂
1	18.5	286	282	1.8
Change	----	----	----	----
2	18.6	257	280	1.8
Change	+5%	-10%	-0.7%	0%
3	18.6	233	284	1.8
Change	+0.5%	-18.5%	+0.7%	0%
4	18.5	163	298	1.8
Change	0%	-43%	+5.6%	0%
5	18.6	206	289	1.8
Change	+0.5%	-30%	+2.4%	0%

5

2500 RPM with No Load

Test Condition	O ₂	CO	NOx	CO ₂
1	17.3	578	192	2.7
Change	----	----	----	----
2	17.3	751	167	2.7
Change	0%	+29%	-13%	0%
3	17.2	650	166	2.8
Change	-0.6%	+12%	-14%	+3.7%
4	17.1	627	172	2.9
Change	+1.1%	+8%	-10%	+7.4%
5	17.2	637	178	2.8
Change	-0.6%	-10%	-7%	+3.7%

10

30 MPH

Test Condition	O ₂	CO	NOx	CO ₂
1	15.5	460	587	4.0
Change	----	----	----	----
2	16.9	421	406	3.0
Change	+9%	-8.4%	-31%	-25%
3	16.8	378	420	3.1
Change	+9%	-17.8%	-28%	-23%
4	16.9	377	505	3.7
Change	+9%	-18%	-14%	-7.5%
5	15.7	369	536	4
Change	-1%	-14%	-8.6%	0%

5

50 MPH

Test Condition	O ₂	CO	NOx	CO ₂
1	13.5	202	760	5.5
Change	----	----	----	----
2	15.3	312	597	4.2
Change	+13%	+54%	-21%	-24%
3	14.2	243	669	4.8
Change	+7%	+20%	-15%	-12.7%
4	13.3	284	636	4.8
Change	-1.4%	+40%	-16%	-14.5%
5	13.6	243	733	5.8
Change	+0.7%	+20%	-3.5%	+5.5%

10

70 MPH

Test Condition	O ₂	CO	NOx	CO ₂
1	13.3	213	457	5.6
Change	----	----	----	----
2	13.8	307	427	5.3
Change	+3.7%	+44%	-6.5%	-5.3%
3	13.4	305	421	5.6
Change	+5.7%	+43%	-7.9%	0%
4	12.5	196	439	6.2
Change	-6%	-7.9%	-3.9%	-10.7%
5	13.4	281	426	5.6
Change	+0.7%	+32%	6.8%	0%

Vehicle – Pont. Bonneville

EXAMPLE III

Emissions Testing

Additive (according to one embodiment of the invention):

- 5 30 LV-% C-400-c Calcium Sulfonate (Crompton Corporation/Great Lakes Corporation (Chemtura))
- 30 LV-% Polyalphaolefin
- 20 LV-% Castor Oil
- 2 LV-% Jojoba Oil
- 10 18 LV-% Canola Oil
- Equaling 100 LV-% additive.

Procedures:

15 In this test, a gasoline vehicle was tested with load, at 75 mph. The vehicle was a 2001 Pontiac Bonneville with a 3800 engine (not turbo-charged). Test No. 1 was performed at 75 mph with conventional, commercial gasoline of 87 octane, and Test no. 2 was performed at 75 mph with the same gasoline plus 1 ounce of additive added per 10 gallons of the gasoline.

20 Results:

The test results show substantial and surprising results in CO emissions and in NOx emissions. CO was reduced by over 15% and NOx was reduced by over 50%, as shown by the table below.

25 Test condition 1-75 mph without additive
2-75 mph with 1 oz additive per 10 gallons of gasoline

30

<u>Test</u>					
<u>Condition</u>	<u>HC</u>	<u>CO</u>	<u>CO2</u>	<u>O2</u>	<u>NOx</u>
1	1	.39	15.2	0	19
2	1	.33	15.1	0	9
Change	0%	-15.3%	-0.6%	0%	-53%

Note: HC = ppm CO = %, CO2 = %, O2 = %, NOx = ppm

Note: While specific baseline and experimental data was not formally collected, it appeared that spikes in HC and NOx during and shortly after rapid acceleration were substantially reduced.

EXAMPLE IV

Emissions Testing, with Incremental PAO Added

Vehicle:

5 MAC Truck from City of Butte, Montana

Analyzer:

ECOM AC Diesel Analyzer

Procedures:

10 In Condition #1, the MAC truck engine was warmed to operating temperature and run at idle at 600 rpm for an additional 15 minutes. Emission readings were taken for 5 minutes during which the readings were stable. The truck engine was then run for 5 minutes at 2000 rpm and 5 minutes of readings were again taken, during which time the readings were again stable.

15 In Condition #2, additive according to the following formula was added in the proportion of once fluid ounce to 20 gallons of #2 diesel fuel:

Baseline Additive Formulation added to the MAC fuel tank in Condition #2:

48 LV% Calcium Sulfonate (Crompton C-400-CFC)

48 LV% Castor Oil from Acme Hardesty

20 4 LV% Jojoba Oil (tech grade from Purcell Jojoba)

Readings were taken at 600 rpm and 2000 rpm, after running the engine on this Condition #2 fuel-additive blend for 5 minutes.

In Condition #3, PAO (Crompton Synton 40) was added to the MAC truck fuel tank at a rate of one fluid ounce of PAO per 20 gallons of the Condition #2 fuel-additive blend.

25 After running the engine on this Condition #3 PAO-enhanced-fuel-additive blend for 5 minutes, readings were taken at both 600 rpm and 2000 rpm.

30 In Condition #4, an additional dose of PAO was added to the MAC truck fuel tank at a rate of one fluid ounce of PAO per 20 gallons of Condition #3 PAO-enhanced-fuel-additive blend. After running the engine for 10 minutes (during which time the NOx and CO readings were dropping), the readings became stable and were taken at 600 rpm and at 2000 rpm for this condition.

In Condition #5, an additional dose of PAO was added to the MAC truck fuel tank at a rate of one fluid ounce per 20 gallons of the Condition #4 PAO-enhanced-fuel-additive

blend. After running the engine for 10 minutes (during which time the NOx and CO readings were dropping), the readings became stable and were taken at 600 rpm and at 2000 rpm for this condition.

5 Results:

The readings for the above conditions may be summarized as shown below. For both the 600 RPM and the 2000 RPM data, the amounts of each added item are shown in fluid ounces per 20 gallons.

10 600 RPM:

Condition/

Fuel #	CaSulfonate	Jojoba Oil	Castor Oil	Synton 40	CO ppm	NOx ppm
1	0	0	0	0	16	148
2	.48	.04	.48	0	10	121
15 3	.48	.04	.48	1	6	110
4	.48	.04	.48	2	5	105
5	.48	.04	.48	3	5	101

2000 RPM:

20 1	0	0	0	0	11	138
2	.48	.04	.48	0	11	73
3	.48	.04	.48	1	8	50
4	.48	.04	.48	2	7	40
5	.48	.04	.48	3	6	37

25 This data clearly show the reduction in CO emission and NOx emission both when the base formula is added to the diesel fuel, and also when the PAO is added to the fuel already enhanced by the base formula. It also shows a diminishing effect with extra PAO (as more and more is added in Conditions #4 and 5).

30 Note that this Example D involves fuel additive being used at a total of 1 to 4 fluid ounces per 20 gallons of fuel. The largest benefit comes from 1 ounce of the baseline additive formula plus 1 ounce of PAO.

EXAMPLE V

Emissions Testing with Acme Wax 225™ as Suspension Agent

Additive (according to one embodiment of the invention):

- 5 40 LV% Calcium Sulfonate (Crompton C-400-CFC™)
- 2 LV% Acme Wax 225™ (From Acme Hardesty)
- 20 LV% Castor Oil (From Acme Hardesty)
- 38 LV% Soy Methyl Ester (B-100 Biodiesel from Cenex in West Fargo ND)

10 Baseline Fuel:

89 Octane gasoline with 10% ethanol, purchased at Casey's General Store, in Detroit Lakes, MN

Emissions Measuring Instrument:

- 15 Ferret 16 five gas analyzer

Vehicle:

1998 Buick Regal
3800 engine, 173267 miles

- 20 The vehicle had a port welded to the exhaust pipe (in from of the catalytic converter) to measure emissions prior to the effects of the catalytic converter

Procedures:

- 25 Vehicle first was driven for 30 miles on the highway. Next the vehicle was allowed to idle for 20 minutes.

Baseline measurements were taken at 30 second intervals for 10 minutes.

The same procedure was used to evaluate during the experimental condition, wherein the above additive was added to the baseline fuel at a rate of one ounce to 15 gallons.

- 30 Mean and median were calculated for the first and second half of the observation as well as for the total observation.

Baseline Condition (with baseline fuel only):

Mean

		PPM	%	%	%	PPM
5	Emissions	HC	CO	CO2	O2	NOx
	First half	147	.267	5.7	12.79	6.3
	Second Half	148.7	.266	5.74	12.71	6.2
	Total	147.9	.2665	5.72	12.75	6.1

10 Median

		PPM	%	%	%	PPM
	Emissions	HC	CO	CO2	O2	NOx
	First half	147	.27	5.7	12.8	6
	Second half	151	.27	5.7	12.7	6
15	Total	149	.27	5.7	12.7	6

Experimental Condition (with additive included in fuel):

Mean

		PPM	%	%	%	PPM
20	Emission	HC	CO	CO2	O2	NOx
	First half	133.6	.231	5.24	13.4	5.3
	Second Half	134.5	.228	5.16	13.43	4.9
	Total	134.0	.2295	5.20	13.42	5.1

25 Median

		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
	First half	133	.23	5.2	13.5	5
	Second half	135	.23	5.25	13.4	5
30	Total	134	.23	5.2	13.4	5

Percent Change from Baseline to Experimental Condition:

Mean

	PPM	%	%	%	PPM
5 Gas	HC	CO	CO2	O2	NOx
First half	-9.1	-13.5	-8.1	+4.8	-15.9
Second half	-9.5	-16.5	-10.1	+5.7	-21.7
Total	-9.3	-13.9	-9.1	+5.2	-16.4

10 Median

	PPM	%	%	%	PPM
Gas	HC	CO	CO2	O2	NOx
First half	-9.5	-14.8	-8.8	+5.5	-16.6
Second Half	-10.6	-14.8	-7.9	+5.5	-16.6
Total	-10.1	-14.8	-8.8	+5.5	-16.6

15

EXAMPLE VI

Emissions Testing with Palm Oil as Suspension Agent

20 Composition of Additive:

- 48% Calcium Sulfonate (Crompton C-400-CFC™)
- 4% Palm Oil (From Columbus Foods)
- 48% Castor Oil (From Acme Hardesty)

25 Baseline Fuel:

87 Octane gasoline with 10% ethanol, purchased at Tesoro Station, in Detroit Lakes, MN

Emissions Measuring Instrument:

Ferret 16 Five Gas Analyzer

30

Vehicle:

1998 Buick Regal
 3800 engine, with 173237 miles

The vehicle has a port welded to the exhaust pipe (in from of the catalytic converter) to measure emissions prior to the effects of the catalytic converter

Procedures:

5 Vehicle first was driven for 80 miles on the highway with the baseline fuel only. Next the vehicle was allowed to idle for 20 minutes. Baseline measurements were taken at 30 second intervals for 10 minutes. For Experiment Case #1, the above additive was blended into the baseline fuel, in a proportion of 1 ounce per 15 gallons. Mean and median were calculated for the first and second half of the observation as well as for the total observation.

10

Baseline Condition (baseline fuel only):

Mean

	PPM	%	%	%	PPM
Emissions	HC	CO	CO2	O2	NOx
15 First half	161.5	.192	4.97	14.37	47.4
Second Half	145.4	.200	5.03	13.74	44.7
Total	153.5	.196	5.00	14.06	46.1

Median

	PPM	%	%	%	PPM
Emissions	HC	CO	CO2	O2	NOx
20 First half	160	.19	4.9	14.0	46.0
Second half	145	.20	5.0	13.8	44.5
Total	150	.19	5.0	13.9	45.0

25

Experimental Case #1 (Baseline fuel plus above palm-oil-containing “base” additive):

Mean

	PPM	%	%	%	PPM
Emissions	HC	CO	CO2	O2	NOx
30 First half	122.5	.199	5.02	13.87	39.8
Second Half	120.0	.193	4.84	13.90	39.4
Total	121.3	.196	4.93	13.89	39.6

Median

	PPM	%	%	%	PPM
Emissions	HC	CO	CO2	O2	NOx
5 First half	124	.195	4.95	14.15	38.5
Second half	118.5	.19	4.85	13.95	39
Total	120	.19	4.90	14.0	39

Percent Change from Baseline to Experimental Case #1:

10 Mean

	PPM	%	%	%	PPM
Emissions	HC	CO	CO2	O2	NOx
First half	-24.1	+3.6	+1.0	-3.4	-16.0
Second half	-17.5	-3.5	-3.6	+1.8	-11.4
15 Total	-21.0	00.0	-1.4	-1.0	-14.1

Median

	PPM	%	%	%	PPM
Emissions	HC	CO	CO2	O2	NOx
20 First half	-22.5	+2.6	+1.0	+0.7	-16.3
Second Half	-18.3	-5.0	-3.0	+1.1	-12.4
Total	-20.0	0.0	-2.0	+0.7	-13.3

25

EXAMPLE VII

Emissions Testing with Palm-Olein as Suspension Agent

Additive (according to one embodiment of the Invention):

48 LV%- Calcium Sulfonate (Crompton C-400-CLR)

30 48 LV%- Castor Oil (From Acme Hardesty)

4 LV% - Palm-Olein (From Columbus Foods)

The Palm-Olein was added to the sulfonate and vigorously stirred with a hand held blender until it appeared to be thoroughly blended. Castor oil was then added and blended as well.

Fuel:

87 Octane gasoline with 10% ethanol, purchased at Tesoro Station, in Detroit Lakes, MN

5 Emissions Measuring Instrument:

Ferret 16 five gas analyzer

Vehicle:

1998 Buick Regal

3800 engine, 173000+ miles

10 The vehicle has a port welded to the exhaust pipe (in from of the catalytic converter) to measure emissions prior to the effects of the catalytic converter.

Procedures:

15 Vehicle first was driven for 80 miles on the highway using baseline fuel.. Next the vehicle was allowed to idle for 20 minutes. Baseline measurements were taken at 30 second intervals for 10 minutes. The same procedure was used to evaluate during the experimental condition, wherein the above composition of additive with palm-olein was added to the baseline fuel at a rate of one ounce to 15 gallons. Mean and median were calculated for the first and second half of the observation as well as for the total observation.

20

Baseline Condition:

Mean

	PPM	%	%	%	PPM
Gas	HC	CO	CO2	O2	NOx
25 First half	188.1	.348	8.75	8.66	82.5
Second Half	188.2	.353	8.63	8.72	80.5
Total	188.15	.351	8.69	8.69	81.5

Median

	PPM	%	%	%	PPM
Gas	HC	CO	CO2	O2	NOx
30 First half	190	.35	8.7	8.7	82.5
Second half	188.5	.355	8.7	8.75	80.5

Total 189 .35 8.7 8.7 81.5

Experimental Condition (With Palm-Olein additive):

Mean

		PPM	%	%	%	PPM
5	Gas	HC	CO	CO2	O2	NOx
	First half	158.2	.298	8.03	9.63	77.6
	Second Half	159.3	.312	7.59	10.2	70.7
	Total	158.75	.305	7.81	9.92	74.2

10 Median

		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
	First half	158	.30	8.0	9.6	78
	Second half	159.5	.31	75.5	10.25	71
15	Total	159	.305	77.5	9.9	74

Percent of Change from Baseline to Experimental:

Mean

		PPM	%	%	%	PPM
20	Gas	HC	CO	CO2	O2	NOx
	First half	-15.9	-14.4	-8.2	+10.9	-5.9
	Second half	-15.4	-11.6	-12.1	+17.5	-12.2
	Total	-15.6	-13.1	-10.1	+14.2	-9.0

25 Median

		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
	First half	-16.8	-14.3	-8.8	+10.3	-5.5
	Second Half	-15.4	-12.7	-13.2	+17.1	-11.8
30	Total	-15.9	-12.9	-10.9	+13.8	-9.2

EXAMPLE VIII

Emissions Testing with Coconut Oil as Suspension Agent

5 Additive (according to one embodiment of the invention):)

48 LV% Calcium Sulfonate (Crompton C-400-CFC™

4 LV% Coconut Oil 92 (from Columbus Foods)

48 LV% Castor Oil (From Acme Hardesty)

10 Baseline Fuel:

89 Octane gasoline with 10% ethanol, purchased at the Tesoro station , in Detroit Lakes, MN

Emissions Measuring Instrument:

Ferret 16 five gas analyzer

15 Vehicle:

1998 Buick Regal

3800 engine 173000+ miles

The vehicle has a port welded to the exhaust pipe (in from of the catalytic converter) to measure emissions prior to the effects of the catalytic converter.

20

Procedures:

Vehicle first was driven for 80 miles on the highway on baseline fuel. Next the vehicle was allowed to idle for 20 minutes. Baseline measurements were taken at 30 second intervals for 10 minutes. The same procedure was used to evaluate during the experimental condition.

25 The above composition of additive with Coconut Oil 92 was added to the baseline fuel at a proportion of one ounce to 15 gallons. Mean and median were calculated for the first and second half of the observation as well as for the total observation.

Baseline Condition:

30 Mean

	PPM	%	%	%	PPM
Gas	HC	CO	CO2	O2	NOx
First half	94.5	.199	4.96	13.83	49.6

Second Half	93.8	.205	5.19	13.55	50.0
Total	94.2	.202	5.08	13.69	49.8

Median

5		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
	First half	94	.20	5.0	138.5	51
	Second half	93.5	.21	5.2	135	50
	Total	94	.20	5.05	137	50.5

10

Experimental Condition (With Coconut 92 additive):

Mean

		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
15	First half	63.1	.165	4.32	14.71	39.8
	Second Half	63.9	.167	4.28	14.74	40.1
	Total	63.5	.166	4.30	14.725	39.95

Median

20		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
	First half	64	.16	4.3	14.7	40
	Second half	61	.165	4.24	14.8	41
	Total	63	.16	4.3	14.7	40

25

Percent of Change from Baseline to Experimental

Mean

		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
30	First half	-33.2	-17.1	-12.9	+6.3	-19.8
	Second half	-31.9	-18.5	-17.5	+8.9	-19.8
	Total	-32.5	-17.8	-15.4	+7.6	-19.8

Median

	PPM	%	%	%	PPM
Gas	HC	CO	CO2	O2	NOx
5 First half	-31.9	-20.0	-14.0	+6.1	-21.6
Second Half	-34.8	-21.4	-18.5	+9.6	-18.0
Total	-32.9	-20.0	-14.9	+7.3	-20.8

10

EXAMPLE IX

Emissions Testing with Calcium Carbonate as Calcium Component

Additive (according to one embodiment of the invention):

- 17% Acme Wax 224™ - Acme Hardesty
- 15 33% Castor Oil - Acme Hardesty
- 17% PAO - Poly Alfa Olefin, Synton 40™ from Crompton Corporation
- 17% Calcium Carbonate - From Specialty Minerals Inc., Alba Fil™, Precipitated Calcium Carbonate A-5-205-32

20

Additive Blend Procedures:

2 ounces (by volume) of calcium carbonate was heated in an electric oven to 120 Degrees F. Next, 2 fluid oz of Acme Wax 224™ was then mixed with the calcium carbonate, until it took on a consistent paste-like composition. Next, 2 fluid oz of castor oil was added and mixed with the combination of calcium carbonate and Acme Wax 224™. PAO was then mixed in.

25

Baseline Fuel:

87 Octane gasoline with 10% ethanol, purchased at Tesoro Station, in Detroit Lakes, MN

30

Emissions Measuring Instrument:

Ferret 16 five gas analyzer

Vehicle:

1998 Buick Regal

3800 engine 173000+ miles

5 The vehicle has a port welded to the exhaust pipe (in from of the catalytic converter) to measure emissions prior to the effects of the catalytic converter.

Procedures:

10 Vehicle first was driven for 80 miles on the highway with the baseline fuel. Next the vehicle was allowed to idle for 20 minutes. Baseline measurements were taken at 30 second intervals for 10 minutes. The same procedure was used to evaluate during the experimental condition, after the above composition of additive with calcium carbonate was added to the baseline fuel at a proportion of one ounce to 24 gallons. Mean and median were calculated for the first and second half of the observation as well as for the total observation.

15

Baseline Condition:

Mean

	PPM	%	%	%	PPM
Gas	HC	CO	CO2	O2	NOx
20 First half	235.9	.343	8.21	9.19	120
Second Half	242.5	.311	7.60	10.09	108.5
Total	239.2	.327	7.91	9.64	114.25

Median

	PPM	%	%	%	PPM
Gas	HC	CO	CO2	O2	NOx
25 First half	236	.35	8.3	9.2	119.5
Second half	243	.31	76.0	101	108.5
Total	239.5	.23	76.5	100.5	109.5

Experimental Condition (With calcium carbonate additive):

Mean

		PPM	%	%	%	PPM
5	Gas	HC	CO	CO2	O2	NOx
	First half	219.3	.314	7.49	102.1	108.8
	Second Half	223.7	.303	7.59	99.7	109.3
	Total	221.5	.308	7.54	100.9	109.1

10 Median

		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
	First half	217.5	.31	7.5	10.6	108
	Second half	223	.30	7.55	9.90	108.5
15	Total	220.5	.31	7.5	10.25	108.5

Percent of Change from Baseline to Experimental:

Mean

		PPM	%	%	%	PPM
20	Gas	HC	CO	CO2	O2	NOx
	First half	-7.0	-8.5	-8.8	+9.8	-9.3
	Second half	-7.8	-2.6	-0.1	-1.2	+0.7
	Total	-7.4	-5.8	-4.7	+4.7	-4.5

25

Median

		PPM	%	%	%	PPM
	Gas	HC	CO	CO2	O2	NOx
	First half	-7.8	-11.4	-9.6	+15.2	-9.6
30	Second Half	-8.2	-3.2	-0.6	-8.7	-0.0
	Total	-7.9	-3.1	-2.0	+1.5	-0.9

EXAMPLE X

Additive in Lawn Mower Fuel, Time Running on One Tank

Ambient Temp:

5 50 degrees

Lawn Mower:

Stanley riding lawn mower with Briggs & Stratton 21HP two cylinder engine.

Procedures & Measurements:

10 Engine was warmed up and run until it burned up all the fuel in the tank and stopped. The mower was then filled with three pints of Condition A fuel (below); engine was started and mower deck immediately engaged. RPM was held at 4400. A "Snap On" Tachometer was used to check the RPM. The engine was run until all of the three pints was burned and the engine stopped. A watch was set to measure the running time of this condition.

15 The mower was then filled with three pints of Condition B fuel (below); engine was started and mower deck immediately engaged. RPM was held at 4400. As above, a "Snap On" Tachometer was used to check the RPM. The engine was run until all of the three pints was burned and the engine stopped. As above, a watch was set to measure the running time of this condition.

20 Condition A fuel: 20 gallons gasoline with an octane rating of 87, plus one (1) ounce additive according to one embodiment of the invention:

Calcium Sulfonate: 30 LV%

Polyalphaolefin: 30 LV%

Castor Oil: 10 LV%

25 Jojoba Oil: 1 LV%

Soy Methyl Ester: 29 LV%

Equaling 100 LV-% additive.

30 Condition B: 100% gasoline with an octane rating of 87 (Not treated with any embodiment of the invented additive).

Results:

Condition A ran for 2910 seconds

Condition B ran for 2715 seconds

5 2910 seconds / 2715 seconds = 1.0712 (approximately a 7% improvement in performance).

EXAMPLE XI

Fuel Mileage (Miles per Gallon) Testing with Various Additives

10

Vehicle: 2002 Toyota, Forerunner

Location: Bozeman MT

Baseline Fuel: Mid-grade 88 octane purchased at Exxon in Bozeman MT

15 Procedures:

Vehicle fuel tank was filled with fuel and then vehicle was driven on a particular route. The vehicle was then refueled at the same station with the same baseline fuel and a composition of additive was added with the fuel, and the same route was followed by the vehicle to test the baseline fuel with that particular additive. Each time the fuel ran low in the tank, the procedure repeated, refueling with baseline fuel and adding alternative compositions of additive. The four variations were:

20

Baseline Operation: Vehicle operation with only mid-grade 88 octane gasoline

25 Case #1 Additive (according to one embodiment of the invention): Formulation follows, in LV%, Added at rate of 1 fluid ounce per 20 gallons of baseline fuel.

40% Calcium Carbonate - From Specialty Minerals Inc.

Product- Alba Fil, Precipitated Calcium Carbonate A-5-205-32

33% Soy Methyl Ester (Cenex B-100 Biodiesel)

30 20% Castor Oil

5% Sulfated Castor Oil (75% sulfated)

2% Acme Wax 224™

Case #2 Additive (according to one embodiment of the invention): Formulation follows, in LV%, Added at rate of 1 fluid ounce per 25 gallons of baseline fuel.

- 25% Calcium Carbonate
- 50 % Castor Oil
- 5 25% Acme Wax 224™

Case #3 Additive (according to one embodiment of the invention): Formulation follows, in LV%, Added at rate of 1 fluid ounce per 20 gallons of baseline fuel.

- 48% Calcium Sulfoante
- 10 48% Castor Oil
- 4% Acme Wax 225™

Case #4 Additive (according to one embodiment of the invention): Formulation follows, in LV%, Added at rate of 1 fluid ounce per 20 gallons of baseline fuel.

- 15 48% Calcium Sulfonate
- 48% Castor Oil
- 4% Palm Oil

	<u>Miles Driven</u>	<u>Gallons Used</u>	<u>Miles per Gallon</u>	<u>%Change in MPG</u>	
20	<u>Baseline:</u>	267	16.28	16.4	---
	<u>Case #1:</u>	267	14.28	18.7	+12.3
	<u>Case #2:</u>	267	14.51	18.4	+10.9
	<u>Case #3:</u>	267	14.29	18.7	+12.2
25	<u>Case #4:</u>	267	14.35	18.6	+11.9

EXAMPLE XII

Fuel mileage testing conducted at
KARCO Engineering of Adelanto, California.

5

Additive (according to one embodiment of the invention):

40 LV% Calcium Sulfonate (Crompton C-400 – CLR)TM

33 LV% Soy Methyl Ester (Cenex B-100 Biodiesel)

20 LV% Castor Oil (from Acme Hardesty)

10 5 LV% Sulfated Castor Oil (from Acme Hardesty)

2 LV % Acme Wax 224TM (from Acme Hardesty)

Procedures:

15 Vehicles A and B were run with baseline, midgrade gasoline, and then the same vehicles were operated with the same baseline gasoline plus the additive above (1 ounce per 20 gallons) for Control A and Test B.

Independent Mileage Test – KARCO

20

Ford Taurus

Run	Miles Driven	Gasoline Used	Miles/Gallon	Improvement
Baseline A	303	11.12	27.25	
Control A	303	10.96	27.65	1.46 %
Baseline B	303	11.03	27.47	
Test B	303	10.28	29.47	7.3 %

EXAMPLE XIII
Fuel Mileage Testing

5 Testing conducted in Butte, Montana, was conducted using the following:

Vehicle:

Mack 12 yard Dump (T-46), 1988

Engine Mack 673

Fuel Tank Capacity 100 gallons

10 Fuel Type Diesel

Additive (according to one embodiment of the invention):

40 LV% Calcium Sulfonate (Crompton C-400 – CLR™)

33 LV% Soy Methyl Ester (Cenex B-100 Biodiesel)

15 20 LV% Castor Oil (from Acme Hardesty)

5 LV% Sulfated Castor Oil (from Acme Hardesty)

2 LV % Acme Wax 224™ (from Acme Hardesty)

Procedures:

20 First tank of diesel fuel was untreated (no additive). Second tank was baseline fuel (diesel) plus 1 fluid ounce additive per 20 gallons (this second tank may be considered a conditioning treatment). Third tank was same baseline fuel plus 1 fluid ounce additive per 20 gallons.

25 Results:

Starting Mileage	Ending Mileage	Fuel Used	Additive	MPG
307028	307800	97.49 gal. (1 st tank)	NO	7.92
307800	308327	60.65 gal. (2 nd tank)	Yes	8.6
308327	309038	81.07 gal. (3 rd tank)	Yes	8.77

30 So, one may see that there is a 8.6 % increase in MPG between the 1st tank baseline and the 2nd tank (with additive) and a 10.77 % increase in MPG between the 1st tank baseline and the 3rd tank (with additive).

EXAMPLE XIV
Fuel Mileage Testing

Testing conducted in Butte, Montana, was conducted using the following:

5

Vehicle:

GMC ¾ Ton (T-20)

Year 2003

Engine Size 6.0 L

Fuel Tank Capacity 32 gallons

10

Fuel Type Gas

Additive (according to one embodiment of the invention):

40 LV% Calcium Sulfonate (Crompton C-400 – CLR)TM

33 LV% Soy Methyl Ester (Cenex B-100 Biodiesel)

15

20 LV% Castor Oil (from Acme Hardesty)

5 LV% Sulfated Castor Oil (from Acme Hardesty)

2 LV % Acme Wax 224TM (from Acme Hardesty)

Procedures:

20

First tank of diesel fuel was untreated (no additive). Second tank was baseline fuel (diesel) plus 1 fluid ounce additive per 20 gallons (this second tank may be considered a conditioning treatment). Third tank was same baseline fuel plus 1 fluid ounce additive per 20 gallons.

25

Results:

Starting Mileage	Ending Mileage	Fuel Used	Additive?	MPG
31098	31347	23.57 gal. (1 st tank)	NO	10.56
31347	32775	90.07 gal. (2 nd tank)	Yes	13.39
33015	34480	119.69gal. (3 rd tank)	Yes	12.24

30

So, one may see that there is a 26.8 % increase in MPG between the 1st tank baseline and the 2nd tank (with additive) and a 15.90 % increase in MPG between the 1st tank baseline and the 3rd tank (with additive).

EXAMPLE XV
Fuel Mileage Testing

Vehicle:

GMC Yukon, 1997

5 Fuel Tank Capacity 32 gallons

Fuel Type Gasoline

Additive (according to one embodiment of the invention):

40 LV% Calcium Sulfonate (Crompton C-400 – CLR)TM

10 33 LV% Soy Methyl Ester (Cenex B-100 Biodiesel)

20 LV% Castor Oil (from Acme Hardesty)

5 LV% Sulfated Castor Oil (from Acme Hardesty)

2 LV % Acme Wax 224TM (from Acme Hardesty)

15 Procedures:

First tank of diesel fuel was untreated (no additive). Second tank was baseline fuel (diesel) plus 1 fluid ounce additive per 20 gallons (this second tank may be considered a conditioning treatment). Third tank was same baseline fuel plus 1 fluid ounce additive per 20 gallons.

20

Results:

Starting Mileage	Ending Mileage	Fuel Used	Additive	MPG
100935	101516	57.65 gal. (1 st tank)	NO	10.09
101516	101725	25.92 gal. (2 nd tank)	Yes	11.69
25 101725	10997	20.45 gal. (3 rd tank)	Yes	13.3
102265	102265	21.81 gal. (4 th tank)	Yes	12.29

So, one may see that there is a 15.9 % increase in MPG between the 1st tank baseline and the 2nd tank (with additive) and a 31.8 % increase in MPG between the 1st tank baseline and the 3rd tank (with additive), and a 21.8 % increase in MPG between the 1st tank baseline and the 4th tank (with additive).

30

EXAMPLE XVI
Fuel Mileage Testing

Additive (according to one embodiment of the invention):

- 5 48 LV%- Calcium Sulfonate (Crompton C-400-CLR)
- 48 LV%- Castor Oil (From Acme Hardesty)
- 4 LV% - Coconut Oil 92 (From Columbus Foods)

Blending Procedure:

- 10 The Coconut oil was added to the sulfonate and vigorously stirred with a hand held blender until it appeared to be thoroughly blended. Castor oil was then added and blended as well.

Vehicle:

- 15 1991 Ford F-250, 4x4, standard cab, 4.9 liter 6 Cylinder engine, Standard Transmission, XLT Lariat

Procedures:

- 20 With fuel tanks nearly empty, the vehicle was filled with 87 octane fuel at the Tesoro Station in Detroit Lakes, MN. It was the driven with the cruise control on at 65 miles per hour in fourth gear, on four lane highways for 345.9 miles. The vehicle was then refueled at the same station, with the additive added to the fuel tank in the proportion of 1 ounce per 20 gallons, and the driving repeated on the same route under the same conditions.

	Miles Driven	Gallons Used	Miles per Gallon
25 <u>Baseline:</u>	345.9	28.20	12.27
<u>Experimental:</u>	345.8	26.79	12.91
<u>% Improvement in Mileage</u>			+5.2

EXAMPLE XVII

Metal Conditioning Properties

5 Additive (according to one embodiment of the invention)::

Calcium Sulfonate: 40 LV%

PAO: 20 LV%

Castor Oil: 20 LV%

Jojoba Oil: 1 LV%

10 Soy methyl ester: 19 LV%

Equaling 100 LV% Additive

Procedures:

15 Testing the muzzle velocity of a 180 grain 30 – 06 bullet when fired from a rifle and measured by a chronograph.

Condition A: hand-loaded cartridge (described above) was fired and velocity measured.

20 Condition B: identical to Condition A above except the cartridges were first put in the above-described Additive and the Additive with cartridges “soaking” therein were heated to 200 degrees F. After several minutes at 200 degrees F, the cartridges were removed, wiped clean, cooled, hand-loaded, and fired.

Results:

Condition A: 2768 feet per second.

25 Condition B: 2916 feet per second.

$2916 / 2768 = 1.0535$ (approximately a 5.4 % increase in muzzle velocity).

30

EXAMPLE XVIII

Mini-Masonry Chain Saw

Additive (according to one embodiment of the invention)::

- 5 Calcium sulfonate: 40 LV%
PAO: 20 LV%
Castor Oil: 20%
Jojoba Oil: 1 LV%
Soy Methyl Ester: 19 LV%
10 Equaling 100 LV % Additive

Procedures:

Use a prototype masonry chain saw, temperature was measured at the hottest point of the saw (tip). Also, an observation was made regarding the speed of cutting.

- 15 Condition A: The saw was used to remove mortar between bricks on an existing wall. Water was used as a coolant.

Condition B: The saw was used to remove mortar between bricks on an existing wall, as in Condition A. Water, treated with PB 10 sulfur chlorinated water-soluble cutting oil, was used as a coolant.

- 20 Treatment rates: 1 oz per gallon of water

Condition C: The saw was used to remove mortar between bricks on an existing wall, as in Conditions A and B. Water, treated with the Condition B water soluble cutting oil and the Additive listed above, was used as a coolant. Treatment rates: 1 oz of the Additive was added to 4 oz PB 10. One ounce of the blend of

- 25 Additive plus PB-10 was added per gallon of water.

Results:

Condition A: Tip Temperature = 161 degree F

Condition B: Tip Temperature = 130 degrees F

- 30 Condition C: Tip Temperature = 91 degrees F

Water soluble oil as a coolant (Condition B) resulted in an average 31 degree F lower temperature compared to Condition A.

Additive plus Water Soluble Oil (Condition C) resulted in a temperature 70 degrees F lower than Condition A, and a temperature 39 degrees F lower than Condition B.

Other advantages included: In Conditions A and B (that is, without the Additive), the cutting debris stuck (impacted) to the chain and bar. Also, with the additive, the operator reported a significant increase in power and RPM, and that the rate of cutting appeared to double.

EXAMPLE XIX

Fuels Lubricity Comparison Test

Film strength of sulfur free gasoline and diesel fuels as compared to same fuels with palm oil as a bonding agent.

Additive (according to one embodiment of the invention)::

48%- Calcium Sulfonate (Crompton C-400-CLR™)

4% - Palm Oil (From Columbus Foods)

48%- Castor Oil (From Acme Hardesty)

Baseline Procedure:

One fluid ounce of sulfur free gasoline was poured into reservoir on bearing test machine and let run for 20 sec. after which one 1lb. weight was applied to the pendulum so that it puts 26 lbs. weight on rotating bearing. Machine immediately stalled and welded the bearings together (approx. 3 seconds).

Case #1:

Next, new bearings were installed on the bearing test machine, and the baseline gasoline plus the above additive was poured into the machine reservoir (one fluid ounce additive per 20 gallons fuel, or 1.4 cc. per gal.)

Results:

The bearing test produced a 28 second run (compared to about 3 sec. above) until film strength failed and bearings welded, stalling the machine.

5

EXAMPLE XX

Acme Wax 224™ and Others as Suspension Agent

10 Acme Wax 224™, from Acme Hardesty Corp., was evaluated as a suspension agent, as described below.

An additive according to embodiments of the invention was blended from:

1 fluid ounce C-400-CLR™ calcium sulfonate;

1 cc ounce Acme Wax 224™; and

15 1 fluid ounce castor oil.

(approximately: 49 LV% calcium sulfonate, 2 LV% Acme Wax 224™, 49 LV% castor oil)

This additive was blended using the method described earlier, so that calcium component and the Acme Wax 224™ were well-blended together first, followed by addition of the castor oil.

This blend was allowed to cool to a temperature of 67 degrees F.

20 One and ½ cc of the above additive was added to ½ pint of fresh mid-grade gasoline, from an Exxon gasoline station, and, even after cooling to -17 degrees F in a freezer for 13 hours (followed by warming to room temperature), the components remained in suspension/solution and no residue or cloudiness was visible in the jar, indicating full calcium suspension.

25 The same suspension results were achieved in the same test with Coconut Oil 92 and Palm Oil as suspension agents.

EXAMPLE XXI

Cold Temp Properties

30

Sample A:

B-100 -- . A "bulk" fuel, soy methyl ester, which is called "Biodiesel" and "B-100" (meaning 100% soy methyl ester).

Sample B:

B-100 plus an embodiment of the invented additive including conventional pour point depressant (Rho-Max 10 – 310™). The embodiment of the invented additive consisted of (LV-%):

40 % Calcium Sulfonate

15% Castor Oil

34% Poly Alpha Olefin (PAO)

10% Pour point depressant (RHO-Max 10 – 310™)

1 % Jojoba Oil

Totaling 100 LV-%

This above additive was then added to B-100 at a rate of one ounce per five gallons of B-100, and heated to 104 degrees Fahrenheit for a period of five hours.

Procedures:

Samples A and B were put in similar containers and brought to lower temperatures. Viscosity and pourability were visually checked.

Results:

Both Samples A and B were observed to have similar viscosity and both samples poured at similar rates from 80 to 30 degrees F.

Sample A became cloudy at about 25 degrees F and turned to a solid at 20 degrees F.

Sample B showed some clouding at -10 degrees F, but continued to pour well at -20 degrees F (that is, poured in a manner similar to Sample A when Sample A was at 70 degrees F). Pourability of Sample B remained at this level with no observable change for a period of two weeks. The sample was then diluted with 50% soy methyl ester (that is, 50 LV% more B-100 was added), and identical results were noted.

Therefore, the inventors believe the additive to be highly effective as an enhancer for pour point depressant over a wide range of concentrations.

EXAMPLE XXII
Cold Temp Properties

The inventors have found that, when embodiments of the invented additive including a conventional pour point depressant and then added to "B-20" (which is common terminology for a bulk fuel of 80 LV-% conventional diesel fuel plus 20 LV-% Biodiesel (soy methyl ester)), the soy methyl ester does not separate from the conventional diesel fuel at - 20 degrees F. This surprising result may be due to the invented additive being a suspension agent between the esters and the hydrocarbons. This benefit may extend to very low temperature, such as -40 degrees F, wherein the additive may act as an anti-gel/anti-separation agent for diesel fuels.

EXAMPLE XXIII

Cold Temp Properties vs. Concentration of Additive in Biodiesel

15 Additive:

Several additives were blended in the following ranges and tested in Biodiesel:

C-400-C calcium sulfonate	40%
PAO	20 - 30%
Castor Oil	10 - 15%
20 Sulfated Castor Oil ("75% sulfated")	5%
Jojoba or similar wax oil/ester	2%
SME	16 - 20%
RHO-MAX—310™	
pour point depressant	2 - 3%

25

Results:

On average, one fluid ounce of the additive added to 10 gallons B-100 biodiesel resulting in the treated biodiesel being liquid at 20 - 25 degrees F.

On average, one fluid ounce of the additive added to 5 gallons B-100 biodiesel resulting in the treated biodiesel being liquid at 10 degrees F.

30

On average, one fluid ounce of the additive added to 2 gallons B-100 biodiesel resulting in the treated biodiesel being liquid at minus 20 degrees F.

5

From the Examples and the foregoing discussion, one may see that a wide range of additive formulations are within the scope of the invention. Formulations of particular interest may be described as comprising:

	Calcium-Containing Component,	
10	preferably calcium sulfonate	
	and/or calcium carbonate	30 – 50 LV%
	PAO	0 LV%
	Castor Oil and supplements	40 – 60 LV%
	Fatty acid ester as suspension agent	1 – 4 LV%

15 -- OR --

	Calcium-Containing Component,	
	preferably calcium sulfonate	
	and/or calcium carbonate	30 – 50 LV%
	PAO	15 – 30 LV%
20	Castor Oil and supplements	30 – 50 LV%
	Fatty acid ester as suspension agent	1 – 4 LV%

25 While many additives may comprise the above components and percentages, some embodiments may consist of the above components and percentages (that is, totaling 100 LV% with no additional ingredients).

30 Of particular interest and benefit is that embodiments of the invented compositions of matter have been shown to reduce harmful emissions from combustion fuels (gasoline, diesel, biodiesel, and gasoline-ethanol) and to increase miles per gallon performance. Embodiments of the additives, and methods of using them in fuels, may reduce NOx, VOC's, HC, smoke and odor from combustion fuels, with NOx emissions being particularly improved by additives according to embodiments of the invention containing PAO, and with smoke and

odor being particularly improved in diesel applications according to embodiments of the invention. The inventors believe, therefore, that automobile, bus, truck, airplane, train, heavy equipment, generators, etc. benefit from the invented additive.

5 The inventors believe that there is a synergistic effect from the invented composition of matter, specifically, treatment of the metal engine surfaces and improvement of combustion characteristics that together result in greatly improved and cleaner engine performance. The immediate effect is seen in terms of reduced harmful and unpleasant emissions, and the longer-term effect is seen in that metal surfaces appear to be changed, at least temporarily, so that an engine run with the invented additive in its fuel continues for a
10 time to exhibit improved performance (compared to pre-additive operation) even when changed back to the original (pre-additive) fuel.

Although this invention has been described above with reference to particular means, materials and embodiments, it is to be understood that the invention is not limited to these disclosed particulars, but extends instead to all equivalents within the broad scope of the
15 following claims.

CLAIMS

1. An additive for fuels and lubricants for improving combustion engine emissions and fuel mileage and improving lubricity, the additive comprising:
- 5 a calcium-containing component;
a castor oil; and
a suspension agent;
wherein said suspension agent is a fatty acid ester with a melt point between 5 – 50 degrees C.
- 10 2. An additive as in Claim 1, further comprising a castor supplement/partial replacement components selected from the group consisting of: sulfated castor oil, soy methyl ester, canola oil, and pour point depressant.
- 15 3. An additive as in Claim 1, further comprising polyalphaolefin as a fourth component.
4. An additive as in Claim 1, wherein said calcium source is selected from the group consisting of: calcium sulfonate, overbased calcium sulfonate, and calcium carbonate.
- 20 5. As additive as in Claim 1, wherein said suspension agent is selected from the group consisting of: fatty acid esters, triglycerides fatty acid esters, waxy esters of ricinoleic acid, palm oil, palm-olein, coconut oil, and jojoba oil.
6. An additive for fuels and lubricants for improving combustion engine emissions and fuel mileage and improving lubricity, the additive comprising:
- 25 10 – 50 LV% calcium-containing component;
10 – 60 LV% castor oil and castor supplements component selected from the group consisting of castor oil, sulfated castor oil, soy methyl ester, canola oil, and pour point depressant; and
- 30 1 – 25 LV% suspension agent, wherein said suspension agent is a fatty acid ester with a melt point between 5 – 50 degrees C.
7. An additive as in Claim 6, further comprising polyalphaolefin as a fourth component.

8. An additive as in Claim 6, wherein said calcium-containing component is selected from the group consisting of: calcium sulfonate, overbased calcium sulfonate, and calcium carbonate.
- 5
9. An additive as in Claim 6, wherein said suspension agent is selected from the group consisting of: fatty acid esters, triglycerides fatty acid esters, waxy esters of ricinoleic acid, palm oil, palm-olein, coconut oil, and jojoba oil.
- 10
10. An additive as in Claim 6, wherein said calcium-containing component is 30 – 50 LV% of the additive, said castor oil and castor supplements component is 40 – 60 LV% of the additive, and said suspension agent is 1 – 4 LV% of the additive.
11. An additive for fuels and lubricants for improving combustion engine emissions and fuel mileage and improving lubricity, the additive comprising:
- 15
- 10 – 50 LV% calcium-containing component;
- 15 – 75 LV% polyalphaolefin;
- 10 – 60 LV% castor oil component and supplements selected from the group consisting of castor oil, sulfated castor oil, soy methyl ester, canola oil, and pour point depressant; and
- 20
- 1 – 20 LV% suspension agent, wherein said suspension agent is a fatty acid ester with a melt point between 5 – 50 degrees C.
12. An additive as in Claim 11, wherein said calcium-containing component is selected from the group consisting of: calcium sulfonate, overbased calcium sulfonate, and calcium carbonate.
- 25
13. As additive as in Claim 11, wherein said suspension agent is selected from the group consisting of: fatty acid esters, triglycerides fatty acid esters, waxy esters of ricinoleic acid, palm oil, palm-olein, coconut oil, and jojoba oil.
- 30
14. An additive as in Claim 11, wherein said calcium-containing component is 30 – 50 LV% of the additive, said polyalphaolefin is 15 – 30 LV% of the additive, said castor oil and

castor supplements components is 30 – 50 LV% of the additive, and said suspension agent is 1 – 4 LV% of the additive.

- 5 15. A method of formulating and using an additive fuels, lubricants, pour point depressants, and cutting fluids, the method comprising:
providing a calcium-containing component;
blending a suspension agent with said calcium-containing component to obtain a blend, wherein said suspension agent is selected from the group consisting of: fatty acid ester; fatty acid ester with a melt point between 5 – 50 degrees C; triglycerides fatty acid
10 esters, waxy esters of ricinoleic acid, palm oil, palm-olein, coconut oil, and jojoba oil; and after said blending, providing castor oil and mixing the castor oil into said blend.
16. A method as in Claim 15, further comprising adding a castor supplement/partial replacement component to said blend after said blending, the castor supplement/partial
15 replacement component being selected from a group consisting of: sulfated castor oil, soy methyl ester, canola oil, and pour point depressant.
17. A method as in Claim 15, further comprising providing an effective amount of said
20 additive in a gasoline fuel in a vehicle, wherein fuel mileage of the vehicle is increased.
18. A method as in Claim 15, further comprising providing an effective amount of said
additive in a diesel fuel in a vehicle, wherein fuel mileage of the vehicle is increased.
19. A method as in Claim 15, further comprising placing an effective amount of said
25 additive in a gasoline fuel for a combustion engine, whereby emissions of NOx hydrocarbons, CO, and CO₂ from the combustion engine are reduced.
20. A method as in Claim 15, further comprising placing an effective amount of said
30 additive in a diesel fuel for a combustion engine, whereby emissions of NOx hydrocarbons, CO, and CO₂ from the combustion engine are reduced.
21. A method as in Claim 20, wherein the diesel fuel is petroleum diesel.

22. A method as in Claim 20, wherein the diesel fuel comprises biodiesel.
23. A method as in Claim 20, wherein the diesel fuel comprises ethanol.
- 5 24. A method as in Claim 15, further comprising adding polyalphaolefin to said blend after said blending.
25. A method as in Claim 24, further comprising placing an effective amount of said additive in a gasoline fuel for a combustion engine, whereby emissions of NO_x
10 hydrocarbons, CO, and CO₂ from the combustion engine are reduced.
26. A method as in Claim 24, further comprising placing an effective amount of said additive in a diesel fuel for a combustion engine, whereby emissions of NO_x hydrocarbons, CO, and CO₂ from the combustion engine are reduced.
- 15 27. A method as in Claim 15, further comprising placing an effective amount of said additive in a cutting fluid, wherein friction is reduced in the cutting operation in which said cutting fluid is used.
- 20 28. A method of suspending calcium in a combustion engine gasoline fuel, the method comprising:
providing a calcium-containing component;
blending a suspension agent with said calcium-containing component to obtain a blend, wherein said suspension agent is selected from the group consisting of: fatty acid
25 esters; fatty acid ester with a melt point between 5 – 50 degrees C; triglycerides fatty acid esters, waxy esters of ricinoleic acid, palm oil, palm-olein, coconut oil, and jojoba oil;
at a time later than said blending, adding a castor oil component into said blend to obtain a mixture; and
at a time later than said adding said castor oil component to obtain said mixture,
30 placing said mixture into gasoline fuel, whereby the calcium is suspended in the gasoline fuel.

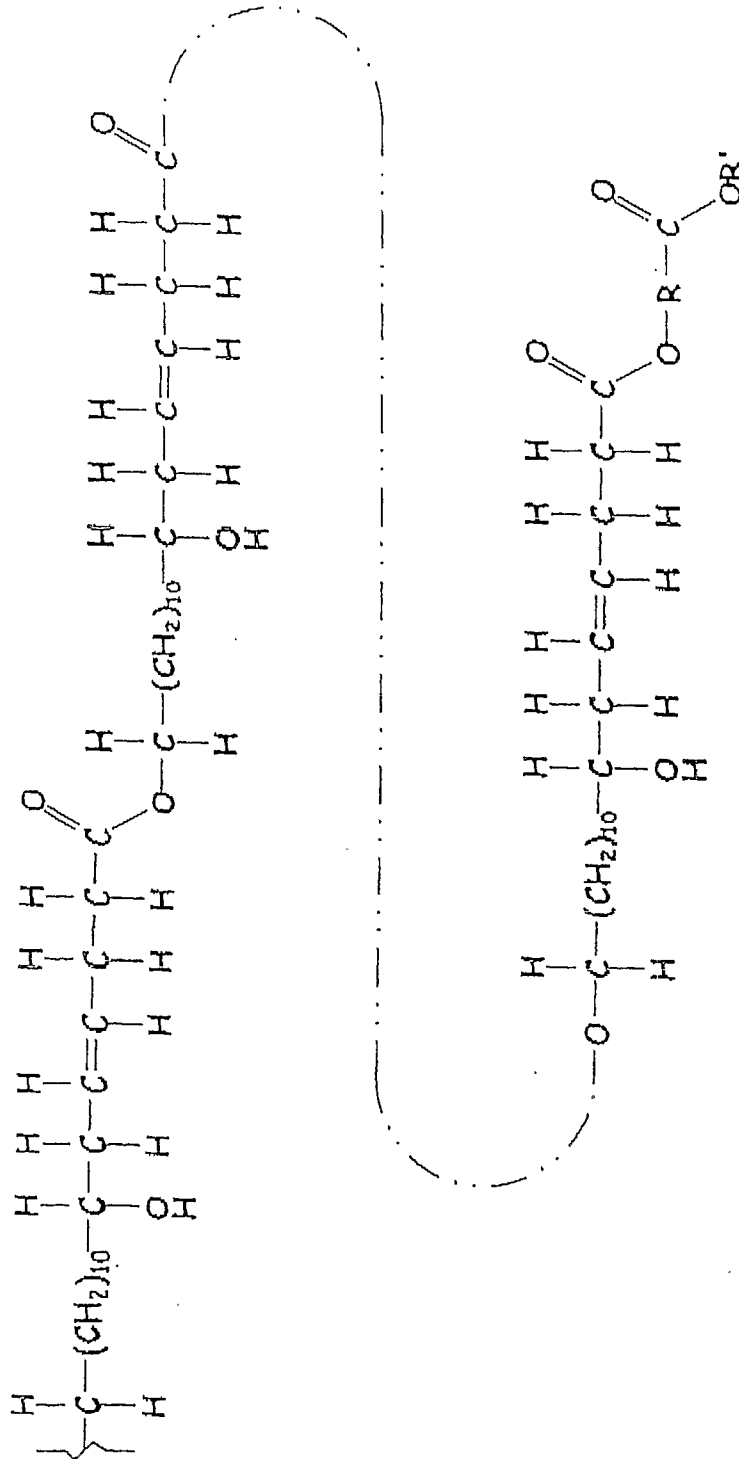
29. A method of suspending calcium as in Claim 28, further adding polyalphaolefin to said blend at a time later than said blending and before said mixture is placed into the gasoline fuel.

5 30. A method of suspending calcium in a combustion engine diesel fuel, the method comprising:
providing a calcium-containing component;
blending a suspension agent with said calcium-containing component to obtain a
blend, wherein said suspension agent is selected from the group consisting of: fatty acid
10 esters; fatty acid ester with a melt point between 5 – 50 degrees C; triglycerides fatty acid
esters, waxy esters of ricinoleic acid, palm oil, palm-olein, coconut oil, and jojoba oil;
at a time later than said blending, adding a castor oil component into said blend to
obtain a mixture; and
at a time later than adding said castor oil component to obtain said mixture, placing
15 said mixture into diesel fuel, whereby the calcium is suspended in the diesel fuel.

31. A method of suspending calcium as in Claim 30, further adding polyalphaolefin to said blend at a time later than said blending and before said mixture is placed into the diesel
20 fuel.

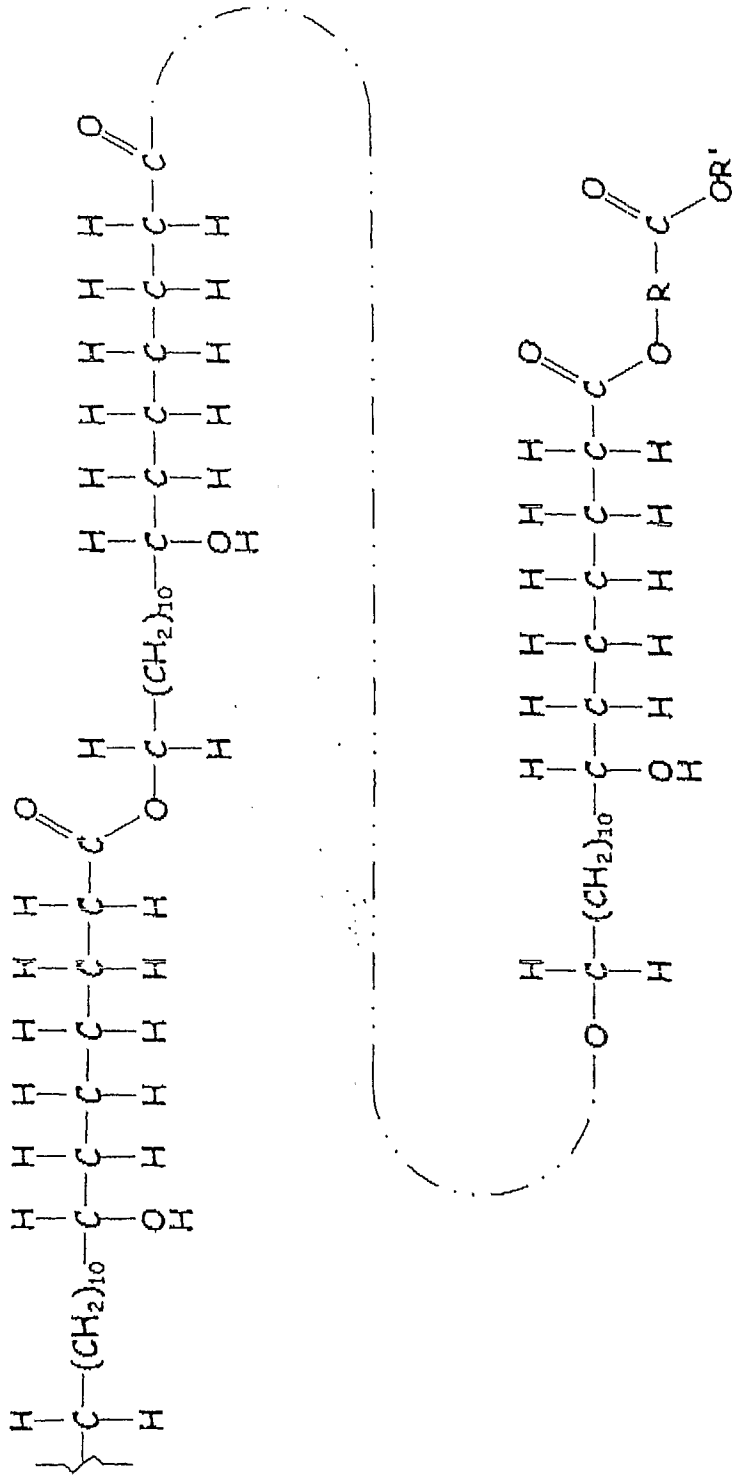
32. A method as in Claim 30, wherein said diesel comprises biodiesel.

33. A method as in Claim 30, wherein said diesel comprises ethanol.



POLYMER ESTER OF RICINOLEIC ACID

Figure 1



POLYMER ESTER OF 12 - HYDROXY STEARIC ACID

Figure 2