

5 FRICTION REDUCING ADDITIVES FOR FUELS AND LUBRICANTS

 This invention is directed to alkylamines which have been reacted with acetoacetamides and/or N-substituted acetoacetamides to form iminoacetamides
10 and the use of the resulting products as friction reducing additives in fuels and lubes. More particularly, it is directed to fuel and lubricating compositions and concentrates containing such friction reducing additives.

 A major concern today is finding methods to reduce engine friction and fuel consumption in internal combustion engines which are safe for the environment and
15 economically attractive. One means is to treat moving parts of such engines with lubricants containing friction reducing additives. Considerable work has been done in this area.

 U.S. Patent No. 4,617,026 discloses the use of monocarboxylic acid ester of trihydric alcohol, glycerol monooleate, as a friction reducing additive in fuels and
20 lubricants promoting fuel economy in an internal combustion engine.

 The use of fatty formamides is disclosed in U.S. Patent Nos. 4,789,493; 4,808,196; and 4,867,752.

 The use of fatty acid amides is disclosed in U.S. Patent No. 4,280,916.

 U.S. Patent No. 4,406,803 discloses the use of alkane-1,2-diols in lubricants
25 to improve fuel economy of an internal combustion engine.

 U.S. Patent No. 4,512,903 discloses amides prepared from mono or poly hydroxy substituted aliphatic monocarboxylic acids and primary or secondary amines which are useful as friction reducing agents.

 Accordingly, it is an object of the present invention to provide a composition
30 for reducing and/or preventing friction.

 It is another object of the present invention to provide a method for reducing friction in the operation of an internal combustion engine.

 The instant invention is directed to iminoacetamides prepared via condensation of alkylamines and acetoacetamides and/or N-substituted
35 acetoacetamides which have been found to be effective friction reducing additives

- 5 for fuels, particularly gasoline, fuel additive concentrates, lubricants and lubricant additive concentrates, with good high temperature decomposing cleanliness.

In accordance with the invention, there is provided a lubricant composition comprising a lubricating oil or grease prepared therefrom and a friction reducing amount of a reaction product obtained by reacting



wherein $X=\text{CH}_2, \text{O}, \text{S},$ or NH ;

$\text{R}=\text{Hydrocarbyl}, \text{alkenyl},$ or $\text{alkyl (C}_1\text{-C}_{60}\text{)}$;

$\text{R}^1=\text{C}_1$ to C_4 alkenyl or substituted alkenyl;

- and acetoacetamide of the formula $\text{CH}_3\text{COCH}_2\text{CON(R}^2\text{)}_2$ wherein $\text{R}^2=\text{H}$ or C_1 to C_4 alkyl.
- 15

There is further provided a fuel composition comprising an internal combustion engine fuel and a friction reducing amount of a product obtained by reacting



- 20 wherein $X=\text{CH}_2, \text{O}, \text{S},$ or NH ;

$\text{R}=\text{Hydrocarbyl}, \text{alkenyl},$ or $\text{alkyl (C}_1\text{-C}_{60}\text{)}$;

$\text{R}^1=\text{C}_1$ to C_4 alkenyl or substituted alkenyl;

and acetoacetamide of the formula $\text{CH}_3\text{COCH}_2\text{CON(R}^2\text{)}_2$ wherein $\text{R}^2=\text{H}$ or C_1 to C_4 alkyl.

- 25 There is still further provided a method for reducing and/or preventing friction in the operation of an internal combustion engine which comprises fueling said engine with a liquid fuel composition comprising per 1000 barrels of fuel between 25 to 250 pounds of a non-borated product obtained by reacting



- 30 wherein $X=\text{CH}_2, \text{O}, \text{S},$ or NH ;

$\text{R}=\text{Hydrocarbyl}, \text{alkenyl},$ or $\text{alkyl (C}_1\text{-C}_{60}\text{)}$;

$\text{R}^1=\text{C}_1$ to C_4 alkenyl or substituted alkenyl;

and acetoacetamide of the formula $\text{CH}_3\text{COCH}_2\text{CON(R}^2\text{)}_2$ wherein $\text{R}^2=\text{H}$ or C_1 to C_4 alkyl.

5 Reaction products of acetoacetamides and alkylamines have been found to have excellent friction reduction properties coupled with excellent high temperature cleanliness and decomposition features necessary for use in high quality fuels and lubricants for internal combustion engines.

10 Suitable alkylamines include pure saturated or unsaturated monoamines and/or diamines or mixtures of alkylamines derived from fatty acids, such as coco, oleyl or tallow.

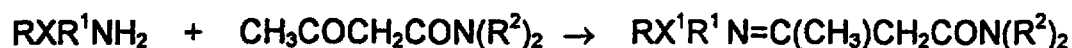
15 The alkylamines can also contain heteroatoms such as oxygen, sulfur or nitrogen in their alkyl chains. The alkyl groups on the amines are long enough to confer friction reduction properties but not too long to prevent the inherent waxiness of long chain paraffins. However, the waxiness may be minimized by introducing a site of unsaturation or a heteroatom into the alkyl chain.

 Suitable acetoacetamides include N-substituted acetoacetamides, such as N,N-dialkylacetoacetamide, particularly N,N-dimethylacetoacetamide.

20 Hydrocarbon solvents or other inert solvents may be used in the reaction. Included among useful solvents are benzene, toluene and xylenes. When solvent is used, the preferred solvent is a mixture of xylenes. In general, any hydrocarbon solvent can be used in which the reactants and products are soluble and which can be easily removed.

25 A constant azeotropic removal with solvent of the water formed during the reaction may be performed using a moisture trap (Dean-Stark apparatus). In some cases, the solvent may be stripped off by continuous heating and completed by applying a low vacuum (10-20 mm/Hg) after the expected quantity of water is removed. In others, the solvent may be kept in the final mixtures to improve their fluidity.

30 The condensation reaction generally proceeds as follows:



wherein $\text{X} = \text{X}^1 = \text{CH}_2, \text{O}, \text{S}, \text{NH}$; when $\text{X} = \text{NH}$, X^1 can be $\text{NC}(\text{CH}_3)(\text{OH})\text{CH}_2\text{CON}(\text{R}^2)_2$ or $\text{N}(\text{CH}_3)\text{C}=\text{CHCON}(\text{R}^2)_2$

$\text{R} = \text{Hydrocarbyl, alkenyl, alkyl (C}_1\text{-C}_{60}\text{) optionally containing aryl, alkylaryl;}$

- 5 $R^1 = C_1$ to C_4 alkenyl or substituted alkenyl; and
 $R^2 = H$ or C_1 to C_4 alkyl.

Generally the reaction temperature is in the range of from 100°C to 200°C and preferably in the range of from 120°C to 165°C. The reaction time is generally in the range of from 1 to 24 hours and preferably in the range of from 4 to 12 hours.

- 10 It is preferred to use stoichiometric quantities of amines and acetoacetamides. However, excess of one or another reagents can be desirable.

The amount of friction reducing additive in the lubricant composition may range from 0.1 to 10% by weight of the total lubricant composition. Preferred is from 0.1 to 2.0 wt. %.

- 15 In the lubricant additive concentrate the amount of friction reducing additive may range from 1.0% to 50.0% by weight of the total lubricant additive concentrate. Preferred is from 10% to 30% by weight.

- The lubricant composition and/or the lubricant additive concentrate may contain other materials normally present in additive packages including dispersants, detergents, antioxidants, antiwear and extreme pressure agents, viscosity index
20 improvers; corrosion inhibitors, anti-rust additives, antifoam agents, pour point depressants, various markers, taggants, and any solubilizing agents, such as oils, polymers, solvents, and the like. These materials impart their customary properties to the particular compositions and do not detract from the value of the compositions
25 into which they are incorporated.

Suitable dispersants include polyalkylene succinimides, Mannich bases, polyethers, polyalkylene amines, various esters, and the like.

Suitable detergents include metallic and/or non-metallic phenates, sulfonates, carboxylates, and the like.

- 30 Suitable antioxidants include hindered phenols, arylated amines, sulfurized olefins, and the like.

Suitable viscosity index improvers include polymethacrylates, olefin copolymers and the like.

5 Suitable antiwear and extreme pressure agents include zinc dialkyl dithiophosphates, dithiocarbamates, thiodiazoles, and the like.

 Generally the total amount of all such other materials will not exceed 10.0 to 30.0 wt. % in the lube compositions and 10.0 to 100.0% of the lube additive concentrates.

10 Furthermore, the lubricants contemplated for use herein include both mineral and synthetic hydrocarbon oils of lubricating viscosity, mixtures of mineral and synthetic oils and greases prepared therefrom, and other solid lubricants. The synthetic oils may include polyalphaolefins; polyalkylene glycols, such as polypropylene glycol, polyethylene glycol, polybutylene glycol; esters, such as di(2-ethylhexyl)sebacate, dibutyl phthalate, neopentyl esters, such as pentaerythritol
15 esters, trimethyl propane esters; polyisobutylenes; polyphenyls; ethers such as phenoxy phenylethers; fluorocarbons; siloxanes; silicones; silanes and silicate esters; hydrogenated mineral oils or mixtures thereof.

 The present invention may also be used in fuels such as gasoline,
20 oxygenated gasolines, reformulated gasolines, gasohols, hydrocarbon fuels, mixed hydrocarbon and oxygenated fuels, jet turbine engine fuels and diesel fuels. The present invention may also be used in fuel additive concentrates.

 Fuel compositions can contain from 10 to 1,000 pounds of friction reducing additive per 1,000 barrels of fuel or more preferably from 25 to 250 pounds per
25 1,000 barrels of fuel.

 In the fuel additive concentrate the amount of friction reducing additive may range from 1.0% to 50.0% by weight of the total fuel additive concentrate. Preferred is from 10% to 30% by weight.

 Fuel and fuel additive concentrates may contain other materials normally
30 present in fuel additive packages including deposit control additives for carburetors, port fuel injectors, intake ports, intake valves, and combustion chambers; carrier fluids; anti-knock agents, such as tetraalkyl lead compounds, organomanganese compounds, lead scavengers, octane enhancing additives, and the like; dyes; markers; taggants; cetane improvers, such as alkyl nitrates, alkyl peroxides, and the

5 like; antioxidants, such as hindered phenols, arylated amines, sulfurized olefins, and the like; rust inhibitors; demulsifiers; bacteriostatic agents; gum inhibitors; anti-icing agents; metal deactivators; exhaust valve anti-recession agents; spark enhancing additives; low temperature solubilizers; solvents necessary for low temperature performances or mixtures thereof.

10 Suitable demulsifiers include oxyalkylated alkylphenolic (formaldehyde) resins, and polyoxyalkylene glycols.

Suitable carrier fluids include mineral and/or synthetic oils, polyalkylenes, sters, polyols, polyethers or mixtures thereof.

Suitable corrosion inhibitors include alkyl lactic succinate esters.

15 The fuel and fuel additive concentrates generally comprise an effective amount of at least one detergent. The detergent is normally selected from the group consisting of polyalkyleneamines and Mannich base-type condensation products of hydrocarbyl phenols, aldehydes and amines. Generally, these detergent agents reduce and/or prevent deposits which have a tendency to form in carburetors and fuel injection systems, thereby improving engine performance. Such detergent agents also improve fuel economy and reduce internal combustion engine exhaust emissions.

25 The preferred polyalkyleneamine detergents are selected from the group consisting of polymeric 1-amines, including polyisobutylene-amines. High vinylic content polyisobutylene-amines are most preferred. Suitable polyisobutylene-amines are described in U.S. Patent Nos. 5,004,478 and 5,112,364, and DE 3942860. Preferred polyisobutylene-amines have an average molecular weight of 500 to 3,000 or greater.

30 Such polyalkyleneamines are available from normal commercial sources or may be prepared by the amination of high vinylic content polyolefins having an average molecular weight of from 500 to 3000 or greater, using methods which are well known to those skilled in the art. Polyisobutylene amines are generally prepared by chlorination or hydroformylation of reactive polyisobutylene and

5 subsequent amination with ammonia, hydrocarbyl amines, hydrocarbyl diamines, hydrocarbyl polyamines, alkoxylated hydrocarbyl amines, or mixtures thereof. Ammonia, ethylenediamine, diethylenetriamine, triethylene-tetramine, tetraethylenepentamine, piperazines, hexamethylenediamine, hydroxyalkyl ethylenediamines, hydroxyalkyl triethylenetetraamines, and the like can be
10 incorporated into the polyalkeneamines. Such amines can be prepared by the chlorination or halogenation of appropriate polymeric olefins, and subsequently converted into corresponding polyalkene derivatives using these or other known methods of manufacture.

The amount of polyalkyleneamine in the fuel composition may be at least 10
15 to 200 pounds per 1,000 barrels of fuel and preferably at least 40 to 150 pounds per 1,000 barrels of fuel.

The amount of polyalkyleneamine in the fuel additive concentrate may be at least 10 wt.%, preferably at least 20 wt.%, and most preferably in the range of from 25 to 60 wt.%.

20 Alternatively, preferred detergent agents are the Mannich base condensation products of hydrocarbyl phenols, aldehydes, and amines. The hydrocarbon-substituted phenols are generally prepared by the alkylation of phenol or phenolics with hydrocarbyl groups having from 10 to 150 carbon atoms. For instance, long chain olefins or polymeric olefins such as propylene and polyisobutylene can be
25 used in the phenol alkylation step. The substituted phenol is then reacted with a carbonyl source and an amine. Carbonyl sources include aldehydes, such as formaldehyde, acetaldehyde, propanal, butanal, and 2-ethylhexanal. In addition, aromatic aldehydes may be used to provide a carbonyl source. For instance, benzaldehyde, tolualdehyde, vanillin, salicylaldehyde and cinnamaldehyde may be
30 used. Polycarbonyl compounds, such as paraformaldehyde or glyoxal can also be used in some aspects of the invention.

Amines useful in the preparation of the Mannich base condensation product include primary or secondary amines and amides. Fatty amines, hydroxyl-containing amines, or polyamines, such as di-, tri-, tetra- and pentamines can be

5 used in some aspects of the invention. For example, linear and cyclic C₂-C₈ alkylene di-, tri-, tetra- and pentamines, polyamines, and their substituted polyfunctional derivatives can be used. Substituted derivatives, as used herein, refer to substitution with substituents such as halo, hydroxy, alkoxy, nitro, thio, carbalkoxy and alkythio substituents. Such Mannich base condensation products
10 are available from normal commercial sources. Suitable Mannich base condensation products are described in U.S. Patent No. 5,169,410.

The amount of Mannich base condensation product in the fuel composition may be at least 10 to 200 pounds per 1,000 barrels of fuel and preferably at least 40 to 150 pounds per 1,000 barrels of fuel.

15 The amount of Mannich base condensation product in the fuel additive concentrate may be at least 10 wt.%, preferably at least 20 wt.%, and most preferably in the range of from 25 to 60 wt.%.

A concentrate utilizing the friction reducing additive of the present invention typically also comprises 15 to 80% solvent. A preferred composition range is as
20 follows:

<u>Component</u>	<u>Wt.% Range</u>
Iminoacetamide	5 to 25
Detergent	20 to 60
<u>Solvent</u>	
Isopropanol	0 to 30
Xylene	15 to 50

25 Where the presently described invention is used as a gasoline additive, the additive package may be added at any point after the gasoline has been refined, i.e. the additive package can be added at the refinery or in the distribution system.

The invention also includes a method for reducing and/or preventing friction in the operation of an internal combustion engine. Additional possible benefits realized from the present invention include enhanced engine cleanliness, enhanced
35 lubricity, enhanced corrosion protection, reduced fuel consumption, increased power

- 5 benefits, and reduced wear. The method comprises delivering to the internal combustion engine a fuel comprising gasoline and a friction reducing additive, and other materials normally present in additive packages, described above.

The following examples are illustrative of the present invention.

Example 1

- 10 Three hundred ten grams (1.5 moles) of an etheramine, C₈-C₁₀ alkoxypropylamine (Tomah PA1214, commercially obtained from Tomah Products, Inc.) and 245 grams (1.5 moles) of an 80% N,N-dimethylacetoacetamide aqueous solution in 103 grams of xylenes as solvent were heated at reflux (145°C) for 80 minutes under an inert nitrogen atmosphere. Water from the N,N-
- 15 dimethylacetoacetamide solution and that formed during the reaction was constantly removed by azeotropic distillation with solvent using a moisture trap. Five hundred seventy six grams of a clear brownish liquid, approximately 80% active in xylenes, was obtained.

Example 2

- 20 Three hundred thirteen grams (1.5 moles) of an etheramine, C₈-C₁₀ alkoxypropylamine (Tomah PA1214, commercially obtained from Tomah Products, Inc.) and 145 grams (1.48 moles) of pure acetoacetamide in 102 grams of xylenes as solvent were heated at reflux (145°C) for 80 minutes under an inert nitrogen atmosphere. Water formed during the reaction was constantly removed by
- 25 azeotropic distillation with solvent using a moisture trap. Five hundred thirty grams of a clear brownish liquid, approximately 80% active in xylenes was obtained.

Example 3

- Three hundred eleven grams (1.55 moles) of a distilled fatty cocoamine (Armeen CD, commercially obtained from Akzo Chemicals, Inc.) and 250 grams
- 30 (1.55 moles) of 80% N,N-dimethylacetoacetamide aqueous solution in 101 grams of xylenes as solvent were heated at reflux (145°C) for 80 minutes under an inert nitrogen atmosphere. Water from the N,N-dimethylacetoacetamide solution and that formed during the reaction was constantly removed by azeotropic distillation with solvent using a moisture trap. Five hundred seventy nine grams of a clear brown,
- 35 slightly reddish liquid, approximately 80% active in xylenes, was obtained.

The products of the examples were evaluated with respect to cleanliness during thermal decomposition using TGA (Thermogravimetric Analysis) and the results are compared to a commercially available friction modifier, glycerol monooleate (GMO) as shown in Table 3 below. Thermogravimetric analysis was performed by heating a small sample at 20°C/min. with an air flow of 100 ml/min. using a Thermogravimetric Analyzer. The percent residue remaining at 425°C was recorded; little or no residue is desirable.

Table 1
Cleanliness

15	<u>Example</u>	<u>Thermogravimetric Analysis</u> <u>% Residue @ 424°C</u>
	1	4.4
	2	5.5
20	3	5.1
	GMO	25.0

As can be seen from the thermogravimetric analysis results in Table 1, the products of this invention show exceptionally higher cleanliness than the commercially available friction modifier, GMO. The iminoacetamides of Examples 1, 2 and 3 are superior to GMO in cleanliness.

The results of the TGA shown in the above Table show the superiority of the products of the present invention over the glycerol monooleate in the cleanliness of decomposition. It is also believed that the additional groups on the amides such as hydroxyl, amino, imino and alkoxy contributes to better surface activity in synergy with the amide function.

Example 4

Using the reaction product of Example 2, the following fuel additive concentrate formulations are prepared:

5	<u>Formulation</u>	A	B	C	D	E	F
	Component (Wt.% Range)						
	Example 2 reaction product	15.0	14.88	22.7	19.46	29.7	10.0
	<u>Detergent</u>						
10	Mannich-base condensation product (Ethyl 4961M)		30.12	47.3		40.3	45.0
	Polyisobutylene amine (Pluradyne AP-92M)	30.0			40.54		
15	<u>Solvent</u>						
	Isopropanol	18.33	18.33	10.0	13.33	10.0	8.0
	Xylene	36.67	36.67	20.0	26.67	20.0	37.0

Example 5

20 Using the reaction product of Example 3, the following fuel additive concentrate formulations are prepared:

	<u>Formulation</u>	A	B	C	D	E	F
	Component (Wt.% Range)						
	Example 3 reaction product	15.0	14.88	22.7	19.46	29.7	10.0
25	<u>Detergent</u>						
	Mannich-base condensation product (Ethyl 4961M)		30.12	47.3		40.3	45.0
	Polyisobutylene amine (Pluradyne AP-92M)	30.0			40.54		
30	<u>Solvent</u>						
	Isopropanol	18.33	18.33	10.0	13.33	10.0	8.0
	Xylene	36.67	36.67	20.0	26.67	20.0	37.0

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The invention having now been fully described, it should be understood that it may be embodied in other specific forms or variations without departing from its spirit or essential characteristics. Accordingly, the embodiments described above are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of

40 equivalence of the claims are intended to be embraced therein.

5 CLAIMS:

1. A lubricant composition comprising a lubricating oil or grease prepared therefrom and a friction reducing amount of a reaction product obtained by reacting
 RXR^1NH_2

10 wherein $X=CH_2, O, S,$ or NH ;

$R=$ Hydrocarbyl, alkenyl, or alkyl (C_1-C_{60});

$R^1=C_1$ to C_4 alkenyl or substituted alkenyl;

and acetoacetamide of the formula $CH_3COCH_2CON(R^2)_2$ wherein $R^2=H$ or C_1 to C_4 alkyl.

15

2. The lubricant composition of claim 1, further comprising a dispersant.

3. The lubricant composition of claim 1, wherein the lubricating oil is selected from the group consisting of mineral oils, synthetic oils or mixtures thereof.

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4. The lubricant composition of claim 1, wherein said acetoacetamide is an N-substituted acetoacetamide.

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5. The lubricant composition of claim 1, wherein the alkylamine is cocoamine.

6. The lubricant composition of claim 1, wherein the alkylamine is an etheramine.

30

7. The lubricant composition of claim 1, wherein the amount of reaction product present is in the range of from 0.1 to 10.0 wt.%.



5 8. A fuel composition comprising an internal combustion engine fuel and a friction reducing amount of a product obtained by reacting



wherein $\text{X}=\text{CH}_2, \text{O}, \text{S},$ or NH ;

$\text{R}=\text{Hydrocarbyl}, \text{alkenyl},$ or $\text{alkyl (C}_1\text{-C}_{60}\text{)}$;

10 $\text{R}^1=\text{C}_1$ to C_4 alkenyl or substituted alkenyl;

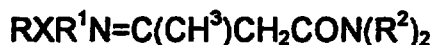
and acetoacetamide of the formula $\text{CH}_3\text{COCH}_2\text{CON(R}^2\text{)}_2$ wherein $\text{R}^2=\text{H}$ or C_1 to C_4 alkyl.

15 9. The fuel composition of claim 8, further comprising a detergent selected from the group consisting of polyalkeneamines and Mannich base condensation products.

10. The fuel composition of claim 8, further comprising a demulsifier.

20 11. The fuel composition of claim 8, wherein the internal combustion engine fuel is selected from the group consisting of distillate fuels, gasoline, hydrocarbons, alcohols, oxygenated hydrocarbons and mixtures thereof.

25 12. A fuel additive concentrate comprising a friction reducing amount of a reaction product of the following formula



wherein $\text{X}=\text{CH}_2, \text{O}, \text{S},$ or NH ;

$\text{R}=\text{Hydrocarbyl}, \text{alkenyl},$ or $\text{alkyl (C}_1\text{-C}_{60}\text{)}$;

$\text{R}^1=\text{C}_1$ to C_4 alkenyl or substituted alkenyl;

30 $\text{R}^2=\text{H}$ or C_1 to C_4 alkyl;

and at least one detergent.



- 5 13. A method for reducing and/or preventing friction in the operation of an internal combustion engine which comprises fueling said engine with a liquid fuel composition comprising per 1000 barrels of fuel between 25 to 250 pounds of a product obtained by reacting



- 10 wherein $\text{X}=\text{CH}_2, \text{O}, \text{S},$ or NH ;
 $\text{R}=\text{Hydrocarbyl}, \text{alkenyl},$ or $\text{alkyl} (\text{C}_1\text{-C}_{80})$;
 $\text{R}^1=\text{C}_1$ to C_4 alkenyl or substituted alkenyl;
 and acetoacetamide of the formula $\text{CH}_3\text{COCH}_2\text{CON}(\text{R}^2)_2$ wherein $\text{R}^2=\text{H}$ or C_1 to C_4 alkyl.

- 15 14. The lubricant composition of claim 1, wherein reaction temperature is in the range of from 100 to 200°C and reaction time is in the range of from 1 to 24 hours.

- 20 15. The fuel composition of claim 8, wherein reaction temperature is in the range of from 100 to 200°C and reaction time is in the range of from 1 to 24 hours.

16. The method of claim 13, wherein reaction temperature is in the range of from 100 to 200°C and reaction time is in the range of from 1 to 24 hours.

