United States Patent Office

3,647,694

Patented Mar. 7, 1972

3,647,694

LUBRICATING OIL COMPOSITION

John W. Swanson, Yardley, Pa., and David A. Hartman and Russel L. Beers, Trenton, and Ernest J. Jamieson, Highland Park, N.J., assignors to Cities Service Oil Company, Tulsa, Okla.

No Drawing. Filed May 29, 1969, Ser. No. 829,142

Int. Cl. C10m 1/32; C10l 1/22

U.S. Cl. 252—51.5 A 7 Claims

ABSTRACT OF THE DISCLOSURE

An improved lubricating oil composition, particularly for use as a two-cycle engine oil, and the operation of a two-cycle engine therewith. The lubricating oil composition comprises a major proportion of a hydrocarbon lubricating oil and a minor proportion of an additive which acts as a dispersant in addition to enhancing the lubricity of the composition. The additives are organic compounds containing at least two amide linkages. A novel additive of this invention is obtained by condensing one mole of a dicarboxylic acid with two moles of a 1-(β-aminoethyl)-2-hydrocarbyl-2-imidazoline to form the corresponding diamide.

BACKGROUND OF THE INVENTION

Two-cycle engines, in which the lubricating oil is mixed with the fuel, range in size from air-cooled, single cylinder engines of about 3 cubic inch displacement to multi-cylinder, water-cooled engines of 100 H.P. or more. Despite this wide range of engine capacity and type, there are many common lubrication problems. The main requirement is to keep the pistons and rings free from deposits. The principle cause of deposits is incomplete combustion of the fuel/oil mixture to form deposit precursors. These deposit precursors then polymerize to resins which form varnish and sludge.

Another type of deposit build-up is the accumulation of carbon deposits in the exhaust ports or the muffler system. Such deposit build-up results in back pressure which causes power loss, particularly with the smaller engines. Therefore, the residue from the combustion of the oil, which is burned with the fuel in the combustion chamber, should be in the form of a friable ash which does not build up in critical areas.

Still another type of deposit build-up is the formation of a "whisker" of lead salts across the electrode gap of the sparkplug. This necessitates frequent plug removal and cleaning.

One of the most satisfactory ways of preventing the build-up of deposits in two-cycle engines is to incorporate a detergent, or dispersant, in the lubricating oil which is mixed with and burned with the fuel. The mechanism for deposit control in two-cycle engines is postulated to be similar to the mechanism proposed for four-cycle gasoline engines. The detergent is adsorbed on the carbonyl and carboxyl groups of the droplets of deposit precursors and resins to form a protective film which prevents these droplets from agglomerating into varnish and sludge. These detergents also keep the deposit precursors and resins suspended in the air/fuel mixture within the combustion chamber for more complete burning or to exit with the gases at the exhaust ports.

It is proposed that the ability of these detergent additives to surround deposit precursors and resin droplets is a function of the detergent's ability to plate out on the surface of the metal where it acts as a lubricant in its own right, thus enhancing the lubricity of the oil composition. It is well known that the frictional properties of oils are related to the rate of chemical and/or physical adsorption, the number of layers adsorbed, and the

strength of the adsorbed film. Our theory finds support in paper number 680762 entitled "Frictional Characteristics of Two-Cycle Engine Oils" by J. Abbotts et al. presented at a meeting of the Society of Automotive Engineers at Tulsa, Okla. in October 1968. The paper shows an apparent relationship between frictional properties of two-cycle engine oils and engine cleanliness, i.e., the higher the degree of lubricity of the oil, the cleaner the engine. Therefore, the lubricity due to an additive of this invention is a function of its dispersant power. Accordingly, by measuring the lubricity of an oil composition containing a detergent additive, a measure of the additive's dispersing power is obtained.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a lubricating oil composition, especially a two-cycle engine oil composition, having improved detergency properties.

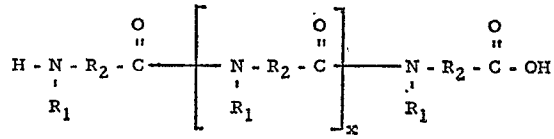
It is another object of this invention to provide a lubricating oil composition, especially a two-cycle engine oil composition, having enhanced lubricity.

It is yet another object of this invention to provide a method of operating a two-cycle engine whereby the build-up of engine deposits is markedly reduced.

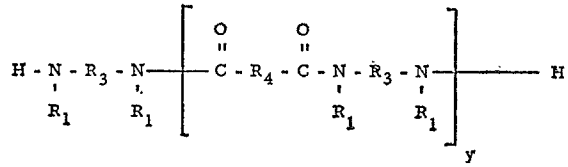
It is still another object of this invention to prepare novel compounds by condensing carboxylic acids with imidazolines containing free amino groups to form the corresponding amides.

Other objects of this invention will be apparent as the discussion proceeds.

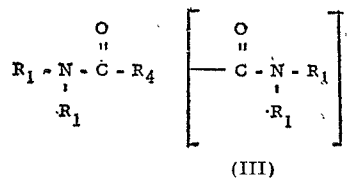
The objects of this invention are attained by incorporating into a major proportion of a hydrocarbon lubricating oil a minor proportion of an organic compound containing at least two amide linkages. The amides of this invention have the following general structures:



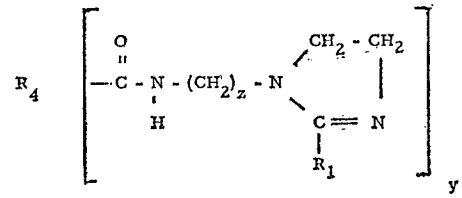
I



II



(III)



IV

wherein R_1 is hydrogen or a hydrocarbyl group of about 1 to about 30 carbons and preferably about 5 to about 25 carbons, i.e., an alkyl group, an aryl group, an aralkyl group, an alkaryl group, a cycloparaffin group, a cycloole-

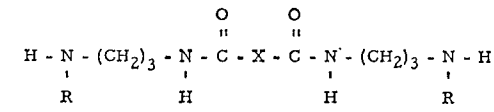
fin group, or an aliphatic olefin group; R_2, R_3 and R_4 are polyvalent hydrocarbyl groups of about 2 to about 65 carbons and preferably about 3 to about 55 carbons, e.g., polyvalent aryl groups or olefinically saturated or unsaturated polyvalent alkyl groups, aralkyl groups, alkaryl groups, and naphthene groups; x is equal to or greater than one; y is such that the total number of amide linkages in the molecule is two or more; and z is an integer of from about 1 to about 8. One or more hydrogens on hydrocarbyl groups R_1, R_2, R_3 and R_4 may be replaced by a functional group such as halide, hydroxyl, carboxyl, carbonyl, ester, mercaptyl, amino, substituted amino, or amide. R_1, R_2, R_3 or R_4 may be the same or different wherever they occur more than once in any one molecule. R_3 and R_4 may be the same or different in compounds represented by structure II. When x and y are greater than one in compounds represented by structures III and IV, the portions of the molecules within the brackets may be attached to the same or different carbons in R_4. In compounds represented by structure IV, it is especially preferred that R_4 be a polyvalent hydrocarbyl group of about 5 to about 35 carbons.

Polyamides of the type represented by structure I may be prepared, for example, by condensing amino acids with one another through their respective amino and carboxyl groups. Polyamides of the type represented by structure II may be prepared, for example, by condensing dicarboxylic acids with diamines.

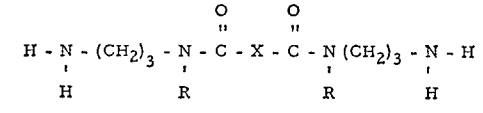
Particularly useful in the practice of this invention are amides of the types represented by structure III when x is 1, 2 or 3 and structure IV when y is 2, 3 or 4. Especially suitable compounds of the types represented by structures III and IV are the diamides of dicarboxylic acids. These amides may be prepared by condensing a dicarboxylic acid with ammonia or an amine. Generally, the dicarboxylic acids contain about 3 to about 50 carbons. Examples of suitable dicarboxylic acids are malonic, succinic, glutaric, adipic, azaleic, terephthalic, and dimer acids produced by the dimerization of polyunsaturated monocarboxylic fatty acids of about 16 to about 20 carbons. Dicarboxylic acids containing between about 30 to about 40 carbons, especially the aforementioned dimer acids, are preferred. In addition to ammonia, the dicarboxylic acids may be condensed with amines selected from primary and secondary amines as well as compounds containing two or more amino groups. Examples of suitable amines are methylamine, diethylamine, n-propyl n-hexylamine, cyclohexylamine, stearylamine, aniline, ethanolamine, pyrrolidines, 2-chlorononylamine, 3-mercaptobutylamine, ethylenediamine, diethylenetriamine, and N-methylaniline. Amines useful to form compounds of the type represented by structure IV are selected from imidazolines containing free amino groups. The preferred amines for formation of the amides of this invention are 10-phenylstearylamine; N-stearyl-1,3-propylenediamine; N-(10-phenylstearyl)-1,3-propylenediamine; and 1-(aminoalkyl)-2-hydrocarbyl-2-imidazolines wherein the hydrocarbyl group in the 2-position is preferably a saturated or olefinically unsaturated alkyl group, or mixtures thereof, containing about 6 to 20 carbons, and the aminoalkyl group in the 1-position is advantageously a β-aminoethyl group.

An especially useful dicarboxylic acid is a commercial dimer acid produced by Emery Industries, Incorporated, under the trade name Empol® 1014. This dimer acid is produced by the dimerization of a polyunsaturated C_{18} monocarboxylic fatty acid to produce a C_{36} aliphatic dicarboxylic acid. The exact structure of this dimer acid is not known with certainty, but it appears to be a long chain dicarboxylic acid with two or more alkyl side chains and containing at least one ethylenic bond. The molecule may possibly contain a cyclic structure. Some physical properties of this dimer acid are refractive index at 25° C., 1.4706; specific gravity at 25°/20° C., 0.95; and viscosity at 25° C., 5,100 centistokes.

While Empol® 1014 may be condensed with ammonia or primary or secondary amines to form the corresponding diamides, it has been found that a particularly satisfactory class of amines is derived from 1,3-propylenediamine. Of these, N-(10-phenylstearyl)-1,3-propylenediamine is especially efficacious when condensed with the dimer acid. The product may have the 10-phenylstearyl group on either the amide nitrogen or the amine nitrogen, and both isomers are probably formed:



V



VI

In the above, X represents the non-carboxyl portion of the dimer acid and R represents the 10-phenylstearyl group. In addition to the diamides, some low molecular weight polyamide-type polymer of about 2 to about 15 repeating units may be formed. It is also possible that the free amino groups in both isomers of the diamide may react with the carbonyl oxygens of the amide groups to split out water and cyclize to form a tetrahydropyrimidine structure. One or both amide groups may be converted to the tetrahydropyrimidine.

In addition to the diamides represented by structure III when x is 1, acids containing three, four, or more carboxyl groups may be converted to the corresponding amides and used successfully in the practice of this invention. An example is a trimer acid designated Empol® 1040. This is the trimer of a polyunsaturated C_{18} monocarboxylic fatty acid, being a C_{54} tricarboxylic acid.

In addition to forming a polyamide by condensing a specific amine with a specific polycarboxylic acid, it is possible to condense mixtures of amines with mixtures of acids. An example of a useful mixture of acids is Empol® 1022 which is comprised of about three parts of the dimer and about one part of the trimer of a polyunsaturated C_{18} monocarboxylic fatty acid. An example of a suitable mixture of amines is two parts of 10-phenylstearylamine and one part of N-(10-phenylstearyl)-1,3-propylenediamine.

As stated earlier, compounds of the type represented by structure IV are prepared by condensing a carboxylic acid with an imidazoline containing a free amino group. A particularly suitable imidazoline of this type is one containing an aminoalkyl group in the 1-position. The choice of carboxylic acid is not especially critical. Dicarboxylic acids, tricarboxylic acids, and compounds with four or more carboxyl groups may be used. Examples of suitable dicarboxylic acids have been disclosed above; an example of a suitable tricarboxylic acid is the trimer acid Empol® 1040 described above. The dimer acid Empol® 1014 has been found to be especially suitable. A particularly efficacious additive is formed when one mole of dimer acid Empol® 1014 is condensed with two moles of a 1-(β-aminoethyl)-2-alkyl-2-imidazoline. Examples of particularly suitable imidazolines of this type are those in which the alkyl group in the 2-position is an alkyl group, an alkenyl group, an alkadienyl group, or mixtures thereof, containing about 8 to 18 carbons.

The polyamides of this invention may be prepared by adding one mole of the amine to each equivalent of the acid in a suitable solvent and heating the mixture. Water formed as a by-product of the condensation reaction is removed from the reaction mixture, for example, by azeotropic distillation. It is convenient when using an aromatic solvent such as toluene or xylene to employ a water separator to collect the by-product water. On completion

of the reaction, removal of the solvent as, for example, by distillation leaves the polyamide.

The amount of the amide additive used in the two-cycle engine oil composition of this invention varies, depending on the additive, from about 3% to about 20% by weight of the composition. The preferred range is about 7% to about 15% amide by weight. In addition to the amide additive, the oil composition may contain other additives, e.g., rust inhibitors, viscosity improvers, and water dispersants. Often a mutual solvent that is miscible with the hydrocarbon base oil and in which the amide additive is soluble is used as a coupling agent to aid in dissolving the amide additive in the hydrocarbon lubricating oil. An example of a suitable coupling agent is a mixture of predominantly C_8, C_{10}, and C_{12} primary alcohols.

The amide additives of this invention may be used with various hydrocarbon base oils which find use as lubricating oils. Naturally occurring base oils include naphthenic base, paraffinic base, asphaltic base, and mixed base lubricating oils. Aromatics in varying amounts may also be present. Synthetic hydrocarbon oils include alkylene polymers such as polymers of propylene, butylene, octene-1, and mixtures thereof, as well as alkylated aromatic hydrocarbons.

As already mentioned, the effectiveness of the amides of this invention as dispersants in two-cycle engine oil compositions is indicated by and is a function of the lubricity imparted to the oil compositions by said amide additives. From friction data, the lubricity index (LI_T) at six different temperatures is determined. The Normal Lubricity Index (NLI) is the average of the lubricity indexes at the six temperatures. The lubricity index is determined from the expression:

$$LI_T = 20\left(\frac{a}{A}+\frac{b}{B}+\frac{b'}{B'}+\frac{d}{D}+\frac{D'}{d'}\right)$$

wherein the lower case letters are for frictional values of a standard oil composition and the upper case letters are the corresponding frictional values for an oil composition containing an experimental amide additive of this invention.

a=static coefficient of friction
b=coefficient of friction at 2 f.p.m.
b'=coefficient of friction at 50 f.p.m.
d=coefficient of slip-stick or

$$\frac{\text{static coefficient of friction}}{\text{coefficient of friction at 2 f.p.m.}}$$

d'=ratio of coefficient of friction at 10 f.p.m. to coefficient of friction at 100 f.p.m.
LI_T=Lubricity index at T° F.

The lubricity index is determined at 100° F., 150° F., 200° F., 250° F., 300° F., and 350° F. The normal lubricity index (NLI), an average of these six lubricity indexes, is represented by the expression:

$$NLI = \frac{LI_{100}+LI_{150}+LI_{200}+LI_{250}+LI_{300}+LI_{350}}{6}$$

From the foregoing it can be seen that if an oil composition containing an amide additive of this invention is equal in lubricity to the standard oil composition at a given temperature T, it will have a value for LI_T of 100. A value for LI_T less than 100 indicates poorer lubricity than the standard and a value of LI_T greater than 100 indicates better lubricity than the standard at temperature T. The same holds true for normal lubricity index (NLI) which is an average of the lubricity indexes at the six different temperatures. Thus if an oil composition containing an amide additive of this invention has a NLI value greater than 100, it will have greater lubricity than the standard oil composition and hence it will have better dispersant power.

The friction data were obtained by using the friction apparatus and procedure described by Hain in a paper entitled "Performance of Oil Additives." The paper was presented at Session 5C of a convention of the American Society of Lubrication Engineers at Chicago, Ill., on May 28, 1964.

The friction aparatus is essentially a modified drill press containing a temperature recorder, a variable speed motor, and a single channel strain gauge to measure coefficient of friction. The friction couple used in these experiments was blotter paper versus polished, cold rolled steel. The blotter paper was chosen because of its consistent porosity and surface roughness as well as its ability to simulate the resin droplets. The consistent porosity insured uniform results from day to day.

Since, as already pointed out, an increase in the lubricity of a two-cycle engine oil results in improved engine cleanliness, a two-cycle engine operating on a fuel/oil mixture in which the oil contains a lubricity-improving additive of this invention will operate cleaner with less deposit build-up than it will on a similar fuel-oil mixture in which the oil contains no additive.

Two-cycle engines generally operate on a fuel-oil mixture in which the fuel is a hydrocarbon boiling in the gasoline boiling range, i.e., about 50° F. to about 450° F. Depending on the engine and operating conditions, the fuel/oil ratio will vary from about 12/1 to about 50/1.

DESCRIPTION

The following specific examples are presented in order to more fully illustrate the preparation of representative additives of this invention as well as the desirable properties of lubricating oil compositions in which said additives are incorporated.

EXAMPLE I

To a stirred solution of 25.4 grams (0.090 equivalent, 0.045 mole) of Empol® 1014 dimer acid in 150 ml. of toluene were added 39.9 grams (0.099 mole) of N-(10-phenylstearyl)-1,3-propylenediamine. An exotherm resulting from the addition of the diamine caused the temperature of the reaction mixture to increase from room temperature to 40° C. The reaction mixture was heated under reflux for 1½ hours at a temperature of about 115° C. and the water formed as a by-product of the condensation reaction was removed by azeotropic distillation and collected in a Dean-Stark trap. Refluxing was continued for an additional 1¼ hours. Total water collected in the Dean-Stark trap during the 2¾ hour reaction time was 1.5 ml., while the theoretical amount was 1.6 ml. The toluene was removed by distillation to yield a residue of the diamide which was a dark yellow viscous liquid. Infrared analysis showed a strong amide absorption band at 1650 $cm.^{-1}$. The results of elemental analysis and a molecular weight determination of the diamide are shown in Table I and are seen to agree closely with the corresponding theoretical values. The product was designated Amide I.

TABLE I

	Theoretical	Found
Molecular weight	1,334	1,229
Percent C	81.0	81.38
Percent H	12.4	12.29
Percent O	2.4	2.42
Percent N	4.2	4.00
Percent basic N	2.1	2.30

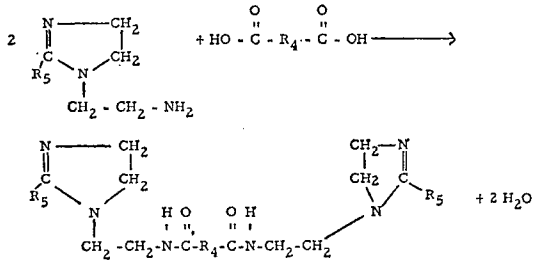
EXAMPLE II

In this experiment, the acid used was Empol® 1022 which is comprised of about three parts by weight of the dimer and about one part by weight of the trimer of a polyunsaturated C_{18} monocarboxylic fatty acid. To a stirred solution of 70.58 g. (0.25 equiv.) of Empol® 1022 in 50 g. of toluene was added a solution of 100.5 g. (0.25 mole) of N-(10-phenylstearyl)-1,3-propylenediamine in 100 g. of toluene at the rate of about 1 ml. per minute. The mixture was stirred under reflux (126° C.) for 17 hours and by-product water removed by azeotropic distillation. The theoretical amount of water for diamide for-

mation was 4.5 ml.; 4.75 ml. of water were produced in the condensation reaction. The polyamide was recovered from the toluene as before. The polyamide on analysis was found to contain 2.39% basic nitrogen; the theoretical amount is 2.10% basic nitrogen. The product was designated Amide II.

EXAMPLE III

In this experiment a diamide was prepared by condensing dimer acid Empol® 1014 with a 1-(β-aminoethyl)-2-alkyl-2-imidazoline in which the alkyl group R_5 in the 2-position was a mixture of heptadecenyl and heptadecadienyl groups:



In the above, R_4 represents the non-carboxyl residue of the dimer acid.

In 100 ml. of xylene at room temperature were placed 0.4 equiv. of dimer acid Empol® 1014 and 0.4 mole of the 1-(β-aminoethyl)-2-alkyl-2-imidazoline. The reaction mixture was heated under reflux at 150°–160° F. for about 16 hours. The water formed as a by-product of the condensation reaction was removed by azeotropic distillation and collected in a Dean-Stark trap. The theoretical amount of water for diamide formation was 7.2 ml.; the quantity of water collected was 7.0 ml. The xylene was removed by distillation under reduced pressure (about 130° F. at 5–10 mm. Hg). The product, a dark brown viscous liquid, was designated Amide III.

EXAMPLE IV

Using the procedure described in Example III, 0.4 equiv. of azelaic acid was condensed with 0.4 mole of 1-(β-aminoethyl)-2-heptadecyl-2-imidazoline to form the diamide. The water formed as a by-product of the condensation reaction was 7.2 ml., 100% of the theoretical amount for diamide production. The product, designated Amide IV, was a light brown waxy solid.

EXAMPLE V

Usuing the procedure described in Example III, 0.4 equiv. of dimer acid Empol® 1014 was condensed with 0.4 mole of 1-(β-aminoethyl)-2-nonyl-2-imidazoline to form the diamide. The water formed as a by-product of the condensation reaction was 6.5 ml., 90% of the theoretical amount for diamide production. The product, designated Amide V, was a dark brown viscous liquid.

EXAMPLE VI

Using the procedure described in Example III, 0.4 equiv. of Empol® 1014 was condensed with 0.4 mole of 1-(β-aminoethyl)-2-octyl-2-imidazoline to form the diamide. The water formed as a by-product of the condensation reaction was 6.5 ml., 90% of the theoretical amount for diamide production. The product, designated Amide VI, was a clear, dark orange viscous liquid.

EXAMPLE VII

To a stirred suspension of 20.8 g. (0.4 equiv.) of malonic acid in 50 g. of toluene was added a solution of 160.8 g. (0.4 mole) of N-(10-phenylstearyl)-1,3-propylenediamide in 50 g. of toluene. The mixture was stirred under reflux (135° C.) for 14 hours. The water formed as a by-product of the condensation reaction was removed by azeotropic distillation. The theoretical amount of water for diamide formation was 7.2 ml.; 7.1 ml. of water were collected. The toluene was removed by distillation to yield the diamide which was designated Amide VII.

EXAMPLE VIII

When Example VII is repeated using 0.4 equiv. of trimer acid Empol® 1040 and 0.4 mole of n-dodecylamine, the corresponding triamide, designated Amide VIII, is obtained.

EXAMPLE IX

When Example VII is repeated using 0.4 equiv. of succinic acid and 0.4 mole of 10-phenylstearylamine, the corresponding diamide of succinic acid, designated Amide IX is obtained.

EXAMPLE X

The lubricities of experimental two-cycle engine oil compositions containing representative amide additives of this invention were obtained by comparing their frictional properties to those of a standard, i.e., a high performance two-cycle engine oil composition. From the friction data, the lubricity indexes and normal lubricity indexes were calculated by using the expressions disclosed above. Because of chatter and squawk, friction data could not be obtained from a blank, i.e., a two-cycle engine oil composition containing no additive. Table II contains the compositions of two representative two-cycle engine oil compositions of this invention and their Lubricity Indexes. The amide additives were prepared according to the procedures disclosed in Examples I and II.

TABLE II

	Example	
	1	2
Paraffinic oil, wt. percent	83	83
Amide I, wt. percent	10	----
Amide II, wt. percent	----	0
Alcohol*, wt. percent	7	7
$LI_{100°}$ F.	96	93
$LI_{150°}$ F.	101	99
$LI_{200°}$ F.	104	101
$LI_{250°}$ F.	107	106
$LI_{300°}$ F.	101	110
$LI_{350°}$ F.	101	109
NLI	102	103

*A mixture of predominantly C_8, C_{10}, and C_{12} primary alcohols.

It is seen from the above that the Normal Lubricity Indexes of the oil compositions containing the amide additives of this invention are higher than that of the high-performance two-cycle engine oil used as a standard.

EXAMPLE XI

When Example X is repeated using a composition comprising 3 weight percent of Amide VII, 5 weight percent of the alcohol coupling agent, and 92 weight percent of a paraffinic base oil, the normal lubricity index of the oil composition is comparable to that of the high-performance two-cycle engine oil which is used as a standard.

EXAMPLE XII

When Example X is repeated using a composition comprising 20 weight percent of Amide VIII, 8 weight percent of the alcohol coupling agent, and 72 weight percent of naphthenic base oil, results comparable to those of Example X are obtained.

EXAMPLE XIII

When Example X is repeated using a composition comprising 15 weight percent of Amide IV, 10 weight percent of the alcohol coupling agent, and 75 weight percent of a naphthenic base oil, results similar to those of Example X are obtained.

EXAMPLE XIV

When Example X is repeated using a composition comprising 7 weight percent of Amide III, 7 weight percent of the alcohol coupling agent, and 86 weight percent of a paraffinic base oil, the normal lubricity index of the oil

composition is comparable to that of the high-performance two-cycle engine oil used as a standard.

It will be understood that various changes in details described and illustrated herein in order to explain the invention may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

We claim:

1. A two-cycle engine oil composition comprising a normally liquid hydrocarbon base oil and about 3% to about 20% by weight of said composition of the condensation product of two moles of N-(10-phenylstearyl)-1,3-propylenediamine and one mole of a dimerized polyunsaturated monocarboxylic fatty acid of 18 carbons.

2. The composition of claim 1 wherein said composition contains about 7 to about 15 weight percent of the diamide.

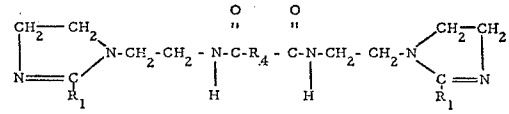
3. A two-cycle engine oil composition comprising a normally liquid hydrodarbon base oil and about 3% to about 20% by weight of said composition of the product which is obtained by condensing one mole of N-(10-phenylstearyl)-1,3-propylenediamine with each equivalent of an acid which is a mixture of about 3 parts by weight of a dimerized polyunsaturated monocarboxylic fatty acid of 18 carbons and about one part by weight of a trimerized polyunsaturated monocarboxylic fatty acid of 18 carbons.

4. The composition of claim 3 wherein said composition contains about 7 to about 15 weight percent of the polyamide.

5. In the method of operating a spark ignition two-cycle engine whereby a liquid hydrocarbon fuel boiling in the gasoline boiling range and having a lubricating oil mixed therewith is passed through a fuel supply system into a combustion chamber of said engine and said fuel/lubricating oil mixture is caused to ignite therein, the improvement comprising operating said engine on a fuel/lubricating oil mixture wherein said lubricating oil contains the condensation product of two moles of N-(10-phenylstearyl)-1,3-propylenediamine and one mole of a dimerized polyunsaturated monocarboxylic acid of 18 carbons in an amount such that the lubricating oil composition contains about 3% to about 20% by weight of said condensation product.

6. In the method of operating a spark ignition two-cycle engine whereby a liquid hydrocarbon fuel boiling in the gasoline boiling range and having a lubricating oil mixed therewith is passed through a fuel supply system into a combustion chamber of said engine and said fuel/lubricating oil mixture is caused to ignite therein, the improvement comprising operating said engine on a fuel/lubricating oil mixture wherein said lubricating oil contains the product which is obtained by condensing one mole of N-(10-phenylstearyl)-1,3-propylenediamine with each equivalent of an acid which is a mixture of about 3 parts by weight of a dimerized polyunsaturated monocarboxylic fatty acid of 18 carbons and about 1 part by weight of a trimerized polyunsaturated monocarboxylic fatty acid of 18 carbons in an amount such that the lubricating oil composition contains about 3% to about 20% by weight of said condensation product.

7. In the method of operating a spark ignition two-cycle engine whereby a liquid hydrocarbon fuel boiling in the gasoline boiling range and having a lubricating oil mixed therewith is passed through a fuel supply system into a combustion chamber of said engine and said fuel/lubricating oil mixture is caused to ignite therein, the improvement comprising operating said engine on a fuel/lubricating oil mixture wherein said lubricating oil contains a diamide having the formula



wherein R_4 is a hydrocarbylene group of about 5 to about 35 carbons and R_1 is a hydrocarbyl group of about 5 to about 25 carbons in an amount such that the lubricating oil composition contains about 3% to about 20% by weight of said diamide.

References Cited

UNITED STATES PATENTS

2,718,503	9/1955	Rocchini	44—66 X
3,169,980	2/1965	Benoit	252—51.5 A
3,219,666	11/1965	Norman et al.	252—51.5 A
3,296,133	1/1967	Ratner et al.	44—58 X
3,310,492	3/1967	Benoit	252—51.5 A
3,337,459	8/1967	Ford	44—58 X

DANIEL E. WYMAN, Primary Examiner

W. J. SHINE, Assistant Examiner

U.S. Cl. X.R.

44—58, 63, 66, 71