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LUBRICANT

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This invention relates to lubrication and to lubricants and to the method of making lubricants. Specifically it relates to the modification of thin film lubricants through the addition of compounds of the general formula

$$RNHC(=O)OR'$$

where R is a hydrogen atom, an alkyl, alicyclic, or aryl group and R' is an alkyl, alicyclic, or aryl group, and where the total carbon content of R and R' is at least four carbon atoms.

Agents previously used for thin film lubrication include such materials as alkyl and aryl phosphates, mono esters of dibasic acids, chlorinated hydrocarbons, and chlorinated esters of long-chain acids.

An object of the present invention is to provide materials which when brought into contact with metal bearing surfaces will form a lubricating film between said surfaces, which lubricating film will adhere to metal surfaces and resist high pressures. Another object is to provide materials which when added to lubricating oils will improve their properties, particularly their oiliness characteristics. Still another object is to provide a method for retarding the wearing, scuffing, and seizing of bearing surfaces adapted to operate at high bearing pressures by contacting said surfaces with materials which will form adherent films on such bearing surfaces, which films do not break down under high bearing pressures. A further object is to provide lubricating compositions which, when brought into contact with bearing surfaces, will form a lubricating film which will adhere to said bearing surfaces and resist high pressures. Another object is to provide neutral lubricating compositions of high stability which when subjected to the temperatures and oxidizing conditions of service will resist breakdown to form sludge and corrosive acids. Another object is to provide a process for improving the oiliness and film strength of lubricants. Still another object is to provide a process for improving the film strength of lubricants. Also this invention has as its object a method for maintaining a lubricating film between bearing surfaces. Other objects will appear hereinafter.

These objects are accomplished by admixing with a lubricant an ester of the hypothetical carbamic acid, having the general structure

$$R—NHC(=O)—OR'$$

where R may be a hydrogen atom, an alkyl, alicyclic, or aryl group, and R' represents an alkyl, alicyclic, or aryl group, and where the total carbon content of R and R' is at least four carbon atoms, and by using said resulting lubricating composition as a lubricant for bearing surfaces of relatively moving bodies.

Preferably the lubricating medium will be a hydrocarbon oil or grease, but other oils or greases may be used; e. g., the animal and vegetable fats and oils.

The term "bearing surface", as used herein and in the claims will be understood to mean surfaces which mutually carry a load and move relatively to each other.

Long-chain esters of carbamic acid suitable for use in the present invention may be prepared by any of the well-recognized methods in organic chemistry such as by reaction of chlorcarbonates with suitable amines or by addition of an isocyanate to an alcohol. General equations for these reactions are:

$$RO—C(=O)—Cl+H_2NR' \longrightarrow RO—C(=O)—NHR'+HCl$$

$$R'NCO+ROH \longrightarrow ROC(=O)—NHR'$$

The compounding of the carbamates of this invention with the oil or grease may be accomplished by any one of a number of methods being employed in the petroleum industry for adding materials to oils and grease. For example, the lubricating composition may be prepared by heating and stirring the mineral oil and carbamate in the desired proportions until solution is complete. Heating is employed to facilitate solution primarily because it decreases the viscosity of the mineral oil and therefore permits more adequate mixing. The concentration of carbamate is generally from one to five per cent by weight of the oil and the temperatures of mixing are usually below 100° C.

The addition of these materials to lubricating oils improves "oiliness' as shown by the lowering of the coefficient of static friction. The effect

on this constant was determined by measuring the force required to start in motion a triangular steel plate, riding on three fixed ball bearings, over a second steel plate with a highly polished surface to which the lubricant has been applied. Examples of results obtained on a naphthenic base SAE 20W oil are as follows:

Compound added to oil	Concentration percent by weight	Coefficient of static friction	Percent reduction in coefficient
None	0	0.26	
Carbamate obtained from alcohols of boiling range 133°–150° C., secured by catalytic hydrogenation of carbon oxides	1	0.21	18
Carbamate obtained as above from alcohols of boiling range 150°–200° C	1	0.17	34
Carbamate obtained as above from alcohols of boiling range 200°–275° C	1	0.17	34
N-phenyl dodecyl carbamate	1	0.19	26
Hexa-(N-dodecyl) carbamate of sorbitol	1	0.15	42
N-dodecyl carbamate of isopropyl ethinyl carbinol	1	0.20	30

These materials also improve film strengths of lubricating oils. The method of testing the compounds was that devised by J. O. Almen (Oil and Gas Journal, 30, 109, 1931). This method consists of running a ¼" diameter drill rod between two halves of a split bushing which is maintained stationary. The load on the bushing is controllable and provision is made for measuring the torque developed by the friction of the lubricant film. A hydraulic system for increasing the loading on the bushing until the oil film breaks and the metal seizes is provided. The rubbing speed is about 50 feet per minute and the method of loading is gradual, one weight being added to the loading lever each ten seconds. Each weight added to the loading lever increases the pressure on the bushing by about 125 lbs. The machine provides for beam loadings up to 20 weights, which corresponds to a pressure of 20,000 lbs./sq. in. on the full projected area of the drill rod. The bearing surface of the bushing is cut to a diameter 0.007 inch larger than the drill rod so that, before any wear occurs, the actual bearing surface is a line. As wear occurs, the bearing surface widens but seldom covers the bushing. After a test, the width of the bearing scar can be measured and an approximate value for the actual bearing pressure obtained. The values given in the following examples represent the calculated actual bearing pressures which were reached in the tests without failure of the film. These values represent film strength or film resistance. Examples of the effect of these materials on film strength of a naphthenic base SAE 30 oil are as follows:

Compounds added to oil	Concentration percent by weight	Film strength lbs./sq. in.
None		2000
Carbamate obtained from alcohols of boiling range 133–150° C. and derived by catalytic hydrogenation of carbon oxides	1	7000
Carbamate obtained as above from alcohols of boiling range 160°–200° C	1	5000
Carbamate obtained as above from alcohols of boiling range 200°–275° C	1	4000
N-dodecyl ethyl carbamate	1	5000
N-phenyl dodecyl carbamate	1	4000

The above examples set forth well defined instances of the application of this invention. They are, however, not to be considered as limitations thereof since many modifications may be made without departing from the spirit and scope of this invention.

This invention covers generally compositions of matter comprising a lubricant and an ester of carbamic acid or an N-substituted carbamic acid. These compounds have the general formula

$$RNHC(=O)OR'$$

where R may be a hydrogen atom or a hydrocarbon radical (aryl, alicyclic, or alkyl), R' is a hydrocarbon radical, preferably aliphatic in character, and the sum of the carbon atoms in R and R' is at least four.

Examples of suitable carbamates for use in this invention are: dodecyl carbamate, N-dodecyl ethyl carbamate, N-naphthyl ethyl carbamate, N-isobutyl cyclohexyl carbamate, and N-ethyl oleyl carbamate. Those prepared from the alcohols obtainable by the catalytic hydrogenation of carbon oxides are especially suitable for the purposes of this invention since they are generally liquids, easily dissolved by mineral oils, and show relatively high film strengths and lowering of the coefficient of static friction.

The addition of as small an amount as 0.05% of the carbamates of this invention to an oil will have a noticeable effect on its properties. For practical purposes, however, it is generally desirable to use from 1% to 10% based on the oil. The actual concentration will depend on the particular compound or mixture of compounds employed and the purpose to which the oil is to be put. For example, it is generally advisable to use higher concentrations in gear oils than in internal combustion engine lubricants. Concentrations up to 20% might be used in some special cases. Further, the amount added to the oil or other lubricating medium will be largely dependent upon the machinery to which it is applied and the area of the metal surfaces with which it will be brought in contact.

A lubricating composition coming within the scope of this invention may be prepared by dissolving in the mineral oil the necessary reactants to produce a carbamate and causing these materials to react.

The present invention permits the production of lubricating oils with a high degree of "oiliness" and superior film strength through the addition of stable relatively non-toxic materials which do not increase the acidity or the corrosive action of the oil, or the tendency to gum or sludge under conditions existing in service. The materials contain no inorganic constituents and cannot leave deposits of an inorganic character on bearing surfaces or other moving parts.

It is apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof and therefore it is not intended to be limited except as indicated in the appended claims.

I claim:

1. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of a compound having the formula

$$RHNCOR'$$
$$\|$$
$$O$$

wherein R is a member of the group consisting of hydrogen and hydrocarbon radicals, R' is a hydrocarbon radical, and wherein the total car-

bon content of R and R′ is at least four carbon atoms.

2. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of a compound having the formula

$$RHNCOR'$$
$$\|$$
$$O$$

wherein R is a member of the group consisting of hydrogen and hydrocarbon radicals, R′ is an aliphatic hydrocarbon radical, and wherein the total carbon content of R and R′ is at least four carbon atoms.

3. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of a compound having the formula

$$H_2NCOR'$$
$$\|$$
$$O$$

wherein R′ is a hydrocarbon radical containing at least four carbon atoms.

4. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of a compound having the formula

$$H_2NCOR'$$
$$\|$$
$$O$$

wherein R′ is an aliphatic hydrocarbon radical containing at least four carbon atoms.

5. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of a compound having the formula

$$RHNCOR'$$
$$\|$$
$$O$$

wherein R is a hydrocarbon radical, R′ is a hydrocarbon radical, and wherein the total carbon content of R and R′ is at least four carbon atoms.

6. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of a compound having the formula

$$RHNCOR'$$
$$\|$$
$$O$$

wherein R is a hydrocarbon radical, R′ is an aliphatic hydrocarbon radical, and wherein the total carbon content of R and R′ is at least four carbon atoms.

7. A lubricant in accordance with claim 1 characterized in that the compound is present in an amount of about 1% to about 10% by weight of the lubricating oil.

8. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of compounds having the formula

$$H_2NCOR'$$
$$\|$$
$$O$$

wherein R′ is an aliphatic hydrocarbon radical of at least 4 carbon atoms and which compounds are derived from alcohols obtained by the catalytic hydrogenation of carbon oxides.

9. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of compounds having the formula

$$H_2NCOR'$$
$$\|$$
$$O$$

wherein R′ is an aliphatic hydrocarbon radical of at least 4 carbon atoms and which compounds are derived from alcohols obtained by the catalytic hydrogenation of carbon oxides which alcohols have a boiling range of 133° C. to 150° C.

10. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of compounds having the formula

$$RHNCOR'$$
$$\|$$
$$O$$

wherein R is a hydrocarbon radical and R′ is a long chain aliphatic hydrocarbon radical.

11. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of N-phenyl dodecyl carbamate.

12. A lubricant comprising a lubricating oil having incorporated therein a minor proportion of N-ethyl oleyl carbamate.

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