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LUBRICANTS

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This invention is that of mineral-type lubricant compositions having improved extreme pressure characteristics especially improved film strength, and containing a major portion of a mineral-type lubricant and a small amount, sufficient to increase the film strength of the lubricant, of a film strength enhancer of a particular type. The particular type of film strength enhancer broadly viewed is a di(halogen-substituted aliphatic hydrocarbon radical) aliphatic hydrocarbon phosphonate that is sufficiently soluble in the mineral-type lubricant to provide in it a sufficient concentration of the phosphonate significantly to enhance the film strength of the lubricant. Such phosphonates are described more specifically below.

By "mineral-type lubricant" is intended the lubricating oils and greases of petroleum origin as well as the compounded oils and greases that have chemical and physical characteristics similar to the petroleum origin lubricating oils and greases.

The many difficult lubricating problems presented by the drastic conditions to which modern machines with moving parts are subjected have created a great demand for lubricants that provide tough, compression resistant films on metal surfaces. In addition, these films must hold up at high temperatures, be inert to water and non-corrosive to the parts they contact. As long as the film is not ruptured, metal to metal contact is avoided and seizure between the parts moving against one another does not occur.

Numerous compounds have been proposed for inclusion in mineral-type lubricants to improve their extreme pressure characteristics. However, many of them are not sufficiently soluble in the lubricant to enable including a concentration sufficient to provide suitable enhancement of these characteristics. Others are unstable as the temperature is elevated. Many are corrosive to the surfaces to be lubricated, and still others are adversely effected by water. Then also, many exhibit several and even all of these and other shortcomings.

The mineral-type lubricant compositions of the invention lack these various shortcomings, by their containing dissolved in the mineral-type lubricant a film strength improving concentration of a film strength enhancer of the invention. Considered broadly, the latter is a di(halogen-substituted aliphatic hydrocarbon radical) aliphatic hydrocarbon radical phosphonate soluble in the mineral-type lubricant in a quantity sufficient significantly to enhance its film strength characteristics, inert to water, stable at elevated temperatures and non-corrosive to ferrous and non-ferrous metals and their alloys, used in machinery requiring lubricants, and having the general formula

$$(X\cdot R\cdot O)_2\overset{O}{\overset{\|}{P}}\cdot R_1$$

In this general formula, X is a halogen radical such as chlorine, bromine, or fluorine; R is a divalent aliphatic hydrocarbon radical, straight or branched chain, saturated or unsaturated; and R_1 is a monovalent aliphatic hydrocarbon radical, beneficially lower-alkyl and advantageously unsaturated. The divalent radical R advantageously is straight chain lower-alkylene with one end carbon linked to the oxygen and the other to the halogen.

Advantageously effective among these film strength enhancers are the di(halo-lower-alkylene) lower-alkenyl phosphonates having the halogen linked to the outer end carbon. Strikingly advantageous among them are the di(beta-halo-ethyl) vinyl phosphonates and especially di(beta-chlorethyl) vinyl phosphonate.

Accordingly, the invention more specifically is that of mineral-type lubricant compositions containing a film strength improving quantity of a di(halo-alkyl) alkenyl phosphonate, with the halogen linked to the outer end carbon of the halo-alkyl radical, and the phosphonate having the characteristics of solubility in the lubricant, inertness to water, heat stability, and non-corrosiveness, as above described.

The mineral-type lubricant compositions of the invention can consist of the mineral-type lubricant and merely the film strength enhancer dissolved in it from a quantity just about sufficient significantly to enhance the film strength up to about ten percent by weight. However, since there can be admixed with mineral-type lubricants conventional additives such as antioxidants, dyes, pour point improvers, and agents to influence vicosity index, any or all of such substances compatible with their film strength enhancers can be included in the lubricant compositions of the invention.

Thus, in many of the embraced lubricant compositions, the mineral-type lubricant is not the only ingredient other than the film strength enhancer, because the composition contains one or more of the various conventional additives as just described. Accordingly, while the lubricant ingredient can be present in an amount under ninety percent, it should, in any event, be the greater or major portion of the composition, that is to say, at least more than half of it by weight.

The di(halo-alkyl) lower-alkenyl phosphonate of the type described above as applicable can be present in the lubricant compositions of the invention in an amount for example, with di(beta-chloroethyl) vinyl phosphonate, as little as one one-hundredth percent by weight up to the maximum given above.

The compositions are prepared by incorporating the selected film strength enhancer in the mineral-type lubricant by dissolving it in any that is liquid. It can be incorporated into any that is not liquid or any of the suitable greases, for example, by warming the grease till it is fluid enough to be stirred and then adding the enhancer and stirring till it is dissolved. The solution can then cool till it again is an unctuous grease.

The invention may be illustrated by, but not restricted to, the following examples:

Example 1.—In ninety-nine and one-half pounds of SAE #20 solvent extracted Mid-Continent lubricating oil there was homogeneously dissolved one-half pound of di(beta-chloroethyl) vinyl phosphonate.

Example 2.—In ninety-nine pounds of the oil of Example 1 there was similarly dissolved one pound of di(beta-chloroethyl) vinyl phosphonate.

Example 3.—In ninety-eight parts of the oil of Example 1 there were similarly dissolved two pounds of di(beta-chloroethyl) vinyl phosphonate.

The lubricant composition of each of the examples was tested on the Burns-type Almen machine for evaluating film strength. In each case the limit of the weight load (twenty-four pounds) was added to the weight carrier suspended from the beam, but no seizure occurred between the bearing and the shaft and the milled end

of the shaft was not sheared off. This showed that the film strength of the composition of each of these examples withstands a projected bearing surface pressure exceeding 94,746 pounds per square inch (the limit of the machine). H. H. Zuidema's "The Performance of Lubricating Oils" (1952), Reinhold Publishing Corporation, New York, N. Y., describes the Almen machine. There is but little difference between it and the Burns-type Almen, in that the Burns-type permits greater pressures to be applied and in it the bearing is rotated at one hundred R. P. M.

The specific lubricating oil used in Examples 1, 2 and 3 can be replaced by any other petroleum source mineral oil or grease or equivalent compounded oil or grease in the same proportions or with any suitable proportion, within the disclosed range, of the film strength enhancer that contributes to the resulting composition a suitable degree of film strength enhancement. Thus, the film strength enhancer can constitute, for example, from about one one-hundredth to about ten percent of the weight of the lubricant composition.

The di(beta-chloro-ethyl) vinyl phosphonate is commercially readily available and is especially effective because of its liquidity, ready solubility in the mineral oils and greases, high boiling point and low vapor pressure, stability at elevated temperatures, inertness to water, non-corrosiveness to the metals of the types above described, mild pleasant odor, and water-white color. In addition to the vastly improved film strength imparted by it to the lubricant, the resulting composition shows markedly reduced coefficient of friction.

Moreover, the di(beta-chloro-ethyl) vinyl phosphonate film strength enhancer used in the examples can be replaced by a comparable amount of any other suitable di(beta-halo-ethyl) vinyl phosphonate or di(halo-lower-alkyl) vinyl phosphonate or di(halo-lower-alkyl) lower alkenyl phosphonate, in which the halogen is linked to an outer end carbon, and which phosphonates are soluble in the mineral-type lubricants up to about ten percent of the total weight, are inert to water, stable at elevated temperatures, and non-corrosive to the surfaces of the metals of the type above described.

In addition to the film strength enhancer, any of the lubricating oil compositions of the examples or of any of the above described possible modifications of them, can contain a suitable amount of any one or more of the conventional additives such as antioxidants, dyes, pour points improvers, and agents to enhance the viscosity index, so long as it is compatible with the film strength enhancer used.

While the invention has been explained by detailed description of certain specific embodiments of it, it is understood that various substitutions and modifications can be made in the lubricant compositions embraced by the invention within the scope of the appended claims which are intended to cover also equivalents of the specific embodiments.

What is claimed is:

1. A mineral oil lubricant composition comprising (*a*) a major proportion of a mineral oil lubricant selected from the class consisting of mineral oils and greases, and (*b*) as the film strength enhancing constituent of said composition a small amount, sufficient to enhance the film strength of the lubricant, of a di(halo-alkyl), mono-olefinic aliphatic hydrocarbon-radical-substituted phosphonate additive wherein the mono-olefinic hydrocarbon radical is linked by a carbon directly to the phosphorus and each of the two halo-alkyl radicals is linked respectively to a separate one of the oxygens linked to the phosphorus, which additive is soluble in the lubricant ingredient at least in said small amount and, in such small concentration in the lubricant, is inert to water, stable at elevated temperatures, and non-corrosive to the ferrous and non-ferrous metals and their alloys that are used in devices requiring lubricants; said composition having enhanced film strength over that which the mineral-type lubricant itself has without this additive.

2. A mineral oil lubricant composition as claimed in claim 1, wherein the halo-alkyl groups are halo-lower-alkyl and each with its halogen linked to its outer end carbon, and the mono-olefinic aliphatic hydrocarbon radical is lower aliphatic, and the thus substituted phosphonate is present in the range of from about one one-hundredth to about ten percent by weight of the composition.

3. A mineral oil lubricant composition comprising (*a*) a major proportion of a mineral oil lubricant selected from the class consisting of mineral oils and greases, and (*b*) as the film strength enhancing constituent of said composition a small amount, sufficient to enhance the film strength of the lubricant, of a di(chloro-lower-alkyl) vinyl phosphonate additive wherein the vinyl group is linked directly to the phosphorus and each chloro-alkyl group has its chlorine linked to the outer end carbon and is linked respectively to a separate one of the oxygens linked to the phosphorus, which additive is soluble in the lubricant ingredient at least in said small amount, and in such small concentration in the lubricant, is inert to water, stable at elevated temperatures, and non-corrosive to the ferrous and non-ferrous metals and their alloys that are used in devices requiring lubricants; said composition having enhanced film strength over that which the mineral oil lubricant itself has without this additive.

4. A mineral oil lubricant composition comprising (*a*) a major proportion of a mineral oil lubricant selected from the class consisting of mineral oils and greases, and (*b*) as the film strength enhancing constituent of said composition a small amount, sufficient to enhance the film strength of the lubricant ingredient, of di(beta-chloro-ethyl) vinyl phosphonate, said composition having enhanced film strength over that of the mineral oil lubricant itself.

5. A lubricant composition as claimed in claim 4, wherein the lubricant ingredient is a mineral lubricating oil.

6. A mineral oil lubricant composition comprising (*a*) a major proportion of a mineral oil lubricant selected from the class consisting of mineral oils and greases, and (*b*) as the film strength enhancing constituent of said composition di(beta-chloro-ethyl) vinyl phosphonate within the range of from about one one-hundredth to about ten percent by weight of the composition, said composition having enhanced film strength over that of the mineral oil lubricant itself.

7. A lubricant composition as claimed in claim 6, wherein the lubricant ingredient is a mineral oil and the di(chloro-ethyl) vinyl phosphonate is present as one percent of the composition by weight.

8. A lubricant composition as claimed in claim 6, wherein the lubricant ingredient is a mineral oil.

9. A lubricant composition as claimed in claim 8, wherein the lubricant ingredient is SAE #20 solvent extracted Mid-Continent lubricating oil.

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