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LUBRICANT

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Our invention relates to a grease-like composition for use in lubricating, sealing or coating metallic surfaces, and one object thereof is to provide a lubricant having high load-carrying properties when applied to complementary metal surfaces.

Another object of our invention is to provide a lubricant having relatively low shear values at low temperatures and which, at high temperatures, does not flow away from bearing surfaces or out of spaces designed to hold reserve supplies of the lubricant.

More specifically, the object of our invention is to provide a grease-like lubricant in the form of an emulsion which is stable under a wide range of conditions.

At the outset, in order to obtain a more clear and comprehensive understanding of the background underlying our invention, it should be realized that fundamentally an emulsion consists of particles or drops of one liquid suspended in another liquid, and, by definition, presumes that the two liquids are mutually insoluble. Two very common types of emulsions are (1) those in which drops of oil or other water-insoluble liquid are suspended in water; or (2) those in which drops of water are suspended in oil or other water-insoluble liquid. As a variation, it is also possible to prepare emulsions in which a solid wax, for example, paraffin wax, is emulsified with water while in the molten or liquid state.

We have discovered that it is possible to prepare stable emulsions of two oils without adding water and without the use of heat, and by so doing we obtain emulsions which have grease-like characteristics and excellent lubricating properties. Specifically we have obtained emulsions by mixing castor oil with various petroleum oils which are neither soluble in nor solvents for castor oil.

We are aware that the prior art is replete with examples of methods of treating mixtures of castor oil and petroleum oil in order to render these two components mutually soluble, but the results to date have not proved entirely satisfactory. It is the presence of the hydroxyl group in castor oil which renders it insoluble in petroleum oil, but it is this hydroxyl group which gives castor oil its enhanced oiliness and hence makes it a desirable component in a lubricant. This valuable property of castor oil is preserved in the lubricant of our invention, since it relies upon the mutual insolubility of castor oil and petroleum oil for its effectiveness. There are some petroleum oils in which castor oil is normally soluble to a limited extent, but our invention depends on the use of those grades of castor oil and petroleum oil which are not mutually soluble. It should be further understood that it is the commonly available grades which are used in producing our improved lubricant.

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In preparing these emulsions we have found that bentonite, which is employed as an accelerator and stabilizer in emulsions made up of water and various oils, fats, and waxes is also capable of accelerating and stabilizing the dispersions to some degree of one of these oils in the other. The term "bentonite," as used here and in the following discussion, refers to natural clays which occur in many locations and of which there are numerous varieties. The term is generally accepted as applying to those natural clays which are of volcanic origin, which contain montmorillonite and/or beidellite as the predominating clay minerals, and which are capable of being dispersed into mica-like plates which are of visible dimensions in two space directions but submicroscopic and colloidal in the third direction, perpendicular to the mica-like plates.

In addition to bentonite other non-metallic solids, powdered metals, and mixtures of bentonite have been tried with some of these others. Considering the solid material or mixture of solid materials as one component (the bentonites are actually mixtures), all of these may be considered as three-component emulsions having two non-aqueous liquid phases and one solid phase. When the total amount of oil in any one of these emulsions is no greater than that accounted for by the oil-absorption value of the solid material the dispersions have a putty-like consistency and are apparently stable. The amount of oil required to produce such a mixture is determined by the oil absorption capacity of the solid component. Between any of these apparently stable putty-like mixtures there are no outstanding differences in consistency or stability which can be attributed to the choice of solid or solids. When the total amount of oil is greater than that accounted for by the oil absorption value of the solid component all of the resulting emulsions are unstable; and if these are allowed to stand undisturbed there is always a tendency for the oil and solid phases to separate. In the case of emulsions of this type, however, there are outstanding differences in stability and consistency which can be attributed to the choice of solids. Specifically, the mixtures containing bentonite as the solid component are more unctuous and separate much more slowly than the mixtures from which the clay minerals

which characterize bentonite are absent. This is true of the mixtures containing bentonite as the only solid constituent. It is also true of the mixtures which contain appreciable amounts of bentonite in addition to some other solid constituent. Moreover, there are obvious differences between the commercial grades of bentonite with respect to their ability to stabilize these emulsions. As an example, the grades in which the characteristic clay minerals have been concentrated by air flotation are obviously more effective than the commonly available foundry grades when either grade is used alone and also when either grade is used in combination with other solid materials. These observations indicate that it is the characteristic clay minerals which are responsible for the behaviour of bentonites in these emulsions. It is believed, therefore, that any mixture containing appreciable amounts of the two clay minerals which characterize bentonites or of any other solid which is similarly capable of being broken up into particles having colloidal dimensions should be capable of accelerating and stabilizing to some degree dispersions of one of these oils in the other.

The above three-component mixtures have fair to good lubricating qualities but they have certain undesirable qualities which are always inherent in solid-liquid mixtures from which the solid phase tends to separate from the liquid phase. We have discovered that the three-component emulsions which contain the bentonite type clay minerals can be stabilized by the addition of another non-aqueous liquid, and for this purpose we have employed members of the general group of chemical compounds known as the lower alkyl phosphates. Specifically, we have obtained good results with triethyl phosphate and with tributyl phosphate. It is apparent that other compounds having somewhat similar properties will be similarly capable of stabilizing these emulsions.

For any one of the partially stabilized three-component mixtures which contain the bentonite type clay minerals there is some critical minimum amount of the fourth component which must be added to completely stabilize the emulsion. When this amount has been added there is a sharp change from a consistency similar to that of a thick paint to a grease-like consistency. In the former condition the mixture, while very viscous, still flows. When the critical minimum amount of the stabilizing agent has been added the mixture no longer flows, and, in this condition, the solid phase will not separate from the liquid phase as a result of standing undisturbed. The consistency of these mixtures can easily be made such that, while soft and easily spread on metal surfaces with brush or spatula, they have enough cohesion that it does not drip nor flow from the container as do ordinary solid-in-oil suspensions. Additional small increments of the stabilizing agent do not produce any outstanding changes in consistency, although, since the stabilizing agent is a liquid, large additions will obviously produce a dilution effect. As an example, additions of stabilizing agent of the order of 1–2% have been sufficient to stabilize most of the mixtures with which we have worked. Where 2% has been sufficient, additions up to 5% have not noticeably changed the physical properties.

In these four-component emulsions the bentonite type clay minerals and the liquid stabilizing agent appear to supplement one another. In no case were we able to obtain a completely stable emulsion when the liquid stabilizing agent was absent, even though bentonite was present in large quantities; and in no case were we able to get a completely stable emulsion when the liquid stabilizing agent was present and the bentonite type clay minerals were known to be absent. This was true even though the total percentage of solids was greater than that of some of the stable mixtures containing bentonite, and when the solids used were ground to a particle size which was equivalent to that of the dry bentonite as shown by sieve tests. As in the case of the three-component mixtures, this difference in behaviour is attributed to the fact that the small aggregates of the bentonite clay minerals break up into still smaller particles having colloidal dimensions when dispersed in a liquid, whereas the other solids do not behave in a similar manner. In the case of emulsions containing mixtures of bentonite and other solids, the air-floated grades of bentonite were more effective than the more common grades. As in the case of the three-component emulsions, this is attributed to the fact that the characteristic clay minerals have been concentrated in the air-floated grade.

The following formulas are typical of the mixtures with which we have been working:

	Formula No. 1	Formula No. 2
	Percent	*Percent*
Castor oil	22.0	22.0
Petroleum oil	22.0	22.0
Bentonite	27.5	37.0
Lithopone	27.5	17.0
Triethyl phosphate	1.0	2.0
	100.0	100.0

Both contain the same amounts and grades of castor oil and petroleum oil, and both contain the same grade of lithopone and the same stabilizing agent. When the triethyl phosphate was left out of the above mixtures neither was completely stable. When it was added in the amounts indicated both were completely stable, the lithopone being primarily a combined whitening agent and filler.

The actual composition of these mixes can be varied over wide limits, depending on the specific purpose for which the final product is to be used and the consistency desired. The solid phase can be entirely a commercial grade of bentonite (a natural mixture) or it can be an artificial mixture of bentonite and some other solid or solids. In the latter case the bentonite should preferably amount to not less than 25% of the total amount of solid material, although the amount actually required may be somewhat less than that. The critical minimum amount of bentonite depends on the concentration of characteristic clay minerals, on the nature of the other solid or solids, and on the grades and relative amounts of the two oils used. Because of the fact that the bentonite and liquid stabilizer are supplementary in their activity a deficiency in the former can be overcome by using more of the latter. The bentonite cannot be eliminated altogether, however, and from a practical standpoint it is preferable to use more of the bentonite than the minimum amount necessary and then use correspondingly less of the liquid stabilizer. The oils can conveniently be varied within a range of 5% of castor oil and 95% of petroleum oil to 95% of castor oil and 5% of petroleum oil. Here, again, the critical minimum amount of one oil or the other will depend on the character of the other constituents

in the entire mixture, but completely stable emulsions were not obtainable unless an appreciable amount of both oils was present. The ratio of total oil to total solids is limited on one side by the oil absorption capacity of the solids and on the other side by the consistency desired in the final mixture. The total amount of oil will always exceed the oil absorption capacity of the solids present, with the amount of this excess oil depending on the grades of oils used and the dispersing power of the bentonite or other colloidal material. In general, the total oil content of these mixtures can conveniently vary between 35% and 65% by weight and the liquid stabilizing agent between 0.5% and 5.0%. The balance will be solids, of the total of which not less than 25% should be bentonite or equivalent material.

By proper selection of the petroleum oil it is possible to take advantage of both the high and low temperature properties of the castor oil and obtain mixtures which will have low shear values at low temperatures and which at higher temperatures do not flow away from bearing surfaces or out of spaces designed to hold reserve supplies of the lubricant. The presence of the mica-like plates having colloidal thickness prevents seizing of complementary metal surfaces and thereby imparts extreme pressure characteristics to these lubricants. This characteristic is enhanced by the added presence of the lower alkyl phosphates, but the use of these chemicals should not be confused with the use of sulfur, sulfur compounds, and chlorine compounds which are commonly employed for the purpose of imparting extreme pressure resistant characteristics to lubricating oils. The lower alkyl phosphates are added for the specific purpose of stabilizing these emulsions, whereas the sulfur and chlorine compounds mentioned will not accomplish this result.

While the product herein described is well adapted for fulfilling all the objects of our invention, it is to be understood that various modifications and changes may be made without departing from the spirit of the invention, and we therefore desire to be limited only by the scope of the appended claims.

We claim:

1. A grease-like lubricant comprising 5 to 45% castor oil and 5 to 45% petroleum oil, the said oils being in such proportions and character that they are not mutually soluble, bentonite clay, and a non-aqueous and soap free liquid stabilizing agent consisting of the lower alkyl phosphate group such as triethyl and tributyl phosphate, the amount of the oils present being greater than

that represented by the oil-absorption value of the bentonite clay, the amount of the said liquid stabilizing agent being sufficient to prevent a separation of the bentonite clay and the said oils into two distinct solid and liquid phases.

2. A grease-like lubricant comprising 5 to 45% castor oil and 5 to 45% petroleum oil, the said oils being in such proportions and character that they are not mutually soluble, bentonite clay, and a non-aqueous and soap free liquid stabilizing agent consisting of the lower alkyl phosphate group such as triethyl and tributyl phosphate, the amount of the oils present being greater than that represented by the oil-absorption value of the bentonite clay, the amount of the said liquid stabilizing agent being not more than 5% of the total weight of the mixture.

3. A grease-like lubricant comprising 5 to 45% castor oil and 5 to 45% petroleum oil, the latter oils being in such proportions and character that they are not mutually soluble, bentonite clay, and a liquid stabilizing agent consisting of the class of the lower alkyl phosphate group such as triethyl and tributyl phosphate, the amount of oils present being greater than that represented by the oil-absorption value of the bentonite clay and in which the amount of the said stabilizing agent is sufficient to prevent a separation of the bentonite clay and the said oils into distinct solid and liquid phases.

4. A grease-like lubricant comprising in combination an oil emulsion of castor oil and mineral oil in the range of 35% to 65% by weight, a liquid stabilizing agent consisting of the class of the lower alkyl phosphate group such as triethyl and tributyl phosphate in the range of 0.5% to 5.0% by weight, and the balance consisting of a solid mixture of bentonite and lithopone, the said bentonite being at least 25% by weight of the solid mixture.

5. A grease-like lubricant comprising 5 to 45% castor oil and 5 to 45% petroleum oil, the said oils being in such proportions and character that they are not mutually soluble, bentonite clay, and a non-aqueous and soap free liquid stabilizing agent consisting of the lower alkyl phosphate group such as triethyl and tributyl phosphate, the amount of the oils present being greater than that represented by the oil-absorption value of the bentonite clay, the amount of the said liquid stabilizing agent being sufficient to prevent a separation of the bentonite clay and the said oils into two distinct solid and liquid phases.

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