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LUBRICANT

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This invention relates to the art of lubrication and is more particularly concerned with new and improved extreme pressure lubricant compositions. More specifically, the present invention provides non-hydrocarbon, extreme pressure lubricant compositions having an outstanding combination of properties.

As is well known to those familiar with the art, during the past few years, automobile design has involved the use of smaller gears of the worm and hypoid type which operate under extremely high pressure loads. Consequently, for effective lubrication, lubricants capable of withstanding pressures appreciably higher than those at which an ordinary hydrocarbon lubricant film will rupture have been required.

In order to obtain some indication of the extreme pressure characteristics of lubricants of this type, various tests have been devised by the automotive and oil industries. The so-called Almen pin test is typical of these tests. It involves the controlled and measured application of load to relatively moving metal surfaces lubricated by the lubricant undergoing testing. The efficacy of the lubricant is measured by the magnitude of the load applied while failure to pass the test is indicated by seizure or scoring of the metal surfaces involved.

The ever-increasing demand for extreme pressure lubricants has led to the development of various extreme pressure addends and to their proposed incorporation in mineral lubricating oils in amounts sufficient to improve their extreme pressure characteristics. The chemically active type of extreme pressure addends are, as is well known to the art, the most widely used. Presumably, these materials possess the property of reacting chemically with the metal surfaces to be lubricated, under the conditions of operation, to produce thereon films or coatings that are capable either of withstanding by themselves the extreme pressure loads or to increase the viscosity of the oil, through a mechanism not too well understood, thereby protecting the relatively moving metal surfaces against seizure and scoring.

In addition to the property of being able to withstand extreme pressure loads, there are other factors that must be considered in evaluating an extreme pressure lubricant. Among the most important are the tendency of the extreme pressure lubricant to corrode the containers in which it is stored and the bearings, gears and housings with which it comes in contact during use, the odor of the material, and the pour point of the lubricant. Numerous materials have been developed in attempts to meet these requirements satisfactorily. In so far as is known, however, no single combination of a mineral lubricating oil with an extreme pressure

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addend of the prior art is outstanding in this respect.

It has now been discovered that combinations of liquid, non-hydrocarbon vehicles with certain types of finely subdivided, crystalline solids, are outstanding extreme pressure lubricants. It has been found that these combinations meet all of the important factors enumerated hereinbefore satisfactorily.

Accordingly, it is a broad object of the present invention to provide new compositions of matter. It is another object to provide new and improved extreme pressure lubricants. It is a further object to afford new and improved extreme pressure lubricants which are non-corrosive, and substantially odorless. It is a more specific object to provide non-hydrocarbon extreme pressure lubricants. It is a very important object to provide non-hydrocarbon, viscosity-independent, extreme pressure lubricants which are outstanding from the standpoint of performance, odor, non-corrosive properties and pour point. Other objects and advantages of the present invention will become apparent to those skilled in the art from the following description and discussion.

Broadly stated, the present invention provides lubricants which comprise a polar, normally liquid substance and a comminuted, inorganic, crystalline solid having low-shear strength properties under shearing stresses at relatively high pressures. Tests have indicated that the lubricating properties of these compositions are largely due to the inorganic, crystalline solids.

For the primary purpose of providing a more complete understanding of the scope of the present invention, but without any intent of limiting the same, the mechanism whereby the compositions contemplated herein effect lubrication, stripped to its essentials, may be postulated to be as follows: The liquid serves two main purposes. In the first place, it functions as a vehicle to transport the inorganic, crystalline solid to and between the relatively moving metallic surfaces to be lubricated. In the second place, it functions as a coolant and heat distribution agent. Since, as stated hereinbefore, the lubrication is effected largely by the inorganic, crystalline solid having low-shear strength properties under shearing stresses at relatively high pressures, it follows that this solid must exist as such and must be deposited between the relatively moving metallic surfaces. Accordingly, it must be present in a sufficiently finely subdivided state to enter the space between the surfaces to be lubricated and to be present therein in sufficient concentrations to achieve the desired lubrication. This implies either that the crystalline solid must adhere to the metallic surfaces or

that its travel through the space is retarded through at least momentary adhesion.

It is common knowledge that metallic surfaces such as are encountered in bearings are readily wetted by non-polar liquids, exemplified by lubricating oils. It has now been found that, in the presence of lubricating oil, the crystalline solid does not readily adhere to metallic surfaces such as are encountered in bearings. On the other hand, it has now been found that, in the presence of polar liquids, exemplified by water, the crystalline solid will adhere to the metallic surfaces under discussion. Indeed, test data clearly indicate that the compositions contemplated herein are far superior to those in which the polar liquid is replaced with lubricating oil. Therefore, the polar liquid will not only carry the crystalline solid at the place where it is needed but, in addition, it will make it possible for the crystalline solid to adhere to the metallic surfaces to be lubricated.

Accordingly, the liquid materials to be used in the compositions contemplated herein are, in general, polar liquids. Water, glycerine, ethylene glycol and mixtures thereof are mentioned by way of non-limiting examples of liquids suitable for the purposes of the present invention. It must be noted that these liquids possess relatively low pour points and are substantially non-corrosive with respect to the metallic surfaces with which they come in contact during use. Thus, for example, a 70 per cent by weight glycerine-water mixture freezes at -38°F . and a 50 per cent by volume ethylene glycol-water mixture freezes at a temperature below -40°F .

The inorganic, crystalline solids to be employed in the compositions contemplated herein are molybdenum disulfide, titanium disulfide, tin disulfide, zirconium disulfide and tungsten disulfide. It has been found that the extreme pressure lubricating properties of these materials is not to be ascribed solely to their crystallographic characteristics. Although this is an essential criterion, it is not by itself definitive of the ultimate performance of the system. Indeed, tests have shown that physically similar solids, in the same liquid, possess different lubricating properties, while the same solid, in different liquids possesses different lubricating effectiveness.

As stated hereinbefore, the inorganic, crystalline solid must be used in a sufficiently fine state of subdivision to enter the space between the surfaces to be lubricated. In the practice of the present invention, it has been found that the degree of comminution should be such that the material passes through a 325-mesh Tyler standard screen scale sieve.

The amount of inorganic, crystalline solid having the desired degree of comminution to be used may vary between wide limits. Thus, for example, concentrations of solid as small as about 0.5 per cent by weight may be employed, if desired. On the other hand, depending on the application to be effected, the solid may be used in sufficiently high concentration to produce thick pastes, i. e., about 90 per cent by weight. From the foregoing, it must be clearly understood that there is nothing critical in the amounts employed, it being apparent, to those familiar with the art, that the solid concentration will be largely determinative of the consistency of the compositions contemplated herein and that the concentration to be utilized in any given case will be more or less dictated by the use to which the material is to be put.

In the practice of the present invention, particularly where the consistency of the composition is relatively fluid, it is desirable, although not essential, to add a suspending agent to the compositions to maintain a substantial proportion of the solid material in suspension. Any water-soluble type surface active material may be used for this purpose. Ordinary soda soap and sodium oleate may be mentioned by way of non-limiting examples of suitable materials. The concentrations to be employed may vary between wide limits, viz., from about 0.01 per cent up to about 10 per cent by weight.

Representative of compositions of the present invention which have been found to be very effective are (percentages given by weight):

1. 10% MoS_2 , 88% H_2O , 2% sodium oleate.
2. 10% MoS_2 , 90% glycerine containing 5% water.
3. 10% MoS_2 , 84% glycerine containing 5% H_2O , 6% soda soap.
4. 5% MoS_2 , 93% glycerine containing 5% H_2O , 2% sodium oleate.
5. 5% MoS_2 , 94% H_2O , 1% sodium oleate.
6. 5% MoS_2 , 94% ethylene glycol, 1% sodium oleate.

The following examples are for the purpose of illustrating the compositions of the present invention and to point out the advantages thereof, it being understood that the invention is not to be considered as being limited to the specific polar liquids, solids and dispersants and to the concentrations of these components set forth therein. As it will be apparent to those skilled in the art, a wide variety of polar liquids, of dispersants and of solids, such as disclosed hereinbefore, and a diversity of concentrations of these components, as discussed hereinbefore, may be employed in formulating the compositions contemplated herein.

EXAMPLES 1-8

The Almen E. P. Lubricant Test employing the Almen test machine was used in each of these runs. The purpose of this test is to determine the ultimate load-carrying capacity of an extreme pressure lubricant. In the test, about 30 grams of the material to be tested are placed in a small metal cup with a $\frac{1}{4}$ -inch steel drill rod shaft rotating in a steel split bushing at 600 R. P. M. Weights are added at 10-second intervals to a loading lever adapted to apply pressure on the split bushing. Failure is evident by a change in the frictional torque-meter reading. The Almen value is expressed as the number of weights added. Each weight weighs two pounds and is equivalent to about 1000 pounds per square inch pressure. Test specimens are operated in the machine until (1) the frictional torque exceeds some high value approximating the shearing strength of the rotating pin; or (2) the bearing surfaces seize and the rotating pin shears, at which time, the frictional torque also exceeds this high value; or (3) until 3140 pounds normal load has been applied without the frictional torque exceeding the limiting value. The coefficients of friction are computed from the geometrical constants of the machine from the formula:

$$\bar{f} = \frac{\text{torque meter reading in pounds per square inch}}{\text{load meter reading in pounds per square inch}} \times 1.53$$

For convenience, the results of these tests ($\bar{f}$) are set forth in the table.

scribed in conjunction with preferred embodiments, it is to be understood that modifications

Table

Ex- ample No.	Material Tested	Number of Almen Weights																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	SAE-140 Gear Oil	0.229	0.172	0.140	0.143	¹ S																				
2A	SAE-140 Gear Oil + 5% MoS ₂	0.191	0.140	0.140	0.199	0.172	¹ S																			
2B		0.191	0.140	0.140	0.176	¹ S																				
2C		0.191	0.140	0.140	0.153			0.191	¹ S																	
2D		0.191	0.115	0.115	0.092			0.071		0.085	¹ S															
2E	Water + 10% MoS ₂ + 2% soda soap	0.191	0.191	0.124	¹ S																					
3	Water + 5% MoS ₂ + 1% Sodium Oleate					0.064				0.043	0.038	0.047	0.054	0.041							0.055	0.053	0.054			
4A	Glycerine + 10% MoS ₂ + 2% Sodium Oleate	0.191	0.115	0.069		0.049	0.043	0.042	0.059	0.076	¹ S															
4B		0.191	0.115	0.061		0.044	0.038	0.035	0.029	0.028	0.029	¹ S														
5	Glycerine + 10% MoS ₂ + 2% Sodium Oleate	0.268	0.140	0.082	0.071	0.064	0.059	0.050	0.051	0.067	0.056	0.060	0.050	0.043												
6	Glycerine + 5% MoS ₂ + 10% Sodium Oleate	0.268	0.140	0.084	0.066	0.060	0.066	0.100	0.079	0.077	0.072	0.064	0.063													
7	Glycerine + 10% MoS ₂ + 6% Soda Soap	0.191	0.102	0.076	0.082	0.064	0.056	0.047	0.046	0.047	0.044	0.055	0.058	0.055												
8	Ethylene Glycol + 5% MoS ₂ + 2% Sodium Oleate		0.127	0.084	0.066	0.055	0.049	0.041	0.038	0.036	0.036	0.040	0.040	0.040												

¹ Means seizure indicating that at the normal load applied, the lubricant fails and $\bar{f}$ assumes large values characteristic of metal-on-metal bearing.

From the data set forth in the table, it will become apparent that the compositions of the present invention are outstanding extreme pressure lubricants. The test results show that there is very little difference between an ordinary gear oil and the same gear oil containing an inorganic crystalline solid such as is utilized herein. On the other hand, when the oil is replaced with polar liquids, the resulting compositions are far superior. In this connection, it must be noted also that the compositions containing these polar liquids possess appreciably lower pour points.

In addition to the foregoing Almen E. P. Lubricant Tests, a lubricant of the type described in Example 3 was subjected to an actual gear test using a new Chevrolet hypoid third-member assembly, 9-37 ratio, installed in the axle housing of a Chevrolet passenger vehicle for which it was designed. The housing was filled with the lubricant and the vehicle was run about 20 miles at not over 25 miles per hour. At the end of this period, the clutch was engaged in high gear and the speed was accelerated (full throttle) to 40 miles per hour. Upon reaching this velocity, the throttle was closed and the speed was reduced to 10 miles per hour, with clutch engaged. This acceleration and reduction in speed was repeated four times. Then, the speed was accelerated, in high gear, to 60 miles per hour and upon reaching this velocity, the throttle was opened wide and the speed was increased to 80 miles per hour. The throttle was immediately closed completely, and the speed was reduced to 60 miles per hour, with clutch engaged. This latter operation was repeated ten times. Finally, the vehicle was returned to the point of inspection at a velocity not exceeding 25 miles per hour. The lubricant was drained and the third-member assembly was removed. Substantially no scoring appeared on the pinion and ring-gear surfaces on the drive and coast sides of the teeth.

Although the present invention has been de-

and variations may be resorted to without departing from the spirit and scope thereof, as those skilled in the art will readily understand. Such variations and modifications are considered to be within the purview and ambit of the appended claims.

What is claimed is:

1. A lubricant consisting essentially of a liquid selected from the group consisting of glycerine and ethylene glycol, containing from about 0.5 per cent by weight and up to about 90 per cent by weight of a comminuted solid selected from the group consisting of molybdenum disulfide, titanium disulfide, tin disulfide, zirconium disulfide and tungsten disulfide.

2. A lubricant consisting essentially of glycerine containing from about 0.5 per cent by weight and up to about 10 per cent by weight of minus 325-mesh molybdenum disulfide.

3. A lubricant consisting essentially of ethylene glycol containing from about 0.5 per cent by weight and up to about 10 per cent by weight of minus 325-mesh molybdenum disulfide.

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