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Sims

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[54] **LUBRICANT CONTAINING DISPERSED BORATE AND A POLYOL**

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[51] **Int. Cl.** **C10m 1/40,** C10m 1/22, C10m 1/10

[58] **Field of Search** 252/18, 25, 33

[56] **References Cited**

UNITED STATES PATENTS

2,676,925	4/1954	Lindstrom et al.	252/18
2,982,733	5/1961	Wright et al.	252/18
2,987,476	6/1961	Hartley et al.	252/18
3,313,727	4/1967	Peeler	252/18

FOREIGN PATENTS OR APPLICATIONS

1,201,089	8/1970	Great Britain	252/18

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[57] **ABSTRACT**

A novel lubricant composition is disclosed, having superioer EP and water tolerance properties, which comprises a nonpolar lubricating oil and minor amounts each of sodium borate, a lipophilic surface-active agent, and a C_3–C_6 polyol containing 2 to 6 hydroxyl groups, including at least 1 hydroxyl group pair separated by at least three carbon atoms.

23 Claims, No Drawings

LUBRICANT CONTAINING DISPERSED BORATE AND A POLYOL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to extreme pressure (EP) lubricating oils.

High load conditions often occur in the gear sets used in automotive transmission differentials and similar devices as well as in many types of bearings. In order to avoid the undesirable effects which result when using an uncompounded oil under these high load conditions, the lubricants for use in such service contain "EP agents." For the most part EP agents have been oil soluble or easily incorporated as a stable dispersion in the oil. Most of the prior art EP agents are chemically reactive; they contain chlorine, sulfur, or phosphorus. These react with the metal surfaces of the gears or bearings at the high temperatures produced under high load.

Recently Peeler in U.S. Pat. No. 3,313,727 disclosed an EP lubricant produced by the dispersion in a nonpolar lubricating oil of a hydrated alkali metal borate. The borate, water, and an emulsifier were introduced into the nonpolar medium. The mixture was then agitated to produce the dispersion of the water in the oil and heated to dehydrate the alkali metal borate. Peeler also disclosed that conventional additives such as rust inhibitors, detergents, foam inhibitors, etc. could be present in the finished lubricating composition containing the borate.

The borate-containing oils described by Peeler have, however, a very serious deficiency in service. If water is introduced into the system containing the borate lubricant (such as an automotive differential), the borate crystallizes out of the oil and forms hard granules. These granules cause severe noise in the system and can, in some cases, severely damage the gears or bearings themselves. Further, loss of the borate by crystallization substantially decreases the EP function of the lubricant.

2. Description of the Prior Art

The Peeler patent is described above. U.S. Pat. No. 2,987,476 describes the dispersion of an "inorganic boric acid compound" in a substantially nonpolar organic liquid, by mixing in the organic liquid a lyophilic surface active agent, a water-miscible organic liquid, and an organic ester of boric acid, and then adding a metal base to the mixture to hydrolyze the organic ester. The water-miscible organic liquid (which may be a monohydric alcohol) is then removed after dispersion of the inorganic boric acid compound. U.S. Pat. Nos. 2,753,305 and 3,338,835 describe aqueous solutions containing polyhydric alcohols and metal borates. U.S. Pat. No. 3,313,729 discloses a soap base lubricant containing an alkali metal pyrophosphate and/or tetraborate. Gear lubrication is discussed in Guthrie, *Petroleum Products Handbook* (1st Ed., McGraw-Hill Book Co.: 1960), on pages 9–47 through 9–49 and in Boner, *Gear and Transmission Lubricants* (Reinhold Publ. Corp.: 1964).

SUMMARY OF THE INVENTION

I have now invented a novel lubricant composition having superior EP and water tolerance properties, which comprises an oil of lubricating viscosity and minor amounts each of sodium borate, a lipophilic surface active agent, and a C_3–C_6 polyol containing 2 to 6 hydroxyl groups and having at least one pair of hydroxyl groups, the members of which pair are separated by not less than three carbon atoms, i.e., they are bonded to carbon atoms which are not less than β to each other. The composition may also contain the borate of another alkali metal such as potassium. These compositions form clear and bright EP lubricants from which the borate will not crystallize in the presence of water.

DETAILED DESCRIPTION OF THE INVENTION

The compositions of this invention are highly stable EP lubricants. They perform well in EP tests such as the four-ball test. They are useful in a number of gear and bearing lubrication applications, particularly as automotive differential lubricants. In contrast to most other EP lubricants, they are essentially noncorrosive to the metal surfaces of the gears. In non-dispersed form these materials have a soft and pliable consistency. Further, many of the concentrates are also transparent, a property which is highly advantageous where visual appearance is important.

The composition of this invention is a lubricant having improved extreme pressure and water tolerance properties which comprises (A) 10 to 100 parts by weight of a nonpolar oil of lubricating viscosity; (B) 2 to 25 parts by weight of amorphous particles of less than 1 micron in size of a hydrated sodium borate of the formula

$$x\mathrm{Na_2O} \cdot \mathrm{B_2O_3} \cdot y\mathrm{H_2O}$$

wherein x is a number of from 0.25 to 1.5 and y is a number of up to 5.0, usually from 0.5 to 5.0; (C) a lipophilic surface active agent in an amount of about 0.05 to 0.5 part by weight per part by weight of the borate; and (D) in an amount of about 0.05 to 2.0 parts by weight per part of borate, a polyol of from 3 to 6 carbon atoms and 2 to 6 hydroxyl groups, which contains in its structure at least one pair of hydroxyl groups, the members of which pair are separated by not less than three carbon atoms, i.e., they are bonded to carbon atoms which are at least β to each other.

The Hydrated Borate

The principal hydrated borates of this lubricant composition are hydrated sodium borates of the formula

$$x\mathrm{Na_2O} \cdot \mathrm{B_2O_3} \cdot y\mathrm{H_2O}$$

wherein x represents a number of from 0.25 to 1.5 and y represents a number of up to 5.0, usually from 0.5 to 5.0. These include sodium metaborate, sodium tetraborate, borax and similar materials, as well as mixtures of two or more sodium borate compounds. Preferably, x will represent a number of from 0.5 to 1.5 and y will represent a number $(1.0–3.0)x$; i.e., one to three times x. For practical reasons, the minimum amount of water of hydration will be about 0.01 moles per mole of B_2O_3. It is possible to obtain an anhydrous alkali metal borate, but it requires an unnecessarily large degree of processing to do so. Further, exposure of the anhydrous material to ambient air will result in the natural accumulation of some water of hydration.

In one embodiment, there will be a mixture containing at least one sodium borate and one borate of another alkali metal, preferably potassium. These compositions can be represented by the following formula

$$xNa_2O \cdot zM_2O \cdot B_2O_3 \cdot yH_2O$$

wherein z represents a number greater than 0 and up to 0.5 and x and y are as noted above. M represents an alkali metal other than sodium. It is usually one of the lighter alkali metals, i.e., lithium or potassium; preferably, potassium. The coefficient z preferably represents 0.25 to 0.50, and is usually $(0.5–1.5)x$.

(The above formulae are meant to be empirical and not structural. The exact structure in which the borate exists in composition is unknown and varies with different amounts of water of hydration. Numerical values for quantities such as percentage contents will, therefore, be based on the empirical formulae. Where a mixture of sodium and other alkali metal borates is involved, references to "borate" as a basis for such parameters as content of other components will mean the total borate mixture.)

The borate will be dispersed as particles throughout the lubricating oil medium by means of an emulsifying agent described below. The borate particles are glass-like and are essentially entirely all less than 1 micron in diameter and for the most part less than 0.5 micron in diameter.

The amount of borate present will depend on the weight percent desired in the final lubricant composition. This will generally be from about 2 to 25 parts by weight (including any water of hydration) of borate and more usually from about 5 to 15 parts by weight, for each 75 to 100 parts per weight of lubricating oil. In concentrate the borate content will be 2 to 25 parts by weight for each 10 to 75 parts by weight of oil.

The water present during dispersion of the borate will be sufficient to dissolve the anhydrous borate but should not be in such excess as to make later dehydration difficult. Generally from about 0.5 to 3 parts by weight of water will be used per part of weight of anhydrous borate and more usually from about 0.5 to 1.5 parts per part of anhydrous borate.

The Polyol

The polyol component of this lubricant will be a C_3–C_6 hydrocarbon substituted with 2–6 hydroxyl groups. The number of hydroxyl groups may equal but not exceed the number of carbon atoms, and no carbon atom will be substituted with more than one hydroxyl substituent. The polyol structure will be such that at least one pair of hydroxyl groups will have its two members separated by at least three carbon atoms; i.e., the two members separated by at least three carbon atoms; i.e., the two hydroxyl groups of the pair will be attached to carbon atoms located no closer than β to each other. The intervening carbon atom or atoms may or may not have their own hydroxyl substituents. Those polyols containing three to four carbon atoms and two to three hydroxyl groups are preferred.

Typical examples of suitable polyols are 1,3-propanediol, 1,3-butanediol, 1,2,3-propanetriol (glycerol), 1,2,3-butanetriol, 1,4-butanediol, mannitol, 1,3-pentanediol, 1,3,5-pentanetriol, and the like.

The amount of polyol present will be determined by the nature and amount of the borate present. Where the borate is a sodium borate with no additional alkali metal borate present, the polyol will be present as 0.3 to 1.0 parts by weight per part of borate, preferably 0.5 to 1.0. Where the borate is composed of a mixture of sodium borate and another alkali metal borate, the polyol will be present in an amount of from 0.01 to 0.5 part by weight per part of the borate mixture, preferably 0.1 to 0.3.

For convenience in processing, the borates are usually incorporated into the lubricating oil as concentrates having 50 to 60 weight percent hydrated borate (as described in the Peeler patent). The polyol is then added to this concentrate and the whole diluted with additional oil to the final concentration. The relative proportions of borate and the polyol are the same in either the concentrate or finished lubricant.

The Lubricating Oil Medium

The nonpolar lubricating oil can be any fluid of lubricating viscosity which is inert under the reaction conditions (particularly nonsaponifiable). Fluids of lubricating viscosity generally have viscosities of 35 to 50,000 Saybolt Universal Seconds (SUS) at 100°F. The fluid medium or oil may be derived from either natural or synthetic sources. Included among the natural hydrocarbonaceous oils are paraffin-base, naphthenic-base or mixed-base oils. Synthetic oils include polymers of various olefins, generally of from two to six carbon atoms, alkylated aromatic hydrocarbons, etc. Nonhydrocarbon oils include polyalkylene oxide, e.g., polyethylene oxide, aromatic ethers, silicones, etc. The preferred media are the hydrocarbonaceous media, both natural and synthetic. Preferred are those hydrocarbonaceous oils having SAE viscosity numbers of 5W to 20W and 20 to 250 (see Guthrie, page 9–13) and particularly those having SAE viscosity numbers in the range of 75 to 250.

The lubricating oil will be present at 75 to 100 parts by weight of the final lubricant composition. In the concentrates, however, the oil may be present as 10 to 75 parts by weight. These concentrates are diluted with additional oil prior to being placed in service to obtain the requisite concentration.

The Lipophilic Surface-Active Agent

A wide variety of emulsifying agents or dispersants may be used. Particularly useful are those dispersants which find use as detergents in lubricating oils. These dispersants are exhaustively described in the aforesaid U.S. Pat. No. 2,987,476, which disclosure is incorporated herein by reference. No attempt will be made to repeat all that is said in the patent; only the highlights of the discussion will be repeated here.

The above-cited patent describes the materials as lypophilic ionic surface-active agents. However, since in this invention, neutral dispersants such as alkenyl succinimides of alkylene amines, disclosed in U.S. Pat. Nos. 3,024,195, 3,018,291, and 3,131,150, and addition polymers of esters and amides, e.g., copolymers of acrylates and vinyl pyrrolidone, may be used, the dispersants will be referred to as lypophilic surface-active agents. By lypophilic is intended a term synonymous with "hydrophobic," which means a compound substantially insoluble in and immiscible with water, and which is readily soluble in organic liquids having electric dipole moments of 0.5 Debye unit or less.

The group of emulsifying agents may be broken down into two major classes, ionic emulsifying agents and neutral emulsifying agents. Exemplifying the ionic materials are the metal salts of oil-soluble acidic organic compounds, e.g., sulfonates, carboxylates, phenolates. Quaternary ammonium salts are also included. Exemplifying the neutral surface-active agents are the alkenyl succinimides, aliphatic amine amides of maleic anhydride modified hydrocarbon polymers and addition copolymers or acrylates and amides.

Of particular interest among the lipophilic ionic surface-active agents are the carboxylates, phenates and sulfonates of alkaline earth metals, e.g., calcium, magnesium and barium. The hydrocarbon chain bonded to the acidic group, i.e., carboxyl, phenolic hydroxyl or sulfonyl, is generally of at least eight carbon atoms and more usually of from 10 to 26 carbon atoms. The group attached to the acidic functionality may be aliphatic, alicyclic or aromatic or combinations thereof, e.g., aralkyl and will be defined as hydrocarbyl.

Illustrative of the nonionic surface-active agent, are: alkenyl succinimides of alkylene amines, having an alkenyl group of from 30 to 200 carbon atoms and an alkylene amine of from two to ten carbon atoms and from one to six nitrogen atoms; copolymers of polymethacrylate or polyacrylate with vinyl pyrrolidone, acrylamide or methacrylamide; or, amides of maleic anhydride modified polymers of hydrocarbons such as ethylene, octene, dodecene, octadecene, and the like.

The effectiveness of the borate compositions of this invention varies with the particular dispersant. Preferred dispersants are the oil-soluble polyvalent metal sulfonates, particularly alkaline earth metal sulfonates, e.g., calcium and barium, wherein the hydrocarbyl group bonded to the sulfur is of from eight to 26 carbon atoms, more usually of from 10 to 22 carbon atoms. The radical bonded to the sulfur may be alicyclic as in naphthenyl sulfonic acid, alkaryl as in octylphenyl sulfonic acid, or alkyl as in cetyl sulfonic acid. The metals may be calcium, magnesium, barium, and the like.

The amount of emulsifier required will vary with the particular emulsifier used, and the total amount of borate in the medium. About 0.05 to 0.5, ; more usually about 0.1 to 0.3 part by weight of emulsifier will be used per part of total borate. Generally the upper ranges of the emulsifier content will be used with the upper ranges of the borate content.

Preparation of the Lubricating Composition

The novel compositions of this invention are prepared by dehydrating a water and oil emulsion of an aqueous solution of borate to provide the desired dispersion of the hydrated borate in the oil medium and then incorporating the polyol into the borate dispersion. This process is carried out by introducing into the inert non-polar lubricating oil medium the sodium borate, and, if desired, at least one other alkali metal borate, water, and the desired emulsifier, and then vigorously agitating the mixture to provide a dispersion of the water in the oil. The mixture is then heated at a temperature and for a time which provides the desired degree of hydration of the borate. Ordinarily, the oil and dispersing agent will be blended and heated first, and then a hot solution of borate added during agitation. Once the borate is disposed and the solution dehydrated to the desired degree, the polyol is added with vigorous stirring until a homogeneous composition is obtained. Alternatively, the polyol can be dissolved in the aqueous borate solution prior to emulsification.

The temperature at which the emulsion is dehydrated will generally be at least 250°F., more usually at least 300°F. Lower temperatures may be used at reduced pressures. However, the process is most conveniently carried out at atmospheric pressures.

The time of reaction will depend on the degree of dehydration desired, the amount of water present, and the temperature. Time is not critical and will be determined for the most part by the variables mentioned.

Other materials may also be present in the composition of this invention. Materials may be added for enhancing the emulsifying effect of the emulsifier, enhancing some of the properties which are imparted to the lubricating medium by the borates, or providing other desirable properties to the lubricating medium. These include such addivites as rust inhibitors, antioxidants, oiliness agents, detergents, foam inhibitors, viscosity index improvers, pour point depressants, etc. Usually these will be in the range of from about 0.1 to 5 weight percent, more usually in the range of from about 0.1 to 2 weight percent, of the total composition.

Lubricant Performance

The following examples will serve to illustrate the performance of these lubricants. The compositions were tested for stability; i.e., resistance to crystallization, and for EP characteristics. In the stability test, 100 g. of the test composition were mixed in a beaker with 3.7 g. water and the water thoroughly dispersed in the lubricant. A large excess of hexane was then added and a borate layer precipitated. The hexane was drained off and the borate layer permitted to sit at ambient temperature. The borate was observed at periodic intervals to determine if any crystals had formed.

The EP test used was the well-known "four-ball test" which is described in the Boner text on pages 222–223. In this test, three ½ inch diameter steel balls are clamped together and immersed in the test lubricant. A fourth ball is then rotated at 1,730 rpm in contact with the other three balls. A 50 kg. load is applied, forcing the rotating ball against the three stationary balls. The test is run for 30 minutes and the size of the wear scars on the three stationary balls are measured and the average scar size in millimeters reported. The smaller the scar, the greater the EP character (i.e., the greater the load-carrying capacity) of the test lubricant. Lubricants which give a wear scar of less than 0.8 mm. are considered acceptable EP lubricants; it is preferred that the wear scar be on the order of 0.3 to 0.6 mm. Lubricants which give four-ball scars in the latter range are generally found also to give good performance in the L-37 gear lubrication test (Federal Test Methods Standard 791a, Method No. 6506-T) a well-known test used for evaluating gear lubricants.

Typical examples with their test performance data are shown in the table below. With one exception, all samples were prepared in the same manner. Approximately 100 g. of a hydrocarbon neutral oil having a viscosity at 100°F. of about 130 and 33 g. of a neutral calcium petroleum sulfonate (containing about 1.67 percent calcium) were mixed in a Waring Blender and heated to 200°F. An aqueous solution of borate and water heated to the same temperature was then added to the Blender and the emulsion partially dehydrated by stirrng at 300°F. at the maximum speed of the Waring Blender. After dehydration, the water content of the concentrate was approximately 1.8 moles of water per mole of anhydrous borate The borate concentration in the concentrate was approximately 50–60 weight percent, based on total borate. After dehydration, the polyol was added to the Blender and stirred to obtain a homogeneous concentrate. The concentrate was then diluted with an SAE 90 hydrocarbon gear lubricant composed of approximately equal parts of the above-mentioned 130 neutral oil, a bright stock having a viscosity at 210°F. of about 180 SUS, and a bright stock having a viscosity at 210°F. of about 220 SUS. Small amounts of a poly(alkyl methacrylate) pour point depressant and a silicone foam inhibitor were added. The final hydrated borate concentration in the test composition was 5 weight percent, the sulfonate concentration was 2 weight percent, and the polyol concentration was as noted in the Table. The sole exception to this preparation scheme was Run No. 22 in the Table in which a polyisobutenyl succinimide was used instead of the sulfonate as the emulsifier.

Run No.	Anhydrous Borate Composition	Polyol Compound	Polyol Wt %	Four-Ball Wear Scar, mm	Crystallization?
1	$Na_2O \cdot B_2O_3$	None	—	0.36, 0.39	Yes
2	do.	1,2,3-propanetriol	0.5	0.40	do.
3	do.	do.	1.2	0.40	do.
4	do.	do.	2.5	0.61	No
5	do.	do.	do.	0.73	do.
6	do.	do.	5	0.65	do.
7	do.	do.	do.	0.79	do.
8	do.	do.	7	1.04	do.
9	$0.5\ Na_2O \cdot 0.3\ K_2O \cdot B_2O_3$	do.	0.5	0.40	do.
10	do.	do.	1.2	0.50	do.
11	do.	do.	1.5	0.63	do.
12	$0.5\ Na_2O \cdot 0.25\ K_2O \cdot B_2O_3$	do.	0.5	0.50	do.
13	do.	do.	1.0	0.55	do.
14	do.	do.	1.2	0.46	do.
15	do.	do.	1.5	0.70	do.
16	$0.25\ Na_2O \cdot 0.5\ K_2O \cdot B_2O_3$	do.	0.5	0.43	do.
17	$0.375\ Na_2O \cdot 0.375\ K_2O \cdot B_2O_3$	do.	1.0	0.636	do.
18	$Na_2O \cdot B_2O_3$	1,3-propanediol	do.	0.40	do.
19	do.	1,3-butanediol	do.	0.40	do.
20	do.	1,4-butanediol	do.	0.53	do.
21	do.	Mannitol	do.	0.72	do.
22	do.	1,2-propanediol	do.	>1.0	do.
23	do.	1,2-ethanediol	do.	0.87	do.

It will be seen from the above data that only those polyols having the structure described above and used in the concentrations described produce satisfactory EP lubricants. Where the concentration of polyol is too low, the borate in the lubricant will still crystallize. Where the structure of the polyol is different from that described above (as in Runs 21 and 22), the large four-ball wear scar indicates the lack of EP character of the lubricant.

Those skilled in the art will recognize many embodiments of this invention not specifically disclosed but clearly within the scope and spirit of the invention.

I claim:

1. A lubricant composition having superior extreme pressure and water tolerance properties, which comprises a nonpolar oil of lubricating viscosity and (a) from 2 to 25 parts by weight of a hydrated sodium borate, (b) from 0.05 to 0.5 parts by weight of a lipophilic, surface active agent, and (c) from 0.3 to 1 part by weight per part of said borate of a C_3–C_6 polyol containing two to six hydroxyl groups, at least one pair of said hydroxyl groups having its two members separated by at least three carbon atoms.

2. The composition of claim **1** further comprising a minor portion of a hydrated alkali metal borate of an alkali metal other than sodium.

3. The composition of claim **1** comprising (a) 10 to 100 parts by weight of a nonpolar oil of lubricating viscosity; (b) 2 to 25 parts by weight of amorphous particles of less than 1 micron in diameter of a hydrated sodium borate of the formula

$$xNa_2O \cdot B_2O_3 \cdot yH_2O$$

wherein x is a number of from 0.25 to 1.5 and y is a number of 0.01 to 5.0; (c) a lipophilic surface active agent in an amount of about 0.05 to 0.5 part by weight per part by weight of said borate; and (d) in an amount of about 0.3 to 1.0 part by weight per part of said borate, a polyol of from three to six carbon atoms and two to six hydroxyl groups, having at least one pair of hydroxyl groups, the two members of which are separated by at least three carbon atoms, and wherein each carbon atom contains not more than one hydroxyl substituent.

4. The composition of claim **3** wherien said borate is present at 5 to 15 parts by weight.

5. The composition of claim **3** wherein x is a number of from 0.5 to 1.5.

6. The composition of claim **5** wherein the anhydrous portion of said borate has the formula

$$Na_2O \cdot B_2O_3.$$

7. The composition of claim **3** wherein y is a number of from 0.5 to 5.0.

8. The composition of claim **7** wherein y is a number $(1.0–3.0)x$, and x is a number of from 0.5 to 1.5.

9. The composition of claim **3** wherein said polyol is of three to four carbon atoms and two to three hydroxyl groups.

10. The composition of claim **9** wherein said polyol is 1,3-propanediol, 1,3-butanediol, 1,2,3-propanetriol, or 1,4-butanediol.

11. The composition of claim **9** wherein said polyol is present in an amount of from 0.5 to 1.0 part by weight per part by weight of said borate.

12. The composition of claim **1** comprising (a) 10 to 100 parts by weight of a nonpolar oil of lubricating viscosity, (b) 2 to 25 parts by weight of amorphous particles of less than 1 micron in diameter of a mixture of hydrated alkali metal borates, said mixture having the empirical formula

$$xNa_2O \cdot zM_2O \cdot B_2O_3 \cdot yH_2O$$

wherein M represents an alkali metal other than sodium, x is a number of from 0.25 to 1.5, y is a number of from 0.01 to 5.0, and z is a number of from 0.25 to 0.50; (c) a lipophilic surface active agent in an amount of about 0.05 to 0.5 part by weight per part of said mixture; and (d) in an amount of about 0.01 to 0.5 part by weight per part by weight of said mixture, a polyol of from three to six carbon atoms and two to six hydroxyl groups, having at least one pair of hydroxyl groups, the two members of which are separated by at least three carbon anoms, and wherein each carbon atom contains not more than one hydroxyl substituent.

13. The composition of claim **12** wherein M represents potassium or lithium.

14. The composition of claim **13** wherein M represents potassium.

15. The composition of claim **12** wherein said borate is present as 5 to 15 parts by weight.

16. The composition of claim **12** wherein x is a number of from 0.5 to 1.5.

17. The composition of claim **16** wherein z is a number of from $(0.5–1.5)x$.

18. The composition of claim **12** wherein said polyol is of three to four carbon atoms and two to three hydroxyl groups.

19. The composition of claim **18** wherein said polyol is 1,3-propanediol, 1,3-butanediol, 1,2,3-propanetriol, or 1,4-butanediol.

20. The composition of claim **19** wherein said polyol is present as 0.1 to 0.3 part by weight per part by weight of said mixture, wherein said lipophilic surface active agent is a metal sulfonate.

21. The process of lubrication which comprises applying to a load-bearing surface the composition of claim **1.**

22. A concentrate comprising a nonpolar oil of lubricating viscosity containing (1) from 50 to 60 weight percent of particulate hydrated sodium borate having a mean diameter of less than 1 micron, (2) from 0.3 to 1 part by weight of a C_3–C_6 polyol containing from two to six hydroxyl groups having at least two of the hydroxyl groups separated by at least three carbon atoms, and (3) from 0.05 to 0.5 part by weight per part of said borate of a lipophilic surface active agent.

23. The concentrate as defined in claim **22** wherein said polyol is 1,3-propanediol, 1,3-butanediol, 1,2,3-propanetriol or 1,4-butanediol.

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