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SINGLE PHASE LIQUID LUBRICATING, ANTI-CORROSION, ANTI-ACID COMPOSITION AND PREPARATION OF SAME

Edward Roy Taylor, Jr., Springfield, Pa., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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This invention relates to a lubricating, anti-corrosion, anti-acid composition adaptable for aqueous dilution and to a method of preparing the same. More particularly the invention relates to a single phase liquid concentrate comprising a water-soluble corrosion-inhibiting salt and a water-immiscible lubricant, the concentrate being designed for 20 to 60 fold dilution on addition to an aqueous heat-exchange liquid in a cooling system of an internal combustion engine to protectively condition the system.

The importance of dissipating combustion heat in the operation of an internal combustion engine is well recognized. Although air-cooling of such engines is operative under certain conditions, the operation of automobile or truck engines practically necessitates liquid cooling by recirculation of the coolant. With these engines, the means for liquid cooling consists of the following essential parts: a liquid heat-exchange liquid which ordinarily is water or an aqueous anti-freeze composition, an engine cooling jacket which serves as a means for enveloping the engine block or combustion chamber with the heat-exchange liquid, a radiator having a high ratio of surface area relative to its liquid capacity which serves as means for dissipating the heat from the heat-exchange liquid to the atmosphere, transmission lines for transferring hot heat-exchange liquid from the engine jacket to the radiator and returning cooled heat-exchange liquid from the radiator to the jacket, and a pump for circulating the liquid between the radiator and the engine jacket.

A variety of metals are used in the fabrication of these several essential parts of the cooling system and all are susceptible to corrosion by the heat-exchange liquid, or by this liquid acidically contaminated with combustion products. As corrosion progresses, the efficiency of cooling is lowered. Hence it is desirable to minimize corrosion by protectively conditioning the heat-exchange liquid with anti-corrosion and anti-acid agents. Lubricants are often included in such conditioning compositions to provide lubrication to moving parts in contact with the heat-exchange liquid.

Operators of liquid cooled internal combustion engines have become educated in the need for anti-corrosion and anti-acid conditioning of the coolant, and numerous proprietary compositions are being advertised and supplied to provide such protection. Some compositions are supplied as water-soluble particulate solid products, others as aqueous solutions and still others as aqueous emulsions which contain a dispersed oil phase. These compositions ordinarily include a buffering salt, such as sodium borate, as the corrosion inhibitor which also serves as an anti-acid component because of its alkalinity, sometimes called "alkaline reserve."

Alkali metal borate salts have limited solubility in water or aqueous heat-exchange liquids. Hence, stable, freeze-recoverable aqueous solutions have limited concentration of borate salt, and the maximum solubility at atmospheric temperatures is ordinarily less than the con-

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centration desired in a concentrate designed for 20 to 60 fold dilution. When a lubricant is incorporated in the product, the amount of salt that can be retained in solution in the aqueous concentrate is further reduced. Another deficiency of these known aqueous liquid condition compositions is that they ordinarily require special packaging. The concentrated aqueous salt solution is sufficiently corrosive to attack metal containers having a conventional coating thickness of 0.5 pound tin-plate. Hence, packaging in glass is often required. Another deficiency is that the aqueous product must be temperature protected to prevent freezing or salting-out of the active ingredients. Borate salts precipitated from a concentrated solution by cooling or freezing difficult to redissolve when the temperature of the composition is restored to room temperature.

The principal object of this invention is to provide a single phase liquid conditioning composition, designed for addition to an aqueous heat-exchange system of an internal combustion engine, which overcomes the deficiencies described above. Another important object is to provide a conditioning composition combining water-soluble corrosion inhibiting components and a water-immiscible lubricant in a stable, single-phase, liquid concentrate. A further object is to provide a lubricating and corrosion-inhibiting single phase liquid concentrate which is resistant to salting-out when stored under temperature conditions at which aqueous solutions of equivalent salt content ordinarily salt-out. A still further object is to provide a lubricating, corrosion-inhibiting liquid concentrate readily dispersible in an aqueous heat-exchange liquid in the cooling system of an internal combustion engine. Another object is to provide a lubricating and anti-corrosive liquid concentrate of unit dosage which when diluted 20 to 60 fold with an aqueous heat-exchange liquid contains highly effective concentrations of alkaline corrosion inhibitor, and lubricant sufficient to provide resistance to corrosion attack on iron, mild steel, aluminum, tin/lead solder, copper and copper-bearing metals which are ordinarily found in contact with the heat-exchange liquid in an automobile cooling system. A further object is to provide a stable lubricating, corrosion inhibiting liquid concentrate packagable in tin-plated metal containers, wherein the tin-plate carries a conventional coating of tin, and storageable at temperatures ranging from -30° F. to 120° F.

These and other important objects disclosed hereinafter are accomplished by (a) chemically combining orthoboric acid with 1,2 ethanediol or 1,2 propanediol by heating these components in the proportion corresponding to at least 2 mols of the diol per mol of B_2O_3 to form an acidic intermediate product, (b) forming a water-soluble alkali metal borate salt of this acidic intermediate product by reacting the boric acid component with alkali in the proportion corresponding to 1 to 2 mols of B_2O_3 per mol of M_2O , where M is potassium or sodium, (c) mixing the resulting borate salt with a water-immiscible monohydroxy 1,2 polyoxypropylene monoalkylether having an average molecular weight in the range of about 450 to 1600 and an average of at least 8 1,2 oxypropylene groups per molecule as a lubricant, and (d) dissolving the mixture of water-soluble borate salt and the water-immiscible lubricant with substantially anhydrous methanol or anhydrous ethanol to form a single phase liquid having a borate salt concentration corresponding to 6% to 25% by weight of B_2O_3 plus M_2O , and a lubricant concentration in the range of 3% to 15% by weight based on the total composition. In use, this single phase liquid concentrate is added to an aqueous heat exchange liquid in such proportion to cause 20 to 60 fold dilution of the concentrate with the resulting diluted composition having a concentration of at least 0.1% by weight of the

alkali borate salt and at least .05% by weight of the lubricant. The resulting liquid is circulated through the cooling system to condition the same.

The following specific examples represent the best modes contemplated for practicing the invention, and these illustrative examples are not to be construed as being restrictive in scope except as specifically limited in the appended claims. The parts and percentage figures are expressed on a weight basis unless otherwise stated.

EXAMPLE 1

First portion:	Parts by weight
1,2 ethanediol (ethylene glycol) -----	25.2
Boric acid—Commercial 99.5% -----	14.2
Caustic potash—Commercial high quality 85% -----	11.8
KOH, low chloride (.5% max. as KCl) -----	51.2
Total reaction charge -----	5.2
Reaction loss -----	46.0
Reaction product -----	100.0
Second portion:	
Water immiscible lubricant—"Ucon" LB-525 -----	9.0
Methanol—Anhydrous -----	45.0
	100.0

The water-immiscible lubricant was a monohydroxy 1,2 polyoxypropylene monobutyl ether having an average of about 26 1,2 oxypropylene groups per molecule. This lubricant was characterized by a viscosity of about 525 Saybolt seconds at 100° F. Carbide and Carbon's "Ucon" LB-525 lubricant is a commercially available product of this type.

In preparing the product of Example 1, the 1,2 ethanediol was charged into a reaction vessel, the boric acid was added and mixed. The caustic potash was gradually added to the acidic mixture, taking advantage of the heat of neutralization to raise the temperature of the mixture. The heat of neutralization in the absence of cooling means was sufficient to raise the temperature of the reaction mixture to about 220° F. The mixture was then heated to a temperature in the range of 250° F. to 255° F. and maintained at this temperature for a period of time sufficient to cause a volatile loss of about 5.2 parts, leaving 46 parts of intermediate reaction product. The volatile loss was predominantly water plus a minor proportion of 1,2 ethanediol. Slightly more than half of the water of reaction was removed from this intermediate product. The residual intermediate product from the first portion was mixed with the synthetic lubricant and diluted with the anhydrous methanol. The order of addition of the lubricant and the diluent solvent is not critical. The product of the first portion alternatively can be initially diluted with the methanol and then mixed with the lubricant.

The resulting product was a single phase liquid which was very light straw in color and clear. The potassium borate salt content of this product was about 17.5 parts by weight of a salt having a composition corresponding to about 1.28 mols of B_2O_3 per mol of K_2O . At this proportion, the borate salt exclusive of the combined 1,2 ethanediol corresponds to about 11.65 parts of KBO_2 and about 5.85 parts of $K_2B_4O_7$ by weight.

On dilution with water, the product of Example 1 produced a stable, opaque aqueous emulsion, with the water-immiscible lubricant as the dispersed phase.

The product of Example 1 was evaluated for its anti-corrosion effectiveness in a corrosion test designed to simulate operating conditions of an automobile cooling system. In this test, various metal slugs were tied together in electrical contact in combination as found in the automobile cooling system. For example, the engine block system was represented by a combination of cast iron, copper and aluminum, the water pump system was represented by a combination of steel and cast iron, and

the radiator system was represented by a combination of brass, 50/50 lead/tin solder, and copper. Each of the metal or alloy slugs had a surface area of about one square inch. The respective combinations, each having its metal slugs in electrical contact, were separately immersed in 200 ml. of the product of Example 1 diluted in the proportion of 12 fluid ounces ($\frac{3}{4}$ pint) with sufficient water to make 16 quarts. The respective tests were carried out in flasks equipped with a condenser and means for slowly bubbling air through the liquid to maintain oxygen saturation. The temperature of the liquid was maintained at about 170 F. during the test period of five days. The individual slugs were weighed prior to immersion and after completion of the test. The change in weight of the slug is a measure of the corrosion and this weight alteration ordinarily is translated into a corrosion rate expressed in terms of "mils of penetration per year." Conversion of the test results to this basis is made by the following formula.

$$\text{Penetration} = \frac{\text{Weight loss in grams} \times 365 \times 1000}{\text{Days of immersion} \times 2.54 \times \text{metal density} \times \text{metal surface area}}$$

In some instances, the change in weight of the slug may be a gain rather than a loss. Penetration is recognized as a negative value (—) in the formula. Hence, a plus value (+) designates a gain in weight.

Results of these tests are shown in Table 1 below in comparison with results obtained with a representative commercially available liquid aqueous emulsion anti-corrosion composition, similarly evaluated at the same dilution. Water was similarly tested as a second reference control.

The reference control anti-rust emulsion product had the following approximate composition:

Control emulsion conditioning composition

	Parts by weight
Orthoboric acid 99.5% -----	7.5
Caustic potash 85% KOH -----	6.3
Water -----	67.2
Turkey red oil -----	1.0
Oil soluble-non-ionic emulsifier—alkylphenoxypolyoxyethylene ethanol -----	2.0
Neutral mineral oil -----	16.0
	100.0

The non-ionic emulsifier contained about 6 oxyethylene groups per molecule and the alkyl substituent contained an average of about 14 carbon atoms.

TABLE 1
Corrosion-penetration

	Example 1	Control	Water
Engine Block System:			
Cast Iron -----	0.8	0.8	24.3
Copper -----	nil	0.3	+0.5
Aluminum -----	+4.0	+1.0	6.5
Water Pump System:			
Steel -----	0.5	0.3	1.1
Cast Iron -----	+0.5	1.2	24.3
Radiator System:			
Brass -----	nil	0.2	+0.5
Solder -----	nil	0.9	10.2
Copper -----	nil	0.2	+0.6

These results showed an overall better performance by the product of Example 1, in comparison with the control anti-rust composition, although the anti-corrosion agent is essentially the same potassium borate salt in both compositions.

The significant advantage of the product of Example 1 over the control product is that it contains nearly twice as much borate salt in the form of a single phase liquid composition as compared with the aqueous emulsion com-

position. The salt concentration of the latter is not significantly removed from the saturation level. The product of Example 1 did not present the packaging, handling and storage problems ordinarily associated with aqueous emulsion products containing chemicals which are potentially corrosive. The invention product was satisfactorily packaged in 0.5 pound tin-plated containers without evidence of can corrosion during lengthy storage. This product remained stable when stored at 120° F. and when subjected to temperatures as low as -30° F.

The product of Example 1 was also subjected to practical accelerated simulated performance tests by circulating the composition at about 42 to 1 dilution with water in a stationary mock-up engine system consisting of a new 1954 Chevrolet engine, 1954 Chevrolet pump, 1954 Chevrolet-Harrison radiator and connecting rubber hoses. The pump was operated at a speed corresponding to 40 to 45 miles per hour. The conditioned water was circulated at a thermostatically controlled temperature of 180° F. and air was sucked into the system at a rate of 0.6 cubic feet per hour. The test under these simulated operating conditions was continued for 3000 hours, corresponding to at least 120,000 miles of engine operation. Then the component parts were dismantled, including the breaking open of the engine water jacket, and examined for corrosion and other effects of conditioning. The spent conditioning liquid was clear and free from rust. Very slight rust scale was found on the cylinder walls, slight rust scale was found at the bottom of the water jacket. The general condition of the engine block was rated very good. Slight rust scale was found on the inner housing of the pump and on the impeller. Very slight rust scale was found on the thermostat housing. The pump seals were in good condition. The hoses and gaskets were in good condition and showed no deterioration due to the presence of lubricant in the conditioning liquid. The radiator had no leaks and showed no evidence of corrosion.

Another commercially available anti-rust-and anti-acid composition in dry particulate form consisting approximately of 96% by weight of borax ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$) and 4% by weight of mercaptobenzothiazole used at the recommended dosage of 5 ounces dissolved in sufficient water to make 16 quarts was similarly evaluated as a reference control. Water was evaluated to show the effect of unconditioned water. The performance of the product of Example 1 was significantly better than that of the reference anti-rust control which showed detectably more build-up of rust in the engine block.

The rusting was more severe with plain water, and in this system the rest showed a greater tendency to flake off as large flakes. This is a disadvantage because these flakes can lead to clogging of the radiator core.

In another test, 12 fluid ounces of the product of Example 1 were added to an automobile cooling system which had a squeaking water pump. Within 15 minutes after addition of the composition of Example 1 to the radiator, lubrication was sufficient to eliminate the squeak.

EXAMPLE 2

First portion:	Parts by weight
1,2 ethanediol (ethylene glycol) -----	24.50
Boric acid 99.5% -----	13.95
Caustic potash 85% KOH -----	11.65
Second portion:	
Water-immiscible lubricant—"Ucon" LB-135 -----	9.00
Methanol—Anhydrous -----	40.88
Odorant—Alamask TA -----	.02
Colorant—Oil Yellow #2 -----	Trace
	100.00

The components of this composition were identical with those used in Example 1 except that the lower viscosity

"Ucon" LB-135 was used in place of "Ucon" LB-525 and an odorant and colorant were included in the product. "Ucon" LB-135 is a monohydroxy 1,2 polyoxypropylene monobutyl ether having an average of about 10 1,2 oxypropylene groups per molecule and is characterized by a viscosity of about 135 Saybolt seconds at 100° F.

Alamask TA is a commercially available odorant often used in lacquer, varnish and paint compositions to mask the odor of volatile solvents and diluents. The colorant, Oil Yellow #2, was present at a concentration of about 3 parts per million.

In the preparation of this product, the 1,2 ethanediol was charged into a reaction vessel provided with means for agitation and temperature control. The boric acid was added and mixed, followed by gradual addition of the caustic potash. Sufficient cooling was provided that the temperature did not exceed 180° F. Under these conditions, there was no significant volatile loss of glycol and reaction water. The reaction product of the first portion was transferred to a mixing tank with the agitation means thereof idle. The components of the second portion were added in successive order to the first portion without agitation. The lubricant formed a heat-insulating layer of liquid over the first portion and the methyl alcohol formed another layer of liquid over the lubricant. Thereafter the combined portions were mixed for about 5 minutes. Addition of the second portion in this manner minimizes the fume hazard of directly mixing the methanol with the hot first portion and minimizes the volatile loss.

This product was a single phase liquid slightly more yellow in color than the product of Example 1. The performance of this product as a conditioning additive in providing anti-corrosion and anti-acid protection and lubrication in an automobile cooling system was equivalent to that of the product of Example 1.

Although this product contains the water resulting from the reaction of the boric acid combining with the diol and neutralization with alkali, this approximate content of about 7.8% water was compatible with the composition.

When "Ucon" LB-1145, a similar lubricant of higher molecular weight corresponding to an average of about 32 1,2 oxypropylene groups per molecule and characterized by a viscosity of 1145 Saybolt seconds at 100° F. was substituted for the "Ucon" LB-135 in the composition of Example 2, the product was cloudy and separated into two liquid phases on standing at room temperature. When the "Ucon" LB-1145 was progressively added in place of "Ucon" LB-135 in the composition of Example 2 to establish the maximum amount which can be tolerated in the composition as a single phase liquid containing the indicated amount of water, a concentration slightly more than 3% was operable. The composition of Example 1, which contained less than half as much water as the composition of Example 2, exhibited a comparatively greater tolerance for "Ucon" LB-1145 when progressively substituted for the "Ucon" LB-525.

Since the reaction of the boric acid with the alkali and the diol is the principal source of the reaction water, the water content of the product is significantly dependent on the borate salt content. It is preferred that the water content of the product be controlled to a content no greater than about 9% by weight. However, compatible single phase liquid compositions can be formulated with a higher water content, such as 12%, when the lower molecular weight species of the lubricant are used.

EXAMPLE 3

First portion:	Parts by weight
1,2 propanediol (propylene glycol) -----	25.0
Boric acid 99.5% -----	7.5
Caustic potash 85% KOH -----	6.3

Second portion:

Water-immiscible lubricant—"Ucon" LB-135	12.0
Methanol-Anhydrous -----	49.2
	100.0

The components of this composition were the same as those used in the composition of Example 2 except that 1,2 propanediol was used in place of 1,2 ethanediol.

This product was prepared as described in Example 2, controlling the temperature of the reaction to a temperature no greater than 180° F. to retain the reaction water in the composition.

The product was a single phase liquid. The conditioning performance of this composition, which contained approximately 53% as much alkali metal borate salt as the salt content of the products of Examples 1 and 2, was satisfactory although not fully as effective as these two reference products. However, the performance was at least fully equal to that of the aforementioned control aqueous emulsion composition which contained an equal amount of the potassium borate salt. The advantage of this composition over this reference control resided in packaging and handling. The product was conveniently and stably packaged and stored in conventional tin-plated containers. The product remained stable during storage at temperatures ranging from -30° F. to 120° F.

Although the specific examples show the preferred use of caustic potash as the alkali, caustic soda or sodium hydroxide can be used as a partial or full replacement on an equimolecular basis for the caustic potash in the formation of the alkali metal borate salt. Potassium borate salts are preferred because they are more soluble than the corresponding sodium borate salts.

In the formation of the alkali metal borate salts, the preferred ratio of boric acid to alkali is in the range corresponding to 1.2 to 1.5 mols of B_2O_3 per mol of M_2O , where M is potassium or sodium, although the ratio can vary in the range of 1 to 2 mols of B_2O_3 per mol of alkalinity for anti-acid performance by the diluted product.

The concentration of alkali metal borate salt in the concentrated single phase liquid composition can vary from 6% to 25% by weight of salt corresponding to B_2O_3 plus M_2O . The preferred concentration is in the range of 10% to 20% by weight on the indicated basis. The 6% concentration is a practical minimum limit which will provide at least the desired minimum concentration of the borate salt in the final dilute conditioning composition as represented by dilution of the concentrate ordinarily in the range of 20 to 60 fold. The upper limit of 25% of salt closely approaches the maximum amount that can be tolerated without salting out of the composition during storage. No advantage in performance was observed in using a salt concentration greater than the preferred range. However, the higher concentration provides an opportunity for packaging the product in smaller units to permit greater dilution. For example, such highly concentrated compositions can be packaged in 6 or 8 fluid ounce containers, instead of 12 and 16 fluid ounce containers and used on the basis of one unit package diluted to the capacity of the average automobile cooling system.

The examples show the preferred proportion of dihydric alcohol corresponding to the range of 3 to 5 mols per mol of B_2O_3 . A proportion as low as 2 mols per mol of B_2O_3 is operative, but when the concentration of dihydric alcohol is less than this proportion, salting-out occurs within the preferred range of borate salt concentration. A proportion of dihydric alcohol greater than 5 mols per mol of B_2O_3 is operative, but no significant advantage was observed in the use of higher concentrations, the excess ordinarily serving only as a costly diluent. In compositions containing the preferred amounts of potassium borate salt and lubricant, the preferred concentra-

tion of 1,2 ethanediol is in the range of 15% to 30% based on the weight of the total composition.

The water-immiscible lubricants useful in the practice of this invention are monohydroxy 1,2 polyoxypropylene monoalkyl ethers having an average molecular weight in the range of about 450 to about 1600. These lubricants contain an average of at least 8 1,2 oxypropylene groups to an average of about 32 such groups per molecule. The viscosity of these lubricants ordinarily ranges from about 60 to 1200 Saybolt seconds at 100° F. The alkyl group of the monoether can be either methyl, ethyl, propyl, butyl, hexyl, octyl or an alkyl group containing as many as 20 carbon atoms. The lubricant can be a mixture of these water-immiscible monoalkyl ethers. The mono-butyl ethers and mixtures of the monobutyl ethers with other lower monoalkyl ethers in which the alkyl group contains from 1 to 8 carbon atoms are preferred. Preparation of monohydroxy 1,2 polyoxypropylene monoalkylethers of this type is described in U.S. Patent 2,448,664 and they are commercially available as "Ucon" LB-Series Lubricants, ranging from LB-65 to LB-1145.

The concentration of the lubricant can range from 3% to about 15%, the preferred content being in the range of 6% to 12% by weight based on the total composition. It is necessary that the product contain at least 3% of lubricant in order that 20 to 60 fold dilution provides at least 0.05% of lubricant in the final conditioning liquid. At least this latter concentration is required for effective functioning as a lubricant. The practical upper limit is 15% of lubricant in the invention compositions, although higher concentrations can be tolerated. Compatibility is greater with the lubricants characterized by a viscosity in the lower half of the viscosity range, that is, in the range of 60 to 600 Saybolt seconds at 100° F. of the 60 to 1200 operative range.

Anhydrous methanol is shown as the preferred diluent in the examples. Anhydrous ethanol can be substituted wholly or in part for the methanol in the practice of this invention, but commercial use of anhydrous ethanol is impractical because of regulations controlling the use of ethanol and the greater cost of this alcohol. While anhydrous isopropanol is a water-miscible alcohol ordinarily used as a substitute for methanol or ethanol, it cannot be used as a substitute for the alcohols in the examples. However, a minor proportion of this alcohol can be tolerated in combination with a predominating proportion of methanol. When the isopropanol is the predominating diluent, salting-out of the alkali metal borate salt occurs at the preferred range of salt concentration.

If desired, the liquid product can be colored with an alcohol-soluble or oil-soluble dye which tolerates the alkalinity of the composition. Such coloring matter is occasionally used for identification purposes and the concentration ordinarily is of the order of several parts per million.

Odorants can also be incorporated in the products, if desired, to mask the normal odor of the product. A concentration of a small fractional percentage of odorant ordinarily is sufficient for the purpose and such a concentration is compatible with the composition.

All the components used in the composition are either anhydrous or as substantially free of water as is practical commercially. Although compatible single-phase liquid products can be prepared with a water content as high as about 12% by weight, it is preferred that the water content be controlled to no greater than about 9.0%. When lubricants having a viscosity in the range of 600 to 1200 Saybolt seconds at 100° F., which are less compatible, are used in the composition, it is desirable to control the water to as little as possible, about 5% maximum.

In carrying out the preparation of the products of this invention, the boric acid and the dihydric alcohol are initially combined and the resulting product is formed into an alkali metal borate salt utilizing the heat of

neutralization to increase the temperature of the reaction mixture. When the reaction water is to be retained in the composition, it is desirable to control the temperature of the reaction mixture to a practical maximum of about 180° F. Other temperatures can be used, but higher temperatures require the use of a reaction kettle equipped with a condenser for returning the condensate to the reaction mixture to avoid volatile loss. When a substantial portion of the reaction water is to be removed to enhance compatibility with certain species of the lubricant, the reaction temperature can be as high as 300° F. However, to avoid significant volatile loss of the dihydric alcohol, it is desirable in practice to control the temperature to no greater than about 260° F. Hence, for water removal, it is desirable to maintain the reaction temperature above the boiling point of water (212° F.) and preferably no greater than about 260° F. Alternatively the water can be removed by distillation under reduced pressure.

Products of this invention present significant advantages over known commercially available compositions designed as concentrates for 20 to 60 fold dilution with water or aqueous heat-exchange liquid in an automobile cooling system of average capacity. The preferred single phase liquid products contain at least 50% more anti-corrosion and anti-acid components than is ordinarily found in currently available compositions or can be tolerated in the prior liquid compositions. Hence, the invention products provide superior anti-corrosion performance, and increased alkaline reserve for improved anti-acid performance. The single phase liquid product is readily dispersed throughout the system on dilution, the lubricant forming an insoluble dispersed phase which migrates to the interior metal walls of the cooling system to provide a microscopic coating which aids in protection against corrosion. The lubricant also migrates to the pump seals and other moving parts to lubricate them and prevent any suspended rust from damaging such parts. The lubricant has no deteriorating effect on rubber parts. The single phase product, significantly low in water content, can be packaged in ordinary tin-plated containers having 0.5 or 0.25 pound tin-plate, and it can be stored for at least one year without significant corrosive attack on the tin-plate container. Unlike aqueous compositions, this product can be stored in an unheated warehouse or the trunk of an automobile where it may be subjected to a temperature as low as -30° F. without freezing or salting-out one or more of the components, which ordinarily are difficult to redisperse.

Although there are disclosed above but a limited number of embodiments of the compatible single phase liquid products of the invention and the methods of preparing them, it is possible to produce still other embodiments without departing from the inventive concept herein disclosed, and it is desired that only such limitations be imposed on the appended claims as are stated therein or required by the prior art.

The embodiments of this invention in which an exclusive property or privilege is claimed are defined as follows:

1. A single phase liquid lubricating, anti-corrosion, anti-acid composition, designed as a conditioning additive for 20 to 60 fold dilution with an aqueous heat-exchange liquid for use in a cooling system of an internal combustion engine, consisting essentially of (a) the water-soluble borate salt product of forming an acidic boric intermediate by heating orthoboric acid and at least one dihydric alcohol selected from the group consisting of 1,2 ethanediol and 1,2 propanediol in the proportions of 2 to 5 mols of said dihydric alcohol per mol of B_2O_3 and reacting said acidic intermediate with caustic alkali of at least one metal selected from potassium and sodium in the proportions of 1 to 2 mols of B_2O_3 per mol of M_2O , where M is said alkali metal, said heating and reacting being controlled to a temperature no greater

than 300° F., water being initially present in said reactants in an amount substantially no greater than B_2O_3 being present as $2H_3BO_3$ and M_2O being present as 2 MOH and a proportion of said water being eliminated from said reactants by volatilization to provide an amount of residual water compatible in the final single phase liquid composition when said initial water content exceeds the water-compatibility level, said resulting borate salt product being present in sufficient amount to provide 6% to 25% of the borate salt expressed as the sum of B_2O_3 plus M_2O , (b) 3% to 15% of a water-immiscible monohydroxy 1,2 polyoxypropylene monoalkyl ether having an average of about 8 to 32, 1,2 oxypropylene groups per molecule and an average molecular weight of about 450 to 1600 as a lubricant, the balance of the composition consisting essentially of (c) at least one water-soluble aliphatic monohydric alcohol selected from the group consisting of methanol and ethanol as a solvent for said salt (a) and said lubricant (b), and (d) a compatible proportion of water in amount no greater than 12%, the indicated percentages being based on the total weight of the composition.

2. The composition of claim 1 in which said dihydric alcohol is present in an amount corresponding to 3 to 5 mols per mol of B_2O_3 .

3. The composition of claim 1 in which said dihydric alcohol is 1,2 ethanediol.

4. The composition of claim 1 in which said lubricant is a monobutyl ether.

5. The composition of claim 1 in which said lubricant is characterized by a viscosity in the range of about 60 to about 1200 Saybolt seconds at 100° F.

6. The composition of claim 1 in which said alkali metal borate salt has a composition corresponding to about 1.2 to 1.5 mols of B_2O_3 per mol of M_2O .

7. The composition of claim 1 in which said alkali metal borate salt is a potassium borate salt.

8. The composition of claim 1 in which said monohydric alcohol is methanol.

9. The single phase liquid composition of claim 1 wherein said borate salt (a) is the reaction product of heating said salt-forming reactants at a temperature sufficient to volatilize water therefrom up to 260° F. and eliminating water from said reaction mixture, in an amount sufficient to provide the single phase liquid composition with a water content no greater than 5% by weight.

10. The single phase liquid composition of claim 1 wherein said borate salt (a) is the product of heating and reacting said salt-forming reactants at a temperature no greater than 180° F., thereby inhibiting volatile loss of said initial water content of the reactants, said reactants B_2O_3 as $2H_3BO_3$ and M_2O as 2 MOH furnishing an initial water content no greater than that which provides the final product with a water content no greater than 9%, and said lubricant (b) is characterized by a viscosity of 60 to 600 Saybolt seconds at 100° F.

11. The single phase liquid composition of claim 1 wherein said borate salt (a) is the product of forming an acidic boric intermediate by heating orthoboric acid with 1,2 ethanediol in the proportions of 3 to 5 mols of 1,2 ethanediol per mol of B_2O_3 and reacting the resulting acidic intermediate with caustic potash in the proportions of 1.2 to 1.5 mols of B_2O_3 per mol of K_2O , said lubricant (b) is said monohydroxy 1,2 polyoxypropylene monoalkyl ether having butyl as the alkyl substituent, said solvent (c) is methanol and said water content (d) is no greater than 9% by weight.

12. The composition of claim 11 in which said borate salt is present in an amount ranging from 10% to 20% by weight expressed as the sum of B_2O_3 plus K_2O and said lubricant is present in an amount ranging from about 6% to about 12% by weight and is further characterized by a viscosity of 60 to 600 Saybolt seconds at 100° F.

13. The composition of claim 11 in which the 1,2 ethanediol is present in an amount ranging from 15% to 30% by weight based on the total composition.

14. The process of preparing a single phase liquid lubricating, anti-corrosion, anti-acid composition, designed as a conditioning additive for 20 to 60 fold dilution with an aqueous heat exchange liquid in a cooling system of an internal combustion engine, comprising the steps of (a) forming a water-soluble alkali metal borate salt by heating orthoboric acid and at least one dihydric alcohol selected from the group consisting of 1,2 ethanediol and 1,2 propanediol in the proportions of 2 to 5 mols of said dihydric alcohol per mol of B_2O_3 , thereby forming an acidic boric intermediate, and reacting said intermediate with caustic alkali of at least one metal selected from potassium and sodium in the proportions of 1 to 2 mols of B_2O_3 per mol of M_2O where M is said alkali metal, heating and reacting being controlled to a temperature no greater than 300° F., water being initially present in said reactants in an amount substantially no greater than B_2O_3 being present as $2H_3BO_3$ and M_2O being present as 2 MOH, and reducing said water by volatilization to a residual water content at a concentration level compatible in the final single phase liquid product when said initial water exceeds the compatibility level, (b) mixing the resulting borate salt with a water-immiscible monohydroxy 1,2 polyoxypropylene monoalkyl ether characterized by an average of about 8 to 32 1,2 oxypropylene groups per molecule and an average molecular weight of about 450 to 1600 as a lubricant, and (c) dissolving the resulting mixture of said borate salt and said lubricant with at least one substantially anhydrous water-soluble aliphatic monohydric alcohol selected from the group consisting of methanol and ethanol, the resulting single phase liquid solution having a concentration of said borate salt from 6% to 25% expressed as B_2O_3 plus M_2O , a concentration of said lubricant from 3% to 15%, a compatible concentration of water no greater than 9%, the balance being said monohydric alcohol, said percentages being expressed on the basis of the weight of the final product.

15. The process of claim 14 wherein said heating and reacting in said step (a) is a temperature sufficient for volatile elimination of a portion of said initial water content up to 260° F. and separating by volatilization that portion of said water in excess of an amount which

provides the final product with a water content no greater than 5% by weight.

16. The process of claim 14 wherein said heating and reacting in said step (a) is at a temperature no greater than 180° F., thereby retaining substantially the entire said initial water content in said borate salt product, said initial water content furnished by said $2H_3BO_3$ and said 2 MOH being an amount which provides the final product with a water content no greater than 9% by weight, and said lubricant is said monohydroxy 1,2 polyoxypropylene monoalkyl ether having butyl as said alkyl substituent and being further characterized by a viscosity of 60 to 600 Saybolt seconds at 100° F.

17. The process of claim 16 wherein said step (a) consists of heating orthoboric acid and 1,2 ethanediol in the proportion corresponding to 3 to 5 mols per mol of B_2O_3 to form said acidic intermediate product, and forming a potassium salt thereof by reacting the boric acid component of said intermediate with caustic potash in the proportion corresponding to 1.2 to 1.5 mols of B_2O_3 per mol of K_2O , step (b) consists of mixing the resulting borate salt with said water-immiscible lubricant, and step (c) consists of dissolving the mixture of the borate salt and the lubricant by mixing with anhydrous methanol in an amount which provides the resulting solution with a concentration of said borate salt from 10% to 20% by weight expressed as the sum of B_2O_3 plus K_2O and a concentration of 6% to 12% by weight of said lubricant.

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