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2,965,574

FIRE RESISTANT HYDRAULIC FLUID

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This invention relates to a fire resistant hydraulic fluid. More particularly, it concerns a water-in-oil emulsion having a specific composition rendering it excellent for use in the process of transmitting power without danger of fire.

In recent years the increased emphasis on industrial safety programs has resulted in a growing awareness on the part of industry that large volumes of mineral hydraulic oils in exposed areas constitute a dangerous safety hazard with respect to fires and explosions. A number of different solutions to the problem have been considered. These consisted of the use of various types of compositions which were intended to duplicate the performance of a mineral oil hydraulic fluid without the accompanying fire hazard. As will be pointed out hereafter, none of these compositions were satisfactory in meeting modern requirements. This invention, however, consists of an improved hydraulic fluid which duplicates mineral oil performance in the process of transmitting power without fire hazard and is not subject to the objections raised against prior art products.

The improved fire resistant hydraulic fluid of this invention is a water-in-oil emulsion comprising from 60 to 40 volume percent of water in the internal phase and from 40 to 60 percent of an oleaginous blend containing a major portion of mineral oil having an upper viscosity limit of 300 SUS at 100° F. in the external phase, at least 4.0 and up to about 12.0 volume percent of an emulsifying agent selected from the group consisting of fatty acid partial esters of six carbon polyhydric alcohol mono- and dianhydrides, alone, in mixtures and in combination with no more than 20 percent, based on the emulsifying agent, of polyoxyalkylene derivatives of fatty acid partial esters of six carbon polyhydric alcohol mono- and dianhydrides, said fatty acids having from 6 to 30, preferably from 12 to 24, carbon atoms, and a volatile corrosion inhibitor in an amount sufficient to inhibit corrosion by the emulsion while in the vapor and liquid phases. Preferably, in order to meet the performance standards of inhibited mineral oil hydraulic fluids, the emulsion contains a minor amount of an antiwear agent and a minor amount of an antioxidant for the oil phase of the emulsion. In addition, an anti-foam agent and a pour point depressant have also been found to be extremely useful.

As previously stated, prior to the present invention, various types of compositions were tried which were found to have serious drawbacks. The compositions included: (1) mineral oil plus snufflers, (2) all synthetic fluids, (3) water-glycol base fluids, (4) oil-in-water emulsions.

Mineral oil plus snufflers were considered unsatisfactory when it was found that the snuffing agents, hexachlorobutadiene and tetrachloroethane, for example, even when present in large quantities up to 50 percent had only a very slight effect on the flammability of the mineral oil and at such concentrations rendered the compositions highly toxic.

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The all synthetic fluid tried also was unsatisfactory when it was found that certain components exhibited excessive toxicity. Other known less toxic all synthetic fluids are expensive and deleteriously affect seal materials.

Water-glycol base hydraulic fluids were found to be less objectionable in use than the preceding type fluids, however, none of the water-glycol base fluids tested came close in performance to a mineral oil hydraulic fluid. This type of fluid is also quite expensive in comparison to a mineral oil hydraulic fluid.

The fourth type of hydraulic fluid considered, namely, oil-in-water emulsions containing from 3 to 50 volume percent mineral oil, was entirely unsatisfactory in the pump type screening test because it failed to lubricate satisfactorily and consequently further consideration was not given to its use.

The high amount of water in the emulsion of the present invention is of the essence in order to guarantee a fire resistant fluid. The standard was set as a result of testing emulsions containing various amounts of water in the Spray Ignition Test defined by the military specification designated MIL-F-7100. This test consists of forcing the test fluid through a small orifice under 1000 pounds pressure. The resulting spray is directed through the heart or hottest part of an oxy-acetylene torch. The torch is moved from 4 to 18 inches from the orifice. Between these distances there should be no evidence of flame propagation either downstream or upstream from the torch. Localized burning in the near vicinity of the torch is acceptable, however, providing no flame propagation occurs. The results of this test on emulsions having the same oil blend comprising 88.7 (vol.) percent of a paraffin base oil having a viscosity of 75 SUS at 100° F., an emulsifier consisting of 5 (vol.) percent of sorbitan monooleate and 1 (vol.) percent of a polyoxyethylene derivative of sorbitan monolaurate, 5 (vol.) percent of tricresylphosphate, 0.3 (vol.) percent of a 50 percent concentrate of 2-hydroxypropylamine-nitrite, 0.3 (wt.) percent of 4-methyl-2,6-di-tertiary butylphenol, and 150 p.p.m. of dimethyl silicone in a 10 percent kerosine solution emulsified with various amounts of deionized water are set forth in the following table.

Table I

Percent H ₂ O	Percent Oil Blend	Result
20	80	Definite burning of emulsion was observed and the flame was propagated downstream.
30	70	Burning was observed about the torch at all times with sporadic flame propagation downstream.
40	60	Intermittent burning of emulsion particularly when the spray actually hit the metal part of the oxy-acetylene torch. There appeared to be no downstream propagation.
50	50	No burning was observed.

The results as indicated in Table I definitely show that at least 40 percent water is necessary to produce a satisfactory fire resistant fluid with this oil blend. The upper limit of water (60%) present in the emulsion represents a safety limit to prevent a reversal of the emulsion and an accompanying drastic loss of viscosity. Within this relatively small given range (40–60%), different concentrations of water will not greatly effect the excellent properties of the emulsion. An increase in the water content, however, will cause an increase in viscosity until the point of emulsion reversal occurs, which is beyond the upper limit of water content of the invention.

Any type of mineral oil or mixture thereof is useful in accordance with this invention as long as the viscosity of the oil does not exceed 300 SUS at 100° F. The pre-

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ferred type of mineral oil is one having a viscosity of from 50 to 100 SUS at 100° F., a flash point ranging from 300 to 375° F., and a pour point of not more than +20° F. Since at least 40 volume percent of water is required to render the emulsion fire resistant, the oil component, of necessity, must meet a low viscosity requirement, so that when mixed with water the resulting fluid is not excessively viscous thus preventing its usefulness as a hydraulic fluid.

The preparation of a water-in-oil emulsion with the concentration of water useful in accordance with this invention without experiencing an emulsion reversal and maintaining emulsion stability had been a problem. However, with the emulsifying agents of the present invention, this problem has been solved.

A large number of emulsifiers were evaluated in the following manner: The selected emulsifying agent was blended with the mixture of oil and additives. In most cases the emulsifiers were readily soluble in the base fluid and no heat was necessary. Heating was, however, employed when necessary. While the oil and emulsifier were being agitated, 50 volume percent of deionized water was added in a small but steady stream. Agitation was

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polyoxypropylene, and polyoxybutylene derivatives of the fatty acid partial esters of hexitans and hexides. Some examples of the fatty acids useful when chemically combined to form partial esters in accordance with the present invention are caproic, sorbic, pelargonic, capric, lauric, myristic, palmitic, margaric, stearic, oleic, linoleic, linolenic, arachidic, behenic, cerotic, and melissic. The preferred emulsifying agent is the combination of sorbitan monooleate and a polyoxy ethylene derivative of sorbitan monolaurate.

Mixtures of the same fatty acid partial esters of a hexitan and a hexide are commonly referred to merely as hexitan monoesters and are included within the scope of the invention. These mixtures, in many instances, have superior emulsifying properties and are less expensive than the pure compounds.

When a combination of fatty acid ester and polyoxyalkylene derivatives thereof is used as an emulsifying agent, it is imperative that no more than 20 percent of the polyoxyalkylene derivative be present in the combination. This limitation results in a balanced hydrophilic lipophilic emulsifier which lends excellent stability to the emulsion. This is demonstrated in the following table.

Table II

Emulsifying Agents	Vol. percent of Emulsifier component	Vol. percent of Emulsifier based on oil	Separating Time and Degree	
			Room Temp.	150° F.
(1) Sorbitan monooleate polyoxyethylene derivative of sorbitan monolaurate.....	70 30	5	Separation in less than 12 hours.	
(2) Sorbitan monooleate polyoxyethylene derivative of sorbitan monolaurate.....	83.7 16.3	6	After 2 weeks no separation.	After 2 weeks very slight oil separation, no water separation.
(3) Sorbitan monooleate polyoxyethylene derivative of sorbitan monolaurate.....	90 10	10	After 3 months trace of oil, slight trace of water.	After 3 weeks 10% oil separation, no water separation.
(4) Sorbitan monooleate polyoxyethylene derivative of sorbitan monolaurate.....	90 10	5	After 4 months trace of oil, slight trace of water.	After 5 weeks 10% oil separation, no water separation.
(5) Sorbitan monooleate.....	100	5	After 4 months 25% oil separated, no water separation.	After 5 weeks 40% oil separation, no water separation.
(6) Sorbitan monooleate.....	100	10	After 4 months 10% oil separated, no water separated.	After 5 weeks 40% oil separation, no water separation.

continued for five minutes after the water addition was complete. The emulsion was then allowed to stand overnight. If separation occurred during this period, the mixture was discarded. If little or no separation occurred, the emulsion was subjected to storage testing which was carried out at room temperature and in a 150° F. heated oven. Periodic inspection of the emulsions were made during which the amount of separated oil and water was noted. Those emulsifiers which caused the emulsion to show little separation after three weeks were considered good.

The emulsifying agents which were found to be suitable in accordance with this invention included a fatty acid partial ester of a six carbon polyhydric alcohol mono- or di-anhydride which is essentially lipophilic either alone, in mixtures with the same type of compound or in combination with a polyoxyalkylene derivative of a fatty acid partial ester of a six carbon polyhydric alcohol mono- or dianhydride which is essentially hydrophilic. The fatty acid portion of the ester having from 6 to 30 carbon atoms and the alkylene group of the polyoxyalkylene derivative having from 1 to 4 carbon atoms. Examples of lipophile emulsifying agents include the partial esters of sorbitan, sorbide, mannitan, mannide, dulcitan, and dulcide. These compounds, per se, and the method of producing them are set forth in U.S. Patents 2,322,820 and 2,322,821. Examples of the hydrophile emulsifying agents include the polyoxymethylene, polyoxyethylene,

It is seen from the foregoing Table II that the emulsifying agent in No. 1 having well over 20 percent of a polyoxyalkylene derivative present in the combination produced no appreciable emulsion stability, whereas those having less than 20 percent and particularly those having about 10 percent were excellent stability producers. Emulsifying agents Nos. 5 and 6 wherein no polyoxyethylene derivatives were combined lent good stability to the emulsion although they were somewhat less effective than the preferred emulsifier combination.

It is pointed out that while the emulsion used herein to demonstrate the superior water-in-oil emulsion properties were made with deionized water, ordinary tap water may also be used so long as it does not contain a high percentage of metal carbonates, such as calcium carbonate or bicarbonate. Tap water emulsions with low carbonate content showed slightly less emulsion stability on storage, however, they were none-the-less adjudged to be satisfactory for use in hydraulic systems.

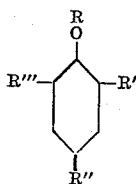
Owing to the large amount of water present in the emulsion, it was found absolutely necessary to incorporate a volatile rust inhibitor to prevent the rusting of the metal parts of the hydraulic system with which the fluid, in both liquid and vapor phases, came in contact. Without such an inhibitor the system would soon become choked with rust necessitating renewal of parts and changing of the fluid. The class of anti-rust agents which is useful is the amine nitrates and amine carboxylates.

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These compounds are excellent two-phase rust inhibitors and are useful in amounts of from 0.05 to 1.0 (vol.) percent based on the oil phase of the emulsion. Examples of such compounds include 2-hydroxypropylamine nitrite, isopropylamine nitrate, cyclohexylamine nitrite, diisobutylamine nitrite, triethylamine nitrite, amylamine benzoate, diisopropylamine benzoate, monoethanolamine benzoate, isoamylamine salicylate, and diisopropylamine butylphosphonate. The preferred rust inhibitor which is used in accordance with this invention is 2-hydroxypropylamine nitrite due to availability and cost. This compound has given excellent rust protection to metal parts of the hydraulic test systems in both the liquid and vapor phase despite the large amount of water present.

In order to obtain a fire resistant fluid which is comparable to inhibited mineral oils with respect to wear properties, it is necessary to incorporate a compatible antiwear agent in the emulsion. Hydrocarbon phosphate esters have been found to be the most satisfactory antiwear agents. These compounds, for example, di- and triphenyl phosphates, tricresylphosphate, tributyl phosphate, triethyl phosphate, trioctyl phosphate, and a mixture of mono- and dialkyl phosphoric acid esters wherein the alkyl group is a straight chain containing from 8 to 16 carbon atoms, are incorporated in amounts up to 10 volume percent based on the mineral oil. The preferred antiwear agent on the basis of availability is tricresylphosphate in an amount ranging from 0.5 to 10 percent by volume based on the oil blend. It is preferably present in the emulsion in the amount of about 5 (vol.) percent based on the oil. The low concentration of the tricresylphosphate eliminates any question of toxicity and adds many hours of wear to the moving parts which contact the fluid.

An antioxidant is also an extremely useful additive in the emulsion to prevent breakdown of the oil phase after continued use. Oxidation of the oil causes it to become excessively acidic and thus harmfully corrosive. This acidic oil will also seriously effect the stability of the emulsion. The antioxidants which have been found to be particularly useful in accordance with this invention are the so-called partially or totally hindered phenols. Such compounds are characterized by the presence of particular organic groups in a certain position on the phenolic portion of the molecule which serve to inhibit a reaction or cause steric hindrance. Compounds which meet the foregoing characterization are represented by the following structural formula:

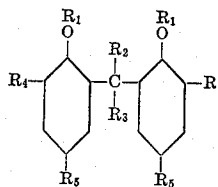


wherein R, R', R'', and R''' represent hydrogen, alkyl and aralkyl, and wherein at least one of the groups in the ortho position relative to the oxy group contains at least three carbon atoms. The total number of substituent carbon atoms should be sufficient to prevent solubility of the compounds in water. Examples of these compounds include: 4-methyl-2,6-di-t-butylphenol; 2-t-butyl-4,6-dimethylphenol; 2,4,6-t-tributylphenol; 2,6-di-t-amyl-4-t-butylphenol; 2,4-dimethyl-6-propylphenol; t-butyl ether of o-sec-butyl-p-cresol; t-butyl ether of o-sec-butyl-p-ethylphenol; t-amyl ether of o-sec-butyl-p-isobutylphenol; mixtures of o- and p-polyalkylbenzylphenol.

Other compounds which are classified as hindered phenols and which are useful with the present invention

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are the alkylene bis alkyl phenols having the following structural formula:



wherein R₁ is a hydrogen, alkyl or aralkyl radical, R₂ is a hydrogen or alkyl radical, and R₃, R₄, and R₅ are hydrogen, hydroxy, amino, halogen, alkyl, aryl, or aralkyl radicals. Examples of such compounds are: 1,1-bis (2-hydroxy-3-t-butyl-5-methylphenyl)ethane; 2,2-bis (2-hydroxy-3-t-butyl-5-methylphenyl)n-propane; 1,1-bis (2-hydroxy-3,5-di-t-butylphenyl)n-butane; 2,2-bis (2-hydroxy-3-t-butyl-5-methylphenyl)-2-tri-fluorethane; 1,1-bis (2-hydroxy-3,5-di-t-butylphenyl)methane.

These antioxidant additives are incorporated in the oil component or blend of the emulsion in amounts up to 1 percent by weight and preferably in an amount of about 0.3 (wt.) percent. The preferred additive is 4-methyl-2,6-di-t-butylphenol on the basis of availability and cost. The preferred compound is sometimes referred to as di-t-butyl-p-cresol.

Initial water-in-oil emulsions tested were found to give somewhat more foam on agitation than was believed desirable. Thus an antifoam additive, preferably a 10 percent solution of dimethyl silicone in kerosine, was added in the amount of 150 p.p.m. to the oil phase of the emulsion with excellent results. No further trouble with foaming was encountered.

In evaluating the emulsion of the present invention a test generally referred to as the Vickers Pump Test is employed. The apparatus used in this test is a hydraulic system which functions as follows: Oil is drawn from a closed sump through a Cuno Type EG Auto-Kleen filter to the intake side of a Vickers V-104A vane-type pump. The pump is driven by, and directly coupled to, a five horsepower, 1740 r.p.m. electric motor. The oil is discharged from the pump through a Vickers Model CT-06-B10 pressure regulating valve. From there it passes through a calibrated venturi (used to measure flowrate) and back to the sump. Cooling of the oil is accomplished by passing cold water through aluminum coils immersed in the sump. No external heat is required, the temperature being raised by the frictional heat resulting from the pump's work on the oil. The sump is air-vented through a calcium chloride dryer. The Vickers V-104A vane-type pump comprises a cylindrical enclosure which houses a so-called "pump cartridge." The "pump cartridge" assembly consists of front and rear circular plates having center shaft supporting circular openings and fluid inlets disposed therein. These shaft support openings are provided with bronze bushings. A rotor is supported for rotation between the front and rear plates by the insertion of its shafts or axes within the front and rear bushings. A plurality of removable vanes are inserted into slots in the periphery of the rotor. A ring or stator member encircles the rotor and encloses it within the two plate members. The inner surface of the ring is cam shaped to enable a rotary pumping action by the vaned rotor against the cam surface.

The Vickers Pump Test procedure in the present case consisted of charging the system with three gallons of the test fluid and running at temperatures ranging from 125 to 135° F. at 1000 p.s.i. pump discharge pressure.

Wear data were made by weighing all the components of the "pump cartridge" individually, except for the vanes which were grouped. At the conclusion of the test run and upon disassembly for weighing, visual examination of the system was made for signs of deposit, varnish, corrosion, etc.

The following table shows the results of the "cartridge" weight loss in the Vickers Pump Test on an inhibited emulsion consisting of 50 percent deionized water and 50 percent of an oil blend consisting of 88.7 (vol.) percent of a paraffin base oil having an SUS viscosity of 70 to 75 at 100° F., a pour of +20° F. and a V.I. of 75; 5.0 (vol.) percent of sorbitan monooleate; 1.0 (vol.) percent of a polyoxyethylene derivative of sorbitan monolaurate; 5.0 (vol.) percent of tricresylphosphate; 0.3 (vol.) percent of a 50 percent concentrate of 2-hydroxypropylaminenitrite; 0.3 (wt.) percent of 4-methyl-2,6-di-t-butylphenol; and 150 p.p.m. of a dimethyl silicone polymer in a 10 percent kerosene solution.

The results of this test on an inhibited mineral oil are shown for comparison. The mineral oil used was a paraffin base oil having an SUS viscosity of 150 at 100° F., a pour of -10° F. and a V.I. of 97. This oil was inhibited with approximately 0.3 (wt.) percent of the antioxidant 4-methyl-2,6-di-t-butylphenol, approximately 0.033 (wt.) percent of an anti-rust 50-50 mineral oil concentrate comprising a mixture of mono- and dilauryl phosphoric acid esters, and about 0.001 percent of an antifoam 10 percent kerosene concentrate of a dimethyl silicone polymer.

Table III

Test Fluid	Running Time (hrs.)	Front and Rear Bushings, Total	Rotor	Cam Ring	Vanes	Total
Inhibited Mineral oil:						
Run 1.....	1 500	0.091	0.018	0.034	0.448	0.591
	2 763	0.428	+0.337	9.998	0.137	10.226
	1 500	0.117	+0.023	0.114	0.017	0.225
Run 2.....	1 1,000	0.137	0.006	0.125	0.018	0.286
	2 1,770	0.222	0.007	11.826	0.323	12.609
Inhibited Emulsion.....	3 1,500	0.463	0.001	0.289	0.076	0.829

¹ Cartridge disassembled, weighed and reassembled.

² Hours to failure. Cartridge replaced.

³ Pump operation still completely satisfactory when run was arbitrarily stopped.

The above table demonstrates that the emulsion of the present invention compares very favorably in cartridge wear to the inhibited mineral oil. On disassembling, the overall condition of the pump system was seen to be excellent. There was no trace of rust below or above the fluid level and no sludge or deposit formation anywhere attesting to the effectiveness of the additives incorporated in the emulsion.

Further evidence that the emulsion of this invention is very satisfactory as a hydraulic fluid lies in the fact that it has been tested in the field by use in a production model welder continuously for over eight months with satisfactory performance without accompanying fire hazard.

Obviously, many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof and, therefore, only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. A fire resistant water-in-oil emulsion suitable for use as a hydraulic fluid consisting essentially of from 60 to 40 volume percent of water and from 40 to 60 volume percent of an oleaginous blend containing a major portion of a mineral oil having a viscosity in the range from 50 to 300 SUS at 100° F., from 4 to 12 volume percent of a lipophilic emulsifying agent selected from the group consisting of fatty acid partial esters of six carbon polyhydric alcohol mono- and dianhydrides, and mixtures thereof, in combination with from about 10 percent to 20 percent, based on said lipophilic emulsifying agent, of polyoxyalkylene derivatives of fatty acid partial esters of six carbon polyhydric alcohol mono- and dianhydrides, said fatty acids having from 6 to 30 carbon atoms, and the alkylene portion of said

polyoxyalkylene derivative having from 1 to 4 carbon atoms, and a volatile corrosion inhibitor in an amount sufficient to inhibit corrosion in both the liquid and vapor phases.

2. The fire resistant water-in-oil emulsion of claim 1 wherein the lipophilic emulsifying agent is selected from the group consisting of fatty acid partial esters of sorbitan and sorbide, and mixtures thereof, in combination with from about 10 percent to 20 percent of polyoxyethylene derivatives of fatty acid partial esters of sorbitan and sorbide, said fatty acids having from 12 to 24 carbon atoms, and said volatile corrosion inhibitor is selected from the group consisting of amine nitrites and amine carboxylates in an amount ranging from 0.05 to 1.0 volume percent.

3. A fire resistant water-in-oil emulsion of claim 2 which also contains a wear inhibiting hydrocarbon phosphate ester in an amount ranging from 0.5 to 10 volume percent based on said blend, and an oxidation inhibiting hindered phenol in an amount ranging up to 1.0 weight percent based on said blend.

4. A fire resistant water-in-oil emulsion suitable for use as a hydraulic fluid consisting essentially of about 50 volume percent of water and about 50 volume per-

cent of an oleaginous blend containing a major portion of mineral oil having a viscosity in the range from about 70 to about 150 SUS at 100° F., from 4 to 12 volume percent of an emulsifying agent consisting essentially of an oleic acid monoester of sorbitan in combination with about 10.0 volume percent based on the emulsifying agent of a polyoxyethylene derivative of a lauric acid monoester of sorbitan, about 0.15 volume percent of a hydroxypropylamine nitrite, about 5.0 volume percent of tricresyl phosphate, about 0.3 weight percent of 4-methyl-2,6-di-t-butylphenol, and from 100 to 200 p.p.m. of a 10 percent kerosene solution of dimethylsilicone polymer.

5. A fire resistant water-in-oil emulsion suitable for use as a hydraulic fluid consisting essentially of from 60 to 40 volume percent of water and from 40 to 60 volume percent of an oleaginous blend containing a major portion of a mineral oil having a viscosity in the range from 50 to 300 SUS at 100° F., and from 4 to 12 volume percent of a lipophilic emulsifying agent selected from the group consisting of fatty acid partial esters of 6-carbon polyhydric alcohol mono- and dianhydrides, and mixtures thereof, in combination with from about 10 percent to 20 percent based on said lipophilic emulsifying agent, of polyoxyalkylene derivatives of fatty acid partial esters of 6-carbon polyhydric alcohol mono- and dianhydrides, said fatty acids having from 6 to 30 carbon atoms, and the alkylene portion of said polyoxyalkylene derivatives having from 1 to 4 carbon atoms.

6. The process which comprises transmitting power in a hydraulic system by means of a water-in-oil emulsion comprising from 60 to 40 volume percent of water and from 40 to 60 volume percent of an oleaginous blend containing a major portion of a mineral oil having an

upper viscosity limit of 300 SUS at 100° F., from 4 to 12 volume percent of a lipophilic emulsifying agent selected from the group consisting of fatty acid partial esters of six carbon polyhydric alcohol mono- and dianhydrides, alone, in mixtures and in combination with no more than 20 percent, based on said lipophilic emulsifying agent, of polyoxalkylene derivatives of fatty acid partial esters of six carbon polyhydric alcohol mono- and dianhydrides, said fatty acids having from 6 to 30 carbon atoms, and the alkylene portion of said polyoxalkylene derivative having from 1 to 4 carbon atoms, and a volatile corrosion inhibitor in an amount sufficient to inhibit corrosion in both the liquid and vapor phases.

7. The process of claim 6 wherein the lipophilic emulsifying agent is selected from the group consisting of fatty acid partial esters of sorbitan and sorbide, alone, in mixtures and in combination with no more than 20 percent of polyoxyethylene derivatives of fatty acid partial esters of sorbitan and sorbide, said fatty acids having from 12 to 24 carbon atoms, and said volatile corrosion inhibitor is selected from the group consisting of amine nitrates and amine carboxylates in an amount ranging from 0.05 to 1.0 volume percent.

8. The process of claim 7 wherein said oleaginous blend contains a wear inhibiting hydrocarbon phosphate ester in an amount ranging from 1 to 10 volume percent based on said blend, and an oxidation inhibiting hindered phenol in an amount ranging from 0.001 to 1.0 volume percent based on said blend.

9. The process which comprises transmitting power in a hydraulic system by means of a water-in-oil emulsion comprising about 50 volume percent of water and

about 50 volume percent of an oleaginous blend containing a major portion of mineral oil having an upper viscosity limit of 150 SUS at 100° F., from 4 to 12 volume percent of an emulsifying agent consisting essentially of an oleic acid monoester of sorbitan in combination with about 10.0 volume percent based on the emulsifying agent of a polyoxyethylene derivative of a lauric acid monoester of sorbitan, about 0.15 volume percent of a hydroxypropylamine nitrite, about 5.0 volume percent of tricresyl phosphate, about 0.3 weight percent of 4-methyl-2,6-di-t-butylphenol, and from 100 to 200 p.p.m. of a 10 percent kerosine solution of dimethylsilicone polymer.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,965,574

December 20, 1960

Raymond B. Tierney et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 75, for "nitrates" read -- nitrites --;
column 5, line 5, for "nitrate" read -- nitrite --.

Signed and sealed this 31st day of July 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents