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Burrous

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[54] **EROSION-INHIBITED FUNCTIONAL FLUIDS**

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[51] **Int. Cl.**[2] **C09K 50/00**

[58] **Field of Search** 252/74, 75, 387, 49, 49.6, 252/49.9, 49.7

[56] **References Cited**

UNITED STATES PATENTS

2,636,861	4/1953	Watson	252/78
2,903,428	9/1959	Moreton	252/78

OTHER PUBLICATIONS

Chemical Abstracts, Vol. 75, 1971, No. 69263d, p. 374.

Chemical Abstracts, Vol. 64, 1966, No. 511g.

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[57] **ABSTRACT**

The addition of a small amount of a soluble salt of perhalometallic or perhalometalloidic acid to an energy-transmitting functional fluid sharply enhances the anti-erosion properties of the fluid.

20 Claims, No Drawings

EROSION-INHIBITED FUNCTIONAL FLUIDS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to fluid compositions which are useful for transmitting power in hydraulic systems. Specifically, it relates to power transmission fluids having a tendency to cause erosion of hydraulic systems and a newly discovered means of controlling such erosion.

Organic phosphate ester fluids have been recognized for some time as advantageous for use as the power transmission medium in hydraulic systems. Such systems include recoil mechanisms, fluid-drive power transmission, and aircraft hydraulic systems. In the latter, phosphate ester fluids find particular utility because of their special properties which include high viscosity index, low pour point, high lubricity, low toxicity, low density and low flammability. Thus, for some years, numerous types of aircraft, particularly commercial jet aircraft, have used phosphate ester fluids in their hydraulic systems. Other power transmission fluids which have been utilized include major or minor amounts of hydrocarbon oils, amides of phosphoric acid, silicate esters, silicones and polyphenyl ethers. Additives which perform special functions such as viscosity index improvement and foam inhibition are also present in these fluids.

The hydraulic systems of a typical modern aircraft contain a fluid reservoir, fluid lines and numerous hydraulic valves which actuate various moving parts of the aircraft such as the wing flaps, ailerons, rudder and landing gear. In order to function as precise control mechanisms, these valves often contain passages or orifices having clearances on the order of a few thousandths of an inch or less through which the hydraulic fluid must pass. In a number of instances, valve orifices have been found to be substantially eroded by the flow of hydraulic fluid. Erosion increases the size of the passage and reduces below tolerable limits the ability of the valve to serve as a precision control device. Many aircraft have experienced sagging wing flaps during landings and takeoffs as a result of valve erosion.

Early investigations indicated that the erosion was being caused by cavitation in the fluid as the fluid passed at high velocity from the high-pressure to the low-pressure side of the valve. The incorporation of water into the hydraulic fluid was found to inhibit the erosion, but continuing experience shows that a significant erosion problem remains.

Recent studies indicate that certain valve erosions are associated with the electrokinetic streaming current induced by the high velocity fluid flow.

2. Description of the Prior Art

A study of the problem attributing valve erosion to the streaming current induced by fluid flow is Beck et al., "Corrosion of Servovalves by an Electrokinetic Streaming Current," Boeing Scientific Research Document D1-82-0839 (September, 1969). Efforts to control hydraulic valve erosion by treating the problem as one of cavitation in the fluid are described in Hampton, "The Problem of Cavitation Erosion In Aircraft Hydraulic Systems," *Aircraft Engineering*, XXXVIII, No. 12 (December, 1966). The Text, *Organophosphorous Compounds*, by Kosolapoff (Wiley, New York, 1950), describes methods or preparing organophosphorous derivatives. Several patents describe phosphate ester hydraulic fluids, including U.S. Pat. Nos. 2,636,861, 2,636,862, 2,894,911, 2,903,428, and 3,036,012.

SUMMARY OF THE INVENTION

It has now been discovered that a soluble salt of perhalometallic or perhalometalloidic acid or mixtures thereof when incorporated into non-aqueous functional fluids, serve to reduce the electrical streaming current of the fluid which is believed to be associated with the erosion of control valves in the system. Specifically, in the art of hydraulic fluid formulation, the improvement comprising the inclusion of 0.0001 to 2 weight percent of the soluble perhalometallic or perhalometalloidic salt in the hydraulic fluid. Preferably, the functional fluid will contain .001 to 1 weight percent of the soluble perhalometallic or perhalometalloidic, and will be comprised of organic phosphate esters.

DETAILED DESCRIPTION OF THE INVENTION

The anti-erosion properties of a functional fluid can be substantially improved by incorporating into the fluid base an effective amount of a soluble salt of a perhalometallic or perhalometalloidic acid.

The term "perhalometallic acid" and "perhalometalloidic acid" as referred to herein encompasses all of the perhalo acids of the metals and metalloids of the periodic table capable of forming the perhalo acids. These acids are sometimes referred to as "super acids." The metals and metalloids which are capable of forming perhalo acids include beryllium of Group IIA, thorium of Group IIIB, titanium and zirconium of Group IVB, niobium and tantalum of Group VB, chromium of Group VIB, manganese and rhenium of Group VIIB, iron, nickel, ruthenium, rhodium, palladium, osmium, iridium and platinum of Group VIII, gold of Group IB, aluminum, gallium and boron of Group IIIA, silicon, germanium, tin, and lead of Group IVA, phosphorus, arsenic and antimony of Group VA and tellurium of Group VIA. Exemplary perhalometallic acids include hexafluoroaluminic, hexafluoroantimonic, hexafluoroferric, hexafluorotitanic, hexafluorothoric, hexafluorogermanic, hexafluorozirconic, tetrafluoroberyllic, trifluorostannous, hexafluorostannic, hexafluoro and heptafluorotantalic, hexafluorochromic, hexafluoroniobic, hexafluoromanganic, tetrafluoroboric, hexafluoro and tetrafluorophosphoric, hexafluorosiliconic, hexafluoroarsenic, hexachloroiridic, hexachloroosmic, tetrachloro and hexachloropalladic, tetrachloro- and hexachloroplatinic, hexachlorohodic, hexaidoplatinic and hexabromoiridic, hexabromoplatinic acids.

The perhalometallate and perhalometalloidate salts can be prepared by reacting the perhalo acid with a basic compound such as an alkali metal base, an alkaline earth metal base, ammonium bases, substituted ammonium bases, phosphonium bases and substituted phosphonium bases. Other basic compounds may also be employed provided that the basic compound forms a salt with the perhalo acid and such resulting salt is sufficiently soluble in the functional fluid to effect a reduction in the streaming current of the fluid. Exemplary basic compounds includes alkali metal hydroxides, oxides and carbonates such as sodium hydroxide, potassium hydroxide, lithium hydroxide, sodium oxide, potassium oxide, sodium carbonate, sodium bicarbonate, potassium carbonate, potassium bicarbonate, etc, alkaline earth metal hydroxides, oxides and carbonates

such as calcium hydroxide, barium hydroxide, calcium oxide, barium oxide, calcium carbonate, calcium bicarbonate, etc. Ammonium hydroxide, substituted quaternary ammonium hydroxides such as tetramethyl ammonium hydroxide, trimethylbenzyl ammonium hydroxide, tetrapropyl ammonium hydroxide, tetrabutyl ammonium hydroxide, etc., phosphonium hydroxide, tetramethyl phosphonium hydroxide, tetrabutyl phosphonium hydroxide, trimethylbenzyl phosphonium hydroxide, etc. Other basic compounds include zinc hydroxide, zinc carbonate, zinc bicarbonate, etc.

The perhalometallates and perhalometalloidates salts may also be prepared by reacting a halogenated metal or metalloid with an ammonium or phosphonium halide or a substituted ammonium or substituted phosphonium halide. Exemplary reactions include a reaction of ammonium fluoride with boron trifluoride, phosphonium fluoride with boron trifluoride, ammonium fluoride with phosphorus pentafluoride, phosphonium fluoride with phosphorus pentafluoride, phosphonium chloride with boron trifluoride, tetramethyl ammonium chloride with boron trifluoride, tetrabutyl ammonium fluoride with phosphorus pentafluoride, methylbenzyl phosphonium chloride with phosphorus pentafluoride, methylbenzyl phosphonium chloride with boron trichloride, ammonium chloride with antimony pentachloride, triethyl oxonium fluoride with boron trifluoride, triphenyl carbenium chloride with phosphorus pentafluoride, etc.

A preferred class of perhalometallate and perhalometalloidate salts which form the basis for this invention are believed to have the following general formula:

$$M\left[AX_y\right]_z$$

wherein

A is a metal or metalloid, and preferably a metalloid;

M is a solubilizing cation;

X is a halogen, preferably chlorine or fluorine and more preferably fluorine;

y is an integer from 3 to 7 and equal to the positive valence of A plus an integer from 1 to 3; and preferably an integer equal to 4 for the metals and metalloids in the second period of the periodic table and equal to 6 for the metals and the metalloids in all other periods of the periodic table;

z is an integer from 1 to 3 and sufficient to maintain the salt electro-neutral.

In the above formula, A is an amphoteric metal or metalloid of the type described supra and capable of forming perhalo acids. In a preferred embodiment, A is selected from the group consisting of phosphorus, boron and antimony and, more preferably, phosphorus or boron. M can be any stable cation which imparts significant solubility to the salts in the functional fluid. This solubility is preferably from at least 0.01 gram per liter of the perhalo salt in the functional fluid and, more preferably, at least about 0.01 gram/liter. The preferred solubilizing cation includes alkali metal, ammonium, phosphonium, C_1–C_{30} hydrocarbyl substituted ammonium, C_1–C_{30} hydrocarbyl substituted phosphonium cations, C_8–C_{30} trihydrocarbyl carbenium, and C_3–C_{30} trihydrocarbyl oxonium. The most preferred solubilizing cations are sodium, potassium and ammonium.

Some of the preferred perhalometallates and perhalometalloidates include, ammonium hexafluorophosphate (NH_4PF_6), N-benzyl-N,N,N-trimethyl ammonium hexafluorophosphate $(CH_3)_3(C_6H_5CH_2)NPF_6$, potassium hexafluorophosphate, tetrabutyl ammonium hexafluorophosphate, ammonium tetrafluoroborate (NH_4BF_4), sodium tetrafluoroborate, zinc tetrafluoroborate, sodium hexafluoroantimonate (N_aSbF_6), ammonium hexafluoroantimonate, N-benzyl-N,N,N-triethyl phosphonium hexafluorophosphate, potassium hexafluoroantimonate, etc.

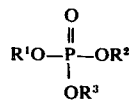
Method of preparation of the various perhalometallates and perhalometalloidates are well known in the chemical literature and many are commercially available from Ozark-Mahoning of Tulsa, Oklahoma.

The concentration of perhalometallate or perhalometalloidate salt in the functional fluid varies, depending upon the salt selected, operating temperature, etc. Generally, however, from 0.0005 to 1 weight percent of the salt is incorporated into the functional fluid and, more preferably, from 0.001 to 0.01 weight percent.

Fluid Base

The functional fluids of the present invention comprise a fluid base present in major proportion in which the halo-containing compounds and other additives are employed. The fluid base includes a wide variety of base materials, such as organic esters or amides of phosphorus acids, mineral oils, synthetic hydrocarbon oils, silicate esters, silicones, carboxylic acid esters, aromatics and aromatic halides, esters of polyhydric material, aromatic ethers, thioethers, etc.

The phosphate esters are the preferred base fluid of the present invention and have the formula



wherein R^1, R^2 and R^3 each represent an alkyl or aryl hydrocarbon group. (As used herein, "aryl" includes aryl, alkaryl, and aralkyl structures and "alkyl" includes aliphatic and alicyclic structures.) All three groups may be the same, or all three different, or two groups may be alike and the third different. A typical fluid will contain at least one species of phosphate ester and usually will be a mixture of two or more species of phosphate esters.

In a particularly preferred embodiment, the hydraulic fluid base of this invention consists essentially of a mixture of trialkyl and triaryl phosphate esters with the trialkyl phosphate esters predominating. The trialkyl phosphate esters may be present in amounts of from 70 to 98 percent by weight of the phosphate ester portion of the total fluid composition. Preferably, the trialkyl phosphate esters will comprise 80 to 92 weight percent of the phosphate ester portion of the composition. The trialkyl phosphate esters which give optimum results are those wherein each of the alkyl groups has one to 12 carbon atoms and, preferably, has from four to nine carbon atoms. The alkyl groups may each be either a straight-chain or a branched-chain configuration. A single trialkyl phosphate ester may have the same alkyl

group in all three positions, or may have two or three different alkyl groups. Mixtures of various trialkyl phosphate esters may also be used. Suitable, but non-limiting species of trialkyl phosphate esters useful in this invention include the tributyl phosphates, particularly tri(n-butyl) phosphate, trihexyl phosphates, and trioctyl phosphates. Particularly preferred are tri(n-butyl) phosphate or the branched-chain isomers of the trioctyl phosphates, such as tri(2-ethylhexyl) phosphate.

The triaryl phosphate esters useful in the composition of this invention may be present in amounts of from about 2 to about 30 percent by weight of the phosphate ester portion of the total fluid composition. The triaryl phosphate esters which give optimum results are those wherein each of the aryl hydrocarbon groups has between six and 15 carbon atoms and, preferably, from six to 10 carbon atoms. These include phenyl groups and alkyl-substituted phenyl groups. As with the trialkyl phosphates, a single triaryl phosphate may have the same aryl groups in all three positions, or may have a mixture of two or three different aryl groups. Various mixtures of triaryl phosphates may also be used. Suitable, but non-limiting species of triaryl phosphates include triphenyl phosphate, tricresyl phosphate, diphenylcresyl phosphate, diphenylxylyl phosphate, diphenyl(ethylphenyl) phosphate, and dicresylphenyl phosphate. Preferred are those triaryl phosphates wherein at least one aryl group is a monoalkyl-substituted aryl group having one or two carbon atoms in the alkyl group, and preferably one carbon atom in the alkyl group.

The mixed phosphate ester portion of the composition of this invention will comprise at least 70 percent by weight of the total composition and, preferably, at least 90 percent by weight of the total composition.

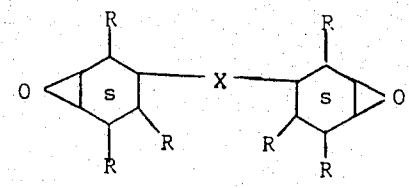
In another embodiment, the base stock can comprise a mixed alkylaryl phosphate ester such as dibutyl phenyl phosphate, butyl diphenyl phosphate, methyl ethyl phenyl phosphate, etc. Particularly preferred is dibutyl phenyl phosphate.

Additives

The hydraulic fluids of the present invention generally contain a number of additives which in total comprise 5–25 weight percent of the finished fluid. Among these is water, which may be added intentionally or often becomes incorporated into the fluid during the inherent operations of the system. Such incorporation can occur when a hydraulic system is being refilled and is open to the atmosphere, particularly in humid environments. Unintentional incorporation of water may also occur during the manufacturing process of a phosphate fluid. In practice, it is recognized that water will be incorporated into the fluid and steps are taken to control the water content at a level in the range of 0.1–1 weight percent of the whole fluid. It is preferred that the water content be in the range of 0.1–0.8 weight percent and more preferably 0.1–0.3 weight percent.

Hydrolysis inhibitors to retard corrosion are often added to hydraulic fluids. They include various epoxides such as the glycidyl ethers described in U.S. Pat. No. 2,636,861. Typical epoxide compounds which may be used include glycidyl methyl ether, glycidyl isopropyl ether, styrene oxide, and epichlorohydrin. Hydrocarbon sulfides, expecially hydrocarbon disulfides, such as dialkyl disulfide, are often used in combination with the epoxide compounds for additional corrosion suppression. Typical hydrocarbon disulfides include dibenzyl disulfide, dibutyl disulfide and diisoamyl disulfide. A particularly preferred class of epoxide hydrolysis inhibitors are those containing two linked cyclohexane groups to each of which is fused an epoxide (oxirane) group. Examples of such compounds include 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate, (marketed by Union Carbide under the brand name ERL-4221) bis(3,4-epoxy-6-methylcyclohexylmethyl adipate, 2(3,4-epoxycyclohexyl)-5-5-spiro(3,4-epoxy)cyclohexane-m-dioxane, (marketed by Union Carbide under the brand name ERL-4234)

A particularly preferred diepoxide which may be employed in the practice of this invention comprises 0.1–15 percent by weight of the total composition and, preferably, 0.1–5 percent by weight of the total composition of a diepoxide having the following generalized formula



wherein X is a divalent organo-radical containing one to 10 carbon atoms, from zero to six oxygen atoms and from zero to six nitrogen atoms; and R is the same or different constituent selected from hydrogen or lower aliphatic radicals. As defined herein, "lower aliphatic" refers to those aliphatic radicals containing one to five carbon atoms. In a preferred embodiment, R is hydrogen. In another preferred embodiment, two of the six R groups are methyl radicals and the other four are hydrogen.

The X radical is preferably a divalent (1) carboxylate group, (2) a dioxane group, (3) an amine group, (4) an amide group or (5) an alkoxy group, or combinations thereof.

The major operative type of structure contained in the diepoxides is the fused ring epoxide group, of which there are preferably at least two in the molecule. Each "fused ring epoxide group" consists of an oxirane oxygen attached to two adjacent carbon atoms in a cyclohexane or substituted cyclohexane ring.

In order to serve their inhibitory function, the fused ring epoxide groups should preferably be present in a minor but significant amount. This amount is essentially independent of the nature of the radical R and may conveniently be measured as "oxirane oxygen" content of the total fluid composition. Oxirane oxygen content should preferably be in the range of from about 0.05 to about 1.5 percent by weight of the total composition.

The hydraulic fluid normally contains 2–10 weight percent, preferably 5–10 weight percent, of one or more viscosity index improving agents such as alkyl styrene polymers, polymerized organic silicones, or preferably, polyisobutylene, or the polymerized alkyl esters of the acrylic acid series, particularly acrylic and methacrylic acid esters. These polymeric materials generally have a number average molecular weight of from about 5,000 to 300,000.

EXAMPLE 1

It has recently been found that the rate of valve erosion in aircraft hydraulic system valves varies with the electrical streaming potential of the hydraulic fluid passing through the valve. Streaming potential is defined on pages 4–30 of the *Electrical Engineers Handbook*, by Pender and Del Mar (New York, Wiley, 1949). It is the EMF created when a liquid is forced by pressure through an orifice and is a function of factors such as the electrical properties and viscosity of the liquid, the applied pressure, and the physical characteristics of the orifice. Since the streaming potential is dependent on several factors, it is found that the streaming potential measurement of a given fluid on a given apparatus at a given time will vary over a small range. For this reason, the ordinary practice is to select as a standard a fluid which is considered to have acceptable erosive characteristics. Each day the apparatus is calibrated by measuring the streaming potential of the standard fluid and then comparing the streaming potential of the test fluids against this standard. The apparatus used to measure streaming potential is described in detail in the Beck et al report referred to above. Measurements are taken at room temperature with the fluid pressure adjusted to 1,500 psi. For convenience, the streaming potential detected by the apparatus is impressed across a standard 100,000-ohm resistor to obtain a resultant current, which is reported as the "streaming current". Table I illustrates the reduction in streaming current obtainable from the inclusion of small amounts of the perhalometallate or perhalometalloidate salts of this invention in a hydraulic fluid. The hydraulic fluid referred to hereinafter as Fluid A is comprised of about 82 weight percent tributylphosphate, 9 weight percent tricresylphosphate, 7 weight percent of a polyacrylate viscosity improver, 2.5 weight percent of 3,4-epoxycyclohexylmethyl-3,4-epoxy cyclohexane carboxylate, 0.5 weight percent water and trace amounts of a foam inhibitor and a dye. The hydraulic fluid referred to hereinafter as Fluid B is tributylphosphate.

TABLE I

Anti-Erosion Properties of Hydraulic Fluid

Test	Additive Type	Additive Conc. (wt%)	Base Fluid	Streaming Current (μa)
1	None	—	A	−0.8
2	NH_4PF_6	0.001	A	−0.07
3	$(\phi CH_2^*)(CH_3)_3NPF_6$	0.002	A	−0.28
4	$NaBF_4$	0.01	A	+0.08
5	KPF_6	0.01	A	−0.3
6	$(C_4H_9)_4PCl$	0.05	A	−0.7
7	$(C_4H_9)_4PCl$	0.25	A	−0.08
8	$NaSO_4$	0.5	A	2.2
9	LiCl	0.002	A	3.2
10	TNBP**	0.1	A	2.6
11	None	—	B	−2.6
12	NH_4PF_6	0.05	B	+0.02
13	$(CH_3)_3(\phi CH_2^*)NPF_6$	0.1	B	−0.12
14	KPF_6	0.1	B	−0.11
15	NH_4BF_4	0.1	B	−0.2
16	$NaBF_4$	0.1	B	−0.12
17	$Zn(BF_4)_2$	0.1	B	+0.12
18	$NaSbF_6$	0.1	B	−0.02
19	$NaSbF_6$	0.005	B	−1.05

*ϕCH_2 is benzyl.
**TNBP TNBP is trioctyl amine salt of butyl acid phosphate.

The above table represents the remarkable demonstration of the halo-containing compounds of this invention in reducing the streaming current of two different types of hydraulic fluids. Tests 6 and 7 illustrate the lesser effectiveness of nonperhalometalloids unless employed at the higher concentrations. Tests 8–10 illustrate the adverse effect of various other nonperhalo- and nonmetal salts.

EXAMPLE 2

The effect of the additives of this invention on the actual erosion of a simulated hydraulic valve is illustrated by this example. The hydraulic fluid base is a high density dibutyl phenyl phosphate. The fluid containing the various perhalometallates or perhalometalloidates of this invention is tested in a hydraulic valve simulator having the general configuration as illustrated by the drawing in U.S. Pat. application Ser. No. 3,649,721. Two nitrided "Nitralloy" blocks are separated by a gasket leaving a clearance between the blocks of 75–100 micro-inches. The description and operating procedure is disclosed in the aforesaid U.S. patent. The increase in fluid flow indicates that erosion has occurred with the greater the increase (rate) connoting a poorer hydraulic fluid. The results of this test are shown in Table II.

TABLE II

Valve Erosion Test

Test	Additive Type	Additive Conc. (Wt%)	Av. Leakage Rate (ml/min/hr)
1	None	—	1.6
2	NH_4PF_6	0.01	<0.01

The above table clearly illustrates the substantial reduction in valve erosion by the incorporation of a small amount of a perhalometaloidate salt into the functional fluid.

EXAMPLE 3

This example is presented to hypothetically illustrate the practice of the claimed invention in making functional fluids containing a perhalometallate or perhalometalloidate salt. The following functional fluids can be prepared by incorporating the particular anti-erosion agent into a dibutyl phenyl phosphate fluid. Also present may be a conventional V.I. improver, and a conventional epoxide acid acceptor.

TABLE III

HYDRAULIC FLUID COMPOSITIONS

Fluid Sample	Anti-erosion Additive Type	Conc. (Wt%)
1	Potassium hexafluorogermanate	0.01
2	Potassium hexafluoromanganate	0.01
3	Potassium hexafluorophosphate	0.5
4	Potassium hexafluorosilicate	0.005
5	Potassium hexafluorotantalate	0.1
6	Potassium heptafluorotantalate	0.01
7	Potassium hexafluorothorate	0.01
8	Potassium hexafluorotitanate	0.01
9	Potassium hexafluorozirconate	0.1
10	Potassium tetrafluoroborate	0.01
11	Potassium tetrafluoroberyllate	0.01
12	Potassium tetrabromoaurate	0.01
13	Potassium hexabromoplatinate	0.01
14	Potassium hexachloroiridate	0.1
15	Potassium hexachloroosmiate	0.01
16	Potassium hexachloropalladate	0.01
17	Potassium tetrachloropalladate	0.01
18	Potassium hexachlororhenate	0.001
19	Potassium hexachlororhodate	0.001
20	Potassium hexachlororuthenate	0.001

TABLE III-Continued

HYDRAULIC FLUID COMPOSITIONS

Fluid Sample	Anti-erosion Additive Type	Conc. (Wt%)
21	Potassium hexachlorotellurate	0.001
22	Ammonium hexachlorogallate	0.1
23	Ammonium hexafluorogallate	0.001
24	Ammonium hexafluorogermanate	0.01
25	Ammonium hexafluorotitanate	0.01
26	Ammonium hexaiodoplatinate	0.01
27	Sodium tetrachloroaurate	0.1
28	Sodium hexachloroiridate	0.1
29	Sodium hexachlororhodate	0.01
30	Sodium hexafluoroaluminate	0.01
31	Sodium hexafluoroantimonate	0.01
32	Sodium tetrafluoroberyllate	0.01
33	Zinc hexachloroplatinate	0.01
34	Zinc hexafluorosilicate	0.01
35	Magnesium hexafluorosilicate	0.01
36	Magnesium hexachlorostannate	0.001
37	Iron hexafluorosilicate	0.01
38	Ammonium hexafluoroselenate	0.001

It is apparent that many widely different embodiments may be made without departing from the scope and spirit of the instant invention.

I claim:

1. A functional fluid composition comprising a fluid base consisting of an ester or amide of a phosphorus acid, hydrocarbon oil, a silicate ester a silicone or a polyphenyl ether, and from 0.0001 to 2% by weight of a soluble perhalometallate or perhalometaloidate salt.

2. The functional fluid of claim **1,** in which the fluid base is a phosphate ester.

3. The functional fluid of claim **2,** in which the phosphate ester is a mixed alkylaryl ester.

4. The functional fluid of claim **2,** in which the phosphate ester is a mixture of a predominant amount of a trialkylphosphate ester and a lesser amount of a triaryl phosphate ester.

5. The functional fluid of claim **4,** in which the trialkyl phosphate ester is tributyl phosphate ester and the triaryl phosphate ester is tricresyl phosphate ester.

6. The functional fluid of claim **2,** in which said perhalometalloidate salt is an alkali metal, ammonium or phosphoniumhexafluorophosphate.

7. The functional fluid of claim **2,** in which said perhalometallate salt is an alkali metal, ammonium or phosphonium tetrafluoroborate.

8. A functional fluid comprising a phosphate ester fluid base and from 0.0001 to 2 percent by weight of a soluble perhalometallate or perhalometalloidate salt having the formula:

$$M[AX_y]_z$$

wherein

A is a metal or metalloid;

M is a solubilizing cation;

X is a halogen;

y is an integer from 3 to 7 and equal to the positive valence of A, plus an integer from 1 to 3; and

z is an integer from 1 to 3 and sufficient to maintain the salt electro-neutral.

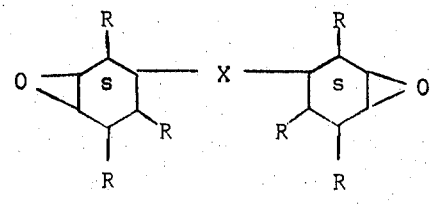
9. The functional fluid defined in claim **8** wherein said M is selected from the group consisting of alkali metals, ammonium, C_1–C_{30} hydrocarbyl substituted ammonium, C_1–C_{30} hydrocarbyl phosphonium, C_3–C_{30} trihydrocarbyl carbenium and C_3–C_{30} trihydrocarbyl oxonium.

10. The functional fluid defined in claim **9** wherein said M is ammonium, an alkali metal, or a hydrocarbyl phosphonium.

11. The functional fluid defined in claim **8** wherein said perhalometalloidate salt is selected from ammonium hexafluorophosphate, sodium tetrafluoroborate, and sodium hexafluorophosphate.

12. The functional fluid defined in claim **8** wherein an epoxide acid scavenger is also present.

13. The functional fluid defined in claim **12** wherein said epoxide has the following formula:



wherein

X is a divalent organic radical containing from one to 10 carbons, from zero to six oxygens and from zero to six nitrogens; and

R is the same or different constituent selected from hydrogen or a C_1–C_5 alkyl.

14. The functional fluid defined in claim **12** wherein said epoxide is 3,4-epoxycyclohexyl methyl-3,4-epoxycyclohexane carboxylate.

15. The functional fluid defined in claim **12,** wherein said epoxide is 2(3,4-epoxycyclohexyl)-5-5-spiro(3,4-epoxy)cyclohexane-m-dioxane.

16. The method of inhibiting the erroding character of a functional fluid selected from the group consisting of an ester or amide of a phosphorus acid, a hydrocarbon oil, a silicate ester, a silicone, or a polyphenol ether, which comprises adding to said functional fluid from 0.001 to 2 wt. per cent of a soluble perhalometallate or perhalometaloidate salt.

17. The method of claim **16,** in which the functional fluid comprises an ester or amide of a phosphorus acid, a hydrocarbon oil, a silicate ester, a silicone, or a polyphenyl ether.

18. The method of claim **16,** in which the fluid comprises a phosphate ester.

19. The method of claim **17,** in which the phosphate ester is a mixed alkylaryl phosphate ester.

20. The method of claim **16,** wherein said perhalometalloidate salt is selected from the group consisting of ammonium hexafluorophosphate, sodium tetrafluoroborate and sodium hexafluorophosphate.

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