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Sheratte

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[54] **FUNCTIONAL FLUID COMPOSITIONS**

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[51] **Int. Cl.**..... **C09k 3/02**

[58] **Field of Search**..... 252/78, 75, 49.9, 58, 399, 252/388, 54.6; 260/989

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[57] **ABSTRACT**

Production of functional fluids, including aircraft hydraulic fluids and aircraft engine lubricants of improved fire resistance, comprising a functional fluid base stock, such as a phosphate ester, e.g., tri-n-butyl phosphate, di-n-butyl phenyl phosphate, or mixtures thereof, and/or a dicarboxylic acid ester, e.g., a diester of adipic acid such as diisodecyl adipate, or mixtures of such phosphate ester or esters, and dicarboxylic acid ester, and a small amount of an organic iodo compound such as iodobiphenyl or iodonaphthalene.

27 Claims, No Drawings

FUNCTIONAL FLUID COMPOSITIONS

This invention relates to functional fluid compositions having improved fire resistance and is particularly directed to compositions comprising certain functional fluids and an additive amount sufficient to improve fire resistance, of certain organic iodo compounds.

Many different type of materials are employed as functional fluids and functional fluids are utilized in a wide variety of applications. Thus, such functional fluids have been utilized as electronic coolants, diffusion pump fluids, lubricants, damping fluids, power transmission and hydraulic fluids, heat transfer fluids and heat pump fluids. A particularly important application of such functional fluids has been their utilization as hydraulic fluids and engine lubricants in aircraft, requiring successful operation of such fluids over a wide temperature range, a particularly important and highly desirable property of such fluids being fire resistance.

Functional, e.g., hydraulic fluids, employed in many industrial applications and particularly hydraulic fluids for aircraft must meet a number of important requirements. Thus, such hydraulic fluids particularly for aircraft use, should be operable over a wide temperature range, should have good stability at relatively high temperatures and preferably have lubricating characteristics. In addition to having the usual combination of properties making it a good lubricant or hydraulic fluid, such fluid should also have relatively low viscosity at extremely low temperatures and an adequately high viscosity at relatively high temperatures, and must have adequate stability at the high operating temperatures of use. Further, it is of importance that such fluids be compatible with and not adversely affect or corrode materials including metals and non-metals such as elastomeric seals of the system in which the fluid is employed. It is particularly important in aircraft hydraulic fluids and lubricants that such fluids have as high a fire resistance as possible to prevent ignition if such fluids are accidentally or as result of damage to the hydraulic system, sprayed onto or into contact with surfaces or materials of high temperatures.

While many functional and hydraulic fluid compositions have been developed having most of the aforementioned required properties, many of these compositions do not have the requisite high fire resistance desired particularly for use of such functional fluid or hydraulic fluid compositions in modern high speed aircraft or in a hydraulic system located near a high temperature jet-turbine power plant of a jet-turbine aircraft.

Thus, as an illustration, many functional and hydraulic fluids have an autoignition temperature ranging from about 450° to about 700°F. It is particularly desirable to increase the autoignition temperature of such functional and hydraulic fluids above 750°F, e.g., to the range of about 800 to about 1,000°F.

It has now been found in accordance with the present invention that the fire resitance, or autoignition temperature, of functional fluid or hydraulic fluid compositions containing as base stock a phosphate ester and/or a dicarboxylic acid ester, or mixtures thereof, can be significantly improved by the addition to such compositions of a small amount of certain organic iodo compounds, e.g., in the form of certain alkyl or aryl iodides, especially aryl iodides, defined in greater detail hereinafter. The inclusion of such iodide additives in the above functional and hydraulic fluid compositions generally does not adversely affect any of the above-noted important characteristics of such fluids, particularly aircraft hydraulic fluids, including their desirable viscosity characteristics.

It has been found that certain aryl and alkyl iodides, and particularly the aryl iodides of the invention described below, e.g., iodobiphenyl or iodonaphthalene, not only function to substantially increase autogenous ignition (autoignition) temperature and reduce flammability of functional fluids and hydraulic fluids containing a phosphate and/or dicarboxylic acid ester base stock, as described above, but in addition have the advantageous properties of being thermally stable, free from toxicity, cause substantially no corrosion of metal parts such as aluminum, iron, copper and titanium, do not have an objectionable odor, are only very slightly colored, and have sufficient solubility in the above functional and hydraulic fluids to effectively function therein as flame inhibitors. In addition, the organic iodo compounds hereof, particularly the aryl derivatives, employed according to the invention, have no adverse effect on low temperature viscosity of the functional fluids, particularly when employed as hydraulic fluids in aircraft, do not adversely affect the thermal stability of the fluid, and are of relatively low cost.

Effective organic iodo compounds for use as additive in the phosphate ester and/or dicarboxylic acid ester functional or hydraulic fluids to reduce flammability and increase autoignition temperature of the fluid, according to the invention, are compounds having the formula RI_n, where R is selected from the group consisting of alkyl, aryl, and alkaryl radicals, such alkyl radical containing from about 1 to about 10 carbon atoms, such aryl and alkaryl radicals containing from about 6 to about 15 carbon atoms, and n is an integer of from 1 to 3.

Thus, where R is alkyl, such alkyl radical can be straight chain or branched chain, and can include methyl, ethyl, propyl, isopropyl, butyl, isobutyl, amyl, isoamyl, hexyl, isohexyl, octyl, isooctyl, nonyl, isononyl, decyl and isodecyl. Examples of alkyl, iodides which are suitable include methyl iodide, ethyl iodide, isopropyl iodide, n-butyl iodide, n-hexyl iodide, n-nonyl iodide, 1,4-diiodobutane, 1,6-diiodohexane, 1,9-diiodononane, 1,10-diiododecane, 1,4,7-triiodoheptane, 1,6,10-triiododecane, and 2,4,6-triiodooctane. Alkyl iodides wherein n is 1 to 2 are preferred.

Aryl iodides which can be employed include iodo compounds of the above formula wherein R can be phenyl, biphenyl, and naphthyl. Examples of such aryl iodides include 4-iodobiphenyl, 2-iodobiphenyl, 4,4'-diiodobiphenyl, 2,4,4'-triiodobiphenyl, iodobenzene, 1,4-diiodobenzene, 1-iodonaphthalene, 2-iodonaphthalene, 1,4-diiodonaphthalene, 1,4,8-triiodonaphthalene, and 1,3,5-triiodonaphthalene. Of the aryl iodides, those wherein n is 1 to 2 are also preferred, the monoiodides thereof being found particularly advantageous.

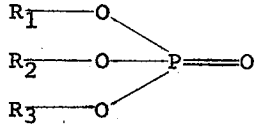
The alkaryl iodides which can be employed include alkyl phenyl, alkyl biphenyl, and alkyl naphthalene compounds. The alkyl portion of such alkaryl compounds can contain from 1 to about 9 carbon atoms, either straight chain or branched chain, e.g., methyl, ethyl, propyl, isopropyl, butyl, amyl or pentyl, hexyl, heptyl, octyl or nonyl. There can be one or more alkyl groups connected to an aryl, e.g. phenyl or biphenyl

nucleus. Thus, such alkaryl radicals can include tolyl, xylyl, ethyl phenyl, propyl phenyl, isopropyl phenyl, methyl naphthyl, ethyl naphthyl, methyl biphenyl, ethyl biphenyl, 4,4'-diethyl biphenyl, and the like. One to three iodo radicals can be connected either to the aryl nucleus or the alkyl substituent on the aryl nucleus, preferably the former. Examples of alkaryl additives which can be employed include 2-iodotoluene, 4-iodotoluene, 4-iodoethyl-benzene, 4-iodo ortho xylene, 5-iodo meta xylene, 2-iodo para xylene, mixtures of such iodo xylene compounds which can be produced by iodinating a commercial xylene mixture, 4-iodo isopropyl benzene, benzyl iodide, 1-iodo-4-methyl, naphthalene, 1-iodo-4-ethyl naphthalene, 4-iodo-4' -methyl biphenyl, 4-iodo-4'-isopropyl biphenyl, 1,5-diiodo-2,6-dimethyl naphthalene, 1,8-diiodo-4,5-dimethyl naphthalene, and 1,4,5-triiodo-8-methyl naphthalene.

Aryl iodides which have been found particularly effective are 4-iodobiphenyl and 1-iodonaphthalene.

Functional fluids whose flammability characteristics are substantially improved by incorporation of the organic iodo compounds according to the invention, are base stocks consisting essentially of a member selected from the group consisting of a phosphate ester and a dicarboxylic acid ester. These include a phosphate ester, mixtures of phosphase esters, a dicarboxylic acid ester, mixtures of the latter esters, and particularly mixtures of a phosphate ester or esters and a dicarboxylic acid ester or esters.

Phosphates which can be employed according to the invention have the general formula:



where R_1, R_2 and R_3 can be the same or different, and each can be aryl such as phenyl and naphthyl, alkaryl such as cresyl, xylyl, ethyl phenyl, propyl phenyl, isopropyl phenyl, and the like, said aryl and alkaryl radicals preferably containing from 6 to about 8 carbon atoms, alkyl, both straight chain and branched chain of from about 3 to about 10 carbon atoms such as n-propyl, n-butyl, n-amyl, n-hexyl, isopropyl, isobutyl, and the like, and alkoxyalkyl having from about 3 to about 8 carbon atoms such as methoxy methyl, methoxy ethyl, ethoxy ethyl, methoxy propyl, and the like.

Preferred phosphate esters are the dialkyl aryl, triaryl, trialkyl and alkyl diaryl phosphates.

Examples of such phosphate esters are the dialkyl aryl phosphates in which the alkyl groups are either straight chain or branched chain and contain from about 3 to about 10 carbon atoms, such as n-propyl, n-butyl, n-amyl, n-hexyl, isopropyl, isobutyl, isoamyl, and the aryl radicals have from 6 to 8 carbon atoms and can be phenyl, cresyl or xylyl, particularly dialkyl phenyl phosphates including dibutyl phenyl phosphate, butyl amyl phenyl phosphate, butyl hexyl phenyl phosphate, butyl heptyl phenyl phosphate, butyl octyl phenyl phosphate, diamyl phenyl phosphate, amyl hexyl phenyl phosphate, amyl heptyl phenyl phosphate, and dihexyl phenyl phosphate.

Examples of triaryl phosphates which can be employed in the invention compositions are those in which the aryl radicals of such phosphates have from 6 to 8 carbon atoms, that is, may be phenyl, cresyl or xylyl, and in which the total number of carbon atoms in all three of the aryl radicals is from 19 to 24, that is, in which the three radicals include at least one cresyl or xylyl radical. Examples of such phosphates include tricresyl, trixylyl, phenyl dicresyl, and cresyl diphenyl phosphates.

Examples of trialkyl phosphates employed according to the invention include phosphates having alkyl groups which are either straight chain or branched chain with from about 3 to about 10 carbon atoms, such as n-propyl, n-butyl, n-amyl and n-hexyl, particularly tri-n-butyl phosphate, tri(2-ethyl hexyl) phosphate, the straight chain alkyl groups preferably containing from 4 to 6 carbon atoms.

Examples of alkyl diaryl phosphates which can be employed to produce the invention compositions include those in which the aryl radicals of such phosphates may have from 6 to 8 carbon atoms and may be phenyl, cresyl or xylyl, and the alkyl radical may have from about 3 to about 10 carbon atoms, examples of which are given above. Examples of the alkyl diaryl phosphates include butyl diphenyl amyl diphenyl, hexyl diphenyl, heptyl diphenyl, octyl diphenyl, 6-methyl heptyl diphenyl, 2-ethylhexyl diphenyl, butyl phenyl cresyl, amyl phenyl xylyl, and butyl dicresyl phosphates.

Any phosphate ester can be employed which is normally liquid between about −65°F and 210°F. Preferably, the above-noted trialkyl phosphates and dialkyl aryl phosphates such as tributyl phosphate and dibutyl phenyl phosphate, are employed, as such phosphates are particularly effective in achieving low viscosity at low temperature. However, for improved higher viscosity at high temperature of the order of 210°F, it is desirable to employ triaryl phosphates as illustrated above, e.g., tricresyl phosphate, particularly in combination with the above-noted trialkyl phosphates. Preferred phosphate ester mixtures are the above-noted dialkyl aryl phosphates such as dibutyl phenyl phosphate, in combination with a trialkyl phosphate such as tributyl phosphate.

Another functional fluid base stock, the flammability or autoignition temperature of which is substantially increased according to the invention is a dicarboxylic acid ester. Preferred types of the latter compounds are the aliphatic dicarboxylic acid esters, particularly the alkyl diesters of adipic and sebacic acid, that is the diester adipates and sebacates. Such esters can contain alkyl groups, either straight chain or branched chain, containing from about 4 to about 12 carbon atoms including butyl, isobutyl, amyl, pentyl, hexyl, isohexyl, nonyl, decyl and isodecyl groups. Specific examples of these diesters are dihexyl, di(2-ethyl-hexyl), dioctyl, dinonyl, didecyl and diisodecyl adipate, and the corresponding sebacates. Of the above-described diesters of adipic and sebacic acid, diisodecyl adipate and diisodecyl sebacate have been found particularly effective, especially diisodecyl adipate. Also, the diesters of the aromatic dicarboxylic acids, particularly the diesters of phthalic acid, that is the phthalate diesters, can be employed as base stocks. The diesters of such aromatic acids can contain alkyl groups of from 4 to 12 carbon atoms, examples of which are given above with respect to the diesters of the aliphatic dicarboxylic acids, adipic and sebacic acid. Illustrative examples of the diester phthalates which can be employed are di-n-butyl phthalate, dihexyl phthalate, dioctyl phthalate, dinonyl

phthalate, didecyl phthalate, and diisodecyl phthalate. Although the two ester, i.e., alkyl, groups in the diesters described above are usually the same, such ester groups on a particular diester can be different, e.g., as illustrated by nonyl decyl adipate.

Mixtures of such dicarboxylic acid esters can also be employed, e.g. a mixture of diisodecyl adipate and diisodecyl sebacate, or a mixture of a diester of an aromatic acid, e.g., a phthalic acid alkyl diester, and an aliphatic acid alkyl diester such as an adipic or sebacic acid alkyl diester.

As previously noted, a functional fluid base stock consisting of a mixture of a phosphate ester or esters, and a dicarboxylic acid ester or esters, particularly an aliphatic dicarboxylic acid ester, as described above, can be effectively improved with respect to increasing fire resistance of such base stock, by incorporation of an organic iodide additive as described above, according to the invention. When such mixtures are employed as base stock, generally a substantial proportion of both the phosphate ester and dicarboxylic acid diester, particularly adipate diester, are employed. Thus, the amount of phosphate ester or esters present in such base stock mixtures can range, by weight, from about 35 to about 85%, preferably about 50 to about 80%, and the amount of dicarboxylic acid diester, e.g., adipate diester, sebacate diester, or mixture thereof, can range, by weight, from about 15 to about 65%, preferably about 20 to about 50%. Functional fluid compositions comprising such mixtures of a phosphate ester or esters and a dicarboxylic acid ester such as an adipic or sebacic acid alkyl diester, are described and claimed in my copending application Ser. No. 129,269, filed Mar. 29, 1971. These are preferred base stock mixtures.

Functional fluid compositions comprising a mixture, by weight, of about 15 to about 75% of a phosphate ester, about 5 to about 75% of a phthalic acid alkyl diester containing alkyl groups of about 4 to about 12 carbon atoms and 0 to about 50% of an adipic or sebacic acid alkyl diester, having alkyl groups containing from about 4 to about 12 carbon atoms, described and claimed in my copending application Ser. No. 129,270, filed Mar. 29, 1971, now U.S. Pat. No. 3,795,620, can also be improved significantly by addition thereto of an organic iodo compound according to the invention.

The disclosures of the base stocks of my above copending applications are incorporated herein by reference.

Where the above-noted mixtures of phosphate ester and dicarboxylic acid ester are employed as base stock, in many instances suitable viscosity characteristics both at low temperatures below −40°F and at high temperatures above 210°F can be achieved in the absence of a viscosity index improver. However, it may be desirable, particularly for improving pump life in a hydraulic system, to incorporate a small amount ranging from 0.1 to about 20%, generally about 2 to about 10%, by weight of the composition, of a viscosity index improver. Examples of the latter are polyalkyl acrylates and polyalkyl methacrylates, in which the alkyl groups may contain from about 4 to about 12 carbon atoms, either straight or branched chain, and having an average molecular weight ranging from about 2,000 to about 15,000. Specific examples of such viscosity index improvers are polybutyl methacrylate and poly n-hexyl acrylate, having an average molecular weight ranging between about 2,000 and about 12,000.

It will be understood that other commonly employed functional fluid additives such as oxidation inhibitors, stabilizers, metal deactivators, and the like, such as epoxides, dialkyl sulfides, benzothiazole, phenyl alpha naphthylamine and phenolic oxidation inhibitors, can be incorporated into the base stock.

For greatest effectiveness in substantially reducing the flammability, and for correspondingly substantially increasing the autoignition temperature of the above functional fluid base stocks according to the invention, it is usually desirable to employ only a small amount of the invention additive, that is, alkyl or aryl, including alkaryl, iodide, as defined above, in the functional or hydraulic fluid base stock. Generally, there can be employed as little as 0.1% and up to about 5% of the alkyl iodide or aryl iodide additive of the invention, preferably from about 0.5 to about 2.5% of such iodide additive, in the functional fluid base stock, based on the weight of the composition.

The following are examples illustrating practice of the invention by incorporation of the alkyl and aryl iodides described herein as additives according to the invention, into functional fluid base stocks of the types described above. In the examples below, the term "AIT" means autoignition temperature, the autoignition temperature of the functional fluid compositions of the invention according to the examples below being determined in accordance with standard methods of test for autoignition temperature according to ASTM D 2155 procedure. All percentages are in terms of per cent by weight of the functional fluid composition.

EXAMPLE 1

To tri-n-butyl phosphate are added varying amounts of 4-iodobiphenyl, and the autoignition temperature of the various fluid compositions and of a control of tri-n-butyl phosphate with no iodo compound, is obtained. The results of such tests are noted in the table below.

TABLE I

Fluid	Additive	Additive Concentration (%)	AIT (°F)
tri-n-butyl phosphate	4-iodobiphenyl	0	730
do.	do.	1.0	810
do.	do.	1.5	900
do.	do.	2.0	880

From the table above it is seen that incorporation of, for example, 1.0% by weight of the above 4-iodobiphenyl additive in tributyl phosphate increases the AIT of the control fluid from an AIT of 730°F for the control, to 810°F, and that increased proportions of such iodobiphenyl additive increases AIT further, e.g., at 1.5 to 2% to 880° to 900°F, substantially higher than the 730°F value for the tributyl phosphate control per se.

EXAMPLE 2

The procedure of Example 1 is repeated except employing in place of 4-iodobiphenyl, 1-iodonaphthalane in a concentration of 1% and 1.5% respectively in the tri-n-butyl phosphate.

The data and results are set forth in Table II below.

TABLE II

Fluid	Additive	Additive Concentration (%)	AIT (°F)
tri-n-butyl phosphate	1-iodonaphthalene	0	730
do.	do.	1.0	800
do.	do.	1.5	940

From Table II above, it is noted that incorporation of 1.0% of the iodonaphthalene additive increase AIT from the 730°F of the control to 800°F, and increasing concentration to 1.5% of such iodo additive substantially increases AIT to 940°F as compared to the 730°F value for the control.

EXAMPLE 3

The following composition is prepared.

Fluid A

	Weight %
tri-n-butyl phosphate	49.4
di-n-butyl phenyl phosphate	8.9
diisodecyl adipate	32.6
poly n-hexyl acrylate viscosity index improver, m.w. - 2,000 (Ucon F.H.25)	4.4
diepoxide oxidation inhibitor (Unox 221)	2.2
4-iodobiphenyl	2.0
water	0.5
	100.0

The autoignition temperatures of Fluid A and of a control of Fluid A in the absence of any iodo compound are obtained, the AIT of Fluid A containing the 2.0% of 4-iodobiphenyl being 810°F, more than 200°F greater than the AIT of less than 600°F for the control.

Results of closed oxidation-corrosion tests at 250°F for 168 hours are set forth in Tables III and IV below, the metals of Table III all being inserted in the same fluid noted above and designated Fluid A, in one test, and the metals of Table IV all being inserted in another portion of Fluid A in another test, the acid number of the Fluid A in each of the tests being determined after the 168 hour test period.

TABLE III

	Weight Change (mg/cm²)					Acid
	Copper	Iron	Magnesium	Alumi-num	Cadmium Plate	Num-ber
Fluid A	0	0	+0.34	0	0	0.64

TABLE IV

	Weight Change (mg/cm²)					Acid
	Bronze	Iron	Titanium	Alumi-num	Cadmium Plate	Num-ber
Fluid A	0	0	0	0	0	1.29

From Tables III and IV above, it is seen that Fluid A shows practically complete freedom from corrosive attack on the metals of such tables, except for magnesium, although the relatively small corrosive value in Table III for magnesium is well within aircraft specification standards, and a low acid number for Fluid A is obtained in both tests reported in Tables III and IV.

EXAMPLE 4

The procedure of Example 3 is repeated, except employing in place of 2% of 4-iodobiphenyl in Fluid A, 2% of 1-iodo-naphthalene.

An increase in AIT of the resulting fluid from an AIT of less than 600°F for the control, to about 790°F for the fluid containing the above concentration of 1-iodonaphthalene is achieved.

Also, substantially similar results are obtained with respect to substantial freedom from corrosive attack on the metals of Tables III and IV, by the fluid containing the 1-iodonaphthalene, comparable to the results obtained in Example 3.

EXAMPLE 5

The following functional fluid compositions B, C, D and E are prepared, and their respective autoignition temperatures obtained.

Components	% by weight
Composition B	
dibutyl phenyl phosphate	99.2
4,4'-diiodobiphenyl	0.8
Composition C	
dioctyl sebacate	97.8
n-hexyl iodide	2.2
Composition D	
di-(2-ethylhexyl) phenyl phosphate	49
diisodecyl adipate	49
2-iodobiphenyl	2
Composition E	
tri cresyl phosphate	49
diisodecyl phthalate	49
iodobenzene	2

In each case the incorporation of the respective iodo compounds into the functional fluid base stock of functional fluid compositions, B, C, D and E above, substantially increases autoignition temperature to between about 800° and 950°F, as compared to the AIT of less than 750°F for each of the respective functional fluid base stocks of compositions B through E, in the absence of the iodo compound, the AIT of the resulting fluid generally increasing in relation to the increase in concentration between 0.8 to 2.2% of the iodo compounds of compositions B through E.

EXAMPLE 6

The functional fluid compositions F, G, H and J set forth below are prepared, and their autoignition temperatures obtained, in relation to the autoignition tem-

perature of the respective compositions in the absence of the recited iodo compounds.

Components	% by weight
Composition F	
2-(ethylhexyl) diphenyl phosphate	98
4-iodo xylene	2
Composition G	
2-(ethylhexyl) diphenyl phosphate	97
iodinated commercial xylene (mixture of 4-iodo ortho xylene, 5-iodo meta xylene and 2-iodo para xylene)	3
Composition H	
diisodecyl adipate	60
diisodecyl phthalate	37.5
1-iodonaphthalene	2.5
Composition J	
phenyl dicresyl phosphate	58
diisodecyl adipate	38
1,9-diiodo nonane	4

For each of the compositions F, G, H and J above, the autoignition temperature is substantially increased to the range of between 800° and 950°F in the presence of the iodo compounds therein, as compared to corresponding autoignition temperatures of less than 700°F for the respective compositions F, G, H and J, in the absence of the respective iodo compounds therein, the AIT of the compositions F, G, H and J generally varying in relation to the concentration of iodo compound therein, the AIT of composition J containing the relatively high concentration of 4% of iodo compound therein however not being substantially greater than that for composition G containing 3% of the iodo compound thereof.

EXAMPLE 7

Functional fluid compositions K. L, M. N and O, set forth below, are prepared, and the autoignition temperatures of such compositions in relation to their controls, in the absence of the respective iodo compounds, are obtained.

Components	% by weight
Composition K	
tri-n-butyl phosphate	80
tri cresyl phosphate	17
diiodohexane	3
Composition L	
tri-n-hexyl phosphate	40
di-n-butyl phenyl phosphate	58.5
diiodobenzene	1.5
Composition M	
tri-n-hexyl phosphate	40
dibutyl phenyl phosphate	59.5
diiodobenzene	0.5
Composition N	
tri cresyl phosphate	45
dioctyl phthalate	52
4-iodo-4'-isopropyl biphenyl	3
Composition O	
tri butyl phosphate	99.5
methyl iodide	0.5

The autoignition temperature obtained for each of compositions K through O above is substantially increased and in the range of about 800° to about 950°F, as compared to autoignition temperatures of less than 750°F, for the respective compositions in the absence of the respective iodo compounds therein. The autoignition temperatures of compositions K through O generally increases with respect to increase in concentration from the 0.5% of the iodo compound employed in compositions M and O, to the 3% of iodo compound employed in compositions K and N.

EXAMPLE 8

The procedure of Example 3 is repeated, except employing in place of 4-iodobiphenyl in Fluid A, 2% of 1,10-diiododecane in a first fluid used in one series of tests, and 2% of n-hexyl iodide in a second fluid used in a second series of tests.

An increase in AIT of the resulting fluids from an AIT of less than 600°F for the control, to about 810°F for the one fluid containing 1,10-diiododecane and 780°F for the other fluid containing n-hexyl iodide are obtained.

Also results comparable to those of Example 3 are obtained with respect to substantial freedom from corrosive attack on the metals of Tables III and IV, employing said first and second fluids above.

The following example illustrates still other functional fluid compositions containing an iodo compound additive according to the invention.

EXAMPLE 9

Components	% by weight
Composition P	
tri-n-butyl phosphate	56.0
diisodecyl adipate	35.0
poly n-hexyl acrylate (av. m.w. - 12,000)	5.0
n-nonyl iodide	1.8
diepoxide oxidation inhibitor	2.2
Composition Q	
di-n-butyl phenyl phosphate	30.0
tricresyl phosphate	30.0
dioctyl sebacate	37.5
4,4'-iodo methyl biphenyl	2.5
Composition R	
tri-n-butyl phosphate	39.0
diisodecyl adipate	48.0
diisodecyl phthalate	10.0
1,4-diiodonaphthalene	3.0

From the foregoing, it is seen that the invention provides novel functional fluid compositions containing certain organic iodo compounds, more particularly certain alkyl or aryl iodides, which function efficiently as flame retardants or flame inhibitors in functional fluids containing as base stock a phosphate ester or a dicarboxylic acid ester, or mixtures thereof, while at the same time rendering such fluids essentially noncorrosive on certain metals, particularly iron, aluminum, copper and titanium, widely employed as hydraulic fluid system components and engine components requiring lubrication, in jet-turbine power plants of jet aircraft.

While many of the above-described functional fluids, e.g., those having as base stock a phosphate ester such as tributyl phosphate, di-n-butyl phosphate, or mixtures thereof, and which may also contain a dicarboxylic acid ester such as diisodecyl adipate, are particularly effective for use as hydraulic fluids in jet aircraft, particularly because of their desirable viscosity characteristics, including relatively low viscosity at low temperature and relatively high viscosity at elevated temperature, many of the above-described functional fluids are of particular utility as industrial functional fluids, for example engine lubricants. Examples of the latter types of fluids are those comprising a base stock composed of certain phosphates such as tricresyl phosphate, or those

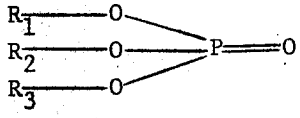
composed of a mixture of phosphate ester with an aromatic acid diester such as dioctyl phthalate, or those having a base stock composed essentially of a dicarboxylic acid ester such as diisodecyl adipate or diisodecyl phthalate, or mixtures thereof. Illustrative of such industrial type fluids are those of compositions C, E, H, J, M and N. Particularly effective aircraft hydraulic fluids are those exemplified by Fluid A and compositions B, D, J, K, L and M.

Applicant is aware of U.S. Pat. No. 3,287,275 which discloses the addition of 2-iodobiphenyl to an organic phosphinate, for reducing corrosion of such phosphinate on iron. However, there is no suggestion or teaching in this patent that the incorporation of a small amount of an organic iodo compound into a composition having as base stock a phosphate ester, a dicarboxylic acid ester, or mixtures thereof, materially reduces the flammability of such base stock and correspondingly increases autoignition temperature thereof, while at the same time functioning to reduce corrosion of such fluids on a variety of metals including the above-noted copper, aluminum, titanium, bronze and cadmium plate.

While I have described particular embodiments of my invention for purposes of illustration, it will be understood that various changes and modifications within the spirit of the invention can be made, and the invention is not to be taken as limited except by the scope of the appended claims.

I claim:

1. A functional fluid composition consisting essentially of a base stock, said base stock consisting essentially of a mixture of about 35 to about 85% of a phosphate ester having the general formula:



wherein R_1, R_2 and R_3 are each a member selected from the group consisting of aryl, alkaryl, alkyl of from about 3 to about 10 carbon atoms, and alkoxyalkyl having from about 3 to about 8 carbon atoms, and about 15 to about 65% of a dicarboxylic acid ester selected from the group consisting of the alkyl diesters of adipic and sebacic acid, containing alkyl groups of from about 4 to about 12 carbon atoms, and an alkyl diester of phthalic acid containing alkyl groups of from about 4 to about 12 carbon atoms, and mixtures thereof; and a small amount of an organic iodo compound sufficient to enhance the autoignition temperature of said base stock, said iodo compound being selected from the group consisting of aryl and alkaryl mono, di and triodides, said aryl and alkaryl radicals containing from about 6 to about 15 carbon atoms.

2. A functional fluid composition as defined in claim **1,** wherein said iodo compound is an aryl iodide.

3. A functional fluid composition as defined in claim **1,** wherein said phosphate ester is selected from the group consisting of dialkyl aryl, triaryl, trialkyl, and alkyl diaryl phosphate.

4. A functinal fluid composition as defined in claim **1,** said dicarboxylic acid ester being selected from the group consisting of adipic and sebacic acid alkyl diesters, having alkyl groups containing from about 4 to about 12 carbon atoms.

5. A functional fluid composition as defined in claim **1,** said base stock consisting essentially of a mixture of about 35 to about 85% of a phosphate ester selected from the group consisting of dialkyl aryl, triaryl, trialkyl, and alkyl diaryl phosphate, and about 15 to about 65% of a dicarboxylic acid ester selected from the group consisting of adipic and sebacic acid alkyl diesters, having alkyl groups containing from about 4 to about 12 carbon atoms, by weight.

6. A functional fluid composition as defined in claim **5,** wherein said iodo compound is selected from the group consisting of phenyl, biphenyl and naphthyl iodides and wherein said iodo compound is present in an amount ranging from about 0.1 to about 5% , by weight of said composition.

7. A functional fluid composition as defined in claim **6,** wherein said phosphate ester is selected from the group cnsisting of tributyl phosphate, dibutyl phenyl phosphate, tricresyl phosphate, and mixtures thereof, and said dicarboxylic acid ester is diisodecyl adipate.

8. A functional fluid composition as defined in claim **5,** wherein said iodo compound is selected from the group consisting of monoiodo biphenyl, monoiodo xylene and monoiodo naphthalene, and wherein said iodo compound is present in an amount ranging from about 0.5 to about 2.5%, by weight of said composition.

9. A functional fluid composition as defined in claim **8,** said base stock consisting essentially of a mixture of tributyl phosphate, dibutyl phenyl phosphate and diisodecyl adipate, and wherein said iodo compound is selected from the group consisting of 4-iodobiphenyl and 1-iodonaphthalene.

10. A functional fluid composition as defined in claim **1,** wherein said iodo compound is present in an amount ranging from about 0.1 to about 5%, by weight of said composition.

11. A functional fluid composition as defined in claim **2,** wherein said iodo compound is selected from the group consisting of monoiodo biphenyl, monoiodo xylene and monoiodo naphthalene.

12. A functional fluid composition as defined in claim **10,** said dicarboxylic acid ester being a mixture of a diester selected from the group consisting of adipic and sebacic acid alkyl diesters, having alkyl groups containing from about 4 to about 12 carbon atoms, and a phthalic acid alkyl diester containing alkyl groups of from about 4 to about 12 carbon atoms.

13. A functional fluid composition as defined in claim **10,** said base stock consisting essentially of a mixture of about 50 to about 80% of a phosphate ester selected from the group consisting of dialkyl aryl, triaryl, trialkyl, and alkyl diaryl phosphate, and about 20 to about 50% of a dicarboxylic acid ester selected from the group consisting of adipic and sebacic acid alkyl diesters, having alkyl groups containing from about 4 to about 12 carbon atoms, by weight.

14. A functional fluid composition as defined in claim **10,** wherein said iodo compound is present in an amount ranging from about 0.5 to about 2.5%, by weight of said composition.

15. A functional fluid composition as defined in claim **14,** wherein said phosphate ester is selected from the group consisting of dialkyl aryl, triaryl, trialkyl, and alkyl diaryl phosphate, said dicarboxylic acid ester being selected from the group consisting of adipic and sebacic acid alkyl diesters, having alkyl groups containing from about 4 to about 12 carbon atoms.

16. A functional fluid composition as defined in claim 10, wherein said iodo compound is selected from the group consisting of phenyl, biphenyl and naphthyl iodides.

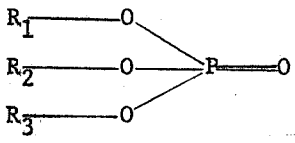
17. A functional fluid composition as defined in claim 16, wherein said iodo compound is a monoiodide.

18. A functional fluid composition as defined in claim 10, wherein said phosphate ester is selected from the group consisting of dialkyl aryl, triaryl, trialkyl, and alkyl diaryl phosphate.

19. A functional fluid composition as defined in claim 18, wherein said iodo compound is selected from the group consisting of phenyl, biphenyl and naphthyl iodides.

20. A functional fluid composition as defined in claim 18, wherein said iodo compound is selected from the grup consisting of monoiodo biphenyl, monoiodo xylene and monoiodo naphthalene.

21. A functional fluid composition consisting essentially of a base stock, said base stock consisting essentially of a member selected from the grup consisting of (a) a phosphate ester having the general formula:



where R_1, R_2 and R_3 are each a member selected from the group consisting of aryl, alkaryl, alkyl of from about 3 to about 10 carbon atoms, and alkoxyalkyl having from about 3 to about 8 carbon atoms, and (b) a dicarboxylic acid ester selected from the group consisting of the alkyl diesters of adipic and sebacic acid, containing alkyl groups of from about 4 to about 12 carbon atoms, and an alkyl diester of phthalic acid containing alkyl groups of from about 4 to about 12 carbon atoms, and mixtures thereof; and a small amount of an organic iodo compound sufficient to enhance the autoignition temperature of said base stock, said iodo compound being selected from the grup consisting of aryl and alkaryl mono, di and triodides, said aryl and alkaryl radicals containing from about 6 to about 15 carbon atoms.

22. A functional fluid composition as defined in claim 21, wherein said iodo compound is an aryl iodide.

23. A functional fluid composition as defined in claim 21, wherein said iodo compound is present in an amount ranging from about 0.1 to about 5%, by weight of said composition.

24. A functional fluid composition as defined in claim 23, wherein said iodo compound is present in an amount ranging from about 0.5 to about 2.5%, by weight of said composition.

25. A functional fluid composition as defined in claim 23, wherein said iodo compund is selected from the group consisting of monoido biphenyl, monoiodo xylene and monoiodo naphthalene.

26. A functional fluid composition as defined in claim 23, wherein said iodo compound is selected from the group consisting of phenyl, biphenyl and naphthyl iodides.

27. A functional fluid composition as defined in claim 26, wherein said iodo compound is a monoiodide.

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