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DIELECTRIC MATERIALS

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Table A

	Benzotrifluoride	Tetrachlorobenzotrifluoride
Boiling point.....° C.	102.3.....	247-249.
Freezing point.....° C.	-20 to -23.....	10.
Viscosity (at 37.8° C.).....	28".....	35".
Dielectric constant (at 25° C.).....	11.5.....	4.5.
Dielectric constant (at 100° C.).....		4.1.
Resistance (ohms/cm.).....	1.4×10 ⁹	40×10 ⁹ .
Flash point.....° C.		210.
Specific gravity.....		1.74.
Inflammability.....	Inflammable.....	Essentially noninflammable.
Solubility in organic solvents.....	Miscible.....	Miscible.
Decomposition at boiling point.....	Nil.....	Nil.
Corrosive action on steel.....	Nil.....	Nil.
Corrosive action on copper.....	Nil.....	Nil.
Action on shellac.....	Nil.....	Nil.
Action on Bakelite.....	Nil.....	Nil.

This invention relates to dielectric materials, more particularly liquids having dielectric properties, and the application thereof.

The use of liquids is required in certain electrical equipment, such as, for example, transformers, capacitors, condensers and switch boxes. Among the functions of the liquid are those of removing heat and of allowing the making of contact in the absence of air or of explosive mixtures. The requirements for such liquids are, among other things, very high resistance to the flow of electric currents, high stability to atmospheric conditions at ordinary and at somewhat elevated temperatures, high resistance to thermal decomposition, low vapor pressure, low congealing temperature, low inflammability and high flash point. Preferably, the liquids should be mobile even at relatively low temperatures and should be good heat transfer agents.

In commercial practise, high-boiling fractions of petroleum distillates have been largely used for this purpose. These liquids do not satisfy all of the above stated requirements. They are relatively poor heat transfer agents and, under the conditions of their use, they gradually decompose with the formation of undesirable products which adversely influence the electrical properties. Some of these products are tarry; others are appreciably volatile and may present fire and explosion hazards.

It is an object of the present invention to provide new and improved dielectric media. A further object is the provision of liquids which are applicable in insulating electrical conductors in electrical equipment such as, for example, transformers, capacitors, condensers and switch boxes. Other objects will appear hereinafter.

In accomplishing these objects according to this invention, it has been found that aliphyl compounds containing fluorine in the side chain, preferably aliphyl compounds in which all of the hydrogens of the side chains have been substituted by fluorine, possess good dielectric properties and are suitable for application as dielectric media. Compounds such as benzotrifluoride are preferred to such compounds as benzyl and benzal fluorides, benzofluorodichloride and benzodifluorochloride because of greater stability. The same comparison holds between derivatives of benzotrifluoride and the corresponding derivatives of the other compounds just noted.

The following table illustrates the properties of two of the substances falling within the scope of the invention, viz., benzotrifluoride and tetrachlorobenzotrifluoride.

Tetrachlorobenzotrifluoride may be prepared by the chlorination of benzotrifluoride. The chlorination may be effected according to well known methods for the chlorination of aromatic compounds. For example, tetrachlorobenzotrifluoride was produced as follows:

Four hundred fifty (450) parts of benzotrifluoride, 2 parts of anhydrous ferric chloride and 20 parts of iron borings were placed in a glass flask and chlorine gas added to the reaction mass during a period of twelve hours. During this period the temperature was gradually increased from 20° C. to 160° C., and the reaction was continued until an increase in weight of 318 parts was obtained.

The cooled reaction mass was drowned in water and the water-insoluble material extracted with dilute aqueous hydrochloric acid. Subsequently, it was washed with water and dilute sodium hydroxide solution. The separation of the product was assisted by extraction with ether. This product was dissolved in ether and the solution again washed with dilute sodium hydroxide solution. The extracted ether solution was dehydrated, after which the solvent was evaporated.

The residue was subjected to fractional distillation. A number of fractions of various chlorinated products were obtained. One of these fractions boiled within the range 240°-250° C. Its chlorine content was 50.5% and it consisted essentially of tetrachlorobenzotrifluoride (theoretical chlorine content 50.0%). This product was further purified prior to making the tests described above.

In general, chlorinated benzotrifluoride com-

pounds containing chlorine in the aromatic ring can be prepared by the general method above described, which is a known method for chlorinating aromatic compounds although, insofar as we are aware, it has never been applied in the preparation of chlorobenzotrifluorides. Chlorinated benzotrifluoride mixtures obtainable by the chlorination of benzotrifluoride possess the desired properties. A chlorinated mixture of benzotrifluoride having a chlorine content of 44.05% boils at 201° C. to 240° C., freezes at -41° C., and has a specific gravity of 1.629. The low congealing temperature of this mixture makes it especially desirable for low temperature uses.

One or more of the ring hydrogen atoms of the aliphyl compound may be replaced by other substituent groups or atoms so long as they do not adversely influence to an undesirable degree the essential electrical and physical properties and the stability. In general, the preferred compounds are non-acidic and are free from groups which readily hydrolyze to form acidic groups. Among the substitution products that might be utilized, there may be mentioned those in which one or more ring hydrogen atoms of a fluorinated aliphyl hydrocarbon containing fluorine in the side chain has been substituted by groups or atoms such as -Cl, -Br, -NH₂, -F, -CF₃, -NO₂, aryl, alkyl, aralkyl, alkylamino and dialkylamino, more specifically compounds such as, for example, trifluoromethylbenzenes, trifluoromethylchlorobenzenes, fluorodibenzyls containing fluorine in the side chain, trifluoromethylfluorobenzenes, di-(trifluoromethyl)-benzenes, and similar fluorinated derivatives. It will be understood that the results with all compounds are not comparable and that better results are obtained with some compounds than with others, since their properties may vary widely as to boiling point, inflammability, etc. Benzotrifluoride has the combined advantages of high electrical resistance, high stability, liquidity at low temperatures, and low viscosity. Halogenated derivatives such as chlorinated benzotrifluorides have the additional advantages of low inflammability and low vapor pressure.

The boiling point of some of the compounds falling within the invention are given by the following table:

Table B

Compound	Boiling range
	°C.
Benzotrifluoride	102-102.5
o-Chlorobenzotrifluoride	151-153.
m-Chlorobenzotrifluoride	137.6-138.
Di-chlorobenzotrifluoride	177-180.
Tetrachlorobenzotrifluoride	247-249.
m-Brom-benzotrifluoride	156-157.
m-Aminobenzotrifluoride	188-189.
m-Dimethylaminobenzotrifluoride	202.5-203.5.
m-Diethylaminobenzotrifluoride	212-215.
m-Iodobenzotrifluoride	182-183.
Bromo-m-dimethylaminobenzotrifluoride	265-267.
2-chloro-1,3-di-(trifluoromethyl)-benzene	155-160.
2-chloro-4-nitrobenzotrifluoride	102-103 (At 5 mm.)
2-chloro-4-aminobenzotrifluoride	90-103 (At 6 to 7 mm.)
2-methoxy-4-aminobenzotrifluoride	248-249.

The fluorinated aliphyl compounds of the type described may be used alone or in mixtures thereof, or in mixtures with other materials which have most of the desired properties, particularly high electrical resistance, high stability and low inflammability. The use of mixtures allows the use of solutions of solid substances such as solid derivatives of benzotrifluoride, of diphenyl, dibenzyl, and of chlorinated derivatives of benzene

and diphenyl. We have found that benzotrifluoride and its substituted products readily dissolve or mix with many organic substances such as those mentioned above and with high-boiling fractions of petroleum distillates. A very desirable application of this invention is the use of benzotrifluoride and/or its substituted derivatives in mixtures with other materials that are less inflammable and have lower vapor pressures, e. g., chlorinated benzotrifluorides.

The present invention provides substances which are eminently suitable for use as dielectric materials. While the characteristics of these substances may vary, they have, in general, the requirements of dielectric materials. In particular, it should be noted that the -CF₃ group, which characterizes benzotrifluoride and its derivatives, is exceedingly stable and is not subject to decomposition by the usual hydrolytic agents, whereas the -CCl₃ group, which characterizes benzotrichloride and its derivatives, is very unstable, being readily hydrolyzed to the carboxylic acid group.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that we do not limit ourselves to the specific embodiments thereof except as defined in the following claims.

We claim:

1. A dielectric medium comprising, in liquid phase, a chlorobenzotrifluoride in which the chlorine is substituted in the aromatic ring and which boils above 200° C.

2. Tetrachlorobenzotrifluoride, a compound boiling at approximately 247° C. to 249° C., having a freezing point at about 10° C., a viscosity of about 35 seconds at 37.8° C., and a dielectric constant at 25° C. of about 4.5, said compound being useful as such or in admixture with other dielectric substances as a dielectric medium.

3. The process which includes insulating electrically conducting materials by separating them with a medium comprising substantial proportions of an aliphyl compound containing fluorine in the side chain.

4. The process which includes insulating electrically conducting materials by separating them with a medium comprising substantial proportions of a mixture of chlorinated benzotrifluorides.

5. The process which includes insulating electrically conducting materials by separating them with a medium comprising essentially a mixture of the chlorinated derivatives of benzotrifluoride including tetrachlorobenzotrifluoride.

6. The process which includes insulating electrically conducting materials by separating them with a medium comprising essentially a mixture of the chlorinated derivatives of benzotrifluoride including a polychlorinated benzotrifluoride which boils above 200° C.

7. The process which includes insulating electrically conducting materials by separating them with a medium comprising substantial proportions of a mixture of chlorinated benzotrifluorides with benzotrifluoride.

8. The process which includes insulating electrically conducting materials by separating them with a medium comprising substantial proportions of a non-acidic benzotrifluoride.

9. The process which includes insulating electrically conducting materials by separating them with a medium comprising substantial proportions of benzotrifluoride.

10. An electrical device containing a dielectric material comprising substantial proportions of a liquid aliphyl compound containing fluorine in the side chain.
- 5 11. An electrical device containing a dielectric material comprising substantial proportions of benzotrifluoride.
- 10 12. A dielectric medium comprising a liquid mixture of a substantial proportion of a fluorinated aliphyl hydrocarbon containing fluorine in the side chain and a substantial proportion of a substance compatible therewith selected from the group consisting of hydrocarbons and their chlorinated derivatives that are stable to atmospheric conditions and have a relatively high boiling range.
- 15 13. A dielectric medium comprising a liquid mixture of a substantial proportion of a non-inflammable fluorinated aliphyl hydrocarbon containing fluorine in the side chain and a substantial proportion of a substance compatible therewith selected from the group consisting of hydrocarbons and their chlorinated derivatives that are stable to atmospheric conditions and have a relatively high boiling range.
- 20 14. A dielectric medium comprising a liquid mixture of a substantial proportion of benzotrifluoride and a substantial proportion of a ring halogenated cyclic hydrocarbon which is miscible therewith, stable to atmospheric conditions and boils above 200° C.
- 30 15. A chlorobenzotrifluoride which is stable to atmospheric conditions and boils above 200° C.
16. A mixture of benzotrifluorides containing a normally liquid chlorobenzotrifluoride which is stable to atmospheric conditions and boils above 200° C.
- 5 17. Mixtures of poly-chloro-benzo-tri-fluorides stable to atmospheric conditions and boiling above 200° C.
18. An electrical device containing a dielectric material comprising substantial proportions of a trifluoromethyl-fluoro-benzene.
- 10 19. A dielectric medium comprising a liquid mixture of a substantial proportion of a trifluoromethyl-fluoro-benzene and a substantial portion of a substance compatible therewith selected from the group consisting of hydrocarbons and their chlorinated derivatives that are stable to atmospheric conditions and have a relatively high boiling range.
- 15 20. The process which includes insulating electrical conducting materials by separating them with a medium comprising substantial proportions of a trifluoromethyl-fluoro-benzene.
- 20 21. A dielectric medium comprising in liquid phase a trifluoromethyl-fluoro-benzene in which fluorine is substituted in the aromatic ring.
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