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DIELECTRIC COMPOSITIONS

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The present invention relates to a new and improved dielectric composition which can be operated at comparatively low temperatures without any substantial loss in dielectric properties over its normally useful temperature range. This is a continuation-in-part of our copending U. S. application Serial No. 344,467, filed March 24, 1953, and now abandoned.

It has been known for many years that the dielectric constant of an organic dielectric varies widely with temperature. In particular, the dielectric constants of materials, such as pentachlorodiphenyl, when subjected to low frequency alternating currents, drop off quite rapidly at temperatures in the neighborhood of 0° F., frequently to a point where they are approximately one-half or less of their maximum value. As an example of this, pentachlorodiphenyl possesses a maximum dielectric constant of about 5.4 at 0° C., and about 2.9 at —20° C., the measurements here being taken with a 60 cycle A. C. voltage. As such the useful operating range of the pentachlorodiphenyl dielectric impregnant is only from about 0° C. to about 85° C. An object of the present invention is to overcome the disadvantages caused by the dielectric constants of organic materials falling off at relatively low operational temperatures.

More specifically, an object of the present invention is to overcome this defect of chlorinated aromatic hydrocarbon dielectric materials so as to extend their permissible operating range by as much as 20 to 30° C. below their usual minimum, without materially injuring their dielectric characteristics particularly power factor, insulation resistance and dielectric constant between room temperature and their high temperature useful limit i. e., about 85° C.

A more limited object is to obtain a dielectric composition useful for direct current capacitor applications in the temperature range of from about —30° C. to about 85° C. These and other objects of the invention, as well as the advantages of it, will be apparent from this specification and claims.

Briefly, the above objects of the invention are obtained by forming a dielectric composition consisting of a liquid chlorinated aromatic hydrocarbon dielectric admixed with from about 5 to about 15% by weight of a branched chain aliphatic orthosilicate compound in which the alkyl radical has from 6 to 18 carbon atoms. A preferred composition within the broad scope of the invention consists of a chlorinated aromatic hydrocarbon dielectric admixed with from about 8 to 12% of tetra 2-ethylhexyl orthosilicate.

A number of branched chain aliphatic orthosilicates in which the alkyl radical has from 6 to 18 carbon atoms can be used with the present invention, although the preferred compound, which is characterized by its electrical and chemical stability and marked lowering of the temperature at which the dielectric constant of the primary dielectric starts abruptly decreasing, is tetra 2-ethylhexyl orthosilicate. Some of such other compounds are tetra 2-ethylbutyl orthosilicate; tetra 1,3-dimethylbutyl orthosilicate; tetra 2-methylpentyl orthosilicate; tetra 1-ethylpentyl orthosilicate; tetra 1-methylhexyl orthosilicate; tetra iso-octyl orthosilicate; tetra nonyl orthosilicate; tetrakis [1-methyl-4-ethyloctyl]orthosilicate and tetrakis [2(1,3,3 - trimethylpropyl) - 5,7,7 - trimethyloctyl] orthosilicate.

Though the reason for the phenomena associated with this invention is not fully understood, it appears that the addition of a minor amount of a low viscosity low temperature solidifying liquid of from moderate to high dielectric constant to the primary dielectric assists in maintaining the dielectric constant of the composite dielectric at a constant level to a temperature much below that possible with the unmodified dielectric. The result is a much more useful liquid dielectric which appreciably extends the utility of capacitors impregnated therewith. This liquid added to the primary dielectric must not, to be useful, materially degrade the dielectric properties of the composition at elevated temperatures. Some compounds extend the depressed temperature range while decreasing the insulation resistance, increasing the power factor and effecting intolerable variations in capacity at elevated temperatures.

The term liquid chlorinated aromatic hydrocarbon used herein has a rather specific meaning in the art. A common dielectric falling within this category is chlorinated diphenyl. Other highly satisfactory compositions are symmetrical trichlorobenzene, pentachlorodiphenyl, tetrachlorodiphenyl, trichlorodiphenyl, and monochlorodiphenyl. Chloro substituted phenylindan derivatives e. g., dichloro-1,3,3-trimethyl-1-phenylindan, also fall within this category.

It will be realized, of course, by those skilled in the art that the herein described invention is capable of wide variation. Thus, the broad teachings can be applied to mixtures of any of the above chlorinated hydrocarbon dielectrics, and mixtures of the specific branch chained aliphatic orthosilicates indicated. Various points of application of these dielectric compositions include condensers, transformers, and the like.

As a specific example of a composition falling within the scope of the present invention, a chlorinated hydrocarbon dielectric consisting primarily of pentachlorodiphenyl which is sold under the trade-name "Aroclor 1254" by Monsanto Chemical Company of St. Louis, Missouri, was admixed with 10% of tetra-2-ethylhexyl orthosilicate sold by the Ornite Chemical Company under the trade-name "Orsil BF–1E." The silicate was purified by filtration with 5% by weight of Attapulgus clay. For convenience, in appraising the success obtained with the invention, the following data with respect to dielectric points of both the dielectric itself used in this example and the new composition of the example at varying temperatures is specifically listed below:

Temperature, ° C.	Aroclor 1254 Dielectric Constant at 60 cycles	Aroclor 1254 +10% Orsil BF-1E Dielectric Constant at 60 cycles
60	4.8	4.4
40	5.0	
25	5.2	4.8
15	5.2	4.9
0	5.4	5.0
—10	4.2	5.2
—20	2.9	5.3
—30		4.0
—40		3.2

As another example of the compositions of the invention, dichloro-1,3,3-trimethyl-1-phenylindan is admixed with 10% of tetra 2-ethylhexyl orthosilicate. The pentachlorodiphenyl-tetra 2-ethylhexyl orthosilicate dielectric

system of above was impregnated into convolutely wound capacitor sections (nominal 3 mfd., aluminum foil-kraft paper. For comparison a dielectric composition of 90% by weight pentachlorodiphenyl (Aroclor 1254) and 10% by weight of tetraethyl orthosilicate was impregnated into identical 3 mfd. sections. The contrast was impressive for though both the orthosilicate additives extended the lower temperature limit about 30° C. the tetra ethyl orthosilicate material degraded the dielectric properties at elevated temperatures, whereas the composition of the invention was useful to about 85° C. Illustrative comparative data is set forth below:

Pentachlorodiphenyl +10% tetra 2-ethylhexyl orthosilicate

Temp.	IR (megohms mfds.)	Capacity Change Percent (60 C. P. S.)	Dissipation Factor, Percent
60° C	800	−1.2	1.0
40° C	2,900	−0.6	0.75
26° C	6,600	standard	0.5
0° C		+0.6	0.5

Pentachlorodiphenyl +10% tetra ethyl orthosilicate

Temp.	IR (megohms mfds.)	Capacity Change Percent (60 C. P. S.)	Dissipation Factor, Percent
60° C	600	+16.6	21.8
40° C	1,275	+2.0	10.2
26° C	2,600	standard	3.5
0° C		+2.0	0.5

Similar extension of the respective useful low temperature limit without material degradation of the elevated temperature dielectric properties obtain with capacitor units impregnated with 90% by weight of dichloro-1,3,3-trimethyl-1-phenylindan and 10% by weight of tetra 2-ethylhexyl orthosilicate.

The compositions of this invention find equally important utilization in direct current applications wherever stability of capacitance over an extended operational temperature range is required.

As many apparently widely different embodiments of my invention may be made without departing from the spirit and scope hereof, it is to be understood that my invention is not limited to the specific embodiments thereof except as defined in the appended claims.

What is claimed is:

1. A new and improved dielectric composition consisting essentially of a liquid chlorinated aromatic hydrocarbon admixed with about 10% by weight of tetra 2-ethylhexyl orthosilicate.

2. The composition of claim 1 in which the chlorinated aromatic hydrocarbon is chlorinated diphenyl.

References Cited in the file of this patent

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