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CONJUGATED DRYING OIL-ISOBUTYLENE FACTICE POTTING COMPOSITION AND METHOD

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This invention relates to compositions for use in electrical devices, illustratively, which are adapted to impregnate and hold electrically conductive elements within a case or housing. The compositions function to immobilize the conductive elements and dampen unwanted vibrations.

More specifically, this invention relates to organic insulating gels produced in situ by metal chloride catalyzed copolymerization of isobutylene monomers with conjugated drying oils.

Transformers provide a preferred illustrative use of the invention. Transformers encased and immobilized as hereinafter described are often called potted transformers and compositions used for encasing the electrically conductive elements of transformers are referred to in the art as potting compositions. Additionally, transformers of the type which are employed in the ballast circuit of fluorescent lights have been selected for description. Such transformers, called ballast transformers, are of potted construction and are a part of a fluorescent lamp fixture ballast circuit, serving to preheat the cathode of the lamp. Preheating the cathode permits a lower starting voltage than otherwise operable.

Transformer ballasts are a necessary component of every modern fluorescent lamp circuit. Thus they are mass produced and minor economies in the cost of manufacture are important factors.

Asphaltic compositions have heretofore been widely used in the art as a filler for ballast transformers because they are low cost. Although asphaltic potting compositions are serviceable under normal operating conditions, they are thermoplastic and melt readily if heat is generated above normal load as when under shorted conditions. Temperatures within a ballast transformer may reach as high as 550° F. Low melting or thermoplastic ballast compositions including asphalt when liquified by heat due to short circuits often leak from the ballast case to damage floors, rugs, furniture, etc.

A principal object of this invention is to provide a low cost thermosetting potting composition for encapsulating electrical conductors in an insulating medium.

Another object of this invention is to provide low-cost potting compositions characterized by little viscosity loss when overheated for encasing fluorescent ballast transformer elements.

In practicing this invention, all the ingredients are thoroughly cold blended prior to filling into ballast transformers or other electrical devices to be encapsulated. The filled cases are then baked, preferably at about 200° F. for ½ hour, in order to obtain a satisfactory jell. Practically useful polymerization temperatures range from about 120° F. to below the decomposition temperature of the reactants, but preferably not above about 275° F. 200° F. for one-half hour is commonly used in the field as is illustrated in the examples.

The ingredients, which according to the preferred form of this invention include isobutylenes, conjugated drying oils, liquid extenders, solid particulate extenders and a

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metal chlorine catalyst, may be cold blended as required for use in the filling process. The liquid ingredients may also be pre-blended and stored for later use. It is not recommended that the potting composition be completed and stored for an extended period prior to filling because the action of the catalyst may cause a jell to form before the material can be used. Also, the particulate extender is not mixed and stored with the liquid materials for long periods because extended storage may result in hard settling with consequent difficulties in redispersing the extender.

The jelled product which is the result of the catalyzed copolymerization of isobutylenes and conjugated drying oil has the appearance of a factice and its characteristics are such that it may be used without modification as a potting composition with good results. However, without the incorporation of extenders the cost of this material is not competitive with the low cost thermoplastic compositions herein described. Liquid or solid extenders may be incorporated in sufficient concentration to permit the formulation of economically competitive ballast compositions without impairing the desirable qualities of the factice base composition.

In addition, inclusion of solid extenders improves the heat transfer characteristics of the jelled potted composition so that parasitic heat is more effectively dissipated from ballast units heated during operation. Liquid extenders, although they permit economies, must be used with care as they contribute plasticity to the mass. Action of the plasticizer is multiplied considerably at elevated temperatures which occur, for example, within a transformer under shorted conditions. Use of liquid extenders in controlled amounts is understood in the ballast art. By control of the amount of metallic chloride catalyst, the jell or factice may be formed either with or without the presence of liquid or solid particulate extenders. The compositions thus produced are cured by heating and have a rubber-like quality which serves an excellent medium for damping vibrations. Their dielectric strength is sufficient for use in low voltage transformers without promoting malfunction thereof due to leakage of currents through the composition.

The term isobutylenes has been used herein to embrace a commercial mixture of predominantly two classes of monomeric materials; diisobutylene and triisobutylene. Isobutylenes may be copolymerized admixed or as separated fractions with certain unsaturated fatty drying oils to form the factice potting composition of this invention. The terms diisobutylene and triisobutylene signify particular mixtures of olefinic compounds. Diisobutylene, for example, is described as consisting of about 75 weight percent of 2,4,4-trimethylpentene-1 and about 23 weight percent of 2,4,4-trimethylpentene-2- with the remaining 2% consisting of mixed octene isomers. Properties of commercial diisobutylene are reported as follows:

Specific gravity at 60° F. -----	0.7227
Bromine No. -----	138
Boiling range:	
Initial ----- ° F. -----	214.7
10% ----- ° F. -----	215.8
30% ----- ° F. -----	216.1
50% ----- ° F. -----	218.3
90% ----- ° F. -----	218.3
Dry point ----- ° F. -----	220.1
Molecular weight, average, calculated -----	112.1
Viscosity at 77° F. -----cs.-----	0.7086
Flash point (open cup method) ----- ° F. min.-----	20

Triisobutylene is described as consisting of two principal ingredients, 2,2,4,6,6-pentamethyl-heptene-3, and 2-neopentyl-4,4-dimethylpentene-1. Properties of commercial triisobutylene are:

Specific gravity at 60° F. -----	0.7640
Boiling range:	
Initial ----- ° F--	348.1
10% ----- ° F--	350.2
30% ----- ° F--	351.1
50% ----- ° F--	351.9
90% ----- ° F--	353.1
Dry point ----- ° F--	354.6
Molecular weight, average, calculated -----	168

Tung oil and oiticica oil form excellent jells with isobutylenes and are preferred drying oils for practice of this invention. Drying oils may be classified generally as triglycerides of long chain fatty acids.

The fatty acid groups in oiticica oil and tung oil consist primarily of groups containing conjugated unsaturation. Oiticica oil contains about 75% licanic acid, an aliphatic acid which contains three conjugated double bonds in the 9-10, 11-12 and 13-14 carbon positions of the fatty acid chain. Tung oil contains about 70% to 80% of eleostearic fatty acid groups which also have three conjugated double bonds at the 9-10, 11-12, and 13-14 carbon positions. With respect to the amount of available conjugated unsaturation, tung and oiticica oil are unique among commercial drying oils. Common drying oils, such as soya and linseed oil, do not contain conjugated fatty acid groups. The less popular drying oils that contain conjugated unsaturation fall short of equalling the concentration of conjugated unsaturation of tung or oiticica oil. Dehydrated castor oil contains an appreciable quantity of conjugated fatty acid groups in the glyceride, but the percentage is believed to be about 25% of the total fatty acid content. While dehydrated castor oil may be made to jell with isobutylenes, the reaction occurs less readily than with tung or oiticica oil. Blown linseed oil among other treated oils has been polymerized with isobutylenes to form a jell but is inferior for the present purposes. Similar treated oils, in addition to inferior quality of final product, are also of less commercial interest because of their higher cost, a factor which is especially limiting with respect to dehydrated castor oil.

Other drying oils which do not contain conjugated unsaturation may contain a considerable amount of non-conjugated unsaturation. Non-conjugated unsaturation is usually divided among the several types of fatty acids forming substantially all the total drying oil fatty acid groups present in the glyceride oils and containing from one to three double bonds per fatty acid hydrocarbon chain. Oils of this type such as soya or linseed oil are slower drying than tung or oiticica oil and attempts to jell them with isobutylenes in the presence of ferric chloride catalyst have been unsuccessful. Evidently, the non-conjugated, unsaturated groups are not sufficiently reactive to copolymerize with commercially available mixed isobutylenes. The reactants described herein form a solid factice within ½ hour at a temperature averaging about 200° F.

Paraffin oils, non-drying fatty oils and drying oils without conjugated unsaturation as mentioned above may be added to the reaction mixture as liquid extenders or diluents for the essential reactants without materially interfering with the factice-forming capabilities of oiticica oil and tung oil with isobutylenes. The amount of liquid diluent and solid particulate extender which may be incorporated depends upon factors including the temperature of reaction, proportions of the various reactants, maximum in-service temperature requirements, etc. and it is within the skill of the art to adjust the proportions in order to influence cost, performance, etc. within the scope of the disclosure and guided by the examples herein set out. As in all formulative endeavor, exacting requirements require

testing procedures to determine whether the resultant quality meets the requirement in a given case.

A small quantity of inhibitor may be used to prevent local gelation during catalyst addition. This precaution is particularly expedient where the most active reactants, tung oil and triisobutylene, are employed. Long chain alcohols, illustratively octyl alcohols, are suitable inhibitors for this purpose.

In the practice of this invention, ferric chloride has been used as the polymerization catalyst although it is contemplated that other well known prior art addition type catalysts including $AlCl_3$ and BF_3 are useful. Metallic chloride addition polymerization catalysts are well known. Catalysts for this purpose are referred to, for example, in U.S. Pat. 2,127,811 including halides of the 2nd or 3rd group of the periodic system. Anhydrous boron trifluoride is described as being very active, polymerizing successfully less reactive semi-drying oils. Anhydrous stannic chloride is also reported as an active member of the class.

Effective catalyst concentration for a particular formulation depends upon several variables including the nature and concentration of the reactants, temperature, extenders, etc. Where large amounts of particulate extenders are used, the amount of catalyst is increased as adsorbed moisture introduced into the system by the extender partially destroys catalysts' strength. Also, the quantity of effective catalyst is further reduced because of the tendency of fine particle extenders to adsorb catalyst at their surface. In use of ferric chloride as the catalyst, optimum catalyst range for commercial purposes was a concentration of from 0.5 to 1.5% ferric chloride on the total reactant solids.

With catalyst content adjustment, isobutylenes will copolymerize and form a jell with fatty drying oils having the described conjugated unsaturation over a wide range of isobutylenes to oil ratios. Useful jells will be formed when the reactants constitute 90% oil and 10% isobutylenes. Conversely, up to 80% triisobutylene monomer with 20% oil are feasible reactant percentages, but as the pot life of this combination is short, prompt use is indicated. Diisobutylene has less reactivity than triisobutylene and it has been found that a maximum of 65% monomer may be reacted with 35% oil in order to prepare a satisfactory jell. Economically, it is preferable that isobutylenes constitute the major portion of the reactants where pot life of the mixture is adequate and the end product fulfills essential physical requirements. Diisobutylene and triisobutylene are substantial equivalents for the purposes of this invention, but the slower evaporation rate of triisobutylene is often advantageous. The preferred ratios between diisobutylene monomer and fatty oil reactants for use in this invention range between 50% diisobutylene to 50% oil and 25% diisobutylene to 75% oil. With respect to triisobutylene and fatty oil reactants, the preferred ratios fall between 60% triisobutylene to 40% oil and 25% triisobutylene to 75% oil. Using the above mentioned proportions and catalyst levels, jells may be obtained within ½ hour by baking the liquid reaction mixture, but below the decomposition temperature of the jell. Similar baking schedules are maintained where the liquid reactants are a part of a potting composition formulation. In this case, the liquid and particulate extenders are mixed with the liquid reactants before baking.

A liquid extender includes non-volatile inert liquids compatible with the reaction mixture. Suitable liquid extenders include various fatty oils either drying or non-drying, and hydrocarbon oils either saturated or unsaturated. In addition to acting as an extender for the more costly diisobutylene-triisobutylene-drying oil factice, the liquid extenders function in part to prevent potting compounds from hardening and cracking under extended high temperatures of operation. Potting compositions employing isobutylenes and oil as the sole potting component have a tendency to harden and shrink or crack under temperatures encountered within a ballast transformer

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which has developed a short circuit. Stygene R-2 (a resin produced by The Chemfax Corporation), described as a mixture of polynuclear aromatic-polymers of petroleum origin, is a useful liquid extender with desirable plasticizing properties. In preferred formulations, from 3 to 10% of a polynuclear aromatic polymer of this class has been used, based on the weight of the total composition.

Solid particulate extenders are included in potting compositions to displace a part of the liquid components with less expensive solids volume. The solid extender component of the composition may be, for example, finely ground silica, silicates, calcium carbonate or other solid inert pigmentary material of the same general quality. The composition, after incorporating the extender but before potting, desirably is of a pourable viscosity yet of sufficiently high viscosity to maintain the extender in suspension. Enough liquid binder component is included to provide mechanical strength and elasticity to the encapsulating jell surrounding the electrical conductors of the final unit. Silica flour is most commonly used as a particulate extender in reducing this invention to practice. It has been found that from 70 to 75% of this extender may be used with 30 to 25% of the liquid component by weight without adversely affecting the flow of the resulting mixture or electrical or physical properties of the jell after baking.

The following examples, while not exhaustive, illustrate the best method of practicing the invention. The nature of the invention permits a wide variation in the choice of ingredients and in the proportions thereof. Exemplary material included in this specification is intended only as a guide to one skilled in the art to formulate potting compositions within the scope of the invention having the properties necessary to meet particular needs.

Example I

The materials listed below were combined and the reactive ingredients copolymerized to form a thermoset ballast composition. Process directions follow the formula:

	Grams
Silica flour #68	300
Stygene R-2 (a polynuclear aromatic polymer)	15
Oiticica oil	35
Triisobutylene	50
Catalyst solution ¹	7

¹ See the following table:

	Grams
Anhydrous ferric chloride	13
Octyl alcohol	13
Tricresylphosphate	74

Oiticica oil and liquid extender were weighed into a container and triisobutylene added while stirring until uniform. Silica flour was added with mixing until dispersed. Lastly, the catalyst solution was added and blended through the mixture.

A ballast transformer was filled with the above mixture and baked at 200° F. for ½ hour. An excellent jell was obtained which did not soften or liquify when held at 500° F. for four hours. The encapsulating jell material also did not shrink or crack under the test conditions.

Example II

The following ingredients were mixed in the same manner as in Example I. Filling and baking the mixture in a ballast transformer at 200° F. for ½ hour resulted in a potting composition having rubber-like properties. At 500° F. the compound did not exhibit any failure due to melting or cracking.

	Grams
Silica flour #68	234
Oiticica oil	50
Stygene R-2	25
Triisobutylene	25
Catalyst solution	7

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Example III

	Grams
Silica flour #68	300
Oiticica oil	40
Triisobutylene	60
Catalyst solution	5
Octyl alcohol	1

The above ingredients were thoroughly mixed as follows:

Oiticica oil, triisobutylene and octyl alcohol were added to a container and mixed until uniform. The silica flour was then added and evenly dispersed in the liquid. After thoroughly incorporating the catalyst, the compound was filled into a ballast transformer.

The above compound jelled when baked in place in the transformer for ½ hour at 200° F. However, it had a tendency to exhibit some cracking when tested at 500° F. for four hours.

Example IV

The ingredients listed below were blended together and tested as follows:

	Grams
Silica flour #68	300
Oiticica oil	30
Fish oil	10
Triisobutylene	60
Octyl alcohol	1
Catalyst solution	10

The oiticica oil and fish oil were added in a container and mixed. Triisobutylene was added slowly to the mixture while stirring until uniformly mixed. The octyl alcohol was then added followed by addition of the silica flour with mixing until a uniform dispersion was obtained. Catalyst was added and blended in the mixture.

This material was jelled in a container at 200° F. for ½ hour. The jell obtained was spongy in character with less mechanical strength than Examples I, II and III. When tested at 500° F. for 4 hours, the potting formulation did not liquify nor crack. Mechanical strength was less than in prior examples. While a time and temperature schedule of ½ hour at 200° F. fits a particular requirement, obviously equivalent energy input schedules may be adapted to fit individual consumer requirements.

What is claimed is:

1. The process of in situ production of a non-leaking potting compound in electrical devices containing conductor elements which comprises copolymerizing (a) a drying oil having fatty acid radicals containing a major proportion of conjugated unsaturation with (b) an ethylenically unsaturated isobutylene selected from the group consisting of diisobutylene, triisobutylene, and mixtures thereof, in the presence of (c) a metallic halide addition polymerization catalyst until said drying oil and isobutylenes have copolymerized to form a rubber-like jell about the conductor elements thereof.

2. The process of claim 1, wherein the ethylenically unsaturated monomers are diisobutylenes.

3. The process according to claim 1 wherein the ethylenically unsaturated monomers are triisobutylenes.

4. The process of in situ production of a non-leaking potting compound in electrical devices containing conductor elements which comprises copolymerizing from 20 to 90 parts of a drying oil having fatty acid radicals containing a major proportion of conjugated unsaturation with from 10 to 80 parts of ethylenically unsaturated monomers consisting essentially of triisobutylenes in the presence of a metallic halide addition polymerization catalyst until said drying oil and triisobutylene monomers have copolymerized to form a rubber-like jell about the conductor elements thereof.

5. The process according to claim 4 wherein the drying oil consists essentially of oiticica oil.

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6. The process according to claim 4 wherein the drying oil consists essentially of tung oil.

7. The process of in situ production of a non-leaking potting compound in electrical devices containing conductor elements which comprises copolymerizing from 35 to 90 parts of a drying oil having fatty acid radicals containing a major proportion of conjugated unsaturation with from 10 to 65 parts of ethylenically unsaturated monomers consisting essentially of diisobutylenes in the presence of a metallic halide addition polymerization catalyst until said drying oil and diisobutylene monomers have copolymerized to form a rubber-like jell about the conductor elements thereof.

8. The process according to claim 7 wherein the drying oil consists essentially of oiticica oil.

9. The process according to claim 7 wherein the drying oil consists essentially of tung oil.

10. A potting composition which comprises from 8 to 18 parts of oiticica oil, from 6 to 15 parts of triisobutylene monomers, from 1 to 8 parts of a liquid extender, from 70 to 80 parts of a solid particulate extender and a metallic chloride catalyst in an amount sufficient to copolymerize said oiticica oil and triisobutylene monomers in an addition polymerization reaction.

11. The composition of claim 10 wherein the liquid extender is a hydrocarbon.

12. The composition of claim 10 wherein the liquid

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extender is a mixture of polynuclear aromatic polymers of petroleum origin.

13. The composition of claim 10 wherein the liquid extender is a fatty oil.

14. The composition of claim 10 wherein the metallic chloride catalyst is ferric chloride.

15. The composition of claim 10 wherein the solid particulate extender is silica flour.

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