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Study of the Compatibility of Phenyltrinitroxylenethane (Phenylxylilethane) with Structural Materials

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Abstract—The influence of structural materials on the basic electrophysical characteristics (relative permittivity, loss tangent, volume electric resistivity, and electric strength) of phenylxylilethane is considered in this paper.

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The operation stability of high-voltage electrotechnical devices, such as high-voltage impulse capacitors, at large electric intensity in a dielectric is mainly determined by the properties of the impregnating dielectric. When selecting a liquid dielectric, one should keep in mind not only the demands for high electric strength, low dielectric loss, and resistance to the effect of partial discharges but also the requirement of the compatibility with the structural materials used. This means that the liquid shouldn't impair the physicomechanical characteristics of the structural materials used and they themselves shouldn't cause a substantial reduction of the electrophysical parameters of the liquid dielectric.

Lack of information on the compatibility of a liquid impregnating dielectric with structural materials doesn't allow predicting the safety and longevity of the electrotechnical device itself.

Phenylxylilethane, being a synthetic hydrocarbonaceous aromatic oil of the diarylalkan series possessing high resistance to gas and stability, is widely employed at present to impregnate capacitors with a dielectric on the basis of polymer films. When evaluating the influence of polymer structural materials applied in capacitor construction on the electrophysical characteristics of phenylxylilethane, there was examined the effect of the compatibility of polymer films, foil, and a metal layer [1, 2, 3], which was estimated according to the change of the loss tangent as one of the most sensitive characteristics integrally reflecting the capacitor efficiency.

In the reference literature [4, 5], information on the reciprocal influence of liquid dielectrics and structural materials is given in a general form: copper and its alloys and salts of organic acids and metals with variable valency (copper, iron, cobalt, etc.) are active catalyzers of liquid oxidation, and it is necessary to select resins individually for every fluid.

Assessment of the impact of structural materials used in capacitor construction on the electrophysical characteristics of phenylxylilethane is the aim of this paper.

The following structural materials were selected to carry out the investigation: aluminum foil A5, polyethyleneterephthalate film PET-KE, polycarbone film PK-K, polypropylene film PP-KSS, copper M1, copper tin coated with solder POS-40, brass L63, glass-epoxidephenol tubing, glass fiber laminate STEF-1, amides PA6 of type B, polypropylene interpolymer 22007-29, rubber MBS-M1, rubber 51-1434, rubber 51-1486, rubber IRP-2025, and lacquer LBS-1.

The structural material samples were placed into separate glass containers with phenylxylilethane and kept for 24 hours under the following conditions:

—residual pressure not more then 6 Pa;

—temperature (80_{-5})°C.

After exposure under the mentioned conditions, the containers with the phenylxylilethane and the structural material samples were cooled in vacuum up to the environmental temperature and were held for 48 hours.[1] The results of the measurement of the phenylxylilethane electrophysical parameters (relative permittivity ε, loss tangent tgδ, volume electric resistivity ρ_v, and electric strength E_{st}) after contact with structural materials are shown in the table and diagrams presented in Figs. 1–4. To make the variation of the phenylxylilethane electrophysical parameters more obvious, there are represented their values before the contact with the structural materials in the form of the base line.

The greatest reduction of the phenylxylilethane electric strength occurred after its contact with resins

[1] Gun'ko, V. I.; Onishchenko, L. I.; Grebennikov, I. Yu.; Dmitrishin, A. Ya.; Toporov, S.O.; Slepets, E. N. Elektronnaya Obrabotka Materialov, 2008, no. 2, pp. 91–97.

Compatibility testing results for phenylxylilethane with structural materials

Materials	Characteristics			
	E_{st}, kV/mm	ε	tan δ	ρ_v, Ohm/cm
Aluminum foil A5	33.12	2.523	2.811×10^{-4}	6.07×10^{12}
Polyethyleneterephthalate film PET-KE	34.08	2.512	2.806×10^{-4}	4.93×10^{12}
Polycarbone film PK-K	33.98	2.520	2.824×10^{-4}	4.78×10^{12}
Polypropylene film PP-KSS	33.76	2.522	2.810×10^{-4}	4.55×10^{12}
Steel St3	34.69	2.524	2.716×10^{-4}	4.98×10^{12}
Steel 45	34.76	2.523	2.738×10^{-4}	5.03×10^{12}
Copper M1	32.82	2.547	4.272×10^{-4}	2.43×10^{12}
Copper tin-coated with solder POS-40	34.29	2.513	3.116×10^{-4}	4.77×10^{12}
Brass L63	33.14	2.536	3.898×10^{-4}	3.73×10^{12}
Glass-epoxidephenol tube	33.88	2.534	2.344×10^{-4}	7.43×10^{12}
Glass fiber laminate STEF-1	33.60	2.541	2.819×10^{-4}	6.64×10^{12}
Amides PA6 of type “B”	33.26	2.489	3.126×10^{-4}	5.48×10^{12}
Polypropylene interpolymer 22007-29	33.51	2.521	2.916×10^{-4}	4.46×10^{12}
Rubber MBS-M1	35.43	2.547	3.017×10^{-4}	9.36×10^{12}
Rubber 51-1434	34.82	2.537	3.226×10^{-4}	6.69×10^{12}
Rubber 51-1486	33.96	2.540	3.132×10^{-4}	4.78×10^{12}
Rubber IRP-2025	32.64	2.549	4.244×10^{-4}	4.26×10^{12}
Lacquer LBS-1 deposited on cable paper K-120	34.82	2.484	3.213×10^{-4}	7.64×10^{12}

Note: Before the compatibility testing with the structural materials, the phenylxylilethane had the following characteristics: E_{st} = 35.2 kV/mm; ε = 2.52; tan δ = 2.5×10^{-4}; $\rho_v = 8.37 \times 10^{12}$ Ohm/cm.

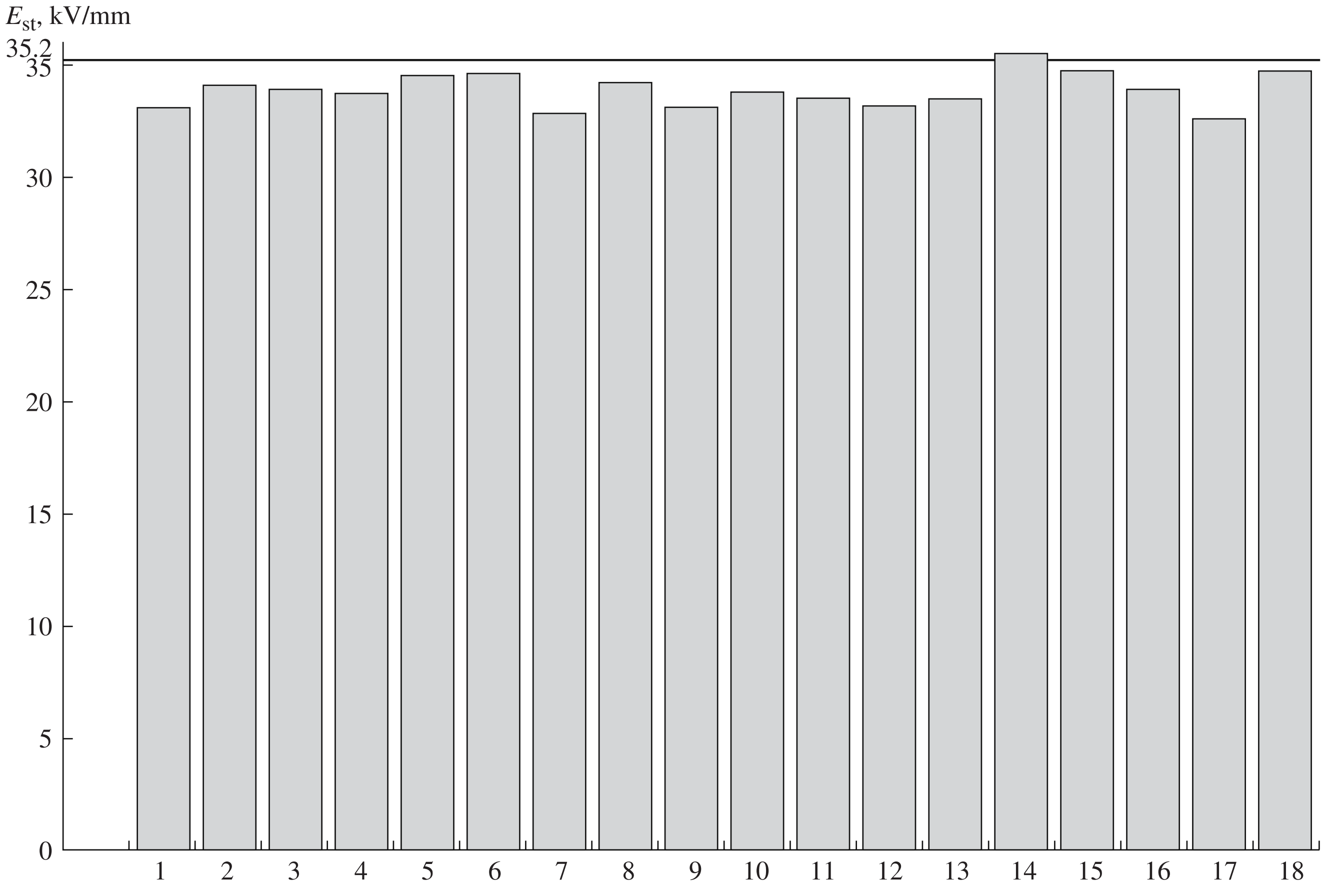

Fig. 1. Variation of the phenylxylilethane electric strength after contact with structural materials. 1 – Aluminum foil A5; 2 – polyethyleneterephthalate film PET-KE; 3 – polycarbone film PK-K; 4 – polypropylene film PP-KSS; 5 – steel St3; 6 – steel 45; 7 – copper M1; 8 – copper tin coated with solder POS-40; 9 – brass L63; 10 – glass-epoxidephenol tube; 11 – glass fiber laminate STEF-1; 12 – amides PA6 of type "B"; 13 – polypropylene interpolymer 22007-29; 14 – rubber MBS-M1; 15 – rubber 51-1434; 16 – rubber 51-1486; 17 – rubber IRP-2052; 18 – lacquer LBS-1.

51-1486 and IRP-2052 by 3.5 and 7.3%, respectively, testifying that it isn't desirable to use them in contact with phenylxylilethane. Resins MBS-M1 and 51-1434 had the lowest influence on the change of the phenylxylilethane electric strength, and they could be recommended to be utilized in constructions where phenylxylilethane is used as a liquid impregnating dielectric.

In estimating the effect of copper and its alloys (brass L63) on the electric strength value of phenylxylilethane, it can be deduced that the copper product surfaces contacting with phenylxylilethane should be tinned. Thus, after the contact with copper whose surfaces were tinned with solder POS-40, the phenylxylilethane electric strength decreased only by 2.6%, while, after the contact with copper and brass L63, the phenylxylilethane electric strength receded by 6.7 and 6.0 %, respectively.

The structural material virtually didn't affect the phenylxylilethane relative permittivity. Its largest change was observed after the contact with lacquer LBS-1 deposited on cable paper K-120 with the variation being only 1.4%.

After the contacting of phenylxylilethane with all the structural materials, the loss tangent value in some way or another arose, especially, (as was expected) after contacting with copper (by 70.8%). The greatest reduction of the phenylxylilethane volume electric resistivity occurred after the contact with copper M1 (by 70.9%) and after the contact with brass L63 (by 55.4%), while, after the contact with copper tinned with solder POS-40, the decrease was only 43%.

Generalizing the results of the conducted investigation on the assessment of the structural materials' effect on the electrophysical characteristics of phenylxylilethane, we can draw the following conclusions:

—The examined structural materials don't considerably impair the electrophysical characteristics of phenylxylilethane. As for copper and alloys based on copper, their surfaces should be tinned.

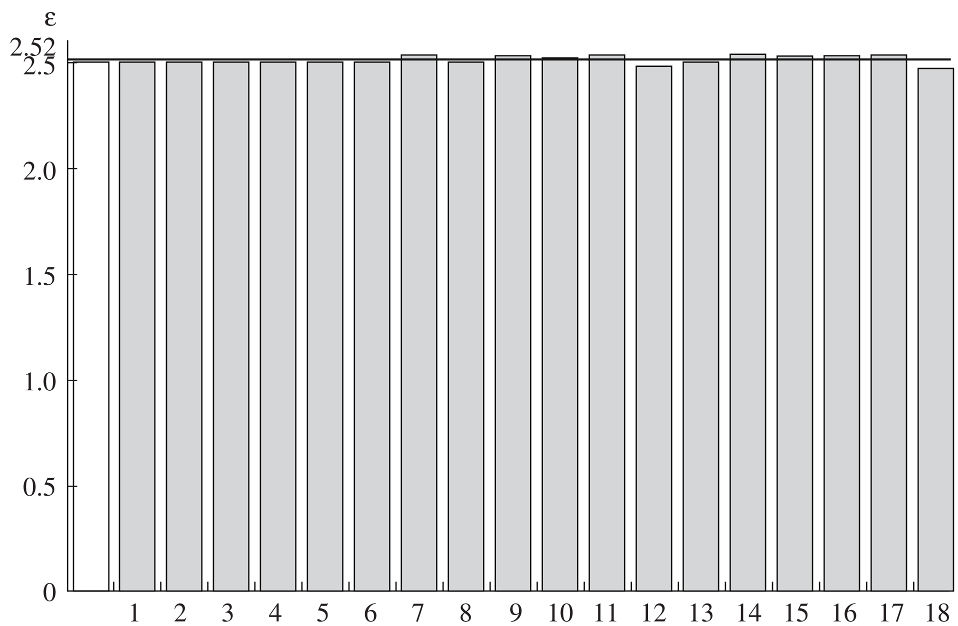

Fig. 2. Variation of the phenylxylilethane relative permittivity after contact with structural materials. 1 – Aluminum foil A5; 2 – polyethyleneterephthalate film PET-KE; 3 – polycarbone film PK-K; 4 – polypropylene film PP-KSS; 5 – steel St3; 6 – steel 45; 7 – copper M1; 8 – copper tin-coated with solder POS-40; 9 – brass L63; 10 – glass-epoxidephenol tube; 11 – glass fiber laminate STEF-1; 12 – amides PA6 of type "B"; 13 – polypropylene interpolymer 22007-29; 14 – rubber MBS-M1; 15 – rubber 51-1434; 16 – rubber 51-1486; 17 – rubber IRP-2052; 18 – lacquer LBS-1.

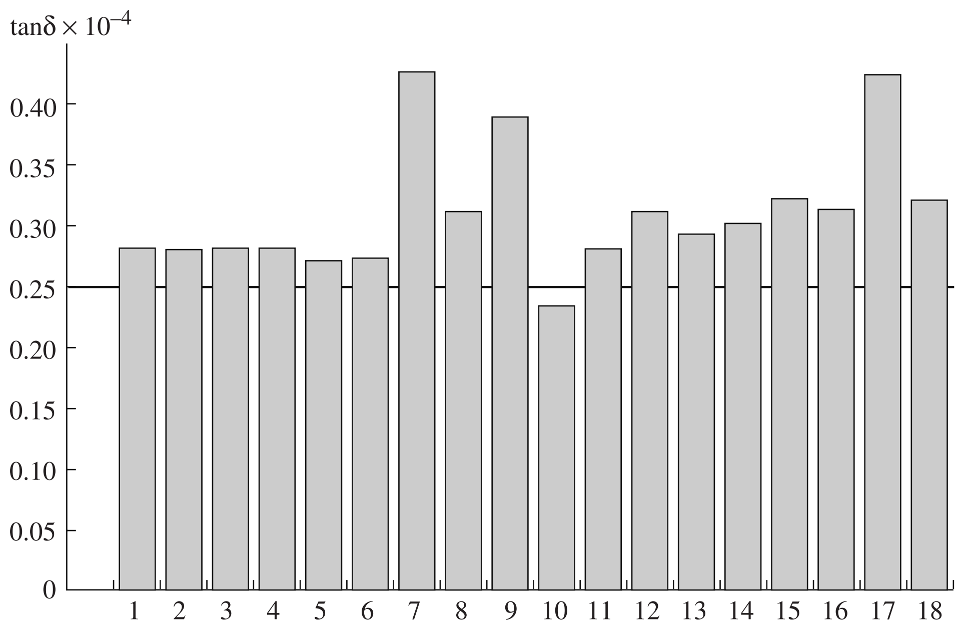

Fig. 3. Variation of the phenylxylilethane loss tangent after contact with structural materials. 1 – Aluminum foil A5; 2 – polyethyleneterephthalate film PET-KE; 3 – polycarbone film PK-K; 4 – polypropylene film PP-KSS; 5 – steel St3; 6 – steel 45; 7 – copper M1; 8 – copper tin coated with solder POS-40; 9 – brass L63; 10 – glass-epoxidephenol tube; 11 – glass fiber laminate STEF-1; 12 – amides PA6 of type "B"; 13 – polypropylene interpolymer 22007-29; 14 – rubber MBS-M1; 15 – rubber 51-1434; 16 – rubber 51-1486; 17 – rubber IRP-2052; 18—lacquer LBS-1.

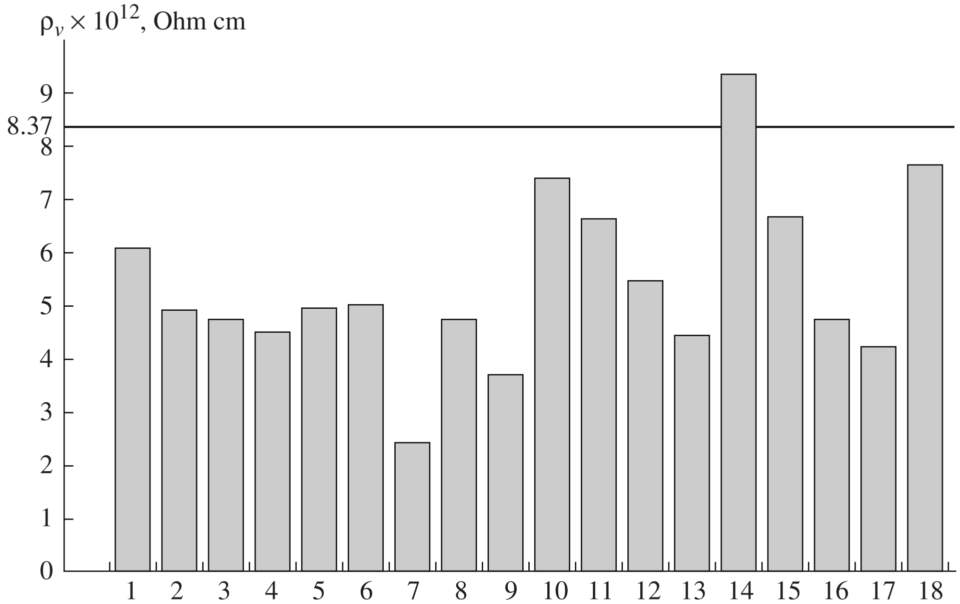

Fig. 4. Variation of the phenylxylilethane volume electric resistivity after contact with structural materials. 1 – Aluminum foil A5; 2 – polyethyleneterephthalate film PET-KE; 3 – polycarbone film PK-K; 4 – polypropylene film PP-KSS; 5 – steel St3; 6 – steel 45; 7 – copper M1; 8 – copper tin coated with solder POS-40; 9 – brass L63; 10 – glass-epoxidephenol tube; 11 – glass fiber laminate STEF-1; 12 – amides PA6 of type “B”; 13 – polypropylene interpolymer 22007-29; 14 – rubber MBS-M1; 15 – rubber 51-1434; 16 – rubber 51-1486; 17 – rubber IRP-2052; 18 – lacquer LBS-1.

—Rubbers of types MBS-M1 and 51-1434 can be recommended for use when there is possible contact with phenylxylilethane.

The obtained results can be applied for designing not only high-voltage impulse capacitors but also many other electrotechnical devices where phenylxylilethane is used.

REFERENCES

1. Zhuravleva, N.M., Andreev, A.M., Molodova, L.A. and Lutskaya, T.V., Selection of Impregnating Fluids for High-Voltage Film Capacitors, *Elektrotekhnika*, 1994, no. 4, pp. 55–58.
2. Andreev, A.M., Zhuravleva, N.M., Aleksandrova, N.P. and Galakhova, N.M., Change of Working Characteristics of the Film-Impregnated Capacitor Insulation due to the Interrelation of its Components, *Elektrotekhnika*, 1996, no. 3, pp. 69–71.
3. Pereselentsev, I.F., Ginsburg, S.L., Stupin, Yu.I., Impregnating Dielectrics for Power Capacitors, *Elektrotekhnika*, 1989, no. 3, pp. 47–51.
4. Berezin, V.B., Prohorov, N.S., Rykov, G.A., et al., *Elektrotehnicheskie materialy* (Electrotechnical Materials), (Reference-book), Moscow: Energoatomizdat, 1983.
5. Spravochnik po elektrotekhnicheskim materialam (Handbook on Electrotechnical Materials), Koritskii, Yu.V., et al., Eds., Moscow: Energoatomizdat, 1986.

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