DOI: https://doi.org/10.15407/techned2016.03.018

FREQUENCY DEPENDENCE OF DIELECTRIC LOSS TANGENT ON THE DEGREE OF HUMIDIFICATION OF POLYETHYLENE CABLE INSULATION

Journal	Tekhnichna elektrodynamika
Publisher	Institute of Electrodynamics National Academy of Science of Ukraine
ISSN	1607-7970 (print), 2218-1903 (online)
Issue	№ 3, 2016 (May/June)
Pages	18 – 24

Authors

A.V. Bezprozvannych[1], A.G. Kessaev[1], M.A. Shcherba[2]*
[1] – National Technical University "Kharkov Polytechnical Institute",
St. Bagaleia, 21, Kharkov, 61002, Ukraine,
e-mail: bezprozvannych@kpi.kharkov.ua
[2] – National Technical University of Ukraine "Kyiv Polytechnical Institute",
pr. Peremohy, 21, Kyiv, 03056, Ukraine,
e-mail: m.shcherba@gmail.com
ORCID ID: * http://orcid.org/0000-0001-6616-4567

Abstract

It is shown that application of the high-frequency relaxation spectroscopy is expedient at the analysis of processes of appearance of free moisture in the polymeric insulation of power cables. The calculated and experimental frequency dependences of dielectric loss tangent on the degree of humidification of cable insulation are given. It is revealed that at prolonged moistening of insulation the peaks of relaxation losses are displaced into area of higher *frequencies and there are the additional maxima corresponding to dispersion of energy dissipation in the new elements of insulation. The range of change of frequency of relaxation losses depends on concentration of free moisture in insulation and its electro-physical and morphological properties.* References 19, figures 5, table 1.

Key words: polyethylene insulation, equivalent circuit, dielectric loss tangent, water micro-inclusions, treeing, dielectric spec-troscopy, relaxation processes.

Received: 21.12.2015
Accepted: 11.02.2016
Published: 25.04.2016

References

1. Bezprozvannych G.V., Naboka B.G. Mathematical models and methods of calculation of electrical designs. Kharkiv: Natsionalnyi Tekhnicheskii Universitet "KhPI". 2012. 108 p. (Rus)
2. Bezprozvannych G.V., Naboka B.G., Moskvitin E.S. Justification of the electrical characteristics of semiconducting shields of high voltage power cables with cross-linked insulation. *Electrical engineering & Electromechanics*. 2010. No 3. P. 82–86. (Rus)
3. Suprunovska N.I., Shcherba A.A. Processes of energy redistribution between parallel connected capacitors. *Tekhnichna Elektrodynamika*. 2015. No 4. P. 3–11. (Rus)
4. Hippel A.R. Dielectrics and Wave. Moskva: Izdatelstvo inostrannoi literatury, 1977. 439 p. (Rus)
5. Shydlovskii A.K., Shcherba A.A., Podoltsev A.D., Kucheriava I.M. Cables with polymeric insulation on ultra-high voltage. Kiev: Institut Elektrodinamiki Natsionalnoi Akademii Nauk Ukrainy, 2013. 552 p. (Rus)
6. Shcherba A.A., Podoltsev A.D., Kucheriava I.M. Electromagnetic Processes in 330 kV Cable Line With Poly-ethylene Insulation. *Tekhnichna Elektrodynamika*. 2013. No 1. P. 9–15. (Rus)

7. Shcherba M.A., Podoltsev A.D. Electric field and current density distribution near water inclusions of polymer insulation of high-voltage cables in view of its nonlinear properties. *Tekhnichna Elektrodynamika*. 2016. No 1. P. 11–18. (Rus)
8. Boggs S.A. Semi-empirical high-field conduction model for polyethylene and implications thereof. Dielectrics and Electrical Insulation. IEEE Transactions on 2.1. 1995. P. 97–106.
9. Bellet J.J., Matey G., Rose L., Rose V. Some Aspects of the Relationship between Water Treeing, Morphology, and Microstructure of Polymers. *IEEE Transactions on Dielectrics and Electrical Insulation*. 1987. Vol. EI–22. No 2. P. 211–217.
10. Ciuprina F., Teissedre G., Filipini J.C. Polyethylene crosslinking and water treeing. *Polymer*. 2001. Vol. 42. P. 7841–7846.
11. Dissado L.A. Understanding electrical trees in solids: from experiment to theory. *IEEE Transactions on Dielectrics and Electrical Insulation*. 2002. Vol. 9. No 4. P. 483–497.
12. Dissado L.A. and Fothergill J.C. Electrical degradation and breakdown in polymers. IEE Materials and Devices Series 9, 1992. Peter Peregrinus. Ltd., London, UK. 601 p.
13. Fothergrill J.C. The Measurement of Very Low Conductivity and Dielectric Loss in XLPE Cables. *IEEE Transactions on Dielectrics and Electrical Insulation*. 2011. Vol. 15. No 5. P. 1544–1553.
14. Kato T., Yamaguchi T., Komori T. Influence of structural change by AC voltage pretesting on electrical-tree inception voltage of LDPE with water-tree degradation. Annual Report Conference on *Electrical Insulation and Dielectric Phenomena*. Montreal, Canada: IEEE. 2012. P. 847–850.
15. Mugala G., Eriksson R., Gäfvert U., Pettersson P. Measurement technique for high frequency characterization of semi-conducting materials in extruded cables. *IEEE Transactions on Dielectrics and Electrical Insulation*. 2004. Vol. 11. Pp. 471–480.
16. Shcherba M.A. Dependences of electric field amplification during water tree branching in solid dielectrics. 2014 IEEE International Conference on *Intelligent Energy and Power Systems* (IEPS). 2014. P. 46–49.
17. Werelius P., Thärning P., Eriksson R., Holmgren B. & Gäfvert U. Dielectric spectroscopy for diagnosis of water tree deterioration in XLPE cables. IEEE Transactions on *Dielectrics and Electrical Insulation*. 2001. Vol. 8. No 1. P. 27–42.
18. Zaengl W.S. Dielectric spectroscopy in time and frequency domain for HV power equipment. I. Theoretical considerations. *Electrical Insulation Magazine*, IEEE. 2003. Vol. 19. No 5. P. 5–19.
19. German-Sobek M., Cimbala R., Kiraly J. Change of Dielectric Parameters of XLPE Cable due to Thermal Aging. *Electrotehnica, Electronica, Automatica* (EEA). 2014. Vol. 62. No 3. P. 47–53.

PDF