

DOI: <https://doi.org/10.15407/techned2016.01.011>

ELECTRIC FIELD AND CURRENT DENSITY DISTRIBUTION NEAR WATER INCLUSIONS OF POLYMER INSULATION OF HIGH-VOLTAGE CABLES IN VIEW OF ITS NONLINEAR PROPERTIES

Journal	Tekhnichna elektrodynamika
Publisher	Institute of Electrodynamics National Academy of Science of Ukraine
ISSN	1607-7970 (print), 2218-1903 (online)
Issue	№ 1, 2016 (January/February)
Pages	11 – 19

Authors

O.D. Podoltsev, M.A. Shcherba*

Institute of Electrodynamics National Academy of Science of Ukraine,
pr. Peremohy, 56, Kyiv-57, 03680, Ukraine,
e-mail: m.shcherba@gmail.com

*ID <http://orcid.org/0000-0001-6616-4567>

Abstract

The mathematical model and the analysis of inhomogeneous electric field and total current density distribution in micro-volumes of crosslinked polyethylene (XLPE) insulation on ultrahigh voltage near water micro-inclusions extracted along the field have been made. The analysis was made considering a nonlinear conductivity dependence on the electric field. The multi-physical character of possible degradation processes of solid polymer insulation of ultra high voltage cables in the appearance of conducting ellipsoidal inclusions and branched water dendrites has been specified. The studies were made with taking into account the calculation

results of electric field macro-inhomogeneity distribution along the cross-section of XLPE insulation of ultra high voltage cables. References 17, figures 4.

Key words: electric field, polyethylene insulation, non-linear properties, inhomogeneity, micro-inclusions

Received: 10.08.2015

Accepted: 15.10.2015

Published: 29.01.2016

References

1. Liakh V.V., Molchanov V.M., Santatsky V.G., Kvitsinsky A.A. Cable line of voltage 330 kV: Some aspects of designing. *Pro melekto*. 2009. No 6. P. 27–33. (Rus)
2. Melnikov N.A. Electrical networks and systems. Moskva: Energiia, 1975. 464 p.
3. Podoltsev A.D., Kucheriava I.M. Multiscale modeling in electrical engineering. Kyiv: Instytut Elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy, 2011. 256 p. (Rus)
4. Shydlovskiy A.K., Shcherba A.A., Podoltsev A.D., Kucheriava I.M. Cables with polymeric insulation on ultrahigh voltage. Kyiv: Instytut Elektrodynamiky Natsionalnoi Akademii Nauk Ukrainy, 2013. 352 p. (Rus)
5. Shcherba A.A., Podoltsev A.D., Kucheriava I.M. Electromagnetic Processes in 330 KV Cable Line With Polyethylene Insulation. *Tekhnichna Elektrodynamika*. 2013. No 1. P. 9–15. (Rus)
6. Shcherba M.A. The features of the local electric field amplifications by conducting inclusions in nonlinear polymer insulation. *Tekhnichna Elektrodynamika*. 2015. No 2. P. 16–23. (Rus)
7. Shcherba M.A. The Force Interaction Between Close Placed Conducting Micro-inclusions in Dielectric Medium Under the Ex-ternal Electric Field. *Tekhnichna*

- Elektrodynamika* . 2012.
No 3. P. 11–12. (Rus)
8. Shcherba M.A., Roziskulov S.S., Vasilyeva O.V. Dependence of Electric Field Disturbances in Dielectrics on the Dispersion of Closely Spaced Water Micro-inclusions. *Tekhnichna Elektrodynamika* . 2014. No 4. P. 17–19. (Rus)
9. Dissado L.A. and Fothergill J.C. Electrical degradation and breakdown in polymers. IEE Materials and Devices Series 9. Peter Peregrinus. Ltd., London, UK, 1992. 601 p.
10. Kato, T., Onozawa, R., Miyake, H., Tanaka, Y., & Takada, T. Characteristics of space charge behavior and conduction current in xlpe and annealed polyethylene under high DC stress. International Symposium on *Electrical Insulating Materials* (ISEIM), Proceedings of 2014 . P. 370–373.
11. Li Y., Kawai J., Ebinuma Y., Fujiwara Y., Ohki Y., Tanaka Y., Takada T. Space charge behavior under ac voltage in water-treed PE observed by the PEA method. Dielectrics and Electrical Insulation. *IEEE Transactions on Dielectrics and Electrical Insulation*. 1997. Vol. 4. No 1. P. 52–57.
12. O'Dwyer J.J. The theory of electrical conduction and breakdown in solid dielectrics. Oxford: Clarendon Press, 1973. 317 p.
13. Rezinkina M., Bydianskaya E., Shcherba A. Alteration of brain electrical activity by electromagnetic field. *Environmentalist*. 2007. Vol. 27. No 4. P. 417–422.
14. Shcherba M.A. Dependences of electric field amplification during water tree branching in solid dielectrics. Proc. of IEEE Intern. Conference on *Intelligent Energy and Power Systems* (IE PS 2014). Kyiv, Ukraine. P. 46–49.
15. Thomas A.J. and Saha T.K. A theoretical investigation for the development of a water tree dielectric response model. IEEE Conf. Electr. Insul. Dielectr. Phenomena. Kansas City. 2006. P. 368–378.
16. Tleis N. Power Systems Modelling and Fault Analysis. Elsevier, 2008. 367 p.
17. Wedepohl L.M. and Wilcox D.J. Transient Analysis of Underground Power Transmission System; System-Model and Wave Propagation Characteristics. *Proceedings of the institution of electrical engineers* . 1973. Vol. 120. No 2. Pp. 252–259.

[PDF](#)

