New technology improves power line performance

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Insulator strings with natural contamination. Credit: Dmitry Titov/ Skoltech

Associate Professor of the Practice Dmitry Titov and Research Engineer Klim Volkhov from the Energy Center published laboratory results of

assessing the possibility of a frequent reason for power outages in Russia—flashovers of high-voltage insulators in overhead power lines.

The flashovers of insulator strings result from surface contamination and reduced flashover characteristics of insulators. Apart from failures, they also lead to high costs on emergency repair works. The research is part of the project aimed to develop a technology for risk-oriented management of insulation.

Owned by the Yuzhnouralsky Insulators and Fittings Plant, a leading manufacturer of high-voltage insulators, the novel technology is now in pilot operation in power lines of the Rosseti Moscow power company. The article came out in the proceedings of the 2023 International Conference on Industrial Engineering, Applications and Manufacturing published by the Institute of Electrical and Electronics Engineers.

According to the authors, it is difficult to determine the state of insulators and level of their contamination, while insulators are replaced either after the expiry of operation or based on subjective assessments of power company employees. The new device—a hardware and software platform with sensors and data processing tools—helps make the assessment process more objective and reduce insulator maintenance costs.

At the first stage, researchers developed a mathematical tool, which assessed the state of the insulation, and then proceeded to sensors. The study involved experiments of two types—at the laboratories and power grid facilities. "Laboratories provide high-voltage equipment, which allows imitating power line operation processes," says Volkhov.

"We used portable oscilloscopes to model different states of insulators and identify their characteristics while they are contaminated, moistened or when their number or types are changed. The second type of

experiment is field measurements. We collected data about leakage currents in insulators at the real plant grid facilities in the Dagestan Republic, Volgograd and Tula regions, and in Moscow. Then, we put them in a dataset and processed it."

Based on the oscillogram analysis, the authors presented 20 most significant for the model development parameters and among them chose those that best reflect the state of insulators. The development and application of sensors that can measure these parameters may prevent accidents in power lines.

"We conducted several stages of field testing and improved our hardware and software platform, which does not seek to control one specific insulator with the sensor, but aims to assess the state of the whole insulation in the power grid region, which adds value to it. Last November, we were among the winners of 'Energoproriyv (Energy Breakthrough)', a competition for the best smart energy solutions. The project became part of the R&D program in the Rosseti Moscow power company. We expect that in the future the company will be able to use the technology without any restrictions," concludes Titov and adds that there are not any other versions of the product in the world with such a successful commercialization experience.

More information: Klim Volkhov et al, Diagnostics of Overhead Line Insulator State based on Leakage Current Regression Analysis, *2023 International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM)* (2023). DOI: 10.1109/ICIEAM57311.2023.10139219

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