Technical sciences

ELECTRICITY QUALITY CONTROL IN DISTRIBUTION NETWORKS

Nerubatskyi Volodymyr
PhD, Associate Professor
E-mail: NVP9@i.ua
ORCID: http://orcid.org/0000-0002-4309-601X
Ukrainian State University of Railway Transport
Hordiienko Denys
Engineer
E-mail: D.Hordiienko@i.ua
ORCID: https://orcid.org/0000-0002-0347-5656
Private JSC "ELAKS"

Most of the technological processes in industry are related to the production, transmission, distribution and use of electricity, as it is the most convenient for the conversion into other types of energy. In addition, the process of production and transmission of electricity in the power system is regulated by regime conditions and restrictions, which determines the need for metering equipment and metering systems to control and manage power consumption [1].

Particular attention is paid to high-voltage substations, where reducing the volume of ballast flows of reactive power in distribution networks allows power grid companies to improve the quality of transmitted electricity and increase the stability of power grids by reducing distortions in current THD_I and voltage THD_U [2]. According to domestic and international standards, the coefficients of harmonic distortion should not exceed 8 %.

The introduction of automated systems for accounting and control of energy consumption makes it possible to obtain operational data, control energy parameters, identify possible ways to save [3]. This, in turn, leads to a decrease in the share of energy resources in the cost of production, increase the efficiency of detection and elimination of deviations from the established consumption regimes, obtaining a stable profit.

Currently, the markets of Ukraine offer a wide range of electricity analyzers. For the most part, these devices meet the requirements of Gosstandart, but most often in the body of the electricity analyzer tend to have not only a recorder for voltage, but also a meter for current and power. Therefore, some series of three-phase analyzers come with current measuring clamps, the presence of which makes it possible to measure current values, power, power consumption, harmonic distortion coefficients for voltage and current.

With the help of a measuring complex developed by company "ELAKS", the parameters of the high-voltage network were measured (Fig. 1).

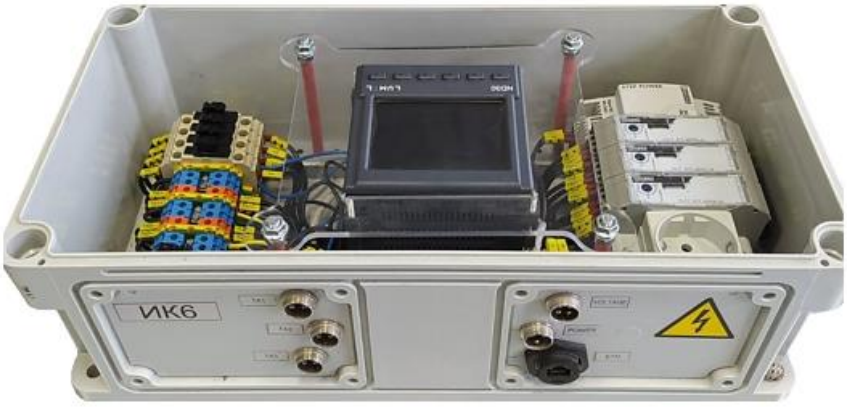

Fig. 1. Measuring set of parameters of the power supply network

The measuring complex includes digital analyzer of quality indicators of industrial electric networks Lumel ND30, current transformers PACT RCP-D95, measuring converters PACT RCP-4000A-1A, 24 VDC power supply.

The advantages of this measuring system include:

– the presence of a universal sensor for measuring current values from 100 A to 3000 A;

– the ability to perform real-time measurements continuously for up to 1 month;

– data archiving with a minimum frequency of 1 value in 1 second;

– unloading of data from a measuring complex in the Offline mode by means of Wi-Fi, GSM;

– control of parameters for current, voltage, power factor, active, reactive, full power, electric energy, as well as coefficients of harmonic distortion for voltage and current;

– diagnostics of measurement;

– reports in the form of tables and graphs.

With the help of this measuring complex, the parameters of the electrical substation 35/6 kV were measured for 22 hours:

– value of current (Fig. 2);

– value of power factor (Fig. 3);

– value of active power (Fig. 4);

– value of reactive power (Fig. 5);

– value of total harmonic distortion by voltage (Fig. 6);

– value of total harmonic distortion by current (Fig. 7).

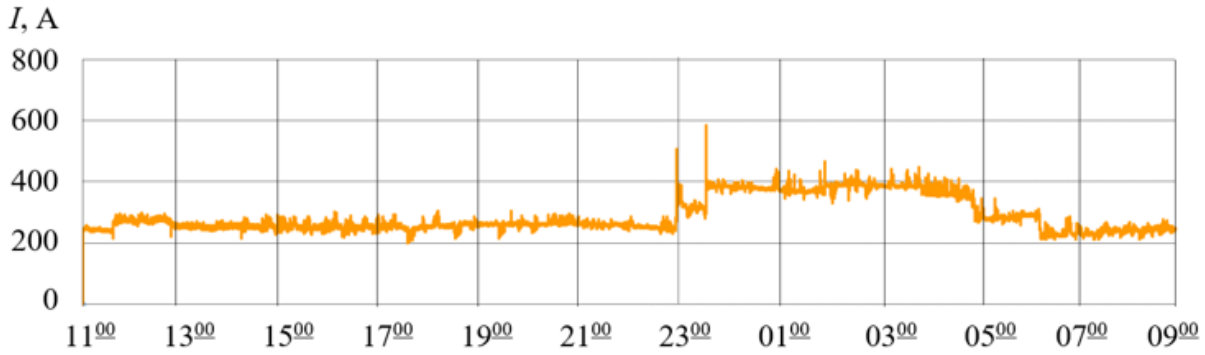

Fig. 2. Average value of current during measurement I_{av} = 297 A

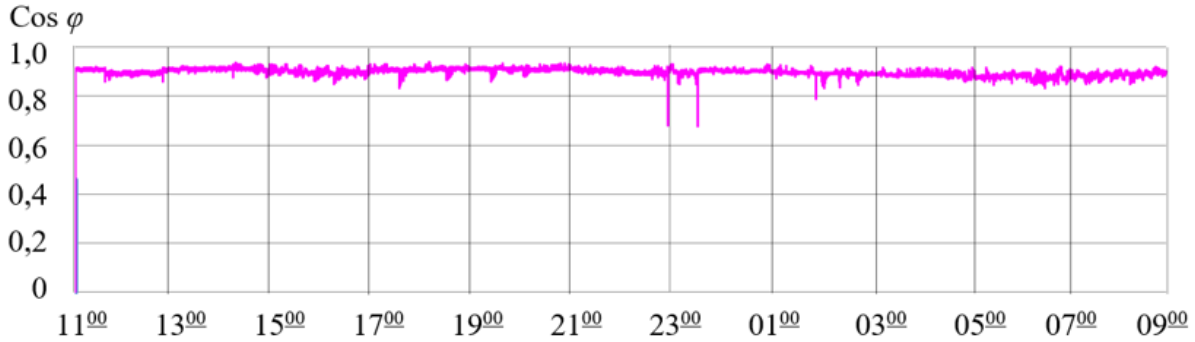

Fig. 3. Average value of power factor during measurement Cos φ_{av} = 0,89

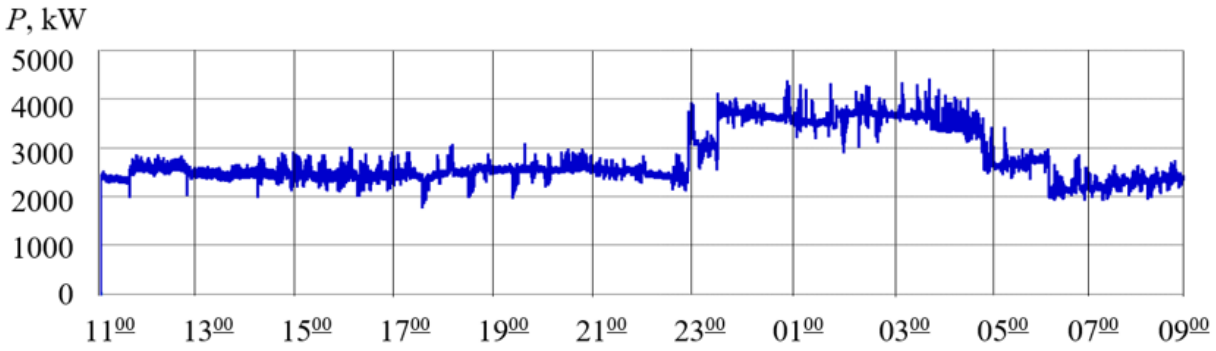

Fig. 4. Average value of active power during measurement P_{av} = 2921 kW

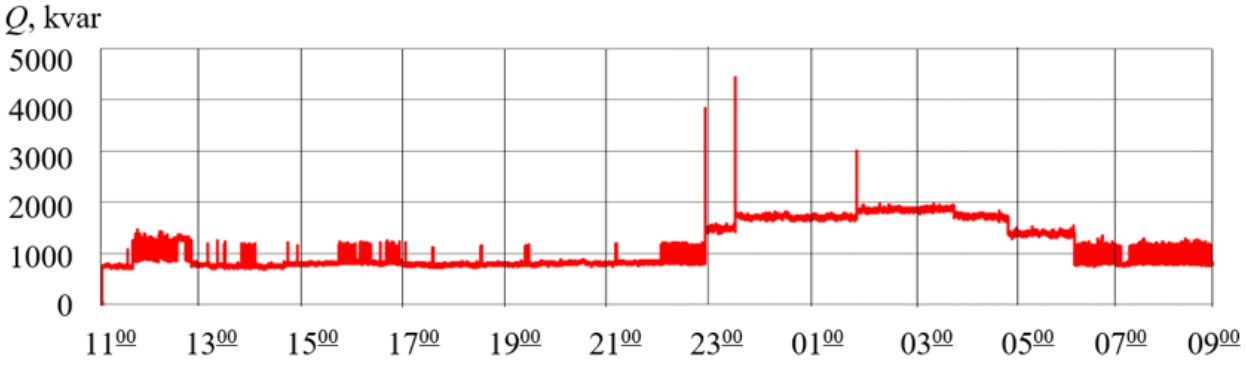

Fig. 5. Average value of reactive power during measurement Q_{av} = 1014 kvar

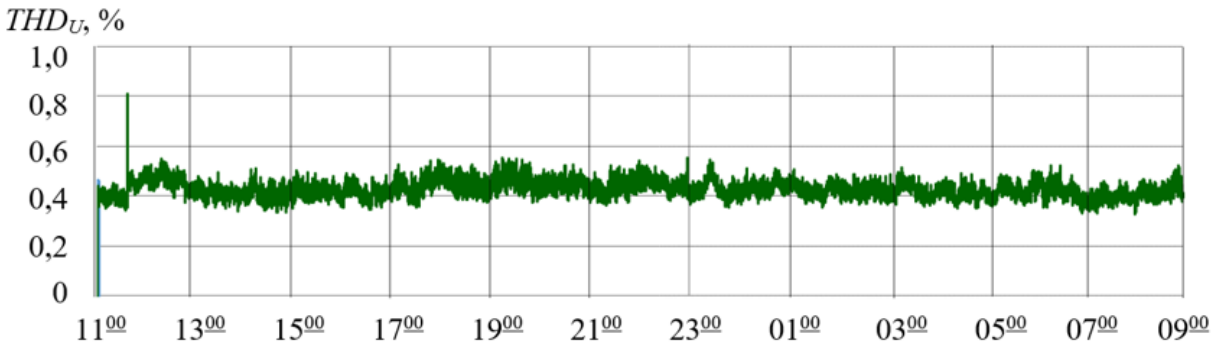

Fig. 6. Average value of total harmonic distortion by voltage THD_U = 0,43 %

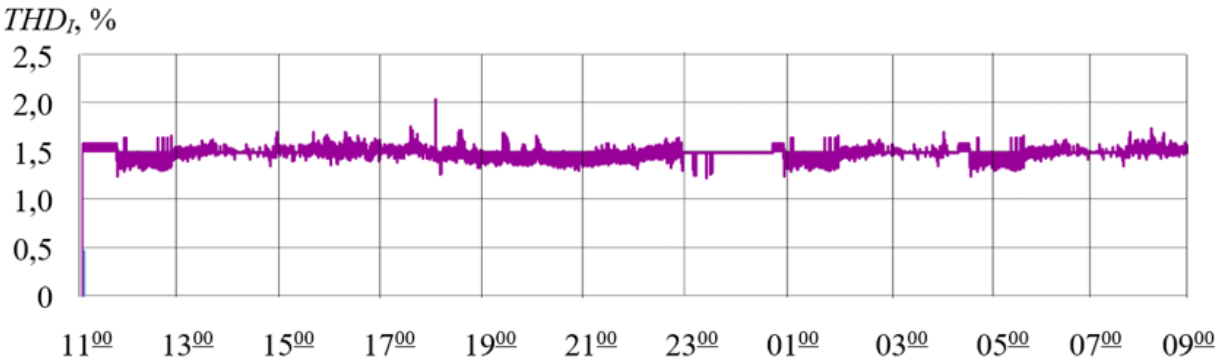

Fig. 7. Average value of total harmonic distortion by current THD_I = 1,51 %

It follows from the measurements that the voltage distortion on the buses of the 6 kV distribution substation (which is characterized by the phase voltage distortion factor THD_U) does not exceed the permissible values throughout the measurement period.

References:

1. Нерубацький В. П., Гордієнко Д. А. Контроль і планування енерговикористання на залізничному транспорті. Матеріали VII міжнародної науково-практичної конференції «Людина, суспільство, комунікативні технології». 2019. С. 227–230.

2. Suslov K., Solonina N., Stepanov V. A principle of power quality control in the intelligent distribution networks. *2015 International Symposium on Smart Electric Distribution Systems and Technologies (EDST)*. 2015.P. 260–264. DOI: 10.1109/SEDST.2015.7315218.

3. Нерубацький В. П., Гордієнко Д. А. Застосування енергетичного аудиту з метою зниження рівня споживання паливно-енергетичних ресурсів тяговим рухомим складом залізниць. Тези стендових доповідей та виступів учасників 32-ї міжнародної науково-практичної конференції «Інформаційно-керуючі системи на залізничному транспорті». 2019. № 4 (додаток). С. 13–14.