

ABSTRACT

of the dissertation for the degree of Doctor of Philosophy (PhD)
in the specialty 6D071800 – Electrical Power Engineering

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DEVELOPMENT OF AN INDIRECT METHOD FOR ASSESSING THE QUALITY OF ENERGY PARAMETERS DURING THE OPERATION OF ELECTRIC LIGHTING SYSTEMS

The thesis is devoted to the issue of creating a simplified method for qualitative assessment of the luminous flux of LED lamps, which will make it possible to understand their compliance with the requirements and also increase their effectiveness in the future.

The purpose of this work is to develop an indirect method for assessing the quality of energy parameters during the operation of electric lighting systems to improve their technical and economic performance.

The object of the study is electrical lighting systems operating in real-world operation, with a special focus on LED lighting fixtures, the parameters of which must be controlled to ensure reliability, energy efficiency and compliance with design requirements.

The idea of the work is to develop an indirect method for assessing the quality of energy parameters of LED lamps used in electrical lighting systems in order to improve their technical and economic performance by monitoring the compliance of the actual characteristics of the equipment with the parameters declared by the manufacturer and design requirements without using expensive laboratory equipment, while the method is based on the analysis of measurable secondary characteristics such as both current, temperature and time characteristics — This makes it possible to identify deviations in a timely manner, diagnose malfunctions and optimize maintenance and operation processes.

The scientific problem lies in the need to study the dependencies of the lighting parameters of luminaires that affect the quality characteristics of lighting installations. Systematization and definition of algorithms for determining the quality characteristics of luminaires without expensive laboratory equipment

Tasks to be solved. During the research, the following tasks were identified:

1. To analyze the modern development of electric LED lighting systems, including the analysis of international experience.
2. To carry out mathematical and computer modeling of processes in electric lighting systems based on LED light sources.
3. Conduct experimental studies using laboratory samples of the system.
4. To develop a method for indirect assessment of the quality of energy parameters of electric LED lighting systems.

Scientific novelty

1. An original physico-mathematical model has been developed that makes it possible to quantify the functioning of an LED lighting system in a specific work area, taking into account the specified energy parameters.

2. New dependencies have been derived reflecting the change in the lighting characteristics of LED lamps over time in response to fluctuations in electrical parameters, taking into account the level of power supply quality.

3. Based on numerical computer modeling of the physical processes occurring in LED lighting installations, the radiation characteristics are determined and quantitative parameters of the optimal range of their functioning are established.

4. A method of indirect evaluation of the energy characteristics of LED lighting systems has been developed, which provides a more reasonable choice of technical parameters of lighting devices to ensure stable and efficient operation of electric lighting installations.

The practical significance lies in obtaining new experimental results that are important for the development of an indirect method for assessing the quality of energy parameters under operating conditions without using certified laboratory equipment. The results obtained are of practical importance for optimizing the operation and design of electronically controlled LED systems. Key scientific developments are used in the educational process at the Karaganda Technical University named after Abylkas Saginov, and are also implemented at the enterprises of Global Light Ltd and Light Engineering LLP.

Provisions to be defended:

1. A physico-mathematical model of electric lighting systems based on LED light sources makes it possible to optimize the procedure for numerical analysis and theoretical prediction of the properties and parameters of the functional elements of LED electric lighting systems.

2. An analytical relationship is formulated that makes it possible to evaluate the change in the lighting characteristics of LED lamps during long-term operation, taking into account fluctuations in electrical parameters and instability in the quality of electricity.

3. The technique of indirect assessment of the quality of energy parameters of electric LED lighting systems allows you to select the necessary technical characteristics of LED devices to ensure the quality of operation of electric lighting installations.

The intended implementation. The results of the study can be used to improve the efficiency of operation and development of electronically controlled LED lighting systems. The method proposed in this paper is planned to be implemented as one of the main methods for evaluating LED fixtures during direct installation, and this method will also be offered as recommendations to all design organizations conducting supervision, as well as to lighting installation maintenance services.

Justification and reliability of the results and conclusions. The reasoned and reliable conclusions and results of the dissertation are based on the use of proven methods for comparing the data obtained by calculation and comparing these data with the results obtained in laboratories.

Scientific statements, results and conclusions are confirmed by comparing the adequacy of analytical research materials with laboratory experimental data. The research results are presented in peer-reviewed journals.