Opinion

Lighting on the way of the spread of Covid-19

Abstract

The article discusses an energy efficient technology for environmental disinfection based on the use of LED light sources to generate ultraviolet radiation. The structure of a disinfection system, a methodology and an algorithm for calculating the light distribution of LED light sources that ensure the efficient use of electrical energy for disinfection are proposed.

Keywords: lighting, ultraviolet radiation, spectrum, Covid-19, bacterial contamination, electrical

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Introduction

According to the results of research conducted by Ukrainian and Japanese scientists (O.M. Beketov NUUEK under the leadership of Prof. Hovorov P.P., Nichia Corp. TOKUSHIMA in Annan, Tokushima Prefecture, etc.), one of the effective ways of disinfection environment is the use of light sources with a certain spectrum of radiation. The experience of using such sources for water disinfection in urban and industrial water supply systems has indicated that its irradiation with lamps in the ultraviolet spectrum with a wavelength of 260-280 nm provides a high level of bactericidal water purification, especially in multilevel network structure and multistage disinfection technology.

The objective and the motivation

Existing UV sources in bactericidal plants are based on the use of gas-discharge mercury-argon or mercury-quartz lamps, in which UV radiation of the bactericidal range is generated in the process of electric discharge. They are installed in a quartz cover in the bag, which is closest to the source of contamination. Disinfection occurs by direct exposure to UV rays on microorganisms. Under these conditions, the presence of harmful substances in space leads to the absorption of light radiation, which reduces the effectiveness of disinfection. This requires constant cleaning of the outer surface of the quartz cover from the accumulated sediment, and also causes relatively high energy consumption. In addition, the design of such bactericidal plants allows cleaning only in places with very high bacterial contamination, but unfortunately in such bactericidal plants there is no effect of aftereffects, which is unacceptable. In this regard, installations for decontamination of the environment on the basis of bactericidal lamps are inefficient, although quite attractive in general. Therefore, the search for new and improvement of existing environmental decontamination technologies is an urgent problem of great importance, especially given the state and consequences of the Covid-19 pandemic.

Analysis of recent research and publications

Ultraviolet radiation technology is widely used. Ultraviolet light can be an insurmountable barrier against all known microorganisms, especially it is very effective against microorganisms resistant to chemicals. However, in order for the UV equipment to really cope with the tasks, it is necessary to provide the required range of radiation and correctly choose the power of bactericidal radiation to provide the desired effect of disinfection. In particular, for disinfection of domestic and urban environments, a UV dose of at least 30mJ/cm^2 should be used. But in practice, the matrix of the environment is so unique that this dose can be more than enough or not enough at all. Ways to improve methods and techniques of disinfection in general should be sought in new ways, involving the use of more flexible and energy efficient systems. According to the analysis, high technical and economic indicators are provided by bactericidal installations based on LED light sources, which, together with improved energy characteristics, also provide the possibility of dispersal of bactericidal installations and the possibility of multistage disinfection. At the same time, the study of disinfection processes and determination of requirements for bactericidal installations based on ultraviolet LED light sources, especially for Covid-19 conditions, has not yet been conducted. This applies to lighting and electrical calculations of bactericidal installations based on LED light sources, which hinders their introduction into existing disinfection systems and causes low energy and lighting efficiency of such installations and uncontrollable growth of contamination, primarily on Covid-19. The above requires research to create a scientific and methodological basis for the calculation of bactericidal installations based on LED light sources and to determine the requirements and parameters of bactericidal installations based on ultraviolet LED light sources, which can overcome the effects of the Covid-19 pandemic.

Methods and technical means of disinfection

To solve the problem of environmental pollution, a distributed disinfection system based on the use of energy-efficient ultraviolet LED light sources is considered. This makes it possible to place bactericidal plants near each source of infection, which makes it possible to avoid the re-development of microorganisms, because when exposed to organic cells of various pathogens by ultraviolet radiation of spectral composition from 200 to 400nm, cell destruction is observed. Since the purpose of the installation of ultraviolet radiation is to neutralize bacteria, the bactericidal properties in them must have only photons with energy that can break the bond of protein molecules by radiation with a wavelength $\lambda<300$nm. Analysis of the graphical dependences shown in Figure 1, leads to the conclusion that the greatest efficiency of bactericidal installations is provided by light sources with a wavelength of 254-258nm. The Nippon Telegraph and Telephone Corporation's research laboratory, led by Dr. Yoshitaka Tanyas, has developed aluminum nitride-based diodes that can emit light in the ultraviolet range with a wavelength of 210nm. Their use is able to provide distributed disinfection of a significant amount

of contamination of elements located on a large plane. However, the widespread introduction of such light sources in bactericidal installations is constrained by the lack of programs and methods of lighting calculation of installations based on them.

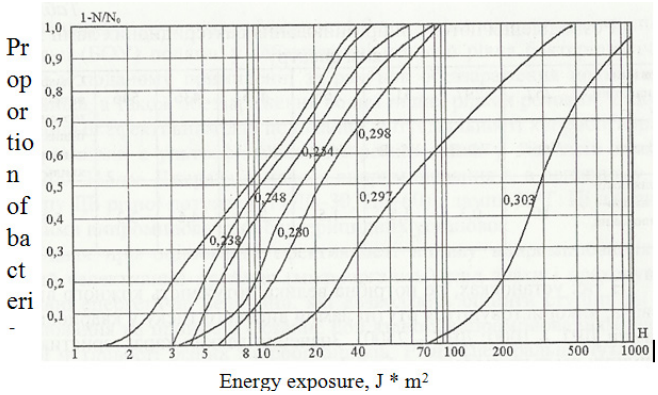

Figure 1 Spectrum of effective bactericidal action of radiation.

Calculation of ultraviolet LED light sources

When calculating disinfecting light emitting devices based on LED light sources, the traditional approach of calculating the light distribution of a single luminous element cannot be applied and requires calculation of the whole area within which the luminous elements are located, taking into account the interaction of these elements their interaction with the environment. Due to insufficiently studied patterns of light distribution of LED light sources and low accuracy of their description, the calculation of the characteristics of UV light emitters based on them is a rather complex and unsolved problem. The structural model of visualization of light space created by UV LED light sources can now be implemented only for individual LEDs. Insufficient technical and methodological support of lighting visualization programs based on LED light sources causes low efficiency of installations based on them.

Results and their commentary

Analysis of publications on the modeling of light space using LED light sources and description of methods for calculating the light distribution of light sources and light devices (SP) based on them showed that mainly publications are devoted to the description of LED light sources in terms of specific tasks. models for any light distribution type of light sources. UV emitting devices consist of the n-th number of LEDs, which opens the possibility of developing a wide variety of design and technical solutions in their design. Therefore, to determine the optimal number of LEDs and their light distribution, taking into account their mutual location in the JV at the design stage, there is a need to model the light distribution of the JV and create on its basis a method of synthesis of installations with specified properties. Accordingly, the first experiments on the inactivation of viral particles COVID-19 indicated the effectiveness of the use under these conditions of LED sources of deep ultraviolet radiation, which provide inactivation of 99.9% of the coronavirus particles. The conducted researches testify to the possibility of construction on the basis of such LEDs of systems of clearing and air conditioning, etc. According to research, the most effective is the inactivation of viral particles at a wavelength of 260nm.[1–3]

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None.

Conflicts of interest

The authors declare that there is no conflict of interest.

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