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Methodological Grounds of Study ofLight-Emitting Diode Illumination Effectiveness

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Abstract- The article deals with the problems concerning peculiarity of estimating efficiency of light-emitting illumination, necessity of using methodology to get significant practical results. Efficiency of light-emitting illumination must be determined, first of all, on the basis of arrangement of conditions being optimal for visual activity and safe from hygienic positions.It has been indicated the basic problem in justification of fields of application of light-emitting illumination that is connected with specificity of spectral composition of illumination of white light-emitting diodesand peculiarities of photobiologicaleffect of its separate parts. It is pointed out the necessity of complex approach to estimating efficiency. In the capacity of bases of comparison it is proposed luminescent lighting as the most examined from the position of effect on different indicators determining hygienic effectiveness, and also visual performance capability of man.It is stressed the necessity of substantiated choice of illumination indicators in experimentation – the range of illuminations and color temperatures.The approaches to the choice of research methods have been considered. It is proposed in the conditions of light-emitting diode illumination to estimate the main functional indicators of the state of the visual organ and human organism on the whole, dynamics of visual capacity for work and visual fatigue. It has been shown the practical importance of experimental material for realization of illumination with light-emitting diodesource of lightsources of light.

Keywords: methodology, light-emitting diodes, lighting, problem, efficiency, scientific approach, complex methods, experimental research, illumination, color temperature, visual functions, fatigue, guidelines.

Introduction

As is generally known, methodologyis a logical arrangement of man's activity, consisting in defining the objective of research, approaches to its conducting, the choice of means and methods that estimate the best result [1].

Not any activity needs to apply methodology, but in research work methodology is essential in achieving goals.

Scientific researches in lighting technology, as, in fact, in the other sciences,are always oriented to objectively new result – creation of new light sources, light devices, enhancement of efficiency of lighting installations, elaboration of normative documentation and so on.

The objective of our research consists in the estimate of effectiveness of light-emitting diode lighting for arrangement of conditions being optimal for man's visual activity and safe from hygienic positions. On the one hand the objectives of research can be considered to current, as light-emitting diode lighting has already been used widely, on the other hand – prospective that open up new possibilities in lighting engineering [2, 3].

The main body of the article

Methodology of any research begins with the choice, setting and formulation of a goal. The object of the research is the systems of lighting realized on the basis of light-emitting diode sources of lighting. In the conditions of energy-saving it is necessary to test operational characteristics of light-emitting diodes,light devices and illuminating installations on their basis, to find new ways of increasing energy efficiency. At the same time, the basic element of the system is man. His capacity for work determines the efficiency of production processes, effectiveness of work in a variety of institutions – administrative, scientific, educationaland so on. But, on the other hand, it is obvious that one cannot solve these problems being out of touch with impact of all factors relating to the use of these prospective sources of light on man.

An important moment in the study is the designation of basic problem. In the study of efficiency of light-emitting diode lighting there is a problem to be solved. This problem is connected with spectral composition of emission, such ashigh intensity of radiant power in blue part of spectrum, which is necessary for production of white emission of light-emitting diodes.At present there is a wide divergence of opinion on conditioning of light-emitting diode lighting, and also biomedical aspect of light-emitting diode radiation effect on the organ of vision, psychophysiological state and general physical healthof man [4 – 7]. Some specialists deliver fears of permanent exposure effects, an overall result of which can show only in years.

As is generally known photobiological effect of light on human organism embraces psychophysiologic effect, including visual perception, emotional state, tonic and therapeutic, andalso damaging effect that can result in, for example, possible lesion of elements of the eye and skin and aftereffects for physical health on the whole (so calledphotobiological hazard).

For some time past it has been appeared sufficient publications dealing with effect of visible radiation color, including dark blue-bluepart of spectrum, on secretion of melatonin and problems of human health connected with it. But everyone knows that eye exposed to light receives a variety of biological and behavioral effects –secretion of melatonin and cortisone, circadian variations.

In the structure of systems of natural shielding of eyes from photopathy there are some independent mechanisms, among whichoptical filters of the eye are cornea, crystalline lens,screening pigments. They cut off short-wave radiations hazard for retina and pigment epithelium – ultravioletandpartially blue. The key role is played by crystalline lens. Its properties change during man's life. In tender years crystalline lens has ultraviolet «window», admitting some part of ultraviolet radiation to retina. Designation of this window remains uncertain for the present.Approximately by 15 «window» disappearsand then it is occurred gradual yellowingof crystalline lens afflicting especially the elderly.Data analysis on damaging action of light on amphiblestrodes and spectral properties of light shielding of the eye shows on the whole that significant attenuation of radiationon the spectral part with wavelength shorter than 450-460 nm (dark-blue radiation) is essential [8, 9].

An important constituent in the content of methodology of the research is approach. Approach is an aspect of the research which the research begins with and which determines its orientation concerning an object.We have chosen the scientific approach as the most effective. It is characterized by scientific goal setting and use of scientific apparatus in conducting research. In studying effectiveness of light-emitting diode illumination the most effective seems to us the approach relating to complex analysis of physiological functions in which the results obtained by means of different methods, complementing each other, reflect the state of the visual organ and human organism on the whole in various way.

Methodology of the research must include definition and formulation of key points and limitations. They enable to do the research more successively and purposefully. We suggest as bases of comparison choosing fluorescent lighting to be the most studied from the position of effect on different

indicators determining hygienic effectiveness, and also visual capacity for work.Incandescent lighting though being used in some cases, for example, in home lighting, has no prospects in using as bases of comparison by virtue of low energy efficiency.

A reasoned choice of ranging of illuminations and color temperatures for conducting researches is essential. Certainly, the wider boundaries of illumination values, the larger volume of experimental material can be obtained for analysis. But the important factor is costs and time allotted for conducting the experiment. The choice of illumination values is done according to the scale [10], depending on the character of visual performance. For example, for living and primary spaces of public buildings of working surface illumination constitute mostly 100 – 1000 lx. Lighting of plant facilities depending on the rank of performed visual works and the system of lighting requires higher levels of illumination. It should be taken into account such factors as characteristic of background, contrast ratio and so on.Incandescent lamps of low voltage keep being used for local lighting (in different facilities – engineering tools, automata, presses and so on) as sources of light for local lighting.

The choice of color temperature range in research is determined by a visual task connected or not connected with color stimulus specifications. According to [10]for artificial illumination it is recommended to use light sources with the color temperature from 2400 to 6800 K.

An important stage of the work is the choice of research methods, on the correctness of which is depended to a large extent by the achievement of the set objective of researches.Practice corroborated the necessity of using the methods of allied sciences in the research.In our opinion, of particular interest for determination of light-emitting diode lighting are the materials of psychophysiologic researches, estimate of functional indicators of the state of visual organ and human organism on the whole, dynamics of visual capacity for work and visual fatigue in the conditions of light-emitting diode lighting. The obtained in the course of the experiment data make it possible to compose psychophysiologic «portrait» of fatigue development and to give estimate of efficiency to the compared variants of lighting. At the same time, it is essential to take into account the character of dynamics and absolute (or relative) values of functional indicators.

A special feature of modern researches is that they are based on the criteria of objectivity, rest upon a number of the works of home and foreign scientists.Hence, we have analyzed the theoretical material and experimental researches of the impact of different factors, connected, first of all, with lighting, on the functional indicators of the visual organ and organism of man on the whole, which allowed to elaborate a complex methodology for estimate of light-emitting diode lighting efficiency [11]. The methodology of the experiment includes:

– functional state of the visual organ;

– functional indicators of the state of human organism;

–integral indicators of efficiency of visual capacity for work and visual fatigue.

The materials of experimental researches have shown that LED lighting does not make deleterious effect on the visual organ and human organism on the whole. The changes of some functional indicators of the visual organ and organism occurring invisual performance enter into the corresponding boundaries of physiological oscillations and have reversible character [12, 13].

Conclusion

The given experimental researches with the use of the developed complex methods of psychophysiological and hygienic estimate of effectiveness of light-emitting diode lighting have shown the adequacy of the methodological approach chosen by us.

Summary

The obtained results are the grounds for continuing the work on the study of effectiveness of

lighting by light-emitting diodes in different branches of industry, and also in the conditions of the natural experiment.

Tocompare the variants of lighting it is reasonable to use the method of psychophysiologic «portrait» of fatigue development, enabling to visually trace the dynamics of functional indicators after visual performance.

It is essential to accumulate the materials of researches on the impact of LED source radiation on the organism of man and his capacity for work, also in order to predict and control long-term effects on which are spoken by the specialists and researchers. It should be done all the best the light-emitting diode illumination being widely used to be maximum safe for vision and health of people.

The suggested methodological approach and based on it the complex methodology of psychophysiologic and hygienic estimate of effectiveness of lighting installations with light-emitting diode sources of light allow to determine the substantiated fields of using light-emitting diode illumination being safe for man, which enables to develop normative documents and corresponding guidelines on application of the system with light-emitting diode sources of light.

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