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DESIGN OF LED LAMPS

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ABSTRACT

In this paper, we study the effect of LED high brightness on the brightness of a luminaire. The nomenclature of diffusers used in the production of "Armstrong" luminaires was considered. The fusion of the diffuser texture and the brightness of a luminaire was studied. The criteria of choosing a luminaire diffuser and LED location in a luminaire were determined. The variant of the lighting system energy efficiency increase with luminaires and linear fluorescent lamps is considered. In the proposed variant, the fluorescent lamps and start regulating devices are replaced with linear LED modules. In order to reduce the glossiness of a luminaire, the LED modules must be covered with opal diffusers, which are used in LED analogues of fluorescent lamps. The presence of a prismatic diffuser provided by the luminaire design and an additional opal diffuser increase the emission area of the LED light, thereby reducing the brightness of the luminescence and, accordingly, the luminosity of the luminaire. Besides, in this case, the curve of a LED lamp light intensity lamp becomes similar to the curve of the light intensity of the same luminaire with fluorescent lamps.

Key words: fluorescent lamps, light-emitting diodes, diffusers, the brilliance of a luminaire, light intensity curve

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1. INTRODUCTION

At present, due to an intensive development of LED lighting, different sources of information have many publications, which discuss the advantages and the disadvantages of LED fixtures [1-4]. Various arguments, mainly high cost, the need for a heat dissipating radiator and an expensive electronic driver, etc. are presented as disadvantages. However, there is little mention of such a lack of LEDs as their high brightness.

When the areas of a luminaire that are very bright appear in the field of view of an observer, the visual functions of the observer are violated. The consequence of these violations are reduced visibility of objects and a rapid fatigue of a visual apparatus. The condition of an eye in this case is called blindness. In order to assess the degree of blinding created by a lamp, the concept of a lamp brilliance is used - this property of luminous surfaces causes the violation of an observer visual functions [5, 6].

In this regard, one of the most important functions of a luminaire is the creation of the necessary screening of light source bright parts within certain angular zones of space. Such screening is created either by light-reflecting or light-scattering elements of a luminaire.

Light-emitting elements are used in light devices of a projector type, as a rule, where the greater part of the light flux is directed to an object of illumination, and the shading elements prevent the reaching of radiation to non-illuminated objects.

Light-scattering matte materials are used in luminaires either to reduce its glossiness, or to mix the radiation of colored lights in a luminaire better [7]. However, the use of matte (milky, opal) light-diffusing materials leads to the decrease of the light flux emitted by a luminaire and, accordingly, to its efficiency decrease. For example, the transmittance of the "Opal" diffuser is 0.65 [8]. Therefore, manufacturers prefer to use transparent materials with a high transmittance as scattering devices, the surface of which has a certain texture. The most common transparent scatterers are shown on Fig. 1 with the transmittance of 0.9: "Prism", "Crushed Ice", "Pin Spot", and "Honeycomb". The diffuser "Microprism" has a slightly lower transmittance - 0.85 [8]. It should be noted that a transparent diffuser with a textured surface also performs aesthetic functions in the switched off state of a luminaire.

The overwhelming majority of fixtures for office lighting were made on the basis of fluorescent lamps in the recent past, the surface of which has a relatively large area and a relatively low brightness. Therefore, the diffusers made of transparent materials with a textured surface allowed to achieve a relatively uniform radiation with a good aesthetic perception of the lamp in the off state.

2. EXPERIMENTAL STUDIES OF LAMP "ARMSTRONG" DIFFUSERS

The emitting part of the LEDs has a small area and a very high brightness. In order to obtain the required luminous flux emitted by a lighting device, a rather large number of single LEDs are used in its construction, which are located in a luminaire evenly.

As the studies show (Figure 2), the uniformity of the "Armstrong" luminaire depends on the texture of the diffuser surface, the power of the LEDs and their location in the light device.

Fig. 2, a-b shows the luminaires with the same scatterers - "Prism", but with a different number of LEDs in LED series. Fig. 3 shows that the orientation of the "Prism" diffuser optical elements relative to the LED series influences the type of LED illumination. At that the length of the "rays" is determined by the geometric dimensions of the single scattering elements of a scatterer.

Fig. 2, в demonstrates the lamp with the diffuser "crushed ice" with 484 LEDs, which shows that the glow of the lamp is almost equal. Such scattering of light emitting diodes occurs as the result of two factors:

- different sizes and irregular arrangement of single scattering elements of a scatterer (Fig. 1, c);
- a uniform distribution of discrete LEDs at a distance from each other less than the "beam length" on a diffuser.

Thus, in order to obtain a uniform dispersion of a light device radiation with an array of discrete LEDs, it is advisable to choose a diffuser with an irregular texture and the refractive elements of various sizes with different refractive surface angles. In this case, discrete LEDs should be located evenly on the radiating surface. A uniform arrangement of LEDs and uneven arrangement of scattering elements (irregular texture) will lead to a more even distribution of LEDs radiation in comparison with the diffusers of a regular structure.

3. EXPERIMENTAL STUDIES OF DIFFUSERS IN LUMINAIRE LPO46-2×36-004

The luminaire LPO46-2 × 36-004 is widely used for general illumination of public buildings, administrative, office and other premises [9]. Due to the use of fluorescent lamps and a prismatic diffuser this luminaire has almost no glare.

At present, in order to improve the efficiency of lighting systems with these lamps, the fluorescent lamps are replaced with LED modules with the preliminary removal of electrical installation devices and a start regulation device. The source of direct current (driver) is fixed in the center of the luminaire base [10] (Figure 5), and LED modules are installed in the locations of fluorescent lamps [11].

After this modernization, the light output of the luminaire increases almost threefold [12]. However, it is seen from Fig. 6a that the prismatic elements of LPO46 luminaire diffuser "stretches" LED radiation from the bottom upwards. In order to reduce the glossiness of a fixture, it is advisable to cover the LED modules with opal diffusers, which are used in the LED analogues of fluorescent lamps [13] or in aluminum profiles for a LED strip [14]. The presence of a prismatic and an additional opal diffuser (Fig. 6, b) increases the area of LED radiation emission, thereby reducing the brightness of glow and, accordingly, the brightness of a luminaire. In this case, the light output of a luminaire decreases somewhat and becomes equal to the light output of a luminaire with LED lamps [15].

Another positive point of an additional opal diffuser use is that the radiating area is increased and the light intensity curve (LIC) (figure 7, b) is close to the lic of the luminaire with a fluorescent lamp. In the absence of an additional opal diffuser, the LIC of the luminaire with LED modules (Fig. 7, a) differs significantly from the LIC of the luminaire with both luminescent and LED lamps [16]. Such a sharp difference in the light distribution of a luminaire with LED modules without an additional opal diffuser can lead to a significant decrease of illumination level between the luminaires in a lighting system as compared with the calculated values that were set during its design.

4. CONCLUSIONS

The results in the sections can be summarized as follows:

The uniformity of the "Armstrong" type lamp depends on the texture of the diffuser surface, the power of the single LEDs used and their location in a luminaire. In order to obtain a uniform dispersion of the radiation from a luminaire with an array of single LEDs, it is advisable to choose a diffuser with an irregular texture and refractive elements of various sizes with different refractive surface angles. In this case, LEDs should be located evenly on a radiating surface.

When fluorescent luminaires with a prismatic diffuser or with mirror optics are upgraded in order to reduce the glossiness of light-emitting diodes, it is advisable to cover the latter with opal diffusers.

5. SUMMARY

Thus, during the design of LED fixtures, attention should be given to LED glossiness reduction used in them. In this case, when LED luminaires are used, the comfort of a room light environment will not deteriorate.

CONFLICT OF INTEREST

The author confirms that the presented data do not contain a conflict of interest.

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LIST OF FIGURES

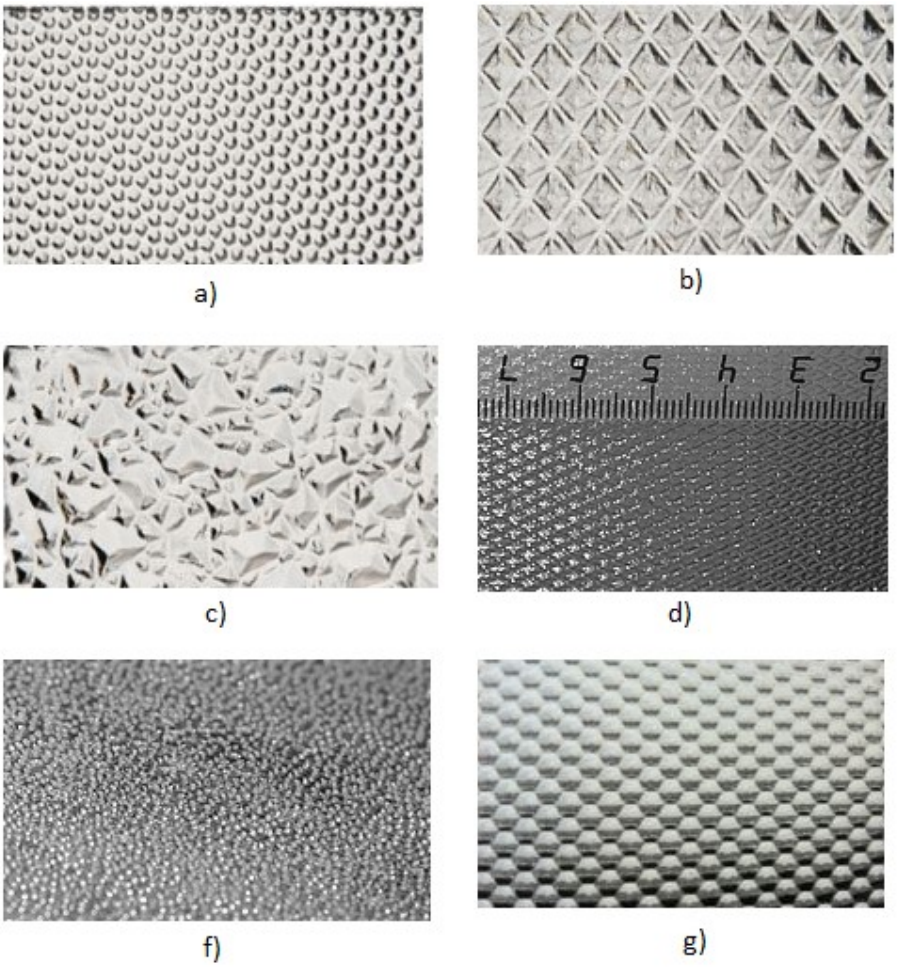

Fig.1. Diffusers for luminaires "Pin spot" (a), "Prism" (b), "Crushed ice" (c), "Microprism" (d), "Manka" (e), "Honeycomb" (f)

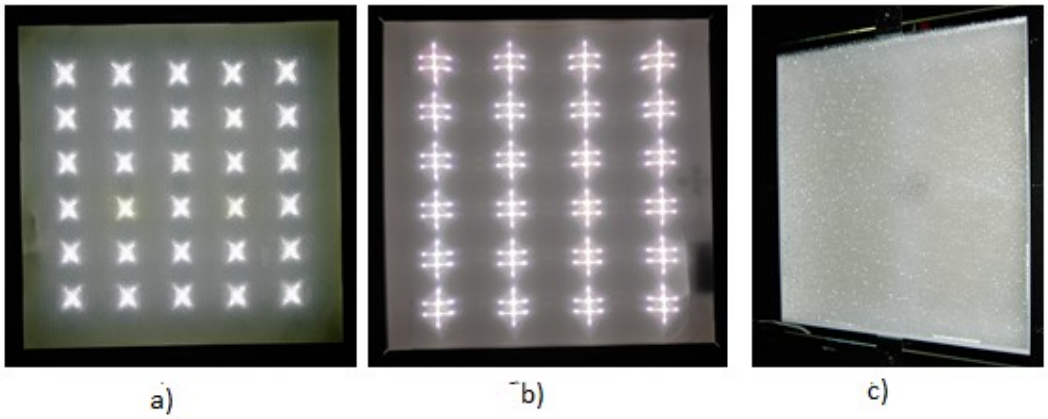

Fig.2. The study of Armstrong lamp with a different number of LEDs:
a) - a diffuser "Prism", 30 light-emitting diodes; b) - the diffuser "Prism", 48 LEDs; c) - diffuser "crushed ice", 484 LEDs

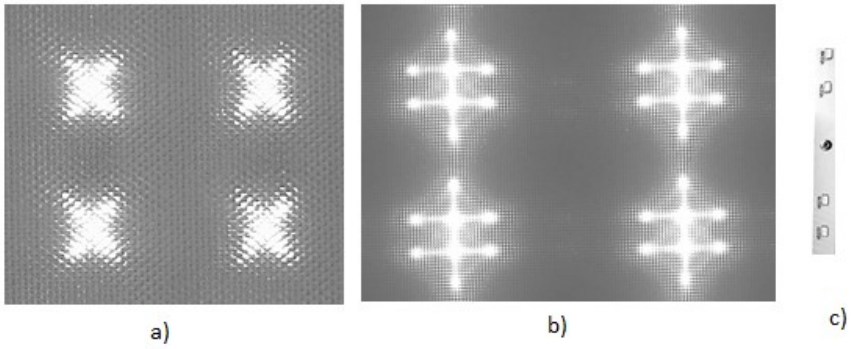

Fig.3. Orientation of the diffuser "Prism" optical elements with respect to the LED series:
a) at the angle of 45 °; б) in parallel; в) - the location of LEDs on the series shown in Figure б)

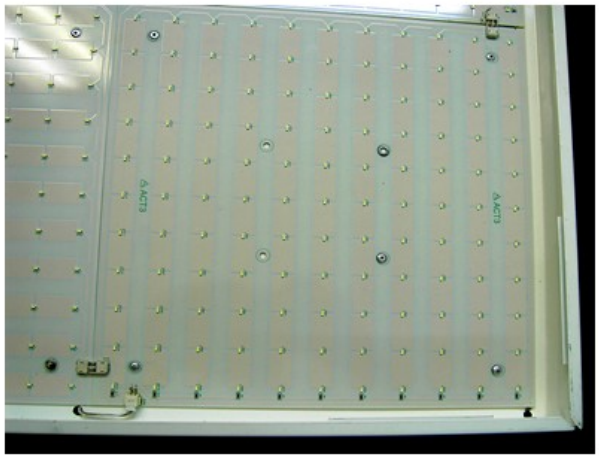

Fig.4. The location of 121 LEDs on ¼ of the fixture area

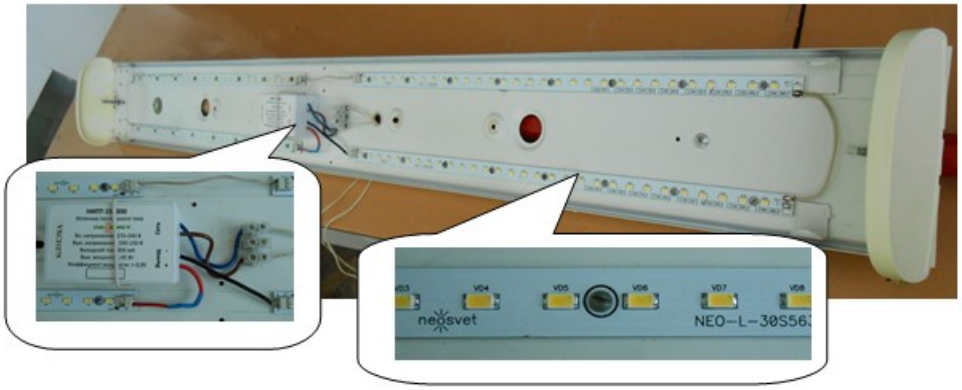

Fig.5. The location of LED modules and direct current source on the basis of the lamp LPO46

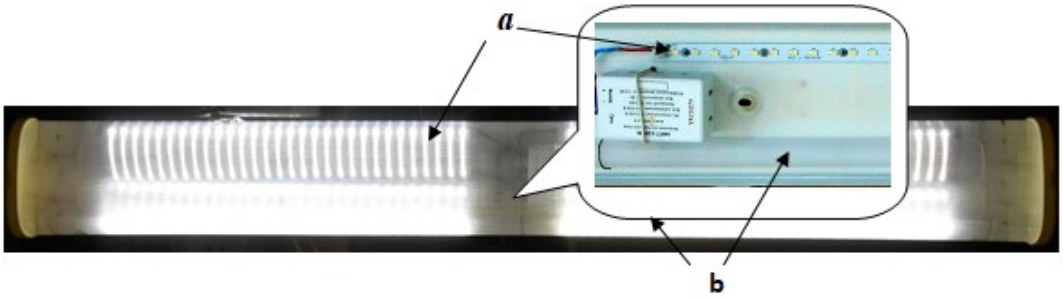

Fig.6. The lighting of LPO46 luminaire with LED modules without a diffuser (a) and with opal diffuser (b)

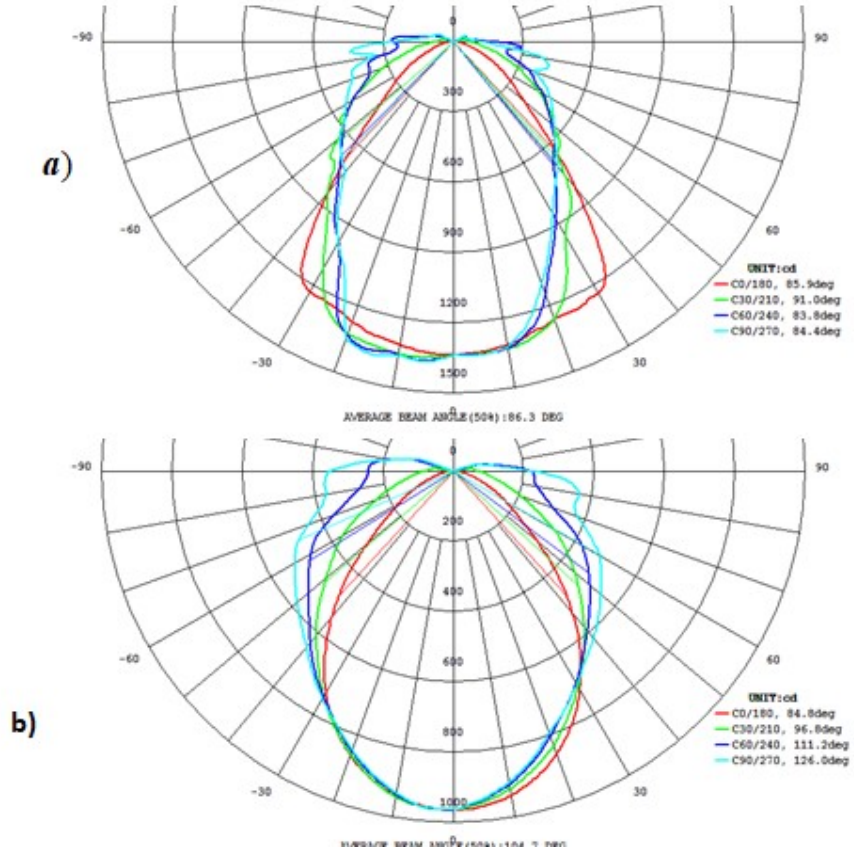

Fig.7. LIC of the luminary LPO46 with LED modules:

a - without additional diffuser; b - with an additional opal diffuser

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