**ERGONOMIC ASPECTS WHEN DESIGNING LUMINAIRES BASED ON LED LAMPS.**

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**Annotation:** Some initial information is given for the competent design of household LED lighting fixtures

**KEYWORDS:** LED LAMP, VISUAL PERCEPTION, COLOR TEMPERATURE, MELANOPSIN

**Introduction**
Fixtures based on LEDs lamps are of interest now, as the direction of actively developing lighting systems and devices. When designing LED luminaires, tasks are set for matching ergonomic studies to reduce the contrast of the light pattern, eliminate the light drop and uniformity of the illuminated space. It should be noted the current trend in designing fixtures-reducing size, weight, saving materials.

**Fundamentals**
The starting points for creating a good living environment lighting: parameters are formed as a result of studying the visually perceptible space, taking into account human physiology.

Lighting by LED emitters performs the following tasks:
- operational (allows you to read, recognize visual information of all kinds, navigate in space)
- psychological (creates favorable incentives, comfort, entertainment and mood)
- provides and creates prerequisites for greater safety of work and leisure
- hygienic (stimulates the maintenance of cleanliness)

The main factors of visual perception:
- maximum improvement of perception of visual information for performance of work.
- provision of an appropriate level of performance of tasks:
- maximum work safety assurance
- provision of necessary level of visual comfort.

Level of required illumination is determined by the following parameters:
- the smallest object size of view, in mm (from 0.15 to 5)
- the scope of visual work: from the 1st to the 9th
- contrast of the object of view with the background (small, medium, large)
- characteristics of the background (dark, medium, light)

Dependence of the visual system on the surrounding space

Perception in the work area allows you to determine the characteristics of the reliability of human performance.

The quality of lighting of any premises should be evaluated complex, according to the requirements and various lighting factors.

Artificial lighting is divided into:
- general,
- local,
- combined and special (with specific technical characteristics: scattered, directional, reflected)

The color of light, or the spectral composition of the light flux, affects the appearance of the illuminated object. Because of the brilliance in direct lighting, the reading efficiency, after 3 hours is reduced by 80%, with a system of reflected light and no glare, the reduction is -10%.

Calculation of the required number of luminaires of general lighting in the premises is made by the formula (the height of the suspension of luminaries -1000mm above the illuminated surface)

\[ n = \frac{1 \times b \times E_m \times k}{F} \]

where "n" is the number of fixtures, pcs.; "k"-coefficient for the color and tone of walls, floor and ceiling (1,5-2,5); "l" - length of the room, m; "b" - width of the room, m; "Em" - illumination given, lx; "F":light-stream of light sources of one lamp, lm. The level of illumination depends on the height of the suspension and decreases in proportion to the square of its change.

The number of lamps must be increased in proportion to the square of the height change.

For local illumination of the workplace in combination with general lighting should be at least -20% of the workplace illumination.

Optimal lighting is designed according to

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<td>-medium</td>
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*With age, sensitivity decreases: the need for a person in the illumination of 30 years of age is 2 times, for a 40-year-old at 3, and for a 50-year-old is 6 times greater than for a ten-year-old.

Advantages when using LED lights:
- there is no flicker of light.
- small size and weight.
- high light output with low power consumption.
- fast turning lights on and off - instant.
- increased stability to vibrations and impacts to other external influences.
- white light of high quality, color rendering index in the range of 80-95.
-optimal radiation pattern depending on the purpose of illumination with the possibility of creating scattered light or directional light.
-absence in the radiation spectrum of the infrared component and low heat generation, lack of heating of surrounding objects and surfaces.
-warranty guarantee with any humidity and ambient temperature from -50 to +50 °C.
-simplified the supply and management of electricity.
-miniature sizes of radiating elements allow to widely embed LEDs in bearing structures and elements of lighting systems.
-the maintenance and operation of the luminaire is simplified.
-automatic control of the luminous flux and the process of switching on the luminaire is possible.
-color temperature control can be provided by electronic sensors and logic systems). Comfort is provided in use, high consumer qualities are formed.
-LED lights have a very high efficiency, reaching 75% or more, which allows you to significantly (in 4-5 times) reduce power, load on the network. The costs associated with the cost of consumed electricity are reduced. Such technological and design solutions are appropriate.

![LEDs produced in a very wide range of colors - up to IR and UV ranges.](image)

They can be either monochrome or multicolored (when several crystals of x colors are concentrated in one body), for example, RGB.

One of the drawbacks of these LEDs is the low scattering angle of the light flux: usually not more than 60°.

![SMD LED](image)

In addition to LEDs, SMD LEDs are also available. This includes super bright white and color LEDs with a power of about 0.1 W in a surface mount case. The dimensions of the housings are usually standard for any SMD type elements: 0603, 0805, 1210, etc., where the marking denotes length and width in hundredths of an inch or in millimeters. In this case, there are both varieties with a convex lens, and without it. Clearly classifying all the variety of LEDs is difficult, because rarely those or other LEDs are produced for some specific purposes. Nevertheless, the main directions of their application - indication and lighting - remain the same for the time being, and the classification given here is suitable for creating a general idea of the types of LEDs.

Specificity and design features of fixtures:

As a rule, the design of the luminaire consists of a support base, a fixing element, a rod, a bracket, a reflector. Also, the lamp is equipped with a diffuser of light or diffusser.

Achievement of uniformly illuminated space is achieved. The problems of reducing the contrast of the light pattern are solved, and the difference in the illumination is eliminated.

The luminaire provides the possibility of using in a complex spatial situation-placement and illumination in hard-to-reach places.

When designing, it is envisaged that the luminaire can be easily mounted and adjusted for operation.

The envelope of the radiating element is of small size (its size is a multiple of the design of the lamp). Weight devices are relatively small, there is a significant savings in materials (while reducing the cost of the lamp).

![Waterproof version of LED for bathroom](image)

No deposits are formed, maintenance and care (removal of dust, insects, other contaminants) are facilitated.

The electrical safety is easily ensured. The risk of injuries and life threatening effects is reduced (the work of the light system is ensured by a low current and voltage strength-usually designed for safe voltages of 12 ÷ 24V).

The mechanical durability of the LEDs is large. Their service life is up to 50000 hours. Therefore, a long service life allows you to increase the period between repair and maintenance.

![Demonstration of formation on the example of LEAD](image)

Influence of modern lamps on health and human vision:

The negative effects of blue LEDs on humans are noted. The blue spectrum, when viewed, causes overstrainment of the visual area of the brain in a matter of minutes.

There are risks of disability in sight at working age. When working with color information, there is also a danger to health. It has been shown to have a negative effect on the retina of the eye; for example, blue light abruptly suppresses the production of melatonin in humans, there is a risk of blindness. With LED light, a large proportion of blue falls on the retina of the eye, than in sunlight with the same illumination of the retina. In sunlight, the ratio of the various components of its spectrum is adequate and does not lead to unnecessary intensity of the human eye.

With a large dose of blue in the spectrum of lighting, the so-called Melanopsin forms a signal to reduce the diameter of the pupil. This reduces the energy illumination of the retina, protecting it from exposure to a large dose of blue light. Melanopsin has 2 peaks of maximum photosensitivity - at 460 nm and 480 nm. The dose of blue light that gets on the retina depends on the pupil ø, which decreases depending on the amplitude at 480nm, the LED has a dip of 480nm. With LED lighting, this ratio is not respected, since there is a dip in the spectrum of such a light source. With a large
dose of blue in the spectrum, melanopsin does not form a signal to reduce the diameter of the pupil. Thus, most of the blue light of the LED hits the retina of the eye.

Comparison of TRI-R technology with filters in a conventional LED:
The newest LEDs of Sun Like emit purple, and the light is not blue, which then passes through a layer of phosphorus with three light filters - for blue. Interlayer technology is called TRI-R. The principle of technology - purple crystals 420 nm, which are painted with red, blue and green phosphors. In the white light spectrum of LEDs (TRI-R technology), the dip at 480 nm is eliminated and there is no excess dose of blue. The spectrum is close to solar.

Advantages of LED lamps using TRI-R technology:
- lighting is optimal in magnitude, close to the calculated
- the spectrum is close to solar
- the lack of pulsation in time and noise from the ballast (ballast)
- uniform distribution of lighting of the working area in accordance with the design
- high manufacturability and structural variability

Prospects for the development and expansion of the use of LEDs:
Designers create conceptual models (Fig.11), prototypes of future systems. The appearance of the lamp is developed in both traditional and retro style (Fig.6), classical or the latest avant-garde trends. Formed not stylized eclectic forms, but the most rational solutions from the structural and aesthetic side.

The possibility of dynamic editing is provided. Providing rotation, shearing and moving in space.

A separate class of luminaires with autonomous power supply (energy sources with solar panels and batteries)

When manufacturing, progressive production processes - 3D printers and other modern technologies can be used. They allow the integration of light-emitting diodes into various materials (such as polycarbonate, polyethylene, epoxy compositions and others) electrical elements.

LED systems are now actively developing in landscape (Fig.8) architecture. In the design of the lighting system in this case, it is easy to take into account various weather factors, difficult weather conditions. The ventilation of the lighting system is simplified. Low accumulation of moisture in the luminaire (there is a slight formation of condensation).

The experience of architectural application proves the perspective of light sources on light-emitting diodes. They allow you to get a light spot of any shape with minimal loss. There are solutions that allow using a single LED illuminator to highlight light columns, bridges and similar architectural elements. (Fig.9)

Based on LEDs, you can create light sources with a small beam angle of 5°-10°.

Technologies on light-emitting diodes allow to pass from static illumination of architectural elements of buildings to dynamic and colorful color representations, to reveal features of architectural objects (Fig.10). To ensure comfortable lighting in various areas and appearance.
The use of light-emitting diodes for illumination of pools and in premises with high humidity has widely spread.

**The main models of luminaires based on LEDs**

Fixtures are developed practically for all household needs: floor, table, suspended, wall, portable, for exterior, landscape use, souvenir and others. Performed in designs for lighting paintings, equipment, highlighting exhibits. Dynamic lighting using LEDs influences the visual estimation of interiors, the perception of dimensions, details, and its color solution. LED lighting fixtures help to harmonize physiological processes in a person, provide vital modes rhythmically, "around the clock".

There are models for building graphical interfaces, other information carriers and systems (visual communications and other information tools). The so-called "Art objects" based on LED systems stand out as a separate consumer niche of household lamps.

They are designed to perform decorative equipment, functions of symbolic indexing of space or creation of the necessary imaginative atmosphere and toys. Used LEDs of different designs, creating almost all the colors of the rainbow.
Based on the results outlined above.
It is necessary to take into account socio-cultural factors, styles of basic aesthetic trends. It is possible to carry out synthesis of modern art and the latest technologies; there are the most extensive opportunities for creating a form. Such technological and design solutions are suitable for providing comfort when using LED, and their high consumer qualities are formed. I believe powerful LEDs will soon replace outdated light sources.

There is a tendency: designers develop "disposable" models of fixtures using LEDs.
The cost of replacing the LED element and repair is comparable to the production of the entire product and may exceed the cost of the lamp itself. This contributes to the marketing appeal. It is easier and cheaper to design LEDs.

Thus, they reflect the latest trends. Optimization contributes to improving consumer properties and quality of household products based on LEDs.

Now the technologies of LED lamps are actively developing, so final standards and standards have not been developed yet.

**Conclusion**

As an illustration of the appearance of the luminaire on the LEDs, the "Danko" system is presented,
(overall size - 750mm x 280mm, Material of construction - plastic).

*List of sources used:*
  http://finelight.ru/svetilniki/lampy/svetodiodnye/sveto
  voj-potok-kratkaya-xarakteristika-osobennosti.html
  http://ledno.ru/svetodiody/vidy-led.html

The "Eol" system is presented,
Lamp for comfort in the living room
(overall size - 1800mm x Ø600mm, Material of execution - steel chromeplated).
The "Shaherezada" system is presented, Floor lamp for creating a cozy atmosphere in the home
(overall size - 1600mm x Ø350mm, material of the lampshade -Silk, base -Cu).
The "Malevich" system is presented, for changing the position of the luminaire suspension in a dwelling (overall size - Ø270mm x 1000mm, Material of execution - steel chromeplated).

As an illustration of the appearance of the luminaire on the LEDs, the "Galaxy" system is presented, (overall size - 2000mm x 1000mm, Material of execution - steel chromeplated).

A feature of this model is the function of changing the location of the LED modules (conical shape). The lighting system has a shaped star structure and is easily transformed. The central reflector can be lowered down for local illumination-an additional function for providing effective and comfortable illumination of space.

Design this model (only 5 models)
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