International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 4 Issue 10, October - 2020, Pages: 173-175

Hybrid Lighting Systems as an Efficient Tool for Energy Efficiency of Production Assets in Production Space

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Abstract: *The article deals with the application of an innovative system of a hybrid lighting complex based on hollow tubular light guides, at industrial facilities of industry, as an effective tool to reduce 56 negative environmental impact and rational use of energy resources.*

Key words: Hollow tubular light guides, hybrid lighting complex, energy efficiency, energy saving, natural lighting.

Introduction

The main reason for the need to improve energy efficiency and energy saving is the depletion of natural resources and their ecologically irrational use, as well as the negative impact on the environment, in particular, gases emitted into the atmosphere when burning fossil hydrocarbon fuels can cause a greenhouse effect.

The world's fossil fuel resources are limited. They practically do not renew. The threat of depletion of the world's fossil fuel reserves forces us to take measures to reduce their consumption. There are three main ways:

a) wider use of renewable energy sources (river energy, wind, geothermal, solar energy);

b) the discovery of new sources of energy; not long ago, great hopes were associated with the use of thermonuclear energy, but in the coming years one can hardly count on the industrial use of thermonuclear energy;

c) energy saving; the transition to energy-saving technologies is a long and expensive process, it requires a radical alteration of many industrial technologies, in addition, the possibilities for energy saving are not unlimited; the transition to energy-saving technologies can reduce energy consumption by about a third.

The first step was the Kyoto Protocol, which is an international agreement on limiting greenhouse gas emissions into the atmosphere. In the Uzbekistan Federation, the Kyoto Agreement is supported by the Federal Law "On Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change" adopted on October 22, 2004, as well as by the Republic of Uzbekistan law No. 261-FZ, adopted in 2009, "On Energy Saving and on Amending Certain legislative acts of the Republic of Uzbekistan".

Lighting systems are one of the main consumers of electricity in the world. In the United States, this accounts for more than 20% of all electricity consumption. In Russia, electricity consumption for lighting reaches 14% of the total generated energy. The oil and gas sector consumes a significant proportion of energy resources. For example, the company "Gazprom" in 1999-2004. 57 gas pipelines for own technological needs annually consumed 50-52 billion m3 of gas. These volumes amounted to about 9% of the corresponding annual gas production at Gazprom. In 2005, Gazprom purchased 17.6 billion kWh of electricity for 18.45 billion rubles. Today, the situation is further complicated by a decline in world oil prices, an increase in the share of energy consumption in the cost of production, as well as a significant increase in prices for the purchase of electricity. In this regard, measures for the implementation of energy-saving and energy-efficient lighting systems are relevant.

Materials and methods

The concept of an energy efficient building assumes a comprehensive solution to the problems of rational use of energy to optimize the energy balance of buildings, in which priority is given to energy-saving technologies that ensure a high quality of the building microclimate. In this regard, the use of environmentally friendly renewable energy sources becomes uncontested, among which solar radiation is the most important. [1,2]

Natural light is an effective energy saving tool. It should be understood that its use does not directly result in energy savings. Reducing energy costs occurs by reducing the use of artificial lighting. According to Western experts, in some cases such a decrease can reach 70%.

It is possible to organize natural light in various ways. One of the most advanced solutions in this regard is the use of hollow tubular light guides - special equipment that allows you to deliver the maximum amount of natural light falling on the roof of the building to the interior, in order to increase natural light from sunrise to sunset.

The idea of lighting with light wells is not new. The ancient Egyptians were the first to use this design. During the construction of the Pantheon in Ancient Rome (125 AD), the prototype of the light well was used. In medieval architecture, the idea of illuminating buildings through skylights located under the roof was embodied in the construction of Romanesque and Gothic temples. The prototype of the modern light well was created by the English photographer Paul Chap pot in the middle of the 19th century. He created a structure of reflective mirrors. The reflectors of his system were sold until 1943. This type of

lampless lighting has evolved from a simple hole in the roof of a building to complex structures using light guides that can illuminate multiple rooms at once.

Result and discussion

For a long time, this idea did not find a response. In 1986 the first example of a modern light well was tested in Australia. The efficiency of its lighting was so obvious that very soon 58 the idea of lampless lighting became very popular all over the world. Since 1991, their serial production has been launched. At the same time, the intensive use of PTSs began to illuminate the shops of industrial enterprises. Today, the design of light wells has been so improved that the efficiency of their application has increased by 500% compared to the first samples. [3]

Innovative systems for introducing natural light into rooms today can be considered hybrid lighting systems based on hollow tubular light guides, in a single device of which structural and emitting components are combined: a natural light source - a hollow tubular light guide, an artificial light source - LED modules and an automatic control system. Such systems from the world's leading manufacturers have been brought to a high degree of perfection, optimized to transmit natural light and create a comfortable light environment with minimal heat gain and heat loss. The use of new-generation LEDs with spectral characteristics close to those of sunlight in the artificial light unit provides a comfortable light environment in combined and artificial lighting modes. The controllability of LEDs opens up prospects for the use of automatic control systems. The smooth change of the artificial component depending on the level of natural illumination, which maintains the constancy of the illumination of the workspace, makes the transitions in the dynamically connected system “natural - mixed - artificial light” invisible to the eye.

Let's consider one of such systems: a hybrid lighting complex “Solar Way” based on hollow tubular light guides “Solatube”.

Depending on the parameters of the room, hollow tubular light guides "Solatube" of different diameters and VLSI of different power can be used. Of a number of modifications presented by the manufacturer, special attention should be paid to the model based on the "Solatube M74" PTS (pipe diameter 740 mm) of the "Sky Vault" series. (Picture 1) This model combines a base unit with a Collector and Amplifier. The manifold is equipped with Ray bender 3000 technology and a Light Tracker reflector that provide low angle light capture for high performance. The collector uses a Spectra light Infinity reflective plate with a specular coating, covering about 50% of the inner surface of the collector, and the "cold light guide" technology, due to which the infrared (IR) component of solar radiation is cut off. The design of the collector allows providing an average luminous flux of natural light of 30,000 lm, in combination with VLSI 9SM x 23W. Luminous flux of artificial light reaches 42,000 lm. [4] Artificial light LED unit 59 (VLSI) - a ring-shaped mounting panel on which LED units are hermetically installed, including an LED module, a cooling radiator and a controlled electronic power supply of the LED module; The emitting module is fixed on the end surface of the cooling radiator so that after the radiator is installed on the mounting panel, the emitter faces the cavity of the lower stage of the optical stage. This option is ideal for diffuser heights of 7 m or more.

Figure 1 - Hybrid lighting complex solar way

based on PTS Solatube M74:

1 - Collector of PTS Solatube M74 of the Sky Vault series; 2 - outer dome;

3 - Border flashing; 4 - light guide of the upper stage of the optical cascade; 5 - LED block of artificial light (VLSI); 6 - light guide of the lower stage of the optical cascade;

The introduction of solar way technologies can reduce the use of electric lighting, and in some cases, completely eliminate it. In relative terms, the electricity spent on lighting may seem insignificant, but in absolute terms it is quite impressive.

Solar way light guides completely eliminate heat gains in summer, thereby reducing air conditioning costs, in contrast to windows through which excess insolation thermal energy can flow. Minimizes heat loss in winter, which reduces heating costs. Unlike windows, an increase in the area of which leads to an increase in heat loss (25% of the heat loss in a room falls on the windows).

Conclusion

It is necessary to take into account the beneficial effect of daylight on a person. Daylight controls biological, physiological and mental processes in the human body. In addition to the formation of visual images, light has a biological effect on a person and his health. Under normal conditions, sunlight causes the formation of a small amount of active photolysis products, which have a beneficial effect on the body. So under the influence of ultraviolet rays with a wavelength of 280-313 nm, provitamins are converted into vitamin D and absorbed into the body. The role of vitamin D is in the absorption of calcium. The normalized characteristics of the light environment under artificial lighting do not correspond to the real biological needs of the human body. Visible light is an effective regulator of biological rhythms, as well as a therapeutic factor.

A significant disadvantage of any natural lighting system is the dependence on the time of year, time of day and weather conditions, and these changes are random. Other factors also affect the use of sunlight during daylight hours: the orientation of the room relative to the cardinal points and other buildings.

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