EFFICIENT ENERGY CONVERSION IN AN ELECTRICAL LIGHTING SYSTEM

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Key words: Lighting, Halogen Lamps, Fluorescent, Light-Emitting Diodes (LEDs), Tungsten, Spiral, Light Extension, Noble Gases, Argon Gases, Electrons, Compact, Bulb, Infrared Red Lighting, Interference, Indexation

Annotatsiya

Bu maqola yoritish sohasida energiya tejamlashning muhim ko'rsatkichlari va bu texnologiyalarning turlari haqida ma'lumot beradi. Ushbu maqolada galogenli cho'g'lanma lampalar, lyuminessent lampalar, svetodiodlar (yorug'lik diodlari), va energotejamkor lampalar kabi asosiy yoritish usullari qisqacha ta'rifi beriladi. Har bir usulning afzalliklari va kamchiliklari, ularning ishlash prinsiplari va foydalanish sohalariga oid ma'lumotlar keltirilgan.

Этот материал предоставляет информацию о важных показателях в области освещения и типах этих технологий. В этой статье кратко описаны основные методы освещения, такие как галогенные лампы, люминесцентные лампы, светодиоды (диоды освещения) и энергосберегающие лампы. Для каждого метода приведены преимущества и недостатки, принципы работы и сферы применения.

This article provides information about important indicators in the field of lighting and types of these technologies. The main methods of lighting, such as halogen lamps, fluorescent lamps, light-emitting diodes (LEDs), and energy-saving lamps, are briefly described in this article. For each method, the advantages and disadvantages, principles of operation, and areas of application are provided.

Today, 40% of the world's energy and 37% of all energy resources are used in residential and public buildings. Lighting makes up a significant share (40-60%) of energy consumption in buildings.

Primary efficient lighting sources:

Efficient lighting sources can be divided into several types, such as:

Halogen incandescent lamps

Fluorescent lamps

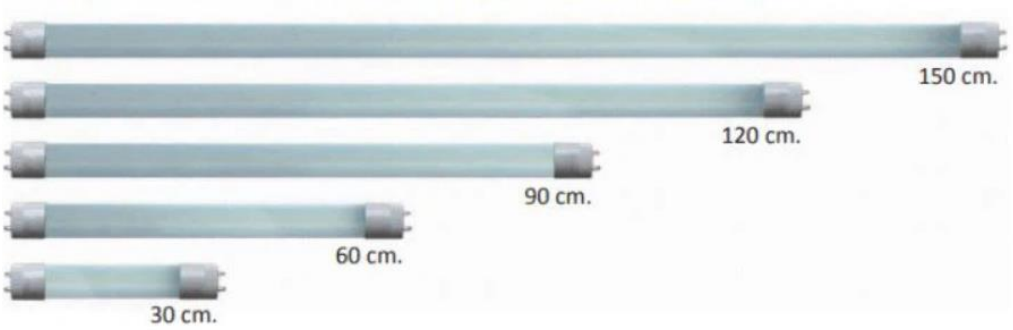
Light Emitting Diodes (LEDs)

Energy-efficient lamps

Halogen incandescent lamps - The primary disadvantage of incandescent lamps is their low light output and short service life (1000 - 3000 hours). If the lamp is filled with halogen gas (non-metal chemical elements fluorine, chlorine, bromine, iodine, and astatine), moisture does not accumulate inside the bulb, resulting in the lamp maintaining its constant light output (lumens) throughout its service life. This efficient result is achieved by adding halogen gases to the tungsten filaments, which later re-deposit on the tungsten spiral at high temperatures. The tungsten atoms emitted from the heated spiral do not reach the walls of the lamp (which reduces blackening) but return to the spiral with chemical reactions. This phenomenon is called the halogen cycle. Therefore, the service life and light output of the lamp are significantly improved. While standard incandescent lamps have a light output of 10 Lm/W, halogen incandescent lamps reach 25 Lm/W. Additionally, halogen incandescent lamps are compact, rare, and suitable for special luminaires. They are available for purchase with a mains voltage of 220 V and low voltage: 6, 12, and 24 V. Low-voltage halogen lamps require an additional transformer.

1-image. Halogen incandescent lamps

Fluorescent lamps - Fluorescent lamps have the highest light output among all types of lamps. In three-band lamps, when light passes through fluorescent layers applied to the lamp's inner surface, it produces visible light. Fluorescent lamps use inert gases such as neon, argon, or mercury vapor as phosphors. Excited electrons produce ultraviolet radiation, which generates visible light when absorbed by the phosphors. Different types of phosphors produce different light spectra. Compact fluorescent lamps or energy-efficient lamps, like standard fluorescent lamps, only operate with starter ignition devices. The service life of fluorescent lamps depends on various factors, mainly on the quality of the materials used. The lamp's lifespan can be affected by rapid ignition of the electrodes, so decorative lighting uses halogen return lamps with power from 10-50 Lm/W and reflector lamps with power from 20-75 W. Such lamps return 2/3 of the heat with infrared radiation, thereby preventing objects from overheating. The standard service life of low-voltage halogen lamps is considered to be 2000 hours. Mechanical stress (spiral for long lamps) and frequent switching shorten the lamps' service life. The color and brightness of halogen lamps are higher than those of ordinary lamps, reaching 3000-3200 K. This parameter can be adjusted in lamps with installed or external light filters. The light output index Ra of halogen lamps is maximized and equals 100 Lm/W, but due to the high operating temperature (compared to ordinary incandescent lamps), halogen incandescent lamps emit greenish-yellow light. The lamp's total service life decreases with frequent switching, and the initial light output decreases to 70% of the initial light output, indicating the beginning of lamp deterioration. Modern fluorescent lamps have an average service life of 8000-15000 hours, depending on the lamp model. Fluorescent lamps cover a color temperature range from 2700 to 10000 K. Colored lamps are also available. The color rendering index Ra, which can range from 60 to 95 for standard fluorescent lamps, affects the quality of color rendering. The improvement of color rendering is associated with the improvement of light output.



2-image. Fluorescent lamps

Light Emitting Diodes (LEDs) - LED lighting is considered the future of lighting sources. LED technology has reached high levels of efficiency. The characteristics of LEDs (the light output of bright LEDs is 25 Lm/W with a power of 5 W, Ra=80-85, and a service life of 100,000 hours) provide them with a niche in lighting equipment, signaling devices, automotive and aviation technology, surpassing previous solutions in these areas. LED sources are gradually penetrating the general lighting market. LEDs are semiconductor devices that convert electrical energy into a wide range of electromagnetic radiation, which can be transformed into visible light in a broad spectrum. LED light sources are characterized by:

- High luminous efficacy. Modern LED light sources surpass incandescent lamps in this indicator.

- High mechanical strength, resistance to shocks (absence of filaments and breakable elements).

- Long service life. However, this life is not indefinite; it can be affected by prolonged use or poor ventilation, causing crystal "aging" and gradual reduction of luminous flux.

- Specific light spectrum. This spectrum is sufficient for most purposes. The ability to extend the spectrum is considered an advantage in information dissemination but is considered a disadvantage in lighting systems. Only laser diodes have a narrow spectrum; otherwise, LEDs have broad spectrum and low coherence; they are harmless, do not require high power, and are resistant to low and very low temperatures. However, like all semiconductor devices, LEDs are negatively affected by high temperatures, typical of all semiconductor devices. However, LED sources have a higher thermal resistance than other sources. Thus, they are more suitable for use in hot environments or where significant temperature differences are expected. However, like all semiconductor devices, LEDs are negatively affected by high temperatures.

3-4-image. Light Emitting Diodes

Energy-saving lamps - The construction of energy-saving lamps is well known. During operation, the lamp's tungsten filament is heated to its luminous intensity by an electric current. However, not everyone knows the construction of energy-saving lamps. Energy-saving lamps are filled with a mixture of mercury and argon and equipped with a starting device (starter). Inside the bulb, there is a special substance called a phosphor. The phosphor, when exposed to ultraviolet radiation, emits light visible to the human eye. If we reach the energy source for the energy-saving lamp, mercury vapor inside the lamp emits ultraviolet radiation, and ultraviolet radiation, in turn, passes to the inside of the lamp through the phosphor, transforming into visible light. Due to the variety of phosphors used, energy-saving lamps can produce light in various colors. Energy-saving lamp sizes are prepared as standard incandescent lamps. Therefore, the base diameter of the lamp can be either 14 or 27 mm. Hence, energy-saving lamps can be installed in chandeliers and luminaires instead of incandescent lamps.

5-image. Energy-efficient lamps

Energy-saving lamps have a high energy efficiency rating, and their light output is approximately five times higher than that of ordinary incandescent lamps. For example, a 20 W energy-saving lamp produces the same light output as a 100 W incandescent lamp. Therefore, energy-saving lamps achieve up to 80% energy savings. Energy-saving lamps have a much longer service life compared to ordinary incandescent lamps. Since incandescent lamps operate by heating tungsten filaments, they can burn out quickly. Energy-saving lamps have a different construction and working principle, so their service life is on average 5-15 times longer than incandescent lamps. This period can range from 5,000 to 12,000 hours (usually, lamp operation is determined by the manufacturer). Therefore, energy-saving lamps are suitable for use in places where frequent replacement is difficult, such as high-ceiling rooms or complex structures.

Energy-saving lamps have low heat output. Since all electrical energy consumed by the lamp is converted into light, energy-saving lamps emit minimal heat, which means that all energy consumed by the lamp is converted into light, i.e., energy-saving lamps dissipate very little heat. It is essential to be cautious when installing them in lamps and luminaires because they do not dissipate much heat and can cause plastic parts of holders or lamp bodies to melt, which, in turn, leads to bulb loosening. Therefore, it is necessary to use energy-saving lamps in lamp holders with limited heat resistance or in rooms with adequate ventilation.

Disadvantages of energy-saving lamps:

The main disadvantage of energy-saving lamps compared to incandescent lamps is their higher purchase price. The price of energy-saving lamps is 10-20 times higher than that of incandescent lamps. Energy-saving lamps are not called incandescent lamps. The fact that they are called energy-saving lamps does not mean that they do not have drawbacks. One of the drawbacks of such lamps is the mercury content. The mercury vapor inside the lamp is poisonous. Therefore, when using such lamps, it is necessary to handle them with care. Therefore, energy-saving lamps are considered environmentally hazardous, and they must be disposed of properly, and their disposal is limited.

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