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COMPARATIVE ANALYSIS OF CONSUMPTIONAL PROPERTIES FOR VARIOUS TYPES OF HOUSEHOLD LAMPS

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This article examines the functions, profitability, economy, and characteristics of different types of household lamps.

Introduction. The sunlight plays an important role in a human life. However, apart from the sunlight, man extensively uses artificial sources to make the environment more suitable for work and leisure. Properly designed and chosen lighting provides comfort and mood, increases brain's efficiency in work, and helps to preserve health. Selection of high-quality lighting is not only to achieve sufficient light, but also reliability, safety, profitability in practical life of people.

Task formulation. The study of different types of household lamps.

In modern lightening of domestic premises, five main types of artificial light sources are used: incandescent lamps, halogen incandescent lamps, fluorescent lamps, discharge lamps and LEDs.

The advantage of ***incandescent lamps (IL)*** is their familiarity, prevalence and low cost. However, the conventional incandescent light bulb (Fig 1, a), due to its design features, 6 - 8% of the electricity consumed is converted to light [1], whereas the rest is converted into thermal energy (heat). As for the disadvantage of incandescent lamps, we take into consideration that the emission spectrum is different from natural daylight which is dominated by the yellow and red lights, and complete the absence of UV light needed for normal functioning. The service life of incandescent lamps is short and usually does not function more than 1,000 hours. Organization of high technical level of lighting using these lamps is difficult. Therefore, despite the fact that incandescent lamps are the most common source of light, they gradually give away places to other types of lamps. Recently, incandescent lamps have become widely used with internal mirror coating that increases the light output. Mirrored lamps that emit directional light are the easiest way to create light accents. They are also designed for the use in embedded, pendant, ceiling and wall lamps.

The light of ***halogen lamps (ILT)*** - scattered from wide, soft, non-giving shadows to dramatically limited narrow beam - makes it possible to find countless lighting options [2]. ILT miniature cones (Fig. 1, b) are not formed from normal glass, but from refractory silica glass. Working conditions of ILT filament can be called "rehabilitation". Evaporation from its surface, tungsten particles connected with particles of halogen, form chemical complexes. Reflected from hot walls of the quartz cone, these convective chemical complexes move back to the filament. The thermal decomposition of complexes returns the tungsten particles back onto the surface of the filament. This return process takes place in a dynamic equilibrium with the evaporation process. Halogen lamps, in contrast to conventional incandescent lamps, provide light with a high color temperature (approximately 3000 K). Elevated values of the color temperature of the filament ILT provides a shift of the emission spectrum to shorter wavelengths. The maximum radiation of IL is in the yellow-green region. In ILT, this region is in the green area, where the sensitivity of the human naked eye is much higher. In other words, ILT light is tightly close to the sunlight. In comparison with IL, they are more durable, they provide more light if subjected to the same quantitative power, and maintain a constant value of flow during the entire period of operation. New generation of halogen lamps has a clear limitation of the beam, the presence of heat-reflective coating, superior color reproduction. The level of ultraviolet radiation emitted by halogen lamps is very little. Therefore, being in a room lit by halogen lamps for a period of 8 hours is equivalent to 10 minutes of being in the direct sunlight.

In ***gas-discharge lamps*** the light emitters are gases or sodium vapor, mercury, arising due to the passage of an electric current through them (Fig. 1, c). The emission spectrum is linear, where a large proportion (30%) is concentrated in the visible region [2]. The glow of gas has a higher profitability. However, the spectrum of gas sources consists of separate lines and is very different from the usual white light to the human eye. If this factor plays a minor role, so such sources successfully replace the incandescent lamps, for example, when illuminating highways. As a serious disadvantage for discharge lamps, we include its inability to adjust the luminous flux. The principle of operating gas discharge lamps is as follows. After turning on the discharge lamp, a current flows through the buffer gas in the burner. Due to thermal effects, there occurs the evaporation of mercury, sodium or halide, until their vapor pressure is stabilized, and reaches the pressure in the working condition. This so-called flare-up time, can be up to 1-4 minutes. The re-ignition time averages out to 10 minutes. Such lamps are usually used for continuous lighting in closed luminaries.

Fluorescent lamps - the world's second most common source of light, and, for example, in Japan, they even occupy the first place, overtaking incandescent lamps. Every year the world produces more than one billion fluorescent lamps (Fig. 1, d). The first samples of the modern type fluorescent lamps have been shown by the American company General Electric at the World Fair in New York in 1938. Over the past 65 years of existence, they have become part of our lives, and now it is hard to imagine any large store or office, in which there would not be a single fluorescent lamp. The fluorescent lamps contain a light emitter substance - phosphor, the glow of which is due to any form of energy other than heat. This is commonly called "cold glow". In household fluorescent lamps, phosphor coated on the inner surface of the discharge lamp radiates band spectrum by ultraviolet radiation of the discharge. The phosphor is selected in such a way, that it compensates with the deficiency of the gas glow luminescence. In the standard bulb type LL halo phosphate is used. The result is a source of radiation which color is close to the Sun. Fluorescent lamps are characterized by their lumen maintenance, improved color and high luminous efficiency. There are also lamps with warm light close to the color of incandescent lamps, as well as the subdued light with a low dose of UV radiations. Small sized ones (up to 0.16 mm) are of high luminous flux and with exceptional design flexibility, easy installation of the light unit in modular ceiling systems, and effective in dealing with the redistribution of the luminous flux. Fluorescent lamps diffuse light much more than the "point" sources (incandescent, halogen or discharge lamps). They are ideal for illuminating open spaces such as an offices or industrial premises. It is recommended for them to be used where low initial costs are a priority. Compact fluorescent (decorative) lamps produce more light with virtually no heat, converting up to 25% of the electricity consumed in the world [3]. The service life of such lamps is 15 times longer than incandescent bulbs.

For the latest generation, light sources include ***LED bulbs and lasers*** - lasers in the optical range (Fig, 1, e). They emit light so-called excited active medium (gases, crystals, solutions), which creates an inverse population of quantum energy levels. At this stage, the LED technology is the most expensive of all the above options, but with an increase in their production, their price and value decreases. Besides, their use does not require recycling industry lamps containing mercury, as well as the fact that LED lamps are the closest to the solar spectrum [4].

a *b* *c* *d* *e*

Fig. 1. Different types of lamps:
a - incandescent lamp; *b* - halogen lamp; *c* - gas-discharge lamp;
d - fluorescent lamps; *e* - led-lamp

To apply a comparative analysis for the functions of different lamp types, we use the characteristics provided in Tab.1 IL3 lamps where used.

Table 1 – Characteristics of different lamps

Name	Power		Price (BYR)	Lifetime (hours)
	Consumption	Light output (equivalent incandescent lamp)		
Incandescent lamp	100	100	0,5-1	1 000
Halogen	40	100	2-3	4 000
Fluorescent (energy saving)	20	100	5-12	10 000
LED	5	100	1-60	100 000

The results of the comparative analysis of power consumption and the cost of replacing the failed lamps are shown in Table 2. It was assumed that the average daily lamp operating time is about 7 hours.

Tabl. 2 – Cost of operation

Name	Power consumption per year (kW·h)	Consumption per 1 year of service (BYN)	Consumption per 2 years of service (BYN)	Consumption per 5 years of service (BYN)
		Taking into account the cost of the lamp and its replacement		
Incandescent lamp	255,5	36,22	74,1	195,68
Halogen	76,65	15,79	32,24	83,07
Fluorescent (energy saving)	51,1	16,64	23,62	56,54
LED	12,78	41,66	43,41	49,14

Experimentally, the lighting characteristics of the two types of bulbs where analyzed: incandescent IL IL B100 and Lisma B. Experiments were carried out on the photometric bench FS-3, as well as for the measuring equipment, HN25/7 visual photometer, light meter U-116, a laboratory autotransformer LATR, voltmeter AC 50-250V (value of division 10V), ammeter with outside 100 - 500 mA (10 mA value of division) were used. The results are shown in Figure 2.

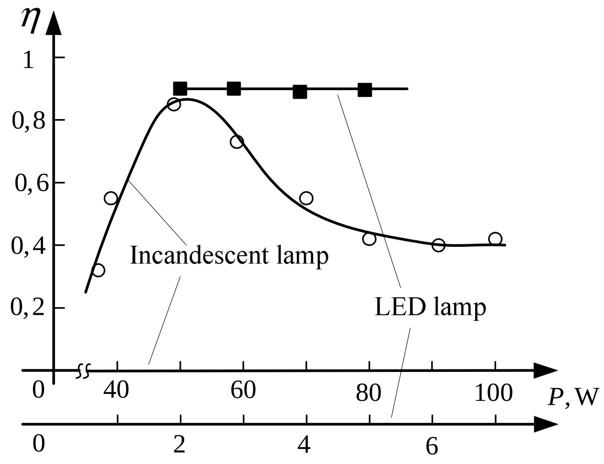

Fig. 2 Efficiency depending on the power consumption

It is evident that the application of light for a period of several years (1-3 years) the most efficient energy consumption and the price is the energy saving lamp. If we are talking about a longer period (over 4 years), the most efficient is LED lamp, because of its low consumption and long service life.

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