Tech Note: Study of led filament lamp parameters (Trademark general lighting systems)

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Abstract.- The article describes the results of electrical, light and spectrocolorimetric parameter measurements of LED filament lamps (LEDFL) with the power of 10 and 13 W (the trademark General Lighting Systems). LEDFL parameters were measured at the "Lighting Engineering Metrology" Collective Use Center of Mordovia State University named after N. P. Ogaryov using GO-2000A goniophotometer (Everfine, China) and Specbos 1211 spectroradiometer (Jeti, Germany). The comparative analysis of the studied LEDFL and general-purpose incandescent lamp (GPL) parameters was performed. The studied LEDFL is advisable to use for lighting public, administrative buildings and residential premises for direct replacement of GPL.

Keywords: LED filament lamp; incandescent lamp; light intensity curve; luminous flux; general color rendering index, radiation spectrum.

Nota técnica: Estudio de los parámetros de lámparas de filamento LED (Sistemas de iluminación general de marcas comerciales)

Resumen.- El artículo describe los resultados de las mediciones de parámetros eléctricos, de luz y espectrocolorimétricos de las lámparas de incandescencia LED (LEDFL) con una potencia de 10 y 13 W (la marca registrada General Lighting Systems). Los parámetros LEDFL se midieron en el Centro de Uso Colectivo "Lighting Engineering Metrology" de la Universidad Estatal de Mordovia que lleva el nombre de N. P. Ogaryov utilizando un goniófotómetro GO-2000A (Everfine, China) y un espectrorradiómetro Specbos 1211 (Jeti, Alemania). Se realizó el análisis comparativo de los parámetros estudiados de LEDFL y la lámpara de incandescencia de uso general (GLP). Demostrando que es aconsejable el reemplazo de la lámpara de incasdecencxia GLP por la LEDFL para alumbrado público, edificaciones administrativas y residenciales.

Palabras clave: Lámpara de filamento LED; lámpara incandescente; curva de intensidad de luz; flujo luminoso; índice de reproducción cromática general.

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1. Introduction

In the context of modern globalization, decision-making on the development of LED light source (LED LS) production should be determined not only by the requirements of their energy efficiency, but also by other aspects: economic, social and environmental.

The LED filament lamp is a modern light source (LS), combining the advantages of incandescent and LED LS, the luminous efficiency of which is currently 150–160 lm/W, and in laboratory samples it has already exceeded 300 lm/W with the service life of 50 thousand hours and above. At the same time, the use of LED LS makes it possible to control the light and colorimetric characteristics of radiation, which opens up the prospects for a dynamic ergonomic light-color medium development [1, 2, 3].

The works described the studies devoted to the analysis of parameters, the assessment of LEDFL

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lighting quality and effectiveness [4, 5, 6, 7, 8].

Table 1 presents the comparative analysis of LEDFL from various manufacturers.

2. Methodology

To measure the light intensity curve (lic) of the studied LEDFL with the powers of 10 and 13 W and GPL with the power of 60 W (comparison lamp), they used the measurement method with GO 2000-A goniophotometer in accordance with GOST R 55702-2013 [9]. The stabilization time of the LS light parameters was at least 5 min after their inclusion to the rated voltage network. The center of the receiving surface of the photometric head was on a straight line passing through the photometric center of the goniophotometer, and its plane was perpendicular to this straight line. The measurement results were processed depending on the nature of the light distribution symmetry of the LS and the adopted photometric system. The processing consisted in obtained light intensity averaging for the meridional planes symmetrically located relative to the axes or planes of the lighting device symmetry [10].

To measure the spectrocolorimetric parameters of the above mentioned LS, they used the measurement method with a spectroradiometer [9].

Also this work used special scientific methods: measurement result comparison, computer simulation method, mathematical statistics methods for measurement result processing.

3. Results and discussion

The parameters of the studied lamps, measured at the voltage of 220 V, are shown in Table 2.

The analysis of the results showed that the power of the studied LS does not correspond to the declared by the manufacturer (it is 30 % less ON AVERAGE for LEDFL, and 3,3 % for GPN). As for the luminous parameters, the following can be stated here: the luminous flux of LEDFL exceeds the luminous flux of GPN by 25 % at least, and the luminous efficiency of LEDFL is more than 1 order higher as compared to GPN.

Figure 1 shows the lic of the studied LS.

Table 3 shows the spectral and colorimetric parameters of LEDFL and GPN.

The analysis of the obtained lic showed that the LEDFL lic significantly differ from the GPN lic. The luminous flux of LEDFL is directed mainly perpendicular to the optical axis of the lamp, and the lic can be characterized as sinus. Lic is closer to uniform among GPN. That is, the main difference is in the area along the optical axis of the lamp: in contrast to GPN, LEDFL almost do not emit light flux in this direction. The spectral radiation distributions of the studied LSs are presented in Figure 2.

LEDFL spectra are characterized by the presence of two maxima. One is in the blue region of the spectrum and is caused by LED crystal glow, the second is in the yellow-orange region and is provided by luminophor glow. The spectral distributions of the studied LEDFL are almost identical, the difference is observed only in the glow region of LED crystals, which can be explained by technological errors or by different crystal use to generate radiation. Comparing the colorimetric parameters of the studied lamps, the following can be noted:

- the correlated color temperature Tcv of the studied LSs is almost the same;
- LEDFL have common color rendering index Ra of more than 80.

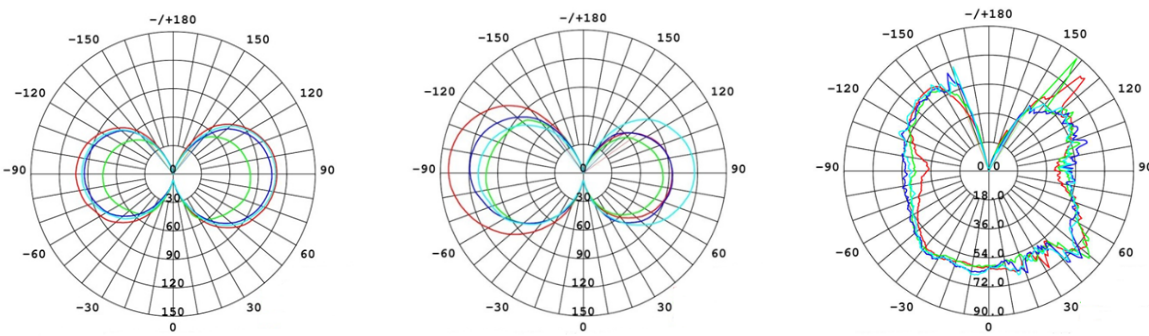
4. Summary

Thus, the results of this work allowed us to conclude that the studied LEDFL can be used for general lighting of public buildings and communal premises of residential buildings, namely:

- when they perform visual work of A-B grades associated with object distinguishing of low requirements for color differentiation with illumination of E = 150 - 300 lux;
- when they perform visual work of Г- Ж grades during colored object distinguishing with low requirements for color differentiation or without requirements for color rendering at E = 150 - 300 lux.

Table 1: Comparison of LEDFL characteristics from various manufacturers

Lamp brand (manufacturer)	Declared power (W)	Luminous flux (lm)	GPL analog (W)	Service life (h)
Maxus filament A60	8	800	60	30000
VIDEX Neo Classic (Filament) A60FA 2200K	7	630	55	40000
Philips LED Classic A60 WW CL D APR	7,5	806	70	15000
OSRAM LED RF CL A60 2700?	6	806	75	15000
Lisma SDF 8 W	8	780	75	30000
«Tomicha» lamp SA 220-8	8	800	75	15000



(a) FL 10W. (b) FL 13W. (c) IL 60W.

Figure 1: LEDFL and GPN light intensity curves

Table 2: Parameters of LEDFL and GPL

Measured characteristics	FL 10 W	FL 13 W	IL 60 W
Power, (W)	7	8	58
Luminous flux, (lm)	876	994	658
Luminous intensity, max., Cd	109,9	143,0	92,3
Luminous efficiency, (lm/W)	131,7	133,6	11,43

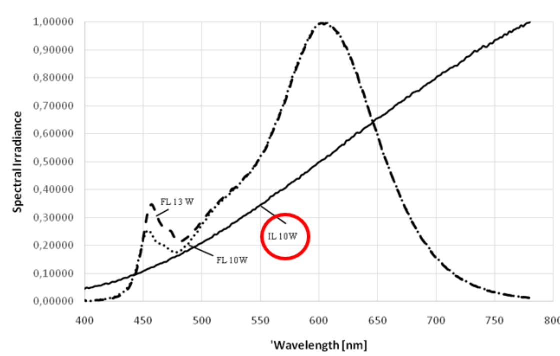


Figure 2: Spectral distribution of the studied lamp radiation

5. Conclusions

The performed work revealed that at much lower LED power, 6 and 4.6 times less than GPN, respectively, the luminous flux of LED LS is 1,3 and 1,5 times higher, respectively than the GPN luminous flux. The luminous efficiency of LEDFL is 11,55 times higher on average than the luminous efficiency of GPN.

They determined that the colorimetric parameters of LEDFL make it possible to use these LEDs for general lighting of public buildings and residential premises.

The spectral distributions of the studied LEDFLs are almost identical; the difference is observed

Table 3: Spectral and colorimetric parameters of the studied lamps

Parameters	FL 10W	FL 13W	IL 60W
Illuminance [lx]	$3{,}99 \times 10^2$	$4{,}79 \times 10^2$	$1{,}43 \times 10^2$
Irradiance [W/sqm] (380-780nm)	1,20	1,46	$9{,}49 \times 10^{-1}$
Correlated Colour Temp. (CCT) [K]	2662	2713	2720
Dominant Wavelength (DWl) [nm]	583,2	583,6	584
Colour Purity (PE) [%]	68,7	63,5	61,3
R_a	80,14	81,49	99,64
Peak Wavelength [nm]	602	607	892
PEAK FWHM [nm]	110,2	110,4	405
Centroid Wavelength [nm]	591,6	589,3	786,8

only in the region of LED crystal glow. The dominant wavelength in the emission spectra of all the studied lamps is practically the same. The peak wavelengths in the LEDFL emission spectra are in the same region (607 and 602 nm); the peak wavelength for GPN is outside the boundaries of the visible spectrum.

The curves of LEDFL light intensity significantly differ from GPN lic. In LEDFL, lic can be characterized as sinus, in GPN lic has the shape close to uniform.

The analysis of the LEDFL parameters of the General Lighting Systems trademark made it possible to determine their areas of application. Further studies of these promising LS parameters will make it possible to develop recommendations to improve the norms and standards in the field of artificial lighting. Research materials can be used by the sanitary-hygienic departments and technical regulatory authorities.

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