ELECTROMAGNETIC FIELDS OF COMPACT ENERGY-SAVING FLUORESCENT LAMPS

Ozerova, Elena S., *Moscow State University of Railway Engineering (MIIT), Moscow, Russia.*
Evdokimova, Maria P., *Research Institute of Occupational Medicine, Moscow, Russia.*
Farafonova, Elena A., *Moscow State University of Railway Engineering (MIIT), Moscow, Russia.*

ABSTRACT

The questions related to potential environmental and hygienic hazard, which may be caused by electromagnetic field of compact energy saving lamps, are considered. The results of measurements of electromagnetic fields in low frequency domain: spectral composition, intensity depending on distance for lamps of various types and power consumption are presented. It is shown that maximum value of electromagnetic field frequency of 50 Hz from the measured energy saving lamps does not exceed the maximum permissible levels.

Keywords: ecological safety, occupational health, compact energy saving lamps, electromagnetic field, spectrum of electromagnetic fields, maximum permissible levels.

Background. *The transition to alternative energy sources and its sustainable use is one of modern global problems. The introduction of resource-saving systems and technologies in JSC Russian Railways is composed of a set of measures aimed at energy conservation and energy efficiency, as defined by federal legislation [1]. Among other things – introduction of energy-efficient lighting equipment for illumination of premises and territories of railway facilities, advanced light sources, which, in particular, include compact fluorescent energy saving lamps.*

Objective. *The objective of the authors is to consider some important issues related to electromagnetic fields strength of compact energy-saving fluorescent lamps.*

Methods. *The authors use general scientific and engineering methods, comparative analysis, graph construction.*

Results.

The object of study

Transition from outdated incandescent light bulbs to new energy-saving lamps is caused by their high luminous efficiency, long service life and low heat generation. In this regard, there are not only technical problems, but also the question of potential danger that can be posed by energy-saving lamps for environment and human [2, 3].

Compact fluorescent lamps, unlike conventional incandescent lamps that emit visible light upon heating of a tungsten filament being in a glass flask with inert gas operate under a principle of a fluorescent tube, collapsed or in a form of a compact spiral or like letter U. The body of such a lamp contains a ballast electronic device that ensures generation of electric pulses to maintain a gas discharge in mercury vapor contained in the tube. The electrical discharge creates a pulsed ultraviolet radiation converted into visible light by phosphor deposited on inner walls of the tube.

This technology has a higher efficiency than conventional incandescent lamps, however, has some drawbacks: other spectral composition of emitted light, content of mercury in the tube and generation of electromagnetic fields (EMF) associated primarily with the electronic ballast device. Measurements of EMF of compact fluorescent lamps of different manufacturers were carried out in low [4], medium and high frequency ranges [5]. But it does not address issues related to spectral composition of EMF of lamps at low frequencies, as well as connection between the form of lamps and their power with distance and intensity of the fields generated by them. And that was the purpose of our study, conducted on the basis of Research Institute of Occupational Medicine.

Materials and methods

The study of electromagnetic field intensity was conducted using the field-intensity meter of electric and magnetic components NARDA EFA-300 (NARDA Inc., USA). It allows EMF spectral analysis using a Fast Fourier Transform in the frequency range of 5 Hz to 32 kHz with a bandwidth (at the level of + 0 / –3 dB) up to 32 kHz. The testing regarded six compact fluorescent lamps «Osram» (France), with minor differences in power consumption and differing in appearance and luminous flux. Type and characteristics of the lamps are shown in Table 1.

Results and discussion

During the measurement antenna of EFA 2245 / 90.31 in the dielectric holder was placed on the vertical axis of the compact fluorescent lamp at five points at distances of 1, 5, 10, 15 and 30 cm from its apex. The first step was to register the EMF spectrum of lamps in the frequency range from 5 Hz to 32 kHz. Analysis of the results showed that the spectra differ only in amplitude of the spectral components, while their ratio does not vary with the type of lamp and its power. The typical form of the EMF spectrum (electric component) of the compact fluorescent lamp is shown in Pic. 1. The spectrum contains the main electric component of EMF at a frequency of 50 Hz and to a lesser extent – harmonics.

Based on the obtained spectral composition of EMF were conducted basic field strength measurements of all lamps at a frequency of 50 Hz. Analysis of the results shows that the value of EMF strength at a distance of 30 cm from lamps within the measurement errors are virtually identical and are in the range of 45,4 to 48,5 V/m. However, at a distance of one cm differences arise regarding primarily bulbs of lamps with a compact spiral

Table 1

The main characteristics of energy-saving compact fluorescent lamps «Osram»

General view and type of lamps	Power	Luminous flux	Color temperature	Dimensions
Osram «Micro Twist»	15 W	970 lm	2700 K	103×48 mm
Osram «Micro Twist»	12 W	740 lm	2700 K	97×48 mm
Osram «Dulux Superstar Classic A»	14 W	740 lm	2700 K	140×71 mm
Osram «Dulux Star compact»	11 W	600 lm	2700 K	119×43mm

Table 2

The values of strength of the electric component of EMF of 50 Hz frequency at different distances from the top of the compact fluorescent energy-saving lamp «Osram» (vertical axis)

Lamp type, power consumption and luminous flux	Strength of electromagnetic field with a frequency of 50 Hz, V/m				
	Distance from the lamp, cm				
	1	5	10	15	30
«Micro Twist» 15 W, 970 lm	459,3	189,6	117,5	82,2	47,4
«Micro Twist» 12 W, 740 lm	449,7	175,6	113, 4	82,2	45,4
«Dulux Superstar Classic A» 14 W, 740 lm	339,8	177,2	105,5	77,8	48,9
«Duluxstar Compact» 11 W, 600 lm	403,2	196,6	109,8	78,0	47,2

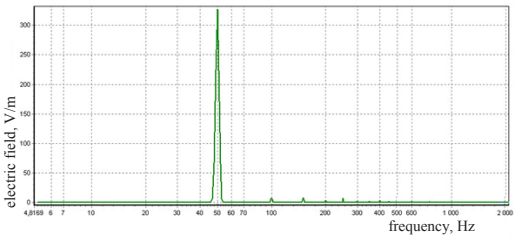
(«Micro Twist») and of classical forms («Dulux Superstar Classic A») (see Table 2).

Of all six measured lamps only for classically shaped «Dulux Superstar Classic A» a value of EMF intensity is less dependent on the distance from the lamp. However, despite the fact that it has the smallest value of its strength of EMF at a distance of 1 cm (339,8 V/m), the value of the same parameter at 30 cm is the maximum of all measurements and is 48,9 V/m. An intermediate position on the results of measurement of EMF with a frequency of 50 Hz is taken by «Duluxstar Compact», in which at least power consumption of 11 W the value of intensity is comparable with the values of «Micro Twist» lamps, but the luminous flux is less and is 600 lm.

Conclusions. *According to the measurement results it can be assumed that the value of strength of electric component of EMF at a frequency of 50 Hz of compact fluorescent lamps depends on design of the light emitting tube, as well as on the power consumption of the lamps.*

The obtained data allow to consider as the most optimal for compatible characteristics (luminous flux, dimensions and even distribution of EMF intensity depending on the distance) the lamp «Dulux Superstar Classic A». The maximum values of EMF intensity at 50 Hz frequency are at a distance of 1 cm of 459,3 V/m and at 30 cm are of 48,9 V/m.

Maximum permissible level of strength of EMF with frequency of 50 Hz in the workplace throughout the work shift in accordance with sanitary-epidemiological rules and norms is 5 kV/m [7], and in residential areas – not more than 0,5 kV/m [8]. Speaking from the standpoint of these criteria about EMF safety of compact fluorescent energy saving lamps, their absolute safety for the environment and humans can be clearly noted.



Pic. 1. The characteristic spectrum of electromagnetic field (electric component) of the compact fluorescent lamp in the frequency range from 4 Hz to 2 kHz.

REFERENCES

1. Federal Law of the Russian Federation dated November 23, 2009 № 261-FZ «On energy saving and energy efficiency improvements and on amendments to certain legislative acts of the Russian Federation» [*Federal'nyj zakon Rossijskoj Federatsii ot 23 noyabrya 2009 g. № 261-FZ «Ob ehnergosberezhenii i o povyshenii energeticheskoj effektivnosti i o vnesenii izmenenij v otdel'nye zakonodatel'nye akty Rossijskoj Federatsii»*]. [Electronic resource]: http://www.rg.ru/2009/11/27/energo-dok.html. Last accessed 18.02.2016.

2. Gurevich, V. Energy-saving lamps: obverse case [*Energosberegayushhie lampy: obratnaya storona medali*]. *Elektrotekhnicheskij rynok*, 2010, Iss. 1–2, pp. 31–32.

3. Are fluorescent lamps harmful? Review of media materials [*Vredny li lyuminestsentnye lampy? Obzor po materialam SMI*]. *Energosovet*, 2010, Iss. 6, pp. 56–59.

4. Azizi, M., Aliabadi, M., Golmohammadi, R. The intensity of electromagnetic fields emitted by common compact fluorescent lamps. *Journal of Ergonomics*, Vol. 3, 2015, Iss. 2, pp. 76–84.

5. Bakos, J., Nagy, N., Juhász, P., Thuróczy, G. Spot measurements of intermediate frequency electric fields in the vicinity of compact fluorescent lamps. *Radiation Protection Dosimetry*, Vol. 142, 2010, Iss. 2–4, pp. 354–357.

6. Nadakuduti, J., Douglas, M., Capstick, M., Kühn, S., Kuster, N. Application of an induced field sensor for assessment of electromagnetic exposure from compact fluorescent lamps. *Bioelectromagnetics*, Vol. 33, 2012, Iss. 2, pp. 166–175.

7. Sanitary-epidemiological rules and norms SanPiN2.2.4 / 1191–03. «Electromagnetic field under production conditions» [*Sanitarno-ehpidemiologicheskie pravila i normativy SanPiN2.2.4/1191–03. «Elektromagnitnye polya v proizvodstvennykh usloviyakh»*]. Moscow, 2003.

8. Sanitary-epidemiological rules and norms SanPiN2.1.2.2645–10. «Sanitary-epidemiological requirements for living conditions in residential buildings and premises» [*Sanitarno-ehpidemiologicheskie pravila i normativy SanPiN2.1.2.2645–10. «Sanitarno-ehpidemiologicheskie trebovaniya k usloviyam prozhivaniya v zhilykh zdaniyakh i pomeshheniyakh»*]. Moscow, 2010.

Information about the authors:

Ozerova, Elena S. – Ph.D. (Biology), associate professor at the department of Chemistry and Environmental Engineering of Moscow State University of Railway Engineering (MIIT), Moscow, Russia, kafedra_ec_miit@mail.ru.

Evdokimova, Maria P. – engineer of Research Institute of Occupational Medicine, Moscow, Russia, yevdokimova.m@gmail.com.

Farafonova, Elena A. – a 4th year student of Moscow State University of Railway Engineering, Moscow, Russia, falenk@mail.ru.

Article received 09.02.2016, revised 18.02.2016, accepted 24.05.2016.