The American Journal of Engineering and Technology
(ISSN – 2689-0984)
Published: November 30, 2020 | **Pages:** 189-196
Doi: https://doi.org/10.37547/tajet/Volume02Issue11-30

IMPACT FACTOR
2020: 5. 32
OCLC - 1121105677

Journal Website: http://usajournalshub.com/index,php/tajet

Copyright: Original content from this work may be used under the terms of the creative commons attributes 4.0 licence.

Problems Of Implementation Of Semiconductored Leds For Fishery Lighting Devices

Olimov Lutfiddin Omanovich
Professor, Dc physical and mathematical Andijan Machine-Building institute, Uzbekistan

Yusupov Abdurashid Khamidillaevich
Doctoral student Andijan Machine-Building institute, Uzbekistan

ABSTRACT

This article discusses the laws of propagation of light rays from various sources of optical radiation in the aquatic environment, spectral characteristics and the results of scientific research on their application in the fishing industry, in particular in lighting devices for fishing. It was shown that a change in the spectral photosensitivity of semiconductor white light Light-emitting diodes (LED)s provides practical assistance to the growth of functional systems of fish and their larvae, reproduction and development of aquatic plants, bacteria, detritus and benthos.

KEYWORDS

Semiconductor LED, light source, luminous intensity, light spectrum, power source, energy saving, voltage, current, power.

INTRODUCTION

In recent years, extensive research has been conducted on the development and implementation of modern, energy-efficient, useful and convenient lighting equipment for fisheries, aimed at expanding the natural food (flying insects) base of the fishing industry [1÷8]. Fishery lighting devices are based on the source of optical radiation and the mechanism of killing flying insects [6÷8], attracting flying insects to the selected optical radiation source, as well as the growth of functional systems of microorganisms in water bodies, especially fish and fish larvae requirements such as the ability to provide practical assistance in the normal development of aquatic plants, bacteria, detritus, benthos, which are the basis of food [1÷5]. The study of optical radiation sources that meet such requirements and their application to fishing lighting devices is one of the most pressing issues today. In this regard, this article is devoted to the results of research conducted in this area. Let us first consider the effect of optical radiation sources on the growth and development of living bio organisms.

It is known that light plays an important role in the growth and development of living bio organisms. Light affects the growth and development of plants on several indicators, in particular: intensity, wavelength, biochemical processes. For example, in greenhouses, the efficiency of the crop is higher if the leaves of plants are given light of the desired wavelength without drying out.

Ultraviolet light $\lambda=360\div410$ nm strengthens plants, neutralizes greenhouses, blue light $\lambda=440\div450$ nm promotes plant growth, but it is used for two-celled plants. Green light $\lambda=500\div600$ nm almost does not affect the leaves of young plants. Therefore, these rays are not of great importance in the development of plants.

Red or infrared rays are $\lambda=620\div750$ nm, of which $\lambda=620\div630$ nm is inefficient for plant development, but rays of wavelength $\lambda>660$ nm are light rays that promote plant growth and are essential for plant survival [9÷11]. Such wavelength light also plays an important role in the development of microorganisms in water bodies, in particular, in the growth of functional systems of fish and fish larvae, in the normal development of plants, bacteria, detritus, benthos growing in the water basin, which are their natural food base.

Zooplankton, phytoplankton, detritus and algae are the natural food base for fish and fish larvae, and their development plays an important role in fisheries [1÷5]. The development and moderate growth of zooplankton, phytoplankton, detritus, and algae depends on light rays. For example, one of the main factors in the development of phytoplankton under the influence of light is the formation of various living pigments in the center of its cell. In phytoplankton, pigment separation depends on the light wavelength, in particular, its maximum pigment separation rate assumes red ranges of wavelength $\lambda=430\div440$ nm, and $\lambda=670\div680$ nm [12, 13]. Light in this range also plays an important role in the development of zooplankton, which feed on fish [14]. Feeding zooplankton with phytoplankton significantly affects the development of the natural nutrient base of fish in the watershed. With this in mind, it is interesting to study the transmission and scattering characteristics of light rays through an aqueous medium. In the calculations we use parameters and expressions related to the scattering of light.

The relationship between the wavelength, speed, and frequency of light:

$$\upsilon=\lambda\nu \quad (1),$$

The speed of light rays in clear water:

$$\upsilon=c/n \quad (2)$$

determined by the expression.

Using expressions (1) and (2), we derive the following equation for the wavelength:

$$\lambda=\frac{c}{n\nu} \quad (3).$$

This equation is for the air environment

$$\lambda_1 = \frac{c}{n_1 \nu} \quad (4),$$

for aquatic environments

$$\lambda_2 = \frac{c}{n_2 \nu} \quad (5)$$

From the expressions, taking into account that the frequency of light does not change, we obtain the following:

$$\frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1} \quad \text{Or} \quad \lambda_1 n_1 = \lambda_2 n_2 \; (6)$$

From this, we can determine the values of light passing through the aquatic environment by knowing λ_1 for each wavelength of light (Table 1):

$$\lambda_2 = \frac{n_1 \lambda_1}{n_2} \quad (7)$$

Table-1

Values of light wavelength passing through an aquatic environment

Color	λ in the air, nm/nm	λ in the water, nm/nm
Ultraviolet (invisible)	10 – 390	7,6 – 300
Purple	390 – 450	300 – 346
Blue	450 – 480	346 – 369
Blue	480 – 510	369 – 392
Green	510 – 555	392 – 426
Yellow green	555 – 575	426 – 442
Yellow	575 – 585	442 – 450
Pink	585 – 620	442 – 476
Red, infrared (invisible)	620 – 880	476 – 677

As can be seen from Table 1, in a clear aqueous medium, red or infrared rays vary in the range λ=476÷677 nm. This corresponds to the values of the pigment separation in phytoplankton depending on the light wavelength. The light from an optical radiation source with such a wavelength allows the development and growth of zooplankton, phytoplankton, detritus, and algae. Therefore, the optical radiation sources selected for fishing lighting devices are required to vary the wavelength of light in the aquatic environment in the range of red or infrared rays λ=476÷677 nm.

SPECIFICATIONS OF LIGHT SOURCES

Today, there are several types of optical radiation sources, including in-candescent, luminescent, halogen, and semiconductor LEDs. Table 2 shows the energy consumption, light efficien-cy, lighting characteristics of different radiation sources. Of these, semiconductors LEDs are superior to other types of lighting in terms of durability, robustness and safety. Also, semicon-ductor LEDs consume 7,5 times less electricity per hour than an incandes-cent lamp in terms of energy consump-tion. Practical research was conducted to verify the above theoretical calcula-tion results as well as the data presented in Table 2.

Table 2.

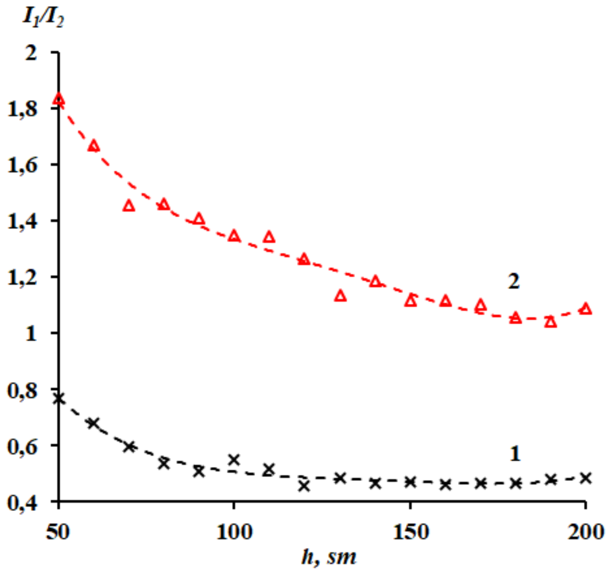
Properties and parameters of optical radiation sources [15-21].

Types	Power, W	Light flux, Lm	Light efficiency, Lm/W	Lighting, Lk (220 V in voltage)	Structural weakness	Presence of harmful substances
Incandescent	60	720 – 780	12 – 13	470	very brittle	no
Luminous	12	780 – 1000	65	310	brittle	mercury
Hallogen	40	800	20	350	brittle	bromine, iodine
LED	8	800	100	650	durable	no

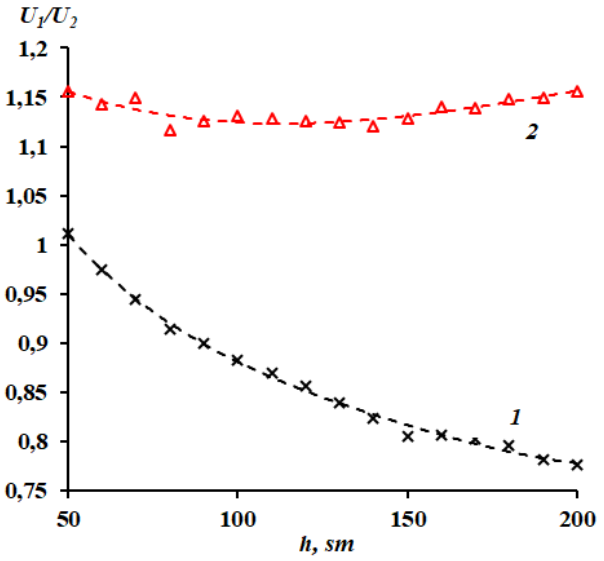
Semiconductor LEDs and incan-descent lamps with a luminous flux of 1200 Lm were selected as the source of optical radiation for the study. As shown in Table 1 above, in a clear aqueous medium, red or infrared light varies in the range ⍰=476 ÷ 677 nm. A silicon-based solar cell was used to control such wavelengths. It is known that the maximum spectral light sensi-tivity of silicon-based solar cells corre-sponds to the wavelength of infrared light [22]. The research was carried out in the open air and in an aqueous environment, in the process of changing the distance between the optical radiation source and the solar cell in the range h=50÷200 cm. The current and voltage generated in the solar cell were measured using a GDM-8245 multimeter.

RESULTS OF THE EXPER-IMENT

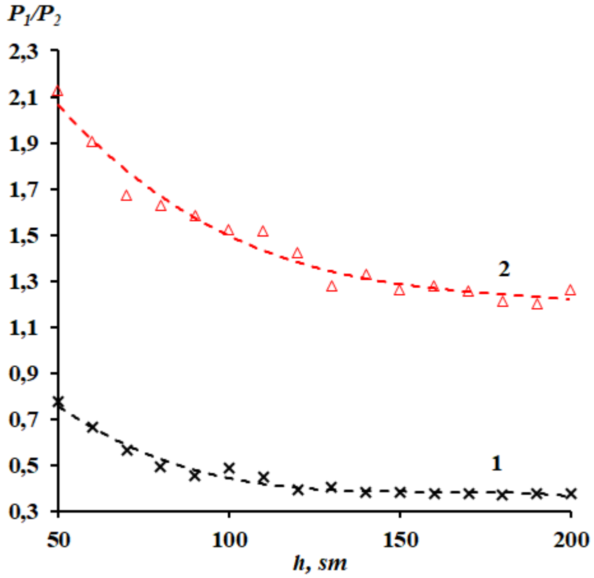
Pic. 1÷3 show the dependence of the photocurrent (I) and voltage (U) and power (P) of a solar cell on h. Here, I1, U1, P1 are the proportions of the results obtained in the aquatic environment, I2, U2, P2 in the open air environment. In all cases, the results obtained for incandescent lamps were found to decrease exponentially (Pic. 1÷3, line-1). For example, with increasing altitude, the photocurrent decreases from ~0,8 to ~0,45 times, the voltage from ~1,0 to ~0,7 times, and the power decreases from ~0,8 to ~0,4 times. In contrast, the results for semiconductor LEDs show that the photocurrent increases from ~1,8 to ~1,15 times, the voltage from ~1,15 to ~1,17 times, and the power from ~2,1 to ~1,34 times, respectively. (Pic. 1÷3, 2-lines).



Pic. 1. Dependence of photocurrent on h. 1 - incandescent lamp, 2 - LED.



Pic. 2. Dependence of photovoltage on h. 1 - incandescent lamp, 2 - LED.



Pic. 3. Dependence of power on h. 1 - incandescent lamp, 2 - LED.

It is known that water is 770 times denser than air, has a higher heat capacity than air, conducts sound vibrations well, and light attenuates light flux. That is, in an aqueous medium, light scattering (k), absorption (σ), and attenuation (ε) are observed. The frequency of the light does not change, on the contrary, the wavelength changes in the direction of the short wavelength. According to the literature analysis, the scattering and attenuation indices of light in pure water, for example at a wavelength of λ=400÷500 nm, have a minimum k=0,0045 1/m, values [23, 24]. Corresponding to the increase in wavelength, its value, for example, at λ=720 nm, the value of k increases 274 times relative to the minimum value [12, 13]. The light wavelength of an incandescent lamp corresponds to the infrared light field [25]. In our case, a large absorption of infrared light in an aqueous medium, a decrease in wavelength from 880 nm to 476 nm (Table 1) leads to a decrease in photocurrent from 0,8 to 0,45 times and voltage from 1,0 to 0,7 times. Comes (Pic. 1÷3, 1-line). The same is true for semiconductor LEDs. However, the luminous flux emitted by white light semiconductor LEDs is close to the spectrum of sunlight and in a wide spectrum [10], and in an aqueous medium it is divided into rays of different wave-lengths. The maximum spectral light sensitivity of a silicon solar cell and the increase in photocurrent from 1,8 to 1,15 times and the voltage from 1,15 to 1,17 times (Pic. 1÷3, line-2) show that the wavelength of light emitted in an aqueous medium corresponds to red or infrared rays.

As mentioned above, red or in-frared light is λ=620÷750 nm, and light of this wavelength is used in the development of microorganisms in water bodies, in particular in the growth of functional systems of fish and fish larvae, plants, bacteria, detritus plays an important role in the normal development of benthos [1÷14].

CONCLUSION

In summary, the use of white light semiconductor LEDs as a source of optical radiation in fishery lighting devices will practically help to expand the natural food (flying insect) base of the fishing industry, the balanced de-velopment of aquatic plants, zooplank-ton, bacteria, detritus, benthos.

REFERENCES

1. V.A. Vlasov, N.I. Maslova, S.I. Ponomaryov, Yu.M. Bakanyova. Vliyanie sveta na rost i razvitie rib. Vestnik AGTU. Ser.: Ribnoe xozyaystvo. 2013. №2, S.24-34
2. A.B. Ruchin. Vliyanie xarakteristik sveta na razvitie, rost i fiziologobioximicheskie pokazateli rib i amfibii. A.B. Ruchin: avtoref.dis. d-ra biol. Nauk. Saransk, 2008. S. 52
3. A.B. Ruchin. Osobennosti rosta i energetiki karpa (Cyprinus carpio) pri razlichnoy osveshennosti. Zoologicheskiy jurnal. 2001. T. 80, №4. S. 433-437
4. D.Xolmirzaev, P.S. Haqberdiev, D.R. SHohimardonov, Ye.S. SHaptaqov. Baliqchilik asoslari. Toshkent, “Ilm ziyo”, 2016, S. 248
5. P.S. Haqberdiev, Baliqlarni oziqlantirish, ularning kasalliklarini davolash va oldini olish. Samarqand, 2012 y.
6. L.O.Olimov, A.Yusupov, F.Omonboev, E.Yusupov “Baliqchilik uchun yoritish qurilmasi” FAP 20190121
7. Problems of introduction of innovative technologies and modern equipment in the fishing industry. L.O. Olimov, Yusupov A.Kh., Alijanov D.D. “International Journal of Research Studies in Electrical and Electronics Engineering” Volume 5, Issue 4, 2019, PP 23-25

8. L. Olimov, A.Yusupov, D.Alijanov. Baliqchilik uchun yoritish qurilmasi. “Ilm-fan va innovatsion rivojlanish” jurnali 6/2019

9. A.P. Gavrilenko. Svetodiodniy svet dlya teplits. OOO «ENOVA Layt» (may 2016)

10. Osobennosti ispolzovaniya svetodiodnix fitosvetilnikov. Kompaniya «LiderLayt». https://www.leadlight.ru

11. Svet dlya rasteniy. https://www.promgidroponica.ru

12. Optika okeana. Pod red. Monina A.S. – T. 1. Fizicheskaya optika okeana. – M.: Nauka, 1983. – 371 s.; T. 2. Prikladnaya optika okeana. – M.: Nauka, 1983. – 236 s.

13. R.M. Pope. E.S. Fry. Absorption spectrum (380-700 nm) of pure water. II. Integrating cavity measurements. Appl. Optics. – 36, № 33. – 1997. P. 8710-8723.

14. A.V. Krilov. Zooplankton ravninnix malix rek. – M. Nauka, 2005. – S. 263.

15. V.B. Kozlovskaya, V.N. Radkevich, V.N. Satsukevich. Elektricheskoe osveshenie. Spravochnik. – Minsk, 2007 ISBN 978-985-6591-39-9, S. 37.

16. Cree LED Components IES LM-80-2008 Testing Results. Cree Inc., 06.12.2012

17. F.E. Shubert, Svetodiodi. – M.: Fizmatlit, 2008. – S. 77-79. – 496. ISBN 978-5-9221-0851-5.

18. V.A. Kaptsov, V.N. Deynego. Riski vliyanie sveta svetodiodnix paneley na sostoyanie zdorovya operatora. FBUN «FNTS mediko-profilakticheskix texnologiy upravleniya riskami zdorovyu naseleniya» Rospotrebnadzora. Analiz riska zdorovyu. – Perm, 2014. – Avgust №4. S. 37-42. ISSN 2308-1155.

19. V.A. Kaptsov, V.N. Deynego. Svetovoy ratsion. Oxrana truda i svetodiodnoe osveshenie. Natsionalnaya assotsiatsiya tsentrov oxrani truda (NASOT) bezopasnost i oxrana truda. – Nijniy Novgorod, 2015. Sentyabr №3. S. 77-80.

20. Sravnenie svetodiodnix lamp s traditsionnimi osvetitelnimi priborami. Kompaniya «KVARTA-RAD». https:/www.quarta-rad.ru

21. Federal energy management program. How to buy an energy-efficient fluorescent tube lamp: journal – U.S. Department of energy, 2020. December.

22. M.Garin, R. Fenollosa, R.Alcubilla, L.Shi, L.F. Marsal, F.Meseguer. All-silicon Spherical-Mie-resonator photodiode with spectral re-sponse I the infrared region. Nature Communications volume 5, Article number: 3440. 2014 y.

23. Opticheskie svoystva vodnoy sredi i zakoni rasprostraneniya v ney sveta. htpps:www.//ewa-marine.ru

24. Osnovi optiki okeana. htpps://dvs.net.ru

25. Lampa nakalivaniya. htpps.www.//ru.wikipedia.org