

## PRACTICAL APPLICATION OF UV-LED IN ENVIRONMENTAL PROTECTION

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### **Abstract**

*It is well known that water is one of the main resources for a person. The production and supply of clean drinking water is always an urgent and strategically important issue with regard to national security. The issue of water purification is the first in the protection of the environment, as the amount of polluted water as a result of human activities is rapidly growing.*

**Keywords:** Environment, maintenance water, UVC LED, bactericidal efficiency.

### **INTRODUCTION**

In most cases, contamination of surface sources of drinking water supply is invisible, because pollutants are soluble in water. But there are exceptions: surface-active substances (foaming detergents), as well as oil products floating on the surface and unpurified drains. There are also several natural pollutants, but their volume is negligible compared to human pollution. Every year, thousands of chemicals with unpredictable effects enter the water basins, many of which are new chemical compounds.

Surface waters are protected from pollution, depletion and destruction of their living inhabitants, due to the introduction of sanitary and hygienic and sanitary and anti-epidemic vaccines and standards, the implementation of which is monitored at the state level. By water depletion, it is worth understanding the reduction of surface and groundwater reserves, i.e. reduction within a certain area (for groundwater) or a decrease in the minimum allowable surface runoff (for surface water). Water is a fundamental resource in human life, the demand for water consumption with the growth of human development increases every year. Water consumption is growing without taking into account the time spent on compensation for resources expended, and although there is a sufficient amount of fresh water sources in Ukraine, the amount of water

bodies polluted as a result of human activity is increasing, which becomes a big problem for our state.

### **EXPOSITION**

The most effective way to protect surface waters from pollution by their sewage is the development and implementation of anhydrous and non-waste production technology, the creation of circulating water supply. All methods of protecting surface water include the process of water purification, which consists of two stages: purification from organic and mineral pollution and purification from biological and bacterial pollution. Currently, the most popular in Ukraine, but outdated, are water purification methods using chlorine and ozonation [1]. With the modernization of enterprises, with the development of technology - technologies that are related to water disinfection (purification of biological and bacterial contamination) are being modernized. At the moment there are already a number of new methods: UV radiation, processing in a magnetic field, irradiation with gamma radiation, processing with electric charges. It should be noted that water treatment with ozone or ultraviolet rays almost completely supplanted chlorination at drinking water treatment plants in many countries of Western Europe [2]. In our country, the use of these environmentally

efficient technologies is limited due to the high cost of retooling drinking water treatment plants.

The above methods were considered for compliance with the 4 criteria: no side effects, complete inhibition of the viability of pathogens and fungi, efficiency of the method, ease of implementation. The results are shown in table 1.

Table 1 – Comparison of water disinfection methods

Method name decontamination	Chlorination	Ozonation	Use of silver ions	UV-radiation	Magnetic field processing	Gamma Radiation Treatment
Compliance method criterion						
Noside effects		+	+	+	+	
Complete inhibition of the viability of pathogens and fungi		+		+		+
Economic effect				+		
Ease of implementation	+			+		

As can be seen from the table, water disinfection with the help of UV radiation meets all the criteria. Although this method is more economical than the other ones, the radiation source (mercury lamp) is no longer considered energy efficient besides high power consumption, mercury is included in this radiation source, which affects the cost of disposal and is not environmentally friendly. Therefore, the method of water disinfection using UV irradiation in our can be upgraded by changing the radiation source to the LEDs [3].

As is known [4], the UVC region ( $\lambda = 200-280$  nm) is characterized by the suppression of the vital activity of pathogens, which is why it is called bactericidal. However, the reaction of a living microbial cell to ultraviolet radiation is different for different wavelengths, therefore, over time, studies of its properties have built a curve of the relative spectral bactericidal efficiency of ultraviolet radiation, which is shown in Figure 1 [5].

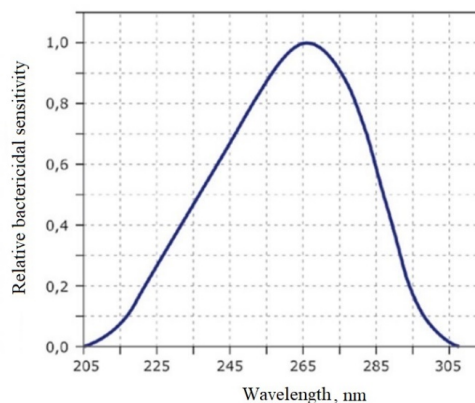


Fig. 1 - Curve of the relative spectral bactericidal efficiency of ultraviolet radiation

It was found [2] that the highest bactericidal efficiency has the radiation range of wavelengths  $\lambda = 254-275$  nm. The main criterion for the effect of UV radiation on a substance is the coefficient of bactericidal efficiency [5], which is found as the ratio of the bactericidal flux to the total flux of the source of study:

$$K_{effect} = \left[ \frac{\int_{200}^{280} \Phi_{relative}(\lambda) d\lambda}{\int_{200}^{500} \Phi_{relative}(\lambda) d\lambda} \right] * 100\%(1)$$

where,  $\int_{200}^{280} \Phi_{relative}(\lambda) d\lambda$  - bactericidal flux of radiation source, lm;

$\int_{200}^{500} \Phi_{relative}(\lambda) d\lambda$  - all radiation source flux, lm.

To assess the practical applicability of UV LEDs in bactericidal installations [3], an LED radiation source TH-UV265A-3535 with a wavelength  $\lambda = 265$  nm was acquired. Measurements of its bactericidal characteristics were carried out: the relative spectral characteristics of the LED in Fig. 2 and the energy illumination.

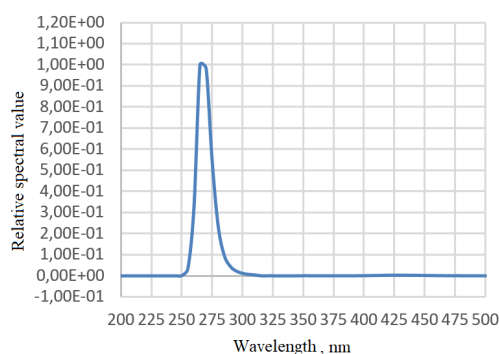


Fig. 2 - Relative spectral characteristics of the LED

**Table 2 – Energy Illumination TH-UV265A-3535**

Length, sm	0,001	5	10	15	20
Energy Illumination, mW/sm <sup>2</sup>	0,2892	0,00769	0,00249	0,001279	0,000807

When calculating the energy illumination, the factor of actinic (correction factor) was also taken into account, which is equal to  $k_{act} = 1.4115$  with the used measuring device.

According to formula 1, the coefficient of bactericidal efficiency of the LED source of UV radiation was calculated for the first time and amounted to  $K_{effect} = 90.28$ .

## CONCLUSION

This article has analyzed in practice the possibility of using LED sources of UV radiation for water disinfection. Water purification is one of the main issues of labor protection, which is getting more and more aggravated every year. According to the measurement results and calculations, the bactericidal efficiency of LEDs is the highest in the world among UVC sources (for low-pressure mercury lamps, 0.85, for high-pressure mercury lamps, 0.42).

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