Investigation of the influence of the light spectrum on the growth efficiency of chlorophyll synthesizing Microalgae

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Abstract - the effect of light wave length on the rate of carbon dioxide absorption by microalgae has been studied. The coefficient of microalgae growth based on the mathematical model has been determined. The optimum length of light wave has been determined to design the flow chart for eliminating carbon dioxide from industrial gas emissionsvia the biological method.

Keywords: photosynthesis, light wave length, microalgae, diffusion, mathematical model, kinetics.

Introduction

A spike of greenhouse gases causing climate change around the world. “The rapid pace of climate change along with the demographic boom of the last century, loss of habitat, chemical and other pollution lead to ecological imbalances” – quoted by the UN news Centre UNEP expert Niklas of Hagelberg. British and Australian scientists have concluded that global warming threatens the loss of biodiversity and leads many natural disasters.

In the Paris agreement, the state promised to keep the global temperature rise at two degrees. But even if achieving this goal the risk of biodiversity loss is reduced only by half scientists [1].

The most important issue today is to prevent a rapid increase in air temperature. This can be achieved by reducing greenhouse gas emissions into the atmosphere and using alternative energy-efficient technologies. Such technologies include biological purification of air from carbon dioxide with the chlorophyll synthesizing microalgae such as Chlorella.

Description of the problem

The basis of the proposed method of solving the problem of global warming is the process of photosynthesis chlorophyllsynthesizing microalgae, which, unlike terrestrial plants, can adapt to the edge of unfavorable living conditions and grow 7-10 times faster. The purpose of the study was to investigate the influence of the wavelengths of different range on the rate of absorption of carbon dioxide by microalgae.

The object of laboratory research was the process of absorption carbon dioxide by culture of green microalgae Chlorella vulgaris, which is cultivated with different colours of light during 14 days in four photobioreactors with a 1.5 L volume. In the first photobioreactor the colour of the light was blue, in the second – green, in the third – yellow and in the fourth one it was red.
The algae received the same amount of the corresponding spectrum of light and bubbling carbon dioxide in all the four photobioreactors. In the further cultivation of algae, their number increased. The pH was 6.5. The temperature of cultivation was 35±1°C. The concentration of algae biomass was determined by a photocolorimetric method. The spectrum of absorption in the visible region of the aqueous solution of Chlorella microalgae presents in Fig. 1.

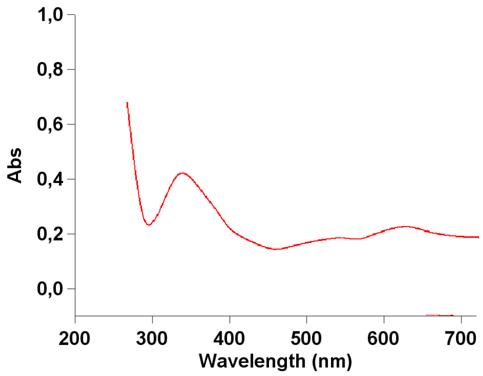

Fig. 1. The spectrum of absorption of the aqueous solution of the studied microalgae.

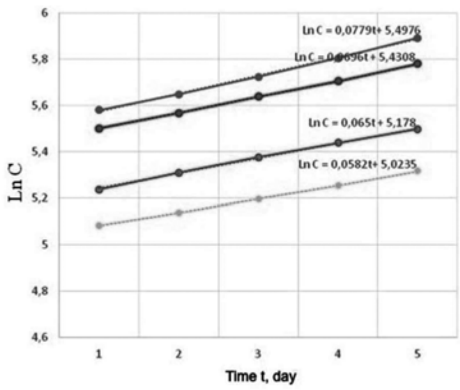

Fig. 2. Kinetic curve lines of increase of concentration of microalgae
in logarithmic coordinates with the appropriate wavelength of light

As shown on figure 2 the dynamics of growth, and thus the intensity of the absorption of carbon dioxide by microalgae significantly depends on the wavelength of light. The experimental curve lines are well described by the famous equation:

$$C = C_o e^{-k_M t} \quad , \qquad (1)$$

where N is the current cell concentration in the biomass of microalgae, N_0 is the cell concentration in the biomass of microalgae at the initial time t=0 , k_M - the coefficient of increase of biomass of microalgae.

In logarithmic coordinates (1) describes a straight line of tangent of the inclination of which allows to determine the growth rate k_M . The results of the transformations are shown in Fig. 2.

The coefficient of growth for the corresponding spectrum of light was determined by the graphic method, as the tangent of the slope of the experimental straights (Fig 3).

$$k = 3{,}2 \cdot 10^{-3} \lambda + 0{,}0756, \qquad (2)$$

where λ is the wavelength of light [2].

Conclusion

Based on experimental studies, the data that indicate the appropriateness of the use of blue and red light spectrums for the cultivation microalgae at night time were obtained. The value of the growth factor of microalgae from the wavelength was determined. The graphic dependence of the growth factor on the wavelength is obtained, the analysis of which allows us to say that the largest absorption region has (440 nm) and (590 nm).

References

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