About problem of absorption of greenhouse gas by chlorophyilsynthesizing microalgae in the presence of sulfur dioxide

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Abstract – The presence of non-competitive reverse inhibition by sulfur dioxide in the process of photosynthesis based on the Lineweaver-Burk theory was theoretically justified and experimentally proved. The mathematical description of the growth of the cells of the microalgae is given and as a result of processing experimental data the growth rates of the algae at certain values of inhibitor concentration was defined. Based on the obtained values the analytical dependence of growth rate of biomass from the substance of inhibitor was redused. The maximum value of concentration of sulphur dioxide which may occur photosynthesis and biomass growth of microalgae was set.

Keywords: photosynthesis, sulfur dioxide (SO_2) , microalgae, diffusion, mathematical model, kinetics, enzymatic catalysis, inhibitor.

I. Introduction

It is well known that the vast majority of created by the modern world technology is unlocked by the processes that form certain waste. The harm and danger of a particular technology to the environment is determined primarily by the quantity and nature of substances which are a by-products, namely, waste technological processes. The question "what to do with the waste?" is very acute. Modern technologies of their utilization require new tough recycling processes, but most of them also provide waste which is not always easy to dispose of. But all the processes occurring in nature are cyclical and well-balanced.

The transformation of matter in ecosystems is realized by the cycle – the waste of one process are used in other biological processes.

A typical example of such process can be the transformation of carbon dioxide into biomass using photosynthesis in an industrial environment. However, the industrial gas emissions include not only carbon dioxide but sulfur dioxide. That's why it is important to reserch the influence of this component on the process of photosynthesis.Algae like other green plants need carbon dioxide and a small amount of minerals for increasing their biomass. They grow 7-10 times faster than terrestrial plants and thus «kill» more carbon dioxide and have the ability to adapt to unfavorable conditions. These properties of microalgae are the objective condition for the introduction of such processes in order to eliminate CO_2 from industrial gas emissions

In such circumstances, proven ability to manage technology treatment of industrial gas emissions using chlorophyilsynthesizing microalgae as basic biological object transform carbon dioxide into energy.

II. Description of the problem

The transformation of substance in ecosystems is realized by the cycle – the waste of one process are used in other biological processes. A striking example of such balance can be the biospheric cycles of carbon, oxygen, nitrogen and other biogenic elements. An amazing balance of natural ecosystems, a high level of correlation nutrixxion biotic processes give people conclusive evidence of their effectiveness, suggest ways of borrowing from the animate nature of the elements and principles that become the basis for the design and development of future technologies. Technology, which is built on ecological principles and is based on minimizing the negative impact on the environment, should be considered environmentally sound technology or environmental technology. In cases where the above principles hold, and the technological process based on the use of certain living organisms, it is advisable to talk about the origin and existence of trends in the environment – biological treatment and technology to be applied – environmental biotechnology

Biological treatment is based on the ability of microorganisms to include a variety of chemical compounds, pollutants in the scheme of metabolism. The decomposition of the pollutants occurs under the action of enzymes produced by microorganisms in the environment of pollutants, which are subject to extraction. To the biological treatment of gas emissions from carbon dioxide can be attributed to photosynthesis [1-2].

Photosynthesis – the process of converting sunlight into energy of chemical bonds and synthesis of organic compounds (carbohydrates) from inorganic (CO_2 ↑ and H_2O). This is the only process in the biosphere, which leads to an increase of free energy from domestic sources. The energy is stored in the products of photosynthesis – the main source of energy for mankind. Therefore, targeted products of photosynthesis can be used for the purpose of energy recovery, including anaerobic biodegradable to produce methane. The ability of photosynthesis are not only with plants, but also microalgae.

This microscopic alga, which has a large supply of chlorophyll and rare complex nutrients, takes part in the process of photosynthesis, absorbing carbon dioxide and saturating the air with oxygen. Microscopic algae chlorella is considered survivor of our planet. [3]

Moreover, the advantage of chlorophyll synthesising microalgae is that they grow quickly and absorb much more carbon dioxide than the plants, and able to adapt to the land of adverse conditions.[4] So, finding ways of photosynthesis in an industrial environment is an urgent task.

The main condition for photosynthesis is the presence of molecules of carbon dioxide, the product of burning solid, liquid or gaseous fuels. However, in such products

of combustion always contain other oxides, in particular sulphur dioxide. The presence of sulfur dioxide in the products of combustion, industrial gas emissions, due to the presence of sulfur compounds in a natural deposits of fuel. The structure of the molecules of sulfur dioxide and carbon dioxide are similar, but because there is an assumption that a stage of sulfur dioxide in the internal volume of the cell of the microalgae is the same as carbon dioxide. However, sulfur dioxide serve as inhibitor. Therefore, there is a need to study the process of purification of industrial gas emissions with participation of chlorophyilsynthesizing microalgae in the presence of carbon dioxide, which is equivalent to the study of the effect of sulphur dioxide on photosynthesis [5].

Substances which are able to inhibit the enzymatic reaction are called inhibitors.

Inhibitors which reduce the activity of enzymes on condition of interaction with the same functional groups of active centers as a substrates are called competitive. Inhibitors which reduce the enzyme activity under condition of interaction with other functional groups, are called noncompetitive. Competitive inhibition can be reduced or even eliminated by increasing the concentration of the substrate. In the noncompetitive inhibition the substrate concentration is not affected [6].

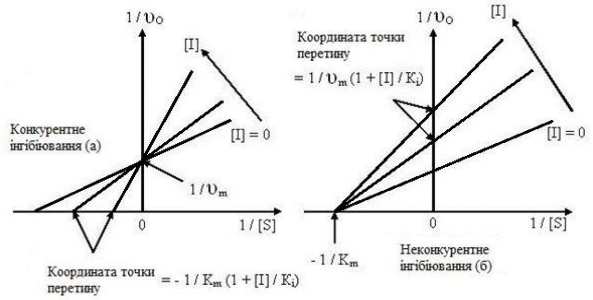

Fig. 1. Lineweaver – Burk plot for competitive (a) and noncompetitive (b) inhibition according to the literature [6].

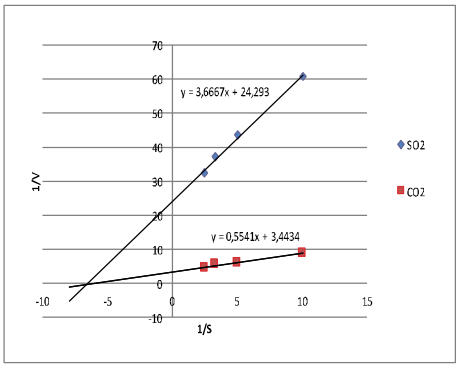

Fig. 2. Lineweaver – Burk plot for determination of type of sulfur dioxide inhibition.

According to our experimental data the sulfur dioxide significantly effects the kinetics of the growth of microalgae, which confirms the assumption that sulfur dioxide serve as an inhibitor. According to the obtained experimental data was constructed the Lineweaver – Burk plot in the coordinates 1/S 1/V (Fig. 2)

Comparing literature data, namely, Lineweaver – Burk plot (Fig. 1.) with the experimental schedule (Fig. 2.) it is important to note the similarity obtained direct lines(Fig.1.(b)) , so it is reasonable to assume that there is a non-competitive inhibition.

Conclusion

The influence of sulphur dioxide on the process of carbon dioxide absorption by chlorophyilsynthesizing microalgae was studied. The results of experimental research to study the dynamics of absorption of carbon dioxide gas from microalgae provided the presence of sulfur dioxide in it.The existence of non-competitive inhibition by sulphur dioxide the process of photosynthesis by chlorophyilsynthesizing microalgae was theoretically justified on the basis of the Lineweaver – Burk theory and experimentally proved. Therefore it is possible to control the absorption of carbon dioxide in the presence of sulfur dioxide.

References

[1] V. V. Dyachok, S. I. Huhlych, O.B. Levko “To study the influence of temperature on the kinetics of absorption of carbon dioxide by microalgae”, No. 812, P. 365-372, 2015.

[2] O. V. Stecenko R.P. Vynogradova “Bioorganic chemistry” K.: High School, 1992, p. 102.

[3] V. V. Dyachok “Extraction process of intracellular substance. Chemistry & chamical technology”, Vol. 4. – No. 2. P. 163-167, 2010

[4] Encyclopedia "Plants of the World", 2009-2014. Access to the encyclopedia: http://roslunu.com.ua/v/45/

[5] A.N. Polovyy “Modelyuvannya diffusion resistance towards CO_2 molecules in green leaf”, Odessa: Herald, 2009, p. 300

[6] S. D. Varfolomyeyev, S. V. Kalyuzhny “Biotechnology. Kinetic foundations microbiological processes”, Moscow: High School, 1999, p. 102

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