The spectral polarimetric control of phytoplankton in photobioreactor of the wastewater treatment

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ABSTRACT

Given structure of spectral-polarimetric system controls the concentration of phytoplankton in the photobioreactor wastewater treatment for controlling the work of photobioreactor and increase the productivity of biomass.

Keywords: phytoplankton, biomass, waste water

1. INTRODUCTION

Rapid population growth in urban areas leads to increasing amounts of wastes of human origin. A considerable part of them are biogenic organic wastes that enter wastewater. This leads to deterioration of the ecological status of water bodies and the gradual reduction of water quality. Ponds overgrow with lots of macrophytes and are covered with silt. The concentration of phytoplankton in natural waters is growing, level of oxygen in water decreases, which dramatically reduces the level of dissolved oxygen and leads to death of fish and other aquatic organisms. A major problem is the supply of urban population with drinkable water.

2. SYSTEM FOR BIOLOGICAL WASTEWATER TREATMENT USING PHOTO-BIOREACTOR

Nutrients discharged into the wastewater can be a fuel for phytoplankton in photo-bioreactors for water cleansing. Block diagram of wastewater treatment systems based on photo-bioreactor is shown in Figure 1.

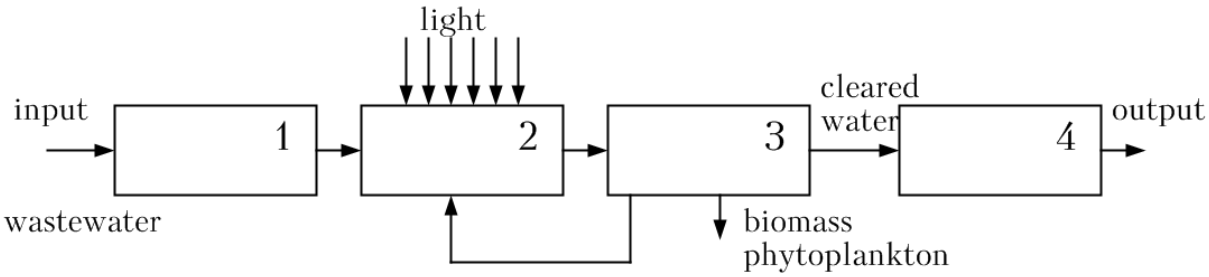

Figure1. Wastewater treatment systems based on photo-bioreactor.

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Wastewater shall be poured in a pool 1 where decomposition of organic matter by aerobic bacteria takes place. To intensify the process of cleaning, a pool filled with plastic filler with a large surface area that is filled with aerobic bacteria. Then the sewage get into the photo-bioreactor with phytoplankton 2. Under the influence of light and nutrients, the amount of biomass of phytoplankton in a photo-bioreactor increases. Then absorption of carbon dioxide and release of oxygen takes place. Removal of phytoplankton biomass from the water can be carried out by separators and filters 3. Purified waste water goes through the fish and household pool used for bioindication of water quality. Since fish can bioaccumulate toxic substances, then analyzing the contents of their internal organs may evaluate the integral level of toxicity of wastewater over a period of time.

When creating the optimal conditions one may get more than 100 tons of biomass of phytoplankton from one hectare a year, the amount of phytoplankton biomass in the bioreactor increases in several times a day. This overcomes any other crops used for biofuel. Different types of phytoplankton have certain features in their use in photo-bioreactor. Selection of the required culture of phytoplankton is quite a challenge. Following factors should be taken into account.

Each species of phytoplankton has its own optimal temperature range. There is about 50 .. 300 types of phytoplankton in natural waters according to their ecological status. The better ecological status of water, the more biodiverse aquatic organisms in it. During the year, temperatures in the reservoir changes, leading to a sharp increase in concentration of certain species. Thus they begin to crowd out of water other types of ecosystems. Therefore, for use in photo-bioreactor should be taken those kinds of phytoplankton, that has optimum temperatures for most of the year. In addition, please note that the phytoplankton can be used for food additives, biofuels, biogas and others. Since phytoplankton absorbs not only nutrients, but toxic substances and accumulate them through bioaccumulation, its use as food additives is limited. Phytoplankton for producing biofuels or biogas should chosen the way that will get the larger amount of biomass and, consequently, biofuel. In this case, promising to use is Blue-green algae. They have extremely high resistance to pollutants and toxic substances that may be present in sewage. Also Blue-green algae create an environment for growing in symbiosis with other groups of microorganisms. As a result, mixed culture can make full or partial degradation of complex organic compounds, including herbicides and pesticides, petroleum products etc.

The objective of this work is to control the concentration of phytoplankton in the photo-bioreactor to create optimal conditions for obtaining the maximum amount of its biomass.

3. ANALYSIS METHODS OF CONCENTRATION CONTROL OF PHYTOPLANKTON

There are a number of experimental methods to control the concentration of particles of phytoplankton. Conductometric method based on measuring the electrical resistance of individual particles in flow devices. This method is sensitive enough to identify the different types of particles with high probability. Photometric method is the most common laboratory method of monitoring the concentration of particles of phytoplankton. Using this method for quantitative estimation of parameters secondary particles of phytoplankton, but to analyze the properties of individual particles is impossible. To investigate phytoplankton widely used scanning flow cytometry, which is a feature of the study of particles in a thin stream created by hydro-focusing head. The overall lack of flow of scanning flow cytometry which measure the scattering indicatrix of individual particles during their motion in the flow by capillary cuvette is a small size range of particles, which can investigate. In addition, the properties of particles of complex shape and internal structure is difficult to determine their scattering indicatrix. The main advantage of such technology analysis of single particles are high speed and versatility of technology and lack of distortion of phytoplankton particles of complex shape in their motion. To investigate phytoplankton particles are widely used methods of automated microscopy with image processing particles of phytoplankton, the definition of geometrical parameters and identification using neuro-processor.

4. THE SPECTRAL-POLARIMETRIC METHOD OF CONTROL OF THE PHYTOPLANKTON CONCENTRATION

Use The proposed method for controlling the concentration of phytoplankton particles is comparable array spectral-polarimetric images of particles obtained in vitro using the CCD camera developed in the controls (Fig. 2). Of characteristic wavelengths of pigments in the specified positions and angles of polarizer analyzer, which allows more

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reliably identify them, determine the volume concentration and quantitative correlation between certain types of particles[1].

Automated tool works as follows. Water particles with different sizes of phytoplankton enters the mixer 26 and shared a set of filters with pores of different diameters 271 ... 27n on the flow of particles of a certain size, which are received in the flow measuring cell 13 corresponding measuring channel 281 ... 28n. Radiation from a light source enters the monochromator 2, the wavelength is fixed stepper motor 3 according to the values characteristic wavelength pigments in phytoplankton particles. More radiation passes through the fiber-optic waveguide 4, 5 and polarizer compensator 8, the rotation angles are set rotary device (6, 9), which rotate by stepper motors (7, 10), respectively. More radiation is running water measuring cuvette 13 with a thin layer of phytoplankton study. Before the experiment, flow measuring cuvette 13 standard solution is washed by flushing pump 11.

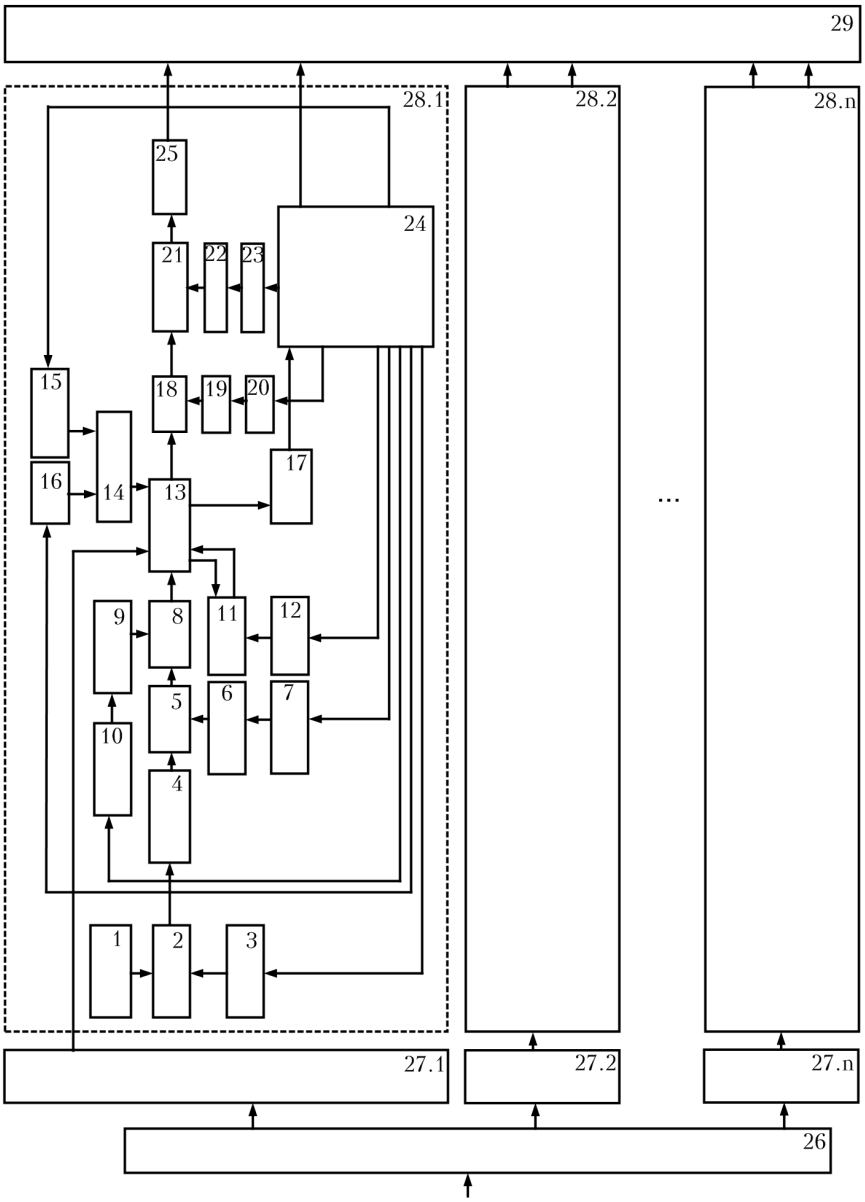

Figure 2. Block diagram of automated means to control the concentration of phytoplankton.

Flow measuring cuvette 13 is placed on the stage of the microscope 14 and can move by stepper motors (15, 16) in the directions X and Y. To ensure stability and repeatability of test flow measuring cuvette 13 is placed in a thermostat 17. More radiation passes through the analyzer 18, the rotation angle is set rotary device 19 by means of stepper motor 20.

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Increase spectral-polarimetric images of phytoplankton particles to size by using an optical microscope system 21. Autofocus microscope by means of AF 22 and stepper motor 23. Control unit 24 Stepping motor provides the necessary control signals for stepper motors. Magnified image of a particle is fixed photodetectors (CCD-camera) 25 and transferred to a personal computer 29. Personal computer 29 by means of specialized software compares the received image with spectral-polarimetric sample and determine the correlation between particles of different species. The obtained correlation between particles of different species of phytoplankton to assess his condition. Number of measuring channels 28_1 ... 28_n and filters 27_1 ... 27_n defined conditions agreement depths of sharp images of space (depth of field) with particle size and thickness of flow measuring cuvette. Thus, if polydisperse aqueous medium to control the concentration of particles with the size $d_{\min} \ldots d_{\max}$, you should use the following number of measuring channels to each of them to provide the conditions for depth of field images of particles and a resolution.

5. CONCLUSION

The method and means of control can efficiently control the concentration of phytoplankton in the photo-bioreactor wastewater treatment plants, and can be used to assess the status of water bodies based on bioindication by phytoplankton and complex human impacts on aquatic ecosystems. With the proposed controls can maintain optimal mode photo-bioreactor wastewater treatment plant that will provide the maximum possible amount of phytoplankton biomass.

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