

Disposal Methods for Cyanobacteria and Blue-Green Algae In Stagnant Waters

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***Abstract:** The contribution deals with the problems of pollution stagnant water cyanobacteria and blue-green algae and their revitalization. It presents the authors carried out an analysis of currently available methods of minimizing respectively eliminates the occurrence of cyanobacteria. Emphasis is placed on mechanical, chemical, biological and electrolytic methods for revitalizing stagnant water. The contribution also presented by the authors designed and patented methods for minimizing the occurrence of cyanobacteria in standing water.*

***Keywords:** blue-green algae, eutrophication, cyanobacteria, methods, water flower*

1 Introduction - Problem Definition

The directive of the European Union and various international conventions is an emphasis on preserving the ecological quality of water [3]. One of the serious problems observes these conditions, eutrophication of waters. Eutrophication is the enrichment of water by nutrients, especially nitrogen and phosphorus, leading to excellent conditions for overgrowth plankton (Fig. 1) and thus the cyanobacteria and blue-green algae (Fig. 2). There are two types of eutrophication and natural when the water receiving nutrients from the soil, bodies from the dead organisms, or artificial, where the excess water by nutrients enrichment can the human factor [2]. In both cases occurs overgrowth of algae and cyanobacteria, which has a negative impact not only on aquatic flora as well as fauna. The high content of nutrients leads to an infringement natural environment and the creation of water blooms on the surface (e.g. species of the genus *Microcystis*, *Anabaena* and *Planktothrix*), what is accompanied by just an overabundance of cyanobacteria [3].

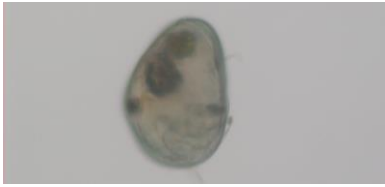


Figure 1

Plankton

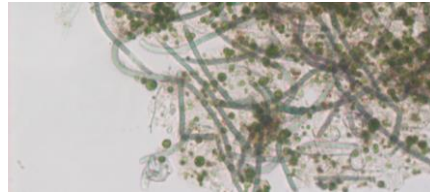


Figure 2

The fibers of cyanobacteria and blue-green algae

The mechanisms that lead to eutrophication are comprehensive and mutually interconnected. Its main cause is the high supply of nutrients into the water body, resulting in an unbalance food chain and the high concentration of the biomass of phytoplankton in the affected layer of water [1]. This condition can lead to the formation of water flower (Fig. 3), whose direct results in excessive consumption of oxygen close to the bottom of the water body. Other factors supporting this process can be divided into two categories depending on whether they are associated with the dispersion of nutrients and growth of the phytoplankton, or the cycles of oxygen in the water layers close to the bottom (limited circulation of oxygen, light, water movement). Depending on the degree of eutrophication can be observed even other adverse effects. At there is a disturbance of the ecosystem loss of biodiversity caused by the increasing content of toxins produced by cyanobacteria. The most serious side effects of eutrophication consider to oxygen deficit, reduction of biodiversity and produce cyanotoxins. [6]

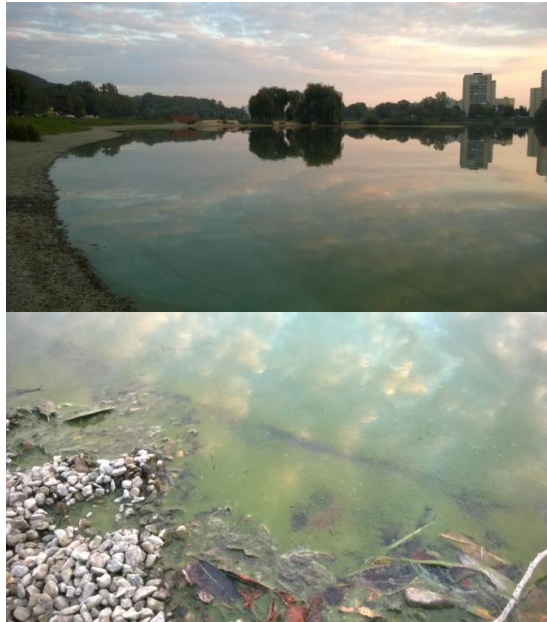


Figure 3

Water flower on the lake in Košice - city district Nad Jazerom

When ecosystem disruptions due to eutrophication occurs not only to the impoverishment of biodiversity but also to a reduction in water quality due to increased levels of toxins called cyanotoxins. Due to eutrophication then it occurs in an aqueous medium to three undesirable practices:

- oxygen deficit.
- the reduction of biodiversity,
- produce cyanotoxins.

To address these problems gained Department of process and environmental engineering and the Department of Industrial Engineering and Management, Mechanical Engineering, Technical University of Kosice prostedok of non-repayable European funds for structural development in the amount of 460,750 €.

2 Project Defining, Strategic and Specific Objectives of the Project

The project is aimed at further development and application of patented technology to improving the environment of the EU, for the needs of its implementation in practice, in solving problems of eutrophication of stagnant water.

The strategic objective of the project is to modernize and streamlining the system of aid for research and development, and improving the infrastructure of universities in order to contribute to improving the competitiveness of the economy, reducing regional disparities, the emergence of new innovative (high-tech) small and medium-sized enterprises, creating new jobs and improving the conditions educational process at universities.

The specific objective of of the project is the extension and modification of the patented technology, that leads to reducing the incidence of cyanobacteria in standing water, through the cooperation of individual departments of the Technical University and the Department of Botany at Institute of of Biology and Ecology, Pavol Jozef Šafárik University in Košice.

Activities of the project stem from the fact that in the previous period similar problems at Faculty of Mechanical Engineering, Technical University of Kosice already addressed, especially for practice and related to the elimination of waste water. At the departments of the faculty are historically developed documents concerning the necessary prerequisites for addressing of the objectives of the project, which is necessary to combine meaningful unit / design experience, construction of new facilities, electrolytic methods, spectrometric and colorimetric measurements and the like. There is a quality technical base, experience with electrolytic treatment method and these can be used to project objectives. It is well as on the technical and design documentation, laboratory equipment, and the like.

Methodology of this activity is based on the knowledge base of scientific research base of participants, concerning the use of graphic manuals, software, and knowledge of the norms, laws and solutions to environmental problems. Methodically will be processed technical documentation, graphics and drawing means shall be accompanied by the necessary changes to the application of existing facilities in practice, and used the know-how of participants and so far experience of previous research projects.

Benefits arising from this activity consists primarily of initiating scientific research experience, mainly water management construction preparation technology equipment, which shall bring new knowledge and these will contribute to increasing scientific research potential, not only the research team. Measurable impact here will be a scientific treatise about the results and long-term effects of

space technology the emergence of new applications similarly of this method as it was at its inception. Their number planned in 2017.

3 Description of Laboratory Experiments

Laboratory experiments to influence of electrolysis microscopic life in the water, we have transferred to a small electrolytic facilities where visual observation process elektroflotacion on a sample of water from the dam Čaña (not far from Košice). Test shall has transferred for about 15 minutes at a voltage of 24 V. The effect came about 10 minutes after the time when the floated material created on the surface (Fig. 4) with a certain characteristic thickness. After a further 5 minutes, the fleets of water samples collected by hand and clearly observed clear water deprived of vegetation coloring (Fig. 4). [4, 5]

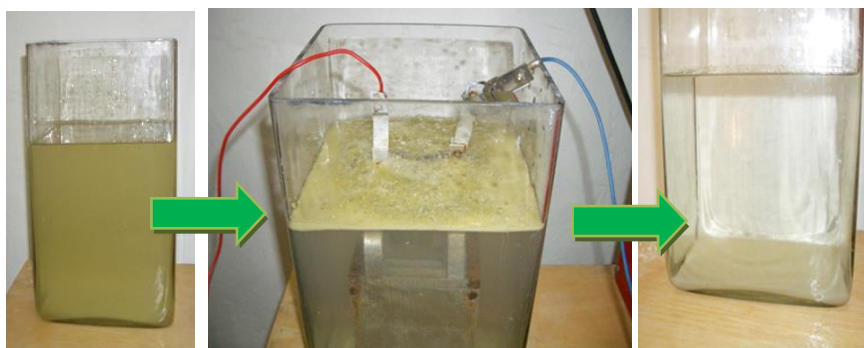


Figure 4

Laboratory Electrodes, inlet water, the emergence of flotts and Water clarification [4]

A device for the disposal of cyanobacteria comprises transparent 70 l vessel, two types of electrodes and a DC power source. Sheet electrodes were placed in a holder that allows you to change the type of material of electrodes, their distance and their involvement. In the experiment, we used two kinds of electrode material and steel and aluminum sheets. Metal electrodes were of dimensions 230 x 230 mm and a 2 mm sheet of Fe and Al 3 mm. Spacing of the electrodes were in the narrowest point 30 mm. Water samples and fleets at the outlet were collected continuously during electrolysis, the initial analysis has been carried out in real time on experimental work, OV and sludge samples were further analyzed by an accredited laboratory Ekolab Košice and on universal emission spectroscopy (Fig. 5 c)) with inductive coupled plasma.- ICPE - 9000 (Fig. 5 b)) the Department of

Process and Environmental Engineering, Faculty of Mechanical Engineering, Technical University of Kosice. [4, 5]

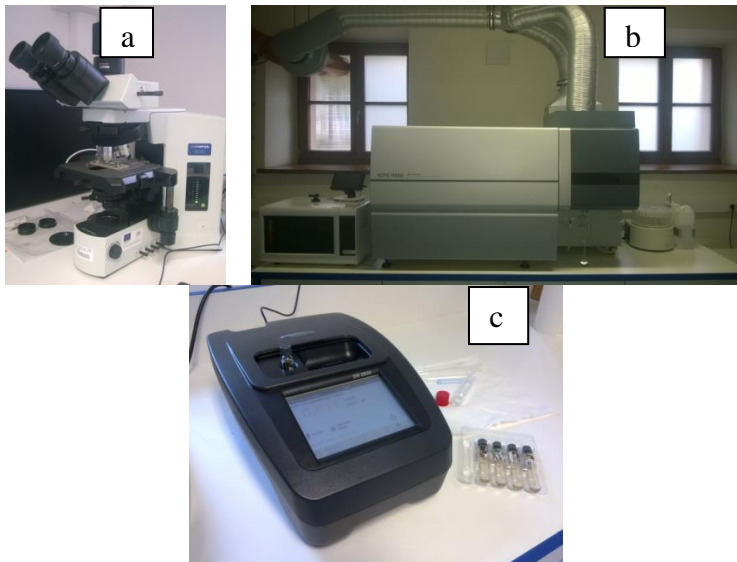


Figure 5

Technical laboratory equipment a) Mikroskop Olympus BX51-P, b) Plasma Analyser ICPE-9000, c) Spectrophotometer DR 2800

Disposed of cyanobacteria, which sedimented, we undergo to microscopic - Olympus BX51-P (Fig. 5 a)) observation and the results are observable in (Fig. 6 and Fig. 7).

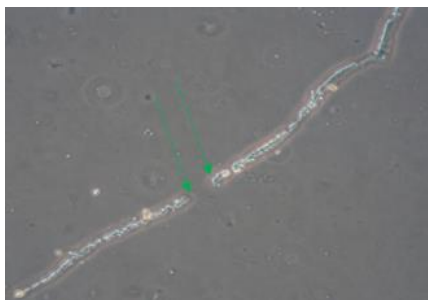


Figure 6

Rupture filamentous cyanobacteria

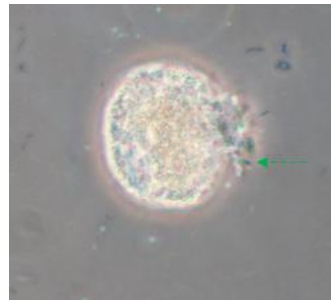


Figure 7

Rupture cell algae

4 Description Exterior Experiment

The exteriors were used in early experiments star-electrodes (Fig. 8), fed from a stationary DC (For WPL 200) power source voltage of 24 V for a month (Fig. 9). Cyanobacteria and algae flott the surface level of the pond. [4]

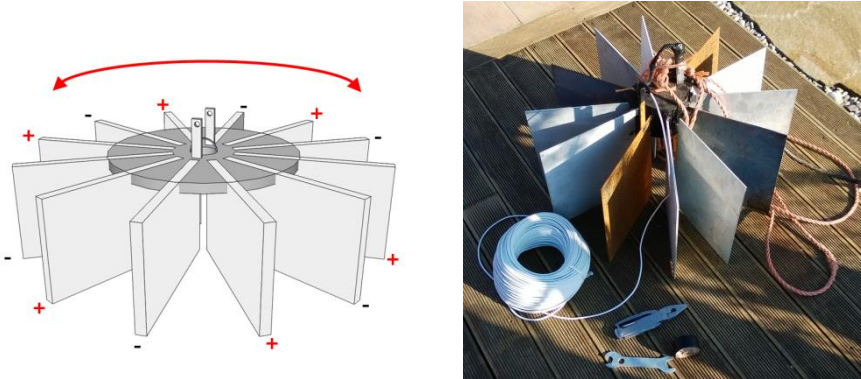


Figure 8

The design of the electrode, patent SR č.282797/2002



Figure 9

Star-electrode with the source and fleets outdoors lake in Rozhanovce

5 The Patented Method of Disposal Blooms in Stagnant Waters

The principle of the patented technology of "quattrolysis" is based on electrolysis using electrodes patented design, the effect of which there is a redox reaction, the flotation of organic materials and also the sedimentation effect flocculation of the electrode materials and thereby, generally in a reduction of soluble and suspended solids in the water and the reduction of chemical and biological oxygen demand. In experiments using two type of electrodes:

- Finish set of electrodes consisting of flat (sheet metal) electrodes arranged in (Fig. 10). perpendicular to the horizontal plane and oriented to the vertical axis of the board, the number of plates is even a link to alternately positive and negative terminals (see model).
- Lower set of electrodes are star-shaped, also consisting of a flat (metal) electrodes arranged in (Fig. 11). perpendicular to the horizontal plane and oriented to the vertical axis of the float, the number of plates is even a link to alternately positive and negative terminals (see the model and image of the assembly).

Uniqueness and innovativeness of the proposed device is that the electrodes thus imposed affect a large amount of standing water, extend electromagnetic field (Huygens principle) over long distances, mutual filming it reinforced.

A device for the disposal of blooms in standing water in a patented solutions for the float structure, serving to hold the two types of bipolar electrodes (1 and 6) under the water and comprises a support float (5), ribs (4), the exploitation of wind energy (9), water pump (2), the discharge pipe (3), the upper float (7), grid electrodes (6), photovoltaic cells (8) Suspension electrode (1) and an electrical power source - the alternator (10). The supporting the float (5) is a hollow body in which are located at the bottom of the cascade stages the dirt. Method of disposal of blooms in stagnant waters is based on quattrolysis cyanobacteria electroflott disposal method.

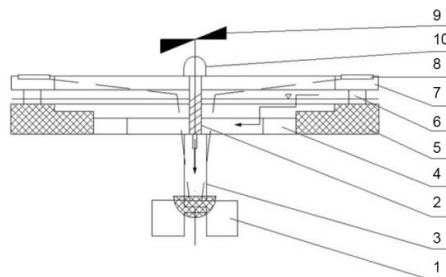


Figure 10

The device for the disposal of cyanobacteria in stagnant waters

The real design differs somewhat from the patented construction, it is easier, the upper electrode has a set of two pairs of electrodes of the steel sheets and the star-shaped lower arm of the real distance according to the depth in the lake water. 3D is the solution to (Fig. 11).

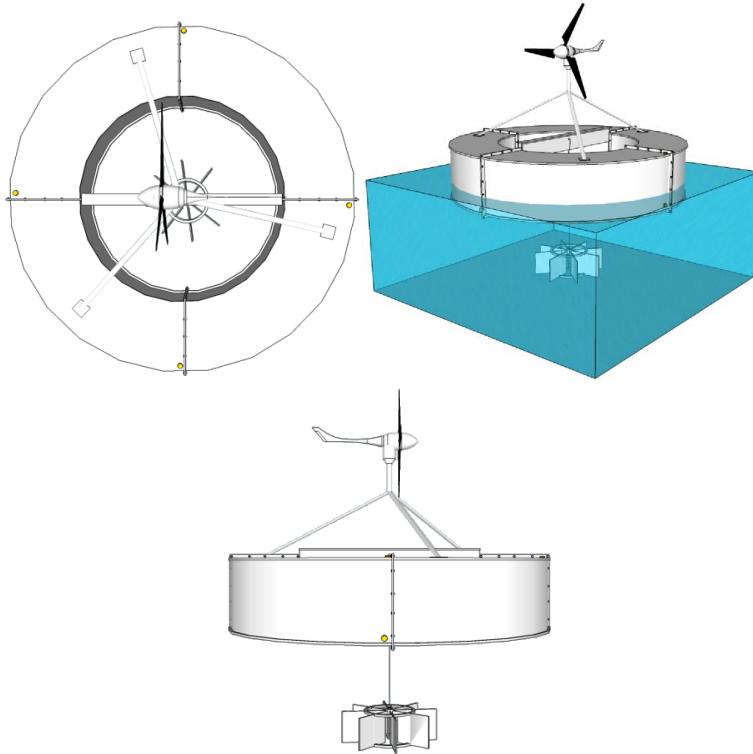


Figure 11

Draft design and patented float shape

The real solution to the float and the effect of electrodes is on (Fig. 12). Flott algae and cyanobacteria are kept mainly in the central part of the float, around the float often disappear due to wind and movement rippled water surface, sediment and water is clarified.

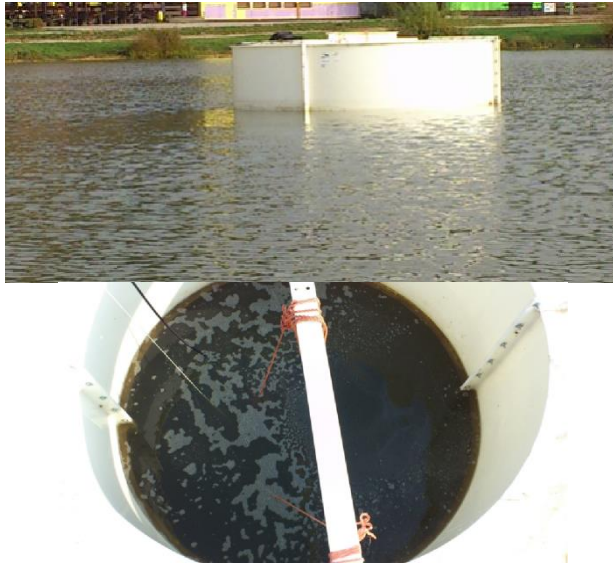


Figure 12

Real solutions and fleet float above the electrodes

The collection surface flottate after quattrolysis effect of the electrodes has been designed catamaran device (Fig. 13). The design of the catamaran consist of: floats, belt press, belt press frame and solar panels, cartridges for batteries, electric motor control unit, the electric belt press, collection container, seats and electric propulsion catamaran.

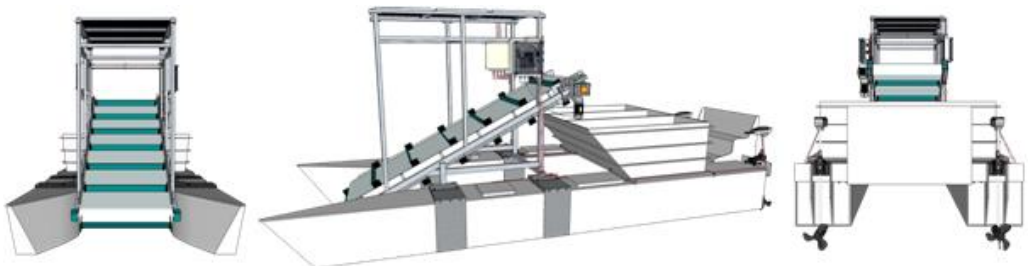


Figure 13

Draft design catamaran device



Figure 14

The real solution catamaran device

To transport catamarans was constructed a special dolly (Fig. 15), structural elements: jaws, solar panels, float, save battery, connection floats with belt frame, tracked list, snatcher cyanobacteria, container, seat, electric drive, frame solar panels and belt press, electric motor, control unit.

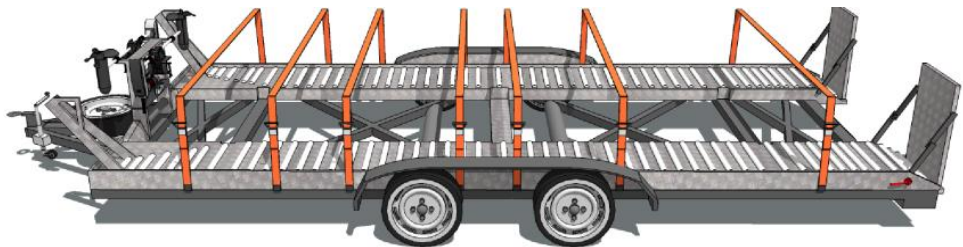


Figure 15

Graphics 3D view trailers for transporting catamaran device

6 The Results of Measurements

The course of the cyanobacteria in the analysed sites measured by Regional Institute of Public Health Košice in Slovakia, which shows (Fig. 16). From these measured values it is clear that the research stagnant waters had rich occurrence of cyanobacteria and algae, caused mainly by climatic conditions.

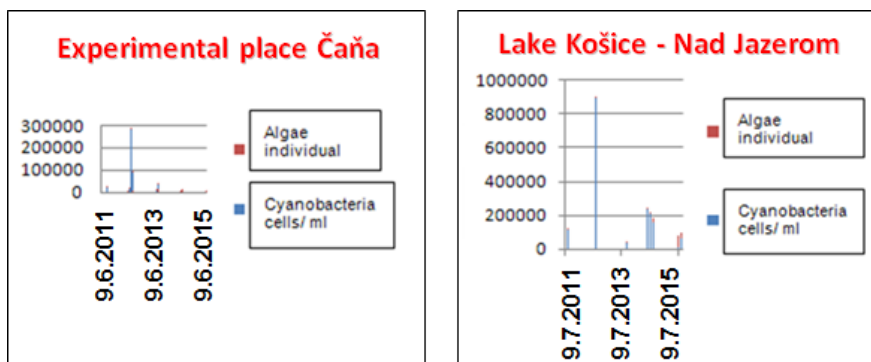


Figure 16

The course of cyanobacteria in the analyzed sites measured by Institute

Fig. 17 shows a single drop of cyanobacteria in standing water lake MC Juh Košice after months of exposure quattrollysis methods on a lake borough Košice over the lake. When microscopic analysis of vital functions of cyanobacteria have been found significant damage to the membrane of one cell algae (Fig. 7) And filamentous cyanobacteria thinning. (Fig. 6). Measurement of electrical potential was at stationary sources of direct electrical current evaluated at different distances from the electrodes. Values tightly to the electrodes showed a decrease from 40 V nominal voltage at the source at 12 V, but at a distance up to 88 meters was reduced voltage drop only to 10.8 V. the above facts give the assumption quattrollysis methods and applications on larger bodies of water, at a safe voltage and long-term effects of the order of several months.

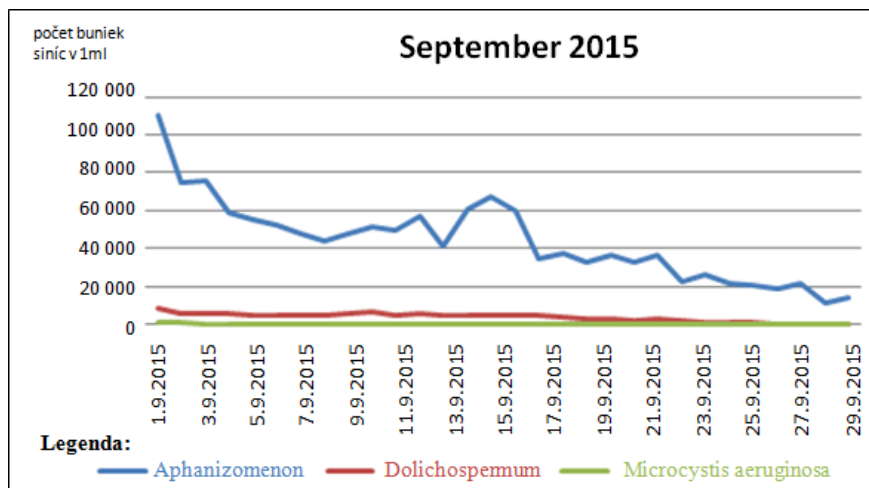


Figure 17

Graphical display of individual species of cyanobacteria

7 Conclusion

Find an appropriate technical solution for the elimination of cyanobacteria in stagnant waters to meet the hygiene standards laid down for recreational purposes, it is a big problem. In the future, it will be deal yet many scientific and professional institutions that will endeavor to limit the growth of cyanobacteria improvement in application methods, techniques and hydrological interventions. When choosing a particular procedure or method is necessary based not only on their availability but also the requirements for their efficiency, the growth of cyanobacteria in a given environment as well as financial performance. Since the presence of cyanobacteria in the summer months has become a global problem and got into the general public consciousness in connection with occurrence of so-called. water flowers of cyanobacteria, this problem over the last decade still relevant and regularly hyped. Water blooms in our water reservoirs threat for water utilities and summer vacationers. Adverse effect represent the water reservoirs that serve as source of drinking water or for recreational or sporting purposes.

That laboratory experiments and outdoor measurements give a promising basis for implementation quattrolysis methods of disposal of blooms in different conditions of eutrophic waters. The size, design and number of devices in the deployment after waterfront is subject to further examination, as well as their impact on the overall microlife in water. From current knowledge, the said methods are non-invasive, without any chemical or biological effects, which moderates the effect of long-term historical burdens and eliminate damage to the environment. Currently, the experimentally observed economic aspects and long-term impact methods for life in the water tank.

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