

# Implementation of Technology Concept for the Reduction of Cyanobacteria in Laboratory

D. Šebo, M. Fedorčáková

**Abstract**—Following the research in the Department of environmental engineering in Faculty of mechanical engineering on Technical University of Kosice and experiences with electrocoagulation style of disposal waste water, there were designed and partly examining the equipment of two stage revitalization on the standing and little fusible water of tenet electrolysis on the little tams. With the cooperation with vet experts was that manners prove and it is innocuous for animals, during which time cyanobacteria are totally paralyzed. For the implementation of science and research results have been obtained by means EU funds for structural development.

**Keywords**—Cyanobacteria, Equipment, Pollution, Stagnant Water, Technology

## I. INTRODUCTION

POLLUTION of standing and slowly flowing waters is a world-wide problem. First of all, the pollutants from the agricultural and industry get into the water, like heavy metals, nitrates and oil substances. Just nitrites besides own toxicity induce also uncontrolled accumulation/ appearance of cyanobacteria, which are for the people toxic and there is also devaluation of water even for bath. Abnormal quantity of nitrogen and phosphorus is the basic symbol of changing the color of surface water, usually on the greenish color, when it is the vegetation coloring. The situation, when the algae are a huge amount formed on the water table and it makes the water bloom. Eutrophication, which is connected with overproduction of algae, degrades the water quality. In the lower parts of the water, where the dead organisms are sink, there is a degradation with the big influence of the low concentration of the oxygen. The conditions for anaerobic process are created. The secondary pollution is mainly from the sulphide, ammoniac, iron and manganese. After the destruction of the compounds of nitrogen and phosphorus, they remain in the water and can support the reproduction and increase production of algae. Eutrophication except the nitrogen and phosphorus in the water is also demanded on the organic substances and of the carbon oxide in the water. Phosphorus is unfavorably presented in the concentration of centimes of mg.l-1, in case of the nitrogen there are concentration of decimals of mg.l-1.

Eutrophication depends on the flow of water and also on temperature stratification. The process of making organic substances is seasonal, with the spring and summer maximum. Eutrophication has negative influence on the fishing and on the recreation and it is not only the aesthetic value of coloring water [1], but also of the hygienic aspects (exanthema on the skin of bathing people).

## II. THE NEED FOR DISPOSAL FACILITIES TO SOLVE GLOBAL PROBLEMS

The occurrence of cyanobacteria in standing water is a global problem for several years. The reason is the development of cyanobacteria in large numbers in summer and autumn period, which pollute surface water. Increased attention is due to the negative effects that occurs massive overgrowth of cyanobacteria. As a result of the proliferation process of eutrophication, which causes excessive nutrient enrichment of water. Overgrowth of cyanobacteria to create a water bloom, which is a major problem in stagnant waters. Prevents water, fish farming and recreational use of stagnant water. In addition to adverse effects with the use of stagnant water, the negative is also active in other organisms living in water bodies. Ability of the water is blue-green algae bloom in the chemical and physical properties of water and release dangerous toxins. These toxic substances are hazardous to human health as well as for individual dwelling organisms in the environment.

## III. THE CURRENT STATE OF THE PROBLEM

Nowadays, many methods available for the disposal of cyanobacteria. Methods and techniques of combating and eliminating water bloom based on mechanical, chemical, biological and electrolytic principle. Mechanical equipment used to remove sediments show low efficiency and their application is expensive. The chemical disposal is undesirable amount of chemical concentrations of disadvantage, which can cause negative effects on other organisms. Its only use prevents or limits the amount of cyanobacteria.

The shortcomings of these methods eliminates the electrolytic method of disarming, whose principle is electrolytic flotation. This physico-chemical process, the principle is the separation of suspended solids in the sample, the observed surface water. A lot of pollutants of standing waters are also situated in Slovakia and especially on eastern Slovakia. The inspiration for proposed project was the application of biological-mechanical equipment float frame presented on environmental show IFAT in Düsseldorf by Moscow University, though on biological principle.

Prof. Ing. Dušan Šebo, PhD. is with Technical University of Kosice, Department of Environmental Science, Park Komenského 8, 04200, Kosice, Slovakia, (phone: +421 55 6023241; e-mail: dusan.sebo@tuke.sk).

Ing. Monika Fedorčáková, PhD. was Technical University of Kosice, Department of Industrial Engineering and Management, Nemcovej 32, 04200, Kosice, Slovakia, (phone: +421 55 6023241; e-mail: monika.fedorcakova@tuke.sk).



Fig. 1 An overview of the largest water basin in Slovakia connected to the cyanobacteria occurrence in the growing season

#### IV. BACKGROUND OF THE PROPOSAL

We must constantly develop new efficient and effective ways to minimize eutrophication have already occurred. Equally important is a need to prevent or minimize further eutrophication of the waters.

Research institutes are trying to improve the techniques, methods and equipment and develop new ways that would become effective at the disposal of cyanobacteria. Project Implementation and modification of technology to reduce the occurrence of cyanobacteria in the backwaters conducted at the Technical University in Kosice is aimed at expanding existing technology eliminating cyanobacteria, which was successfully used to reduce eutrophication of stagnant water electrolysis-based methods for small water bodies and modify this and used for large bodies of water. It focuses on further development and application of existing patented technology to improve the quality of stagnant water and the need to implement technology into practice. The base solution is a patent solution of the Industrial Property Office (IPO SR) no. 282797/2002. Planned duration of project activities is 30 months, starting from 2010.

*This project aims to:*

- Development and application of the patented technology to improve the environment for the EU need to implement in practice.
- Modernization and streamlining of support for research, development and improvement of infrastructure of higher education (HE).
- Increasing the competitiveness of the economy.
- Reduction of regional disparities.
- Creation of new innovative SMEs.
- Creation of new jobs.
- Improvement of the educational process at universities.

*Other specific objectives of the project may include:*

- Adaptation of existing facilities to revitalize the stagnant water
- Extend their use to large bodies of water.
- Testing and verification of the proposed technology,
- Measurement of water parameters before and after treatment.

Experimental equipment will be tested on lakes near Kosice. Disposal of cyanobacteria will be conducted in the following stages:

- Radical operation electrolytic depth electrodes.
- Surface floated collection of cyanobacteria levels.
- Installation of equipment to float a separate power adapter.

These devices will be installed a long time on the water surface. With photovoltaic cells will be energy self-sufficient, thereby reducing energy consumption. These simple devices and their applicability will bring positive impact on aquatic ecosystems, human health and improve the hygienic condition of water bodies. Make and try out of equipment for more lakes are considerably expensive and especially for long term application Achieved effects are by [2] promising and waters itself seems uninfected as with the other technologies (mainly chemical treatment), which are also expensive.

The advantage of offered solution is also wide applicability of such equipment on full territory of the European Union, because there are a lot of listed troubleshooting standing waters. Project is for all that centered on development and examining of floating equipment with electrolytic device and also in hanging carrier for standing water which takes only a few hectares (ha). For more contaminated water we could use several equipment in parallel.

Works on the research project are planned into two phases. In the first phase the verification of effects of the equipment, this was developed on the Department of Environmental Science in Technical University of Kosice. The second phase is oriented on the development, production and verification of the floating equipment on the seasonal decreasing of cyanobacteria appearance and paralyzing of them in the standing waters. From the environmental point of view is the project an investment to the sustainable development. It has potential to improve the water quality and contribution to the development of the science and technology.

#### V. INFRASTRUCTURE FOR DEVELOPMENT OF THE EQUIPMENT

Technical infrastructure of the Department for the needs of project consists of technical equipment, which mostly consists of patented design of special electrodes, measuring technique to determine water-quality parameters and last but not least it consists of the software package to verify the operating complex in experiments. The cost of infrastructure will serve as the basis of scientific research and the educational structure of the newly formed activities, particularly for science and education center and also as the field for laboratory experiments. The laboratory should cover following activities: Construction activity and Laboratory activity.

First activity is provided by designers of mechanical and electrical equipments on the 3 major computer units in 2D and 3D designs with the possibility of visualizing the proposed solutions. A color plotter is also a part of the workplace and it is used for printing the documentation and the brochures of existing project. The office places with a minimum floor area of 20 m<sup>2</sup> are necessary. Laboratory measurements will focus on the microscopic monitoring of cyanobacteria vitality before and after the experimental treatment, including the possibilities of making high-quality digital images on a microscope with magnification up to 1000 times of spotted object.

The second workplace will be the system of measuring the quality of water itself, especially it will handle with the basic water characteristics like BOD, total nitrogen, phosphorus and also insoluble substances. The laboratory table devices are necessary to realize these activities. The estimated surface area of the laboratory should not overreach 20 m<sup>2</sup>.

#### VI. NEED PRODUCTION OF SPECIAL EQUIPMENT

This activity aims to produce the parts of laboratory and experimental equipment that are the objects of patent rights or that have a specific shape. It is concerned mainly with parts of floats, electronic equipment, remote controls, etc. These parts will be used also for repairs of existing machines and equipment, which was damaged during the operation (e.g. damaged shell float, breakdown in electrical equipment, etc.) The estimated area for this activity is 160 m<sup>2</sup> in total, mainly by reason of the size of catamarans, floats and electrodes. There were not clearly identified areas of the laboratory at the time of project preparation. That is the reason why we design the layout of laboratory according to the figure 2. The location of individual rooms, also linking of machines, equipment and individual workplaces are illustrated on the picture. The layout of workplace respects the linking of various activities and these activities complement one another. In the case the whole area will not be available; it is possible to situate the construction and laboratory separately, but with a computer network connection. The laboratory activities are proposed to two separated workplaces: Construction workplace and Laboratory of aquatic organisms. The structural preparation of equipment in aid of realized project is focused mostly on structural development, drawing the plans of individual arrangements, drawing the production plans of individual parts and interactive 3D version with the possibility of shooting angles. This workplace will also include the drawing of normative pictures for patented documentation. In regard of expected qualification of designers and technical equipment of the workplace, it is possible to deliberate the other commercial contracts on the base of economic activity.

This workplace is for experimental devices, their construction and the measurement results of individual application. The measurement results and their values are signals for correction of particular solutions, mostly for the construction of the electrodes, floats and catamarans, which do not have to be optimal in the original design.

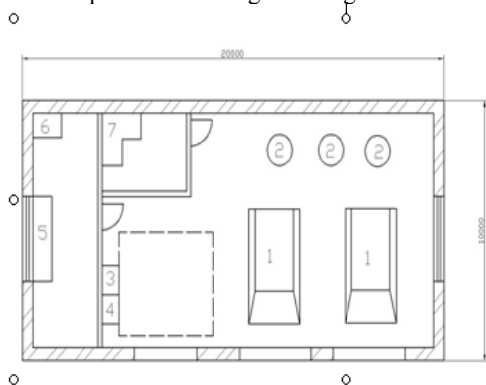


Fig. 2 The layout of the laboratory

One of the main goals of the station is to have the ability to distinguish the microbes in stagnant water, as algae, cyanobacteria and other water animals in mutual relation (e.g. the effects of electrolysis on water life, or possibly on humans).

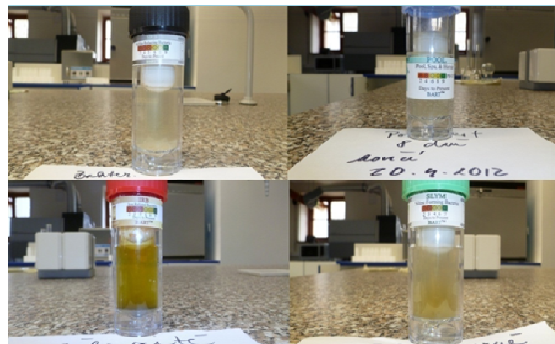


Fig. 3 Tested water samples

It is also important to monitor the individual water quality parameters and macro micro life on experimental water surface like figure 3.

The activities in this laboratory can be technologically characterized in the following categories: determine the number of KTJ bacteria, cyanobacteria, and pathogenic elements, determine the characteristics of water chemistry, measuring of quantitative characteristics of undesirable substances in water, measuring the adhesion of organic flatters on the collectors, determine the ways of treating the organic fleet. All these activities / stations give also a place for education of students, especially those on the second and third stage of university studies. On the figure 4 we can see already purchased equipment which serve for the activities mentioned above.



Fig. 4 Electrolytic reactor

#### VII. CONCLUSION

Minimize the impacts of eutrophication of surface waters is a complex problem not only in Slovakia, whose solution is not easy, but it is necessary to implement measures that can contribute to minimizing the impact of these water bodies. You must constantly develop new more effective and efficient methods for their disposal, to share information about development if it will serve as a laboratory which is devoted to the contribution in question. The laboratory and its equipment will be used for implementation of the consultation, taking water samples, measure water quality with the parties concerned.

## ACKNOWLEDGEMENT

This contribution is the result of the project implementation: "Implementation and modification of technology to reduce the occurrence of cyanobacteria in stagnant waters" ITMS: 26220220028, supported by the Research & Development Operational Program funded by the ERDD and by research grant VEGA 1/0102/11 Methods and techniques of experimental modeling of production and nonproductive processes in enterprises.

## REFERENCES

- [1] Šebo, D., Stavnikovičová, D., Frimer, R.: Equipment for disposal of cyanobacteria in standing waters. In: Konferencija Obdržavanja "Kod 2008", Zbornik radova, Tivat, 2008, Podgorica, Univerzitet Crna Gora, p. 195-200,
- [2] Badida, M., Majernik, M., Sebo, D., Hodolič, J.: Engineering and manufacturing environment, Košice, Vienau, 2001, ISBN 80-7099-695-1, in Slovak,
- [3] Bendiková, M.: Eutrophication of small reservoirs. In: I. international conference: Small waterworks alternative energy sources, Košice, Litera, 2001, p. 85-90, ISBN 80-232-0205-7, in Slovak,
- [4] Horecká, M., Nagy, V., Head, J.: Cyanobacterial water blooms in recreational waters, Slovakia, Czech Phycology, Olomouc, p. 175-182, 2004, in Slovak,
- [5] The Slovak Environmental Agency. The organization of the Ministry of Environment. Enviromagazín 5/2009. Status of surface waters of Slovakia. [online] [cited 2012-01-04]. Available at: [http://www.sazp.sk/slovak/periodika/enviromagazin/enviro2009/enviro5/05\\_stav.pdf](http://www.sazp.sk/slovak/periodika/enviromagazin/enviro2009/enviro5/05_stav.pdf), in Slovak,
- [6] Water Research Institute. State subsidized organization run by the Ministry of Environment. Status of water and water management problems in the basins of Slovakia. [online] [cited 2012-01-04]. Available at: [http://www.vuvh.sk/download/VaV/Vystupy/Stav\\_vod\\_a\\_VPvPS\\_Info\\_rmacna\\_brozura.pdf](http://www.vuvh.sk/download/VaV/Vystupy/Stav_vod_a_VPvPS_Info_rmacna_brozura.pdf), in Slovak,
- [7] Water Research Institute. State subsidized organization run by the Ministry of Environment. Proceedings. Counting cyanobacteria and algae on the chamber. [online] [cited 2012-03-05]. Available at: [www.vuvh.sk/download/kniznica/zborniky/zb.../hlubikova.doc](http://www.vuvh.sk/download/kniznica/zborniky/zb.../hlubikova.doc), in Slovak.

**Prof. Ing. Dušan Sebo, PhD.**, Member of the Scientific Editorial Board of the International Conference Flexible Technology MMA Fakultet tehničkih science, Novi Sad, Serbia, [www.ns.ac.yu/start/mma/internet\\_srpski.htm](http://www.ns.ac.yu/start/mma/internet_srpski.htm), a member of the international scientific editorial board: Journal of production engineering, ISSN 1821-4932, member of the commission for the defense of candidate and doctoral theses since 1993, a qualified person to assess the impact of activities on the environment according to § 42 of the Act. No. 127/1994 Z.z. Assessment of environmental impact in the field - the field of action under § 9 of the Decree of the Ministry of Environment SR no. 52/1995 Z.z. in Branch: 2T technology, 2m waste management, from the date of 15.08.1996 and many other features resulting from nearly 50 years at the Technical University in Kosice, is currently a professor with all requirements.

**Ing. Monika Fedorčáková, PhD.**, in 2003 began work as a lecturer at Faculty of Mechanical Engineering since 2009 and is devoted to research in the Department of Industrial Engineering and Management, where he now works as a science educator. While at the university is involved in the provision of various objects. He is author or co-author of study materials, 39 scientific articles and publications listed in the collections of scientific papers in conference proceedings, 7 of them abroad. Under her leadership, has been defended 8 and 11 master's thesis. It is co-organized international conference "Trends in corporate governance systems." Participates in the preparation of solutions and VEGA, KEGA, ASRD, ESF and HC. Principal subjects / occupational skills are Environmental sciences, statistical analysis.