UDC 628.168

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PREVENTION OF BIOFOULING OF INDUSTRIAL REVERSE WATER SUPPLY SYSTEMS BY PLASMA WATER TREATMENT

Reagent-free methods of biofouling prevention in reverse water supply systems are of the utmost interest. It is a specific class of process techniques, which should include the physical methods based on preliminary treatment of reverse cycle water with ultrasonic vibrations, UV radiation, electrolysis, vacuum treatment, etc. At the same time, new modern methods based on advances in high-energy chemistry find practical application in the technology of water treatment. Among these are radiolysis and methods based on electric discharges of various types (spark, quiet, barrier discharges); each of them makes a certain energy contribution to biofouling prevention in the process pipelines of recirculated water supply systems. The processes of pre-treatment of aqueous media with low-temperature non-equilibrium contact plasma are of particular interest. Scientific works in this domain have been conducted for the last few years in the plasma process laboratory of USUCT. Previous studies showed that the use of NCP (non-equilibrium contact plasma) for treatment of water from various reservoirs could solve a number of problems of water treatment for industrial purposes, since the basis of such processes is the accumulation of reactive particles, radicals, peroxide and superoxide compounds in the aqueous medium, combined with the action of UV radiation and classical electrolysis.

First of all, studies of water samples of the Dnipro River as a main source of water intake of industrial enterprises located on its banks, were conducted. The experiments were carried out in duplicate. Comparison samples and those exposed to NCP were held for 12 months. 1 l glass bottles filled with water taken from the natural sources (as a reference) and bottles with the same water after

its plasma treatment were placed so that part of them stayed in the natural light in normal daily mode, while the other part was in the darkness at the constant temperature, close to 18°C. Samples of the Dnipro water were treated at the following parameters of contact plasma: current *I*=80-100 mA, voltage *U*=550-600 V in accordance with the recommendations given in [ ]. In the course of plasma treatment of samples, the changes of pH factor and concentration of peroxide compounds in the aqueous media were recorded.

Apart from zooglea bacteria, fouling in the reverse cycle is represented also by nematodes and oligochaetes, rotifers, infusorias, and a large number of the protozoans and algae (diatom, green and blue-green algae). Thread-like iron bacteria are often growing in water supply pipes, and such growth significantly reduces the pipes' capacity or causes their complete blockage. *Leptothrix orchaceae* are more common in pipes. Unicellular iron bacteria in the form of individual cells and mucous zooglea, various species of *Siderocapsa* and *Sideromonas*, can be found there as well. Gallionellas (*Gallionella ferruginea Ehrb*) are often found in water pipelines filled with water from underground sources. Furthermore, in case of severe contamination of water with organic compounds the fouling caused by various species of aquatic fungi may develop. The activity of bacteria in pipelines is often accompanied by the decrease in pH, which accelerates the corrosion processes. Inorganic compounds involved in the fouling are carbonates, phosphorus compounds and sulfur present in water. To a large extent, probability and intensity of the biofouling development is determined by the environmental conditions, i.e. physical and chemical properties of water. Thus, the underlying factors and sources of biofouling of the inner surfaces of pipelines deprived of penetrating light, as well as the surfaces of cooling towers in the conditions of the natural light, were identified. The behavior of biofouling is typical for the other sources of water intake without any additional treatment and after plasma treatment. The insignificant differences are observed in case of studying samples taken from slow-moving/small rivers, where the level of contamination with various species of bacteria and microorganisms is slightly higher than, for example, in the Dnipro River. These differences do not change the general picture of the degree of biofouling in the recirculated water supply systems, which is a

criterion for the viability of using NCP for the conditioning of industrial water at food factories and in other branches of industry, first of all, from the natural reservoir such as the Dnipro River. The studies found that as a result of contact action of non-equilibrium plasma on water samples taken from different sources, irreversible processes occurred in the liquid medium, which affected the properties and composition of water.

The mechanism of chemical transformations in such system is described in detail in [1,2]. Results of studies indicate that plasmochemical treatment of water inhibits the process of active development of algae within the closed and open process facilities.

Therefore, in the process of use of non-equilibrium contact plasma for treatment of the aquatic environments, it is possible to solve a number of important systemic problems of the provision of industrial production with high-quality return water, increase in the level of operation of process equipment, and reduction of water consumption for heat-exchange processes and pollution of external water basins after removal of return water from the process cycle.

References

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UDC 556: 550.8.05.

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CHANGE OF HYDRODYNAMIC STATE WITHIN THE KILIYA DISTRICT OF ODESSA REGION

In recent years, due to global cataclysms on the planet, much attention has been paid to the study of the harmful effects of water. The concept itself refers to important environmental, socio-economic problems that require constant attention and solutions, includes three