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ECOLOGY AND ENVIRONMENTAL PROTECTION TECHNOLOGIES

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PROPOSALS TO IMPROVE THE TECHNOLOGY OF URBAN WASTEWATER TREATMENT FACILITIES

The main source of pollution of water bodies are enterprises that receive wastewater after use in industrial facilities and in everyday life. Anthropogenic impact changes the quality of natural water in surface and groundwater, which further serve as sources of water supply. The imperfection of the technological mode of operation of biological treatment facilities leads to periodic violations of the conditions of their work. This causes contaminants to enter the water body. Therefore, there is an urgent need to increase the efficiency of biological treatment facilities through measures that will ensure compliance with environmental requirements for urban wastewater treatment.

Many scientists are involved in ensuring the quality of wastewater treatment. They offer various ways to overcome the environmental problem associated with the ingress of untreated wastewater into water bodies:

– reducing the load on water by improving production technologies that transmit large amounts of water use [1];
– equipment upgrades and reagent applications [2];
– modification or change of cleaning technology [3].

Scientists also include a lot of attention to the issue of forecasting wastewater treatment [4], which confirms the relevance of research in the areas. The aim of the work is to increase the efficiency of biological treatment facilities, which consist of the system «aeration tank-displacer - secondary settling tank».

To achieve this goal you need:

– analyze the features of wastewater treatment that enters the treatment plant;
– identify factors that affect the cleaning process;
– propose measures to increase the efficiency of biological treatment facilities;
– justify the feasibility of the proposed measures.

As a result of the analysis of the peculiarities of the system «aeration tank-displacer - secondary settling tank» [5-6] it was determined that the main influence on the operation of

structures has the concentration of activated sludge, air volume and properties of wastewater entering treatment. Taking into account these indicators, it is proposed to regulate the ratio of «sewage - active sludge - air» and change the efficiency of biological treatment. This will help protect the environment from contamination by insufficiently treated or untreated wastewater.

To build a mathematical model, the factors that have the greatest impact on the mode of operation of the system «aeration tank - secondary settling tank» are identified. The analysis of the peculiarities of the process showed that such factors are the consumption of wastewater coming for treatment, the efficiency of saturation of the mixture of activated sludge and wastewater with oxygen, the quantity and quality of activated sludge fed into the aeration tank. The peculiarities of the processes that take place at different stages and in different parts of the buildings are also taken into account. To control the course of the treatment process at different stages, the following parameters were selected: consumption and concentration of contaminants in wastewater entering treatment, consumption and concentration of activated sludge, the intensity of aeration of the mixture. To build a mathematical model, changes in these indicators were studied and sampling sites were selected. Processing the results of the experiment made it possible to obtain a regression equation *(1)*:

$$y_{st} = 3.61333 + 0.08833 \cdot x_1 + 1.05167 \cdot x_2 - \\ -0.065 \cdot \mathrm{x}_1^2 - 0.025 \cdot \mathrm{x}_2^2 - 0.225 \cdot \mathrm{x}_1 \cdot \mathrm{x}_2 \quad (1)$$

Equation *(1)* describes the dependence of the sludge concentration on the consumption of return sludge supplied to the aeration tank regenerator and on the dose of sludge entering the regeneration.

The following indicators were used to assess the quality of wastewater treatment at the outlet of biological treatment facilities: consumption and concentration of pollutants in wastewater; concentration of activated sludge; air supply intensity. According to the results of the experiment, the regression equation is obtained *(2)*:

$$y_2 = 0.01736 - 0.00063 \cdot x_3 - 0.00107 \cdot x_4 - 0.00429 \cdot x_5 + 0.0009 \cdot x_6 - \\ -0.00027 \cdot x_3^2 - 0.00227 \cdot x_4^2 + 0.00198 \cdot x_5^2 + 0.00397 \cdot x_6^2 + 0.00006 \cdot x_3 \cdot x_4 - \\ -0.00069 \cdot x_3 \cdot x_5 - 0.00044 \cdot x_3 \cdot x_6 + 0.00181 \cdot x_4 \cdot x_5 - 0.00194 \cdot x_4 \cdot x_6 - \\ -0.00094 \cdot \mathrm{x}_5 \cdot \mathrm{x}_6 \quad (2)$$

The influence of the parameters included in equation (2) on the change in the concentration of contaminants at the outlet of biological treatment plants is shown in fig. 1. Equations *(1)* and *(2)* allow to obtain numerical values of parameters, to study the behavior of individual components that affect the process of biological treatment of a mixture of wastewater from domestic and industrial consumers.

To comply with environmental requirements for the operation of the system «aeration tank-displacer - secondary settling tank», which is designed to treat a mixture of domestic and industrial wastewater, measures are proposed to ensure compliance with environmental requirements for biological treatment facilities. These measures include changes in the organization of facilities for specific operating conditions.

The paper proposes to use empirical dependences (1) and (2) on the basis of the obtained data of laboratory researches (characteristics of sewage at the entrance to the aeration tank, activated sludge, consumption of sewage and activated sludge, aeration intensity). Based on the results of the calculation, it is proposed to quickly adjust the ratio of «wastewater - activated sludge - air». This will allow to obtain the concentration of pollutants at the exit from the buildings not higher than the maximum allowable values and to comply with environmental requirements.

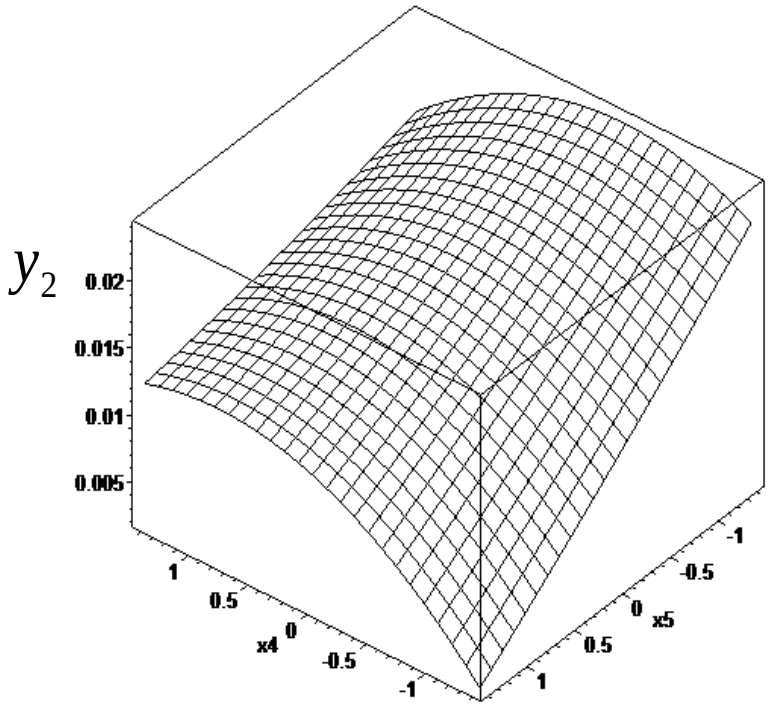

Fig. 1. **Change in the concentration of pollutants in purified water (y_2) depending on the intensity of air supply (x_4) and wastewater consumption (x_5)**

The task is solved on the basis of assessing the quality of treated water at the outlet of biological treatment plants. After that, changes in the technological mode of its operation by adjusting the flow rate of sludge fed to the regenerator of the aeration tank and the intensity of aeration are proposed. This ensures that the concentrations of contaminants in the treated water at the outlet of the buildings do not exceed the maximum allowable values, the concentration of sludge in this case meets the norm. The final decision on the choice of technological mode of operation of aeration tanks belongs to the technologist of the cleaning complex. The sequence of the proposed order is presented in the form of an algorithm of four blocks. The first block analyzes the initial data on wastewater from mechanical treatment, activated sludge and aeration intensity, and calculates it using a computer program. The second block - record the results of the calculation. The third block - to compare the results, the fourth ¬ to draw a conclusion about the need to change the mode of operation of facilities.

Conclusions. The practical significance of the proposed measures is the ability to reduce the negative environmental impact of biological treatment plants on the environment. The measures proposed in the paper can be used at different stages of design, reconstruction or operation of buildings. Their use allows you to monitor the state of the wastewater treatment process; make an informed decision to change the regime of wastewater supply for treatment; to increase the ecological safety of water bodies and with minimal financial costs to protect water bodies into which wastewater is discharged after treatment, from pollution by insufficiently treated wastewater.

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