CHARACTERISTICS OF A BIOFILM ON A CARRIER FOR WASTEWATER TREATMENT

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Abstract

The research investigates the characteristics of a biofilm formed on a carrier for use in the processes of domestic wastewater treatment. The aim of the study was to determine the quantitative indicators of biomass immobilized on the carrier surface. It was found that the average concentration of biomass on the carrier surface reached 5425 mg/dm³. The results obtained indicate the prospects of using the studied carrier for effective wastewater treatment.

Keywords*: biofilm, wastewater treatment, carrier, biotechnology*

Introduction. Due to the optimal choice of a carrier for the immobilization of microorganisms, considering the specific conditions of microbial transformation of organic substances contained in wastewater, the carrier can actively influence the environment, stimulate microbial metabolism, protect cells from adverse factors and contribute to the long-term preservation of their biochemical activity. The choice of a carrier for biofilm formation is a critical factor, as the carrier affects the optimal biofilm thickness, biomass growth, and biodegradation efficiency of pollutants of various nature [1, 2].

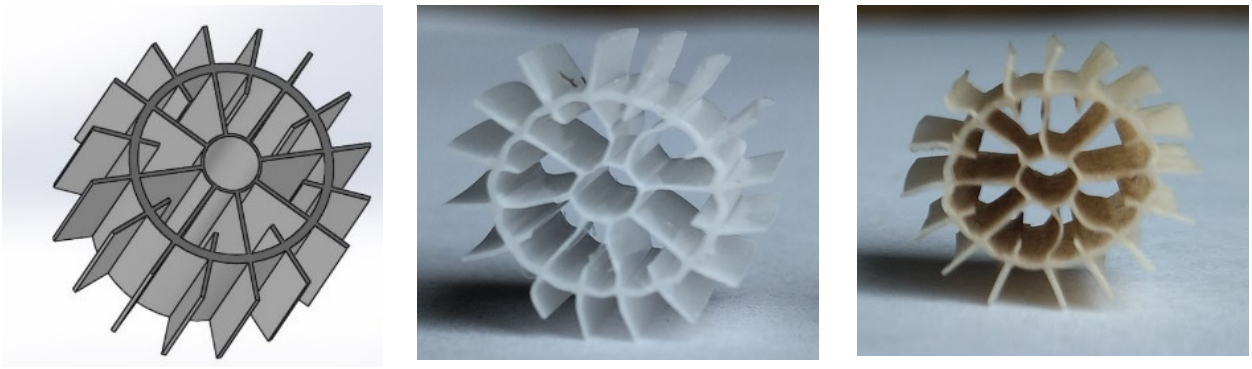
The nature of microbial cells in activated sludge favors their attachment and aggregation on hard surfaces. In addition, the retention of slowly growing nitrifying colonies in the form of a biofilm in a bioreactor increases the efficiency of wastewater treatment. A biofilm can be defined as a biocenosis of microorganisms consisting of bacteria, protozoa and fungi living together on a solid surface. These microorganisms are responsible for the production of extracellular polymeric substances (EPS) that serve to stabilize the microbial community and promote the adsorption and accumulation of a variety of organic and inorganic substances, including pesticides, chlorophenols, polycyclic aromatic hydrocarbons, and heavy metal ions. The metabolic activity, elasticity, strength, diffusivity, porosity, and density of a biofilm are determined by the main components of the EPS, such as lipids, nucleic acids, proteins, and polysaccharides [2, 3].

The aim of this work is to determine the characteristics of the biofilm on the carrier studied for wastewater treatment.

Materials and methods. The study was conducted at the Department of Bioenergy, Bioinformatics and Ecobiotechnology of Igor Sikorsky Kyiv Polytechnic Institute. For the research, we used a carrier for immobilizing microorganisms provided by Fiberika LLC, according to the contract Dndch/22.00/98/25 of 05.03.2025.

For the study of biofilm, to treat domestic wastewater formed on the carrier, a bioreactor with a working volume of 4.2 dm^3 was used to provide small-bubble aeration using Resun AIR 3000 compressors. The model solution was added to the bioreactor daily with a BOD:N:P ratio of 100:5:1 to maintain microorganisms and activated sludge once on the first day of the experiment. The test lasted 15 days in three replicates. A spherical carrier with a diameter of 9.95 mm was used (Fig. 1, a, b). Data processing was performed using Microsoft Excel and R.

Results and discussion. We studied such characteristics of the biofilm as the concentration of biomass immobilized on the surface of the carrier, the specific biomass per unit surface area, for the treatment of domestic wastewater (Fig. 1, c).



a) b) c)

Fig. 1 The studied carrier: a) - 3D model of the carrier; b) photo of a dry clean carrier; c) photo of the carrier dried with biomass.

As a result, it was found that the average concentration of biomass immobilized on the surface of the carrier was 5425 ± 10 mg/dm^3. The specific biomass per unit area of the carrier surface was 0.83 ± 0.06 mg/cm^2.

The high concentration of biomass on the carrier can be explained by the highly developed outer surface of the carrier – the surface area of one element is measured to be 20.83 ± 0.5 cm^2, the complex configuration of the carrier element (many partitions, ribs on the outer and inner surfaces of the wheel – Fig. 1), small size and a large number of elements in the bioreactor volume – 350 pcs.

Conclusions. Thus, the studied media can be used in moving bed biofilm reactor systems (MBBR) for effective wastewater treatment, as well as for improving the operation of aeration tanks by modernizing them – creating zones with media in their volume to increase the efficiency of wastewater treatment from organic matter, nitrogen compounds, especially at the stage of nitrification, and phosphorus compounds.

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