The influence of hydrodynamic conditions in bioreactor with activated sludge on the morphological properties of sludge flocs and the characteristics of eukaryotic organisms communities

Proper realization of the wastewater treatment process in bioreactors with activated sludge is possible only in if the existence of appropriate size and shape of activated sludge flocs as well as composition of biocenosis of organisms conducting wastewater treatment processes is ensured. The course of the treatment process is significantly affected by the appropriate degree of mixing of wastewater with the flocculent suspension of microorganisms. Properly selected parameters of the mixing and aeration system also improve the structure of flocs affecting their sedimentation capacity. Hence, the mixing system in a bioreactor with activated sludge should provide the level of turbulence that causes complete homogenization of the reactor volume, and does not tear or fragment the activated sludge flocs. An important role in the assessment of hydrodynamic conditions in bioreactors, in the opinion of the authors of the project, can be played by the bioindication studies of activated sludge relating to the observed specific reactions of individual species of organisms to the changing hydraulic conditions in the bioreactor. On their basis, a kind of biomarkers indicating irregularities and inadequate homogenization within the reaction chambers can be distinguished.

The project is aimed at determining the interrelationships between the hydrodynamic conditions in activated sludge bioreactors as well as the morphological properties of flocs and groupings of eukaryotic organisms. Establishing these relationships will enable to develop the guidelines for creating a method of biomarkers and indices of floc structure that assess the hydrodynamic conditions in activated sludge bioreactors. Identification of markers would consist in checking the changes in the abundance of easily identifiable and distinguishable protozoan species normally included in the biocenosis of activated sludge flocs, occurring as a result of hydrodynamic conditions imposed by the action of mechanical stirrers. Such markers would enable to test the response of populations to aeration and agitation system designs that are changed during process optimization.

In order to achieve this goal, on the basis of the analysis of the composition of eukaryotic organisms in the activated sludge, the selected microorganisms will be characterized and their quantitative changes will be determined during the experiment conducted under varying hydrodynamic conditions (governed by the design of the mixing and aeration system, rotational speed of the stirrer, method of introduction and size of air bubbles). The data on individual species of eukaryotic organisms will be analyzed by means of structure indices allowing for the assessment of the changes occurring in the composition of the entire community. The research will also result in a detailed characterization of activated sludge flocs formed under different hydrodynamic conditions inside the bioreactor, including floc size ranges, nuclear density of size distribution, distribution structure, circularity, and fractal dimension. All the afore-mentioned parameters of the process medium will be related to the sedimentation properties of the sludge and the quality of treated wastewater, in particular the level of suspended solids and the turbidity of the bioreactor effluent.

The proposed project covers important issues related to the analysis of the process agent of biological wastewater treatment – activated sludge. It relates to the assessment of stability and effectiveness of bioreactor performance as well as leads to the development of methods for detecting the early symptoms of process failure situations. The obtained research results will contribute to bridging the knowledge gaps on the influence of hydrodynamic conditions in bioreactors arising from mechanical stirring on the morphology of activated sludge flocs and the composition of eukaryotic organism communities. The research will provide unique information on the changes in the abundance of indicator species.