

BIOINDICATION PROCEDURES SUPPORTED WITH ELECTRONIC SENSES FOR ANALYSIS AND CONTROL OF WASTEWATER TREATMENT PROCESSES

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Control of technological processes carried out in individual devices of wastewater treatment plants (WWTPs), and in particular within bioreactors with a living process factor, can be carried out using various research methods. It may be based on the results of tests of physical and chemical parameters (e.g. TSS, TOC, BOD, COD, biogenic compounds, etc.), as well as the results of biological tests, which are the basis of the bioindication method. Biological tests in WWTPs are most often carried out to assess the parameters of activated sludge or biofilm, predict the quality of treated sewage, and detect the causes of disruptions to processes conducted in bioreactors. Hence, most of the studies described in the literature concern bioindication studies carried out in the biological part of the WWTP. However, it should be remembered that treatment plants consist not only of bioreactors with activated sludge or biological bed, but also include other devices that change the properties of treated wastewater. Taking into account the fact that the surfaces of all treatment plant devices in contact with sewage are covered with a specific biofilm (pecton), the properties of which are related to local conditions, this formation also can be used for bioindication purposes. Mentioned biological formation comprises assemblages of organisms spontaneously inhabiting the available surfaces, without intentional actions of the object operator, and sometimes even against such actions. The term pecton was taken from the work by R. Margalef, 1947 (*Collectanea Botánica*, 15(1): 247-259), used for distinguishing the biofilm which develops on a solid inanimate substrate coming into contact with the wastewater in WWTP objects, without being a biofilm understood as a process factor of biochemical processes of treatment. In such meaning, pecton developing in consecutive devices of a WWTP can be understood as tantamount to the periphyton in polluted surface watercourse in the consecutive stages of a natural process of water self-purification. Therefore, taking the advantage of the presence of organism assemblages in the form of pecton in devices, they can be used for bioindication in all points in main treatment line in WWTP, similarly as in the case of the studies on the water quality in inland surface water bodies, where individual populations of organisms or entire communities are used as indicators of the level of pollution or the stage of self-purification of water. Measures characterizing communities (e.g. a measure of diversity based on entropy adopted from the description of the operation of tele-informatics systems) calculated on the basis of the number of individuals within morphological groups or particular species can be treated as indicators of wastewater quality, as well as the stage and stability of the treatment process. However, bioindication procedures require qualified specialists who can quickly and effectively identify individuals taken into account during analyzes and assign them to appropriate sets that together create multidimensional data structures. The procedures for localization and identification of organisms can also be carried out using computer vision techniques, for example those based on deep neural networks. The mentioned supervised machine learning method combined with an image acquisition device (digital camera) and the optical system of a microscope is an example of the application electronic eye in procedures of WWTP processes supervise. For validation of results could be used classical pollution indicators (e.g. TSS, TOC, BOD, COD, etc.), but also electronic tongue and electronic nose pre-calibrated for this indicators.