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## **Reduction of water quality variations in the dispersed distribution system of the City of Poznań**

### **Abstract**

The task of water supply companies is to produce and supply consumers with drinking water that maintains a consistently high quality and biological stability regardless of the distance of the abstraction point from the water treatment plant (WTP). In order to develop an appropriate strategy to maintain low abundance of heterotrophic bacteria in the extensive water distribution system (DWDS) of the city of Poznań, comprehensive studies were carried out in this study to identify the microorganisms building biological membranes on the inner walls of pipelines, to determine their metabolic activity and source of origin, and to assess their resistance to disinfectants. The study was carried out both under model conditions, on a semi-technical scale, and on an actual water supply network. Under model conditions, biofilms were generated on plastic pipes supplied with water after individual unit processes. The results were compared with those obtained for biofilms taken from pipes in long-term operation in the actual distribution network of the city of Poznań. The biofilms were analysed by microscopic evaluation (SEM), next-generation sequencing (NGS), amplification of bacterial 16s rRNA gene sequences to determine their species affiliation (PCR) and cytometric analysis. The results showed that all biofilms (model and real) were dominated by bacteria from the Pseudomonadaceae and Bacillaceae families, naturally occurring in the raw waters entering WTPs, and that their abundance and metabolic activity was strongly related to the process flow. After unit processes using disinfectants and/or disinfecting agents, virtually no viable microorganisms were recorded in the membranes, but there was a significant increase in the proportion of fractions with intermediate metabolic activity, representing partially damaged microorganisms capable of secondary multiplication under favourable environmental conditions. Analysis of the biofilms isolated from DWDS showed that they are mainly composed of microorganisms introduced into the network with the treated water, and that both active cells and cells with intermediate metabolic activity, as well as dead cells, are present in their structure. The availability of nutrients, under-concentration or periodic disappearance of residual disinfectant in the transferred water, and, less frequently, irregularities related to the operational work carried out at the WTPs, were assumed to be the main reasons for the occurrence of well-developed biofilms on the pipe walls. The results

obtained in this study made it possible to formulate technological guidelines and instructions for proceeding during the replacement of filter beds at WTPs limiting the generation of stress conditions for bed-bound bacteria, which will reduce the number of bacteria introduced to the DWDS, and to introduce changes to the developed water disinfection strategy based on maintaining a constant, low and limiting the secondary growth of microorganisms in water throughout the dispersed distribution system of the city of Poznań.

**Keywords:** drinking water distribution systems, psychrophilic bacteria, biofilm, drinking water, biological stability of water, disinfection