Popular science summary

Industrial facilities, waste management as well as municipal and industrial wastewater treatment are the main sources of volatile organic compounds (VOCs) emissions to the atmosphere. Very often these are odorous compounds. Odors evoke a sense of danger and can be the cause of negative psychosomatic symptoms. For this reason, the emission of odoriferous gases into the atmosphere is increasingly significant social and environmental problem. There are four main methods of air deodorization, including combustion, adsorption, absorption and biological methods. One of the biological methods of air deodorization is biofiltration. Due to the low operating costs, high purification efficiency of large amounts of gases containing relatively low concentrations odorous compounds and the ability to completely decompose the removed compounds (which does not shift the problem of pollution to another part of the environment), biofiltration is considered one of the most favorable method of deodorization. The biofiltration process involves the degradation of pollutants by bacteria or other microorganisms found in the biofilm, formed on the surface of the elements of the filter bed. An important limitation of using this method is the relatively low efficiency of hydrophobic compounds removal, due to their limited availability to microorganisms. There are several ways to increase the efficiency of hydrophobic VOC biofiltration, including by the addition of a surfactant, the use of two-phase bioreactors or pre-treatment with UV radiation. Interestingly, research indicates that there is a possibility of improving the efficiency of removing hydrophobic compounds by adding hydrophilic compounds. This approach can achieve the effect of “waste treatment with waste”, e.g. when waste gases of different composition are mixed together and the biofiltration efficiency is higher than for single gas stream. The goal of this project will be to investigate the mechanisms of the influence of the addition of ethanol (hydrophilic compound) on the effectiveness of removing selected hydrophobic compounds (hexane, cyclohexane and toluene) in a biofilter with a trickled bed packed with polyurethane foam and inoculated with a consortium of fungi. Biotrickling filters, compared to conventional ones, are characterized by more stable operation and the possibility of more complete process control. In turn, fungi, due to their morphological structure, show higher removal efficiency of hydrophobic compounds than bacteria, and also show greater ability to survive adverse conditions (e.g. low pH). The implementation of the goal will include determining the performance characteristics of biofilters for individual hydrophobic compounds and their mixtures with ethanol. The efficiency of the process will be assessed by gas chromatography and electronic nose (continuous). Biofiltration studies will be supplemented with microbiological analysis of biofilms. The expected effects of the project include determining the mechanism of improved biofilter efficiency of air contaminated with hydrophobic compound vapors as a result of the addition of hydrophilic compound vapors. The obtained project results are supposed to answer the question about the reason for the improved removal of hydrophobic compounds: is this strengthening the result of increased growth of microorganisms caused by the presence of readily biodegradable ethanol, or is it due to changes in the composition of the purified gas, affecting mass transfer properties, i.e. causing easier penetration of compounds into microbiological biofilm.