Comparative analysis of olfactometric and electronic nose techniques in assessing biofilter efficiency for odor control

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Odor emissions are a significant problem because of their negative consequences for the environment, public health, and the quality of life of residents. Unpleasant odors can decrease air quality, leading to odor nuisance and adversely affecting the environment and people's quality of life. Waste management facilities such as landfills, composting plants, and waste processing plants are potentially significant sources of odor emissions. The decomposition of organic substances in waste generates gaseous chemical compounds responsible for unpleasant odors. Measuring the olfactory impact presents a challenge due to the subjective nature of odor perception by human individuals. Various methods exist for assessing odor emissions. These include chemical analysis of gas composition (e.g. GC-MS), sensor-based measurement of odorant concentrations, electronic noses, and evaluating the impact of odors on people through sensory studies (dynamic olfactometry). To determine the extent of impact, it is necessary to conduct mathematical dispersion modeling of odors in the air, based on emission measurement results, or carry out field studies to determine imission. The occurrence and degree of olfactory nuisance can be identified through sociological research, such as surveys or smell diaries. These should be confirmed by field studies of odor frequency and intensity, such as grid or plume measurements.

Seasonal variability in odor emissions, particularly the differences in odor intensity between summer and winter, is a significant aspect of air quality research. Increased biological activity often observed in the summer leads to intensified odor emissions from various waste management-related sources. This intensification may also be linked to the varying efficiency of gas treatment installations in reducing odors. Our study assessed the deodorization efficiency of two full-scale biofilters at a Waste Management Facility in southwestern Poland, focusing on both summer and winter seasons. The facility processes composting and fermentation gases, and we analyzed inlet and outlet samples from the biofilters. The methods used for analysis included dynamic olfactometry, GC-MS, GC-FID, gas sensors, a photoionization detector, and an electronic nose. For summer investigations, higher odor concentrations were recorded at the inlet and outlet of the biofilter for composting and amounted to 2397 ou/m^3 and 393 ou/m^3, respectively. For the biofilter for digestion, the concentrations were 785 ou/m^3 and 124 ou/m^3 at the biofilter inlet and outlet, respectively. These results align well with the odor concentrations indicated by the electronic nose, reinforcing the reliability of these measurements in our study. The sensors for NH_3 and H_2S indicated the presence of these gases but only at the inlets of both biofilters. Meanwhile, the PID detector exhibited presence of VOCs at both the inlets and outlets of the biofilters, with significantly higher concentrations at the inlets. Furthermore, analyses identified ethyl acetate as the primary VOC responsible for the perceived odors.

The results clearly indicate that both sensory and analytical methods are effective in assessing deodorization effectiveness. These methods should not be viewed as competing, but rather as complementary, providing maximum information about the odor samples analyzed. Additionally, in evaluating the efficiency of biofilters with natural media, examining the odor of the filter material itself can provide valuable additional information.

REFERENCES

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