Olfactometric and instrumental multidisciplinary investigations of odors and odorants at selected Waste Management Plant

Justyna Jońca[1], Urszula Miller[1], Marcin Pawnuk[1], Adalbert Arsen[2], and Izabela Sówka[1,*]

[1]Department of Environment Protection Engineering, Faculty of Environmental Engineering, Wroclaw University of Science and Technology, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

[2]calval.pl sp. z o.o., Emili Plater 7F/8, 65-395 Zielona Góra, Poland

The emission of odors from Waste Management Plants (WMPs) has led to societal concerns about the health and well-being of both the employees and the inhabitants of surrounding areas [1]. Consequently, minimizing unpleasant odors has become a critical objective in this sector. Equally important is the validation of the effectiveness of these odor reduction measures. Olfactometric investigations are the most commonly used approaches for examining odors. These methods are effective for assessing the concentration, intensity, frequency, character, and hedonic tone of odors, though they do not provide data about their chemical composition. On the other hand, instrumental techniques like GC-FID and gas sensors can quantify specific odorants but do not offer insight into the overall odor impact. An innovative approach involves utilizing electronic noses, which are capable of delivering partial insights into the chemical composition of odorous samples. Additionally, electronic noses can be configured to differentiate between various odor sources or to pinpoint the primary sources of odor at a specific location. Having all this in mind, olfactometric and instrumental methods should be regarded as complementary tools in odor analysis [2]. Such an approach was applied in a study of a selected Waste Management Plant, focusing on odors and odorants immission. Measurements were conducted in different periods (October and November 2022 and then, July and August 2023). The study utilized field investigations, field olfactometry, PID detector, and gas sensors (NH_3, H_2S) at all times. During the investigation in August 2023, an electronic nose was also used to obtain a high spatial resolution of the odor concentration at the site of interest. Additionally, GC-FID investigations were performed at selected points in order to achieve more details about Volatile Organic Compounds (VOCs) present at the site.

The odors identified on the premises of the WMP demonstrate relatively high intensity and frequency. An average odor intensity of 3 or greater (on a scale of 0-6) was recorded at nearly each examined point. At almost all measurement points, odor frequencies were 80% or higher. Similarly to the odor intensity, the average odor concentration on the site predominantly falls around the upper limit of detectability. In most of the measurement points, concentrations ranging from 22 to 78 ou/m³ were recorded, with half of these points being at the upper detection limit of the field olfactometer. Higher odor concentrations were observed at the municipal and green waste reception and sorting facility and the waste storage area. The use of an electronic nose confirmed these findings but also revealed that the odor concentration at selected measurement points is much higher than the upper limit of detectability of the used field olfactometer. Therefore, a field olfactometer capable of achieving higher dilutions is more accurate for these investigations.

Measurements with the specific sensors and PID detectors revealed that the VOCs are mainly responsible for the perceived odors. Indeed, as the total VOCs concentration increases, the odor concentration increases as well, reaching maximum concentration of 10 ppm at the municipal and green waste reception and sorting facility. At these points, odorants such as pentane, hexane, acetone, methanol, isopropanol, sec-butanol, isobutanol, and cumene were found. The Spearman's test gave the highest correlation coefficient between total VOCs and odor concentration equal to 0.79. The correlation coefficients may be further improved by the application of a field olfactometer capable of achieving higher dilutions. Meanwhile, the Spearmans' tests between odor concentration and H_2S and NH_3 concentration gave the correlation coefficient of 0.59 and 0.42, respectively.

In summary, the obtained results highlight the importance of applying several complementary approaches to achieve maximum information about the investigated odorous samples. Future work will focus on further use of the electronic nose for the selected site investigation in order to obtain a high spatial and temporal distribution of odor concentration.

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