NATIONAL INSTITUTE OF RESEARCH AND DEVELOPMENT FOR INDUSTRIAL ECOLOGY
ECOIND
EXCELLENCE IN RESEARCH AND ENVIRONMENTAL SERVICES

INTERNATIONAL SYMPOSIUM „THE ENVIRONMENT AND THE INDUSTRY" SIMI 2023

DETERMINING THE ODOUR EMISSION RATE FROM ACTIVE SURFACES SOURCES AND ESTIMATING THE ODOUR CONCENTRATION IN THE SURROUNDING AIR

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INTRODUCTION

Odour characterization and measurement has become a particularly important concern in recent years as people become increasingly aware of the impact of these odours on air quality and public health. In recent decades, several techniques and methods have been developed and studied to address this problem.

This work focuses on three essential aspects: odour sampling, emission rate estimation from active surface sources, and odour concentration assessment in ambient air. The main purpose of this work is to develop and apply the techniques available so far for estimating the odour emission rate from active surface sources and estimating the odour concentration in the ambient air using mathematical modeling. To make a significant contribution to the understanding and control of odour pollution, as it enables the direct measurement and assessment of the impact of odours on the environment and public health.

MATERIALS AND METHODS

Sampling of odour samples in this study was carried out in special nalophan bags, certified, using a vacuum sampling system type CSD-30 Olfasense 10 liters and a dedicated sampling hood, with a surface of coverage of 1 m^2 (Fig 1).

The sampling method involves dividing the surface of the biofilter into equal rectangles, having the size of the sampling areas. Next, a sufficient number of rectangles are selected, placed as evenly as possible, to cover at least 10% of the total area of the source. Odour gas samples must be collected in a specific sequence from the selected rectangles, one from each cell.

The larger the area of the sampled source, the more samples need to be taken for analysis.

To determine the odour concentration, a dynamic olfactometer (fig. 2) was used, which works as a high-accuracy diluter, and the human nose, respectively a group of 4 odour evaluators, is used as a detector.

The odour concentration was determined by the delayed dynamic olfactometry method, in compliance with the provisions of the SR EN 13725:2022 standard.

odour concentration, generally expressed as odour units by volume (OU_E/m^3) is numerically equal to the dilution factor of the sample required to reach the group-specific perception threshold, the minimum concentration perceived by 50% of the population of 1 OU_E/m^3.

Materials and equipment used

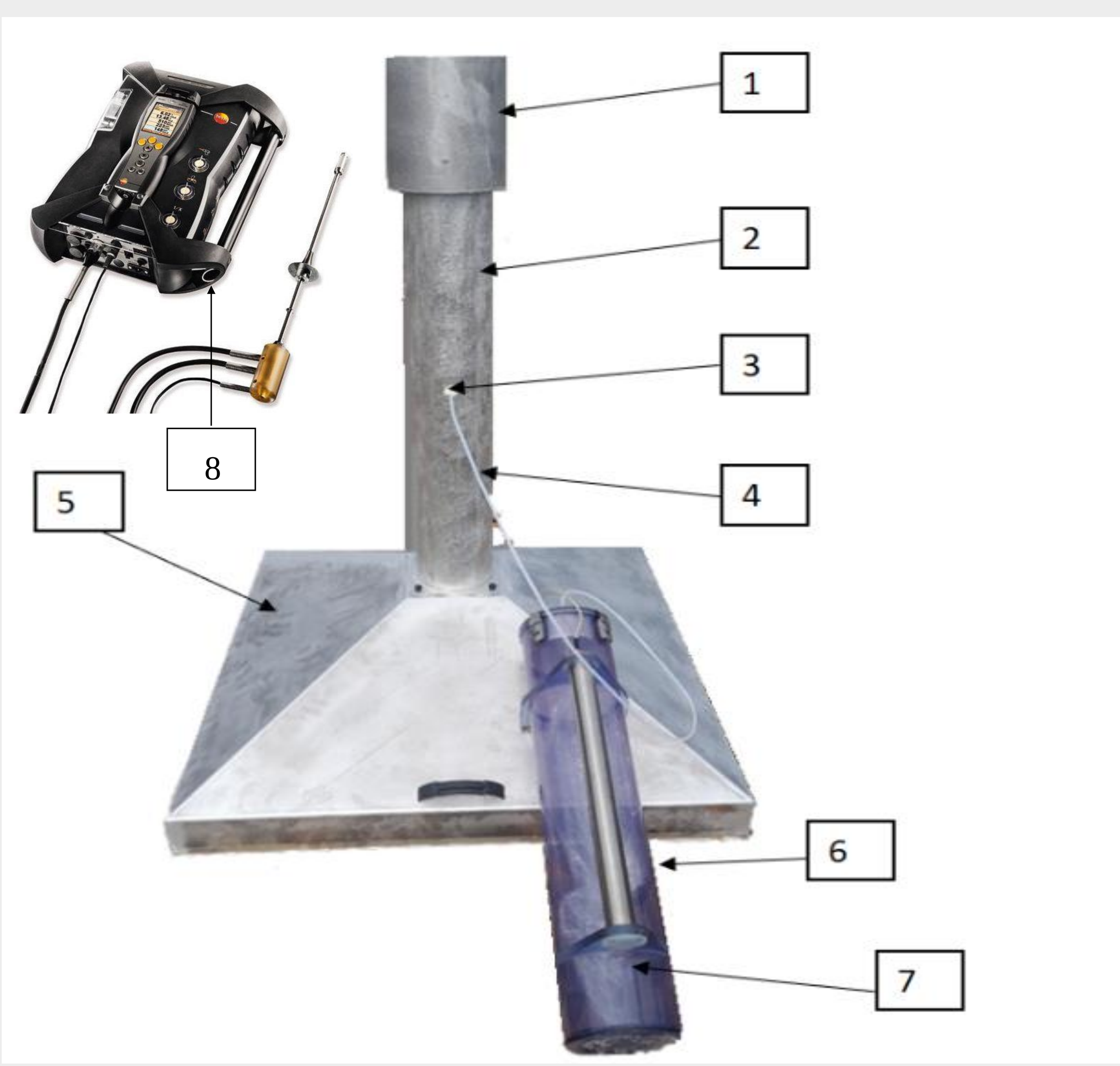

Fig. 1 hood used for sampling surface active sources

1 chimney collar, 2 outlet duct, 3 duct sampling/measurement orifice, 4 teflon tube, 5 surrounding apron, 6 depression pump, 7 recipient bag, 8 testo 350 analyzer

Nr. Crt.	Cod,I ouE/m^3	Temp. °C	Pressure, mbar	Flow velocity m/s	product cod,i_vrh	Temp. °K	Volume flow rate m^3/s	vrh,293,hood Nm^3/s	source values			Samples cells (n)	$qod,clean$ ouE/s	$qod,clean$ m^2 $\frac{ouE}{s}/m^2$
1	460	30.1	1021	0.88	369.99	323.1	0.88	0.80	Asource	120	m^2	12	4941.896	41.182
2	392	29.2	1022	0.93	334.47	322.2	0.93	0.85	Ahood	1	m^2			
3	385	30.5	1021	0.98	344.43	323.5	0.98	0.89						
4	452	30.6	1021	1.03	424.87	323.6	1.03	0.94						
5	512	30.9	1020	1.18	550.30	323.9	1.18	1.07						
6	491	30.2	1021	1.23	551.82	323.2	1.23	1.12						
7	612	30.4	1021	1.20	670.62	323.4	1.2	1.10						
8	516	29.1	1020	0.95	448.99	322.1	0.95	0.87						
9	495	29.8	1020	1.12	506.70	322.8	1.12	1.02						
10	623	29.6	1021	1.17	667.26	322.6	1.17	1.07						
11	555	30.3	1020	1.22	617.88	323.3	1.22	1.11						
12	564	30.1	1021	1.19	613.44	323.1	1.19	1.09						

$$q_{od,clean} = \frac{A_{source}}{n * A_{hood}} \sqrt[n]{\prod_{i=1}^{n} c_{od,i} * V_{RH,293,hood}}$$

$q_{od,clean}$ is the odour emission of the source area (ouE/s);
A_{source} the source area (m2);
A_{hood} the sample hood surface (m2);
n is the number of sample cells sampled;
$c_{od,i}$ is the odour concentration of the sample (ouE/m3);
$V_{RH,293,hood}$ is the volume flow rate measured in the sampling hood (m3/s), at standard conditions for olfactometry.

Table 1 Emission rate calculation model for surface sources.

The weather data characterize 6 parameters (temperature, pressure, humidity, cloudiness, wind speed and direction) being provided in the form of hourly averages, according to the requirements of the dispersion program and was provided by the National Meteorological Administration. The weather data were treated statistically with the Aermet View program to eliminate outliers and create the wind rose (Figure 5), which, presented in "blowing from" format, represents the annual distribution of the wind direction in the area. In general, a homogeneous distribution of winds is observed, in all directions up to a level of 4-5% with predominant directions from NE (23%) followed by E-SE (21%), without identifying a strongly dominant direction.

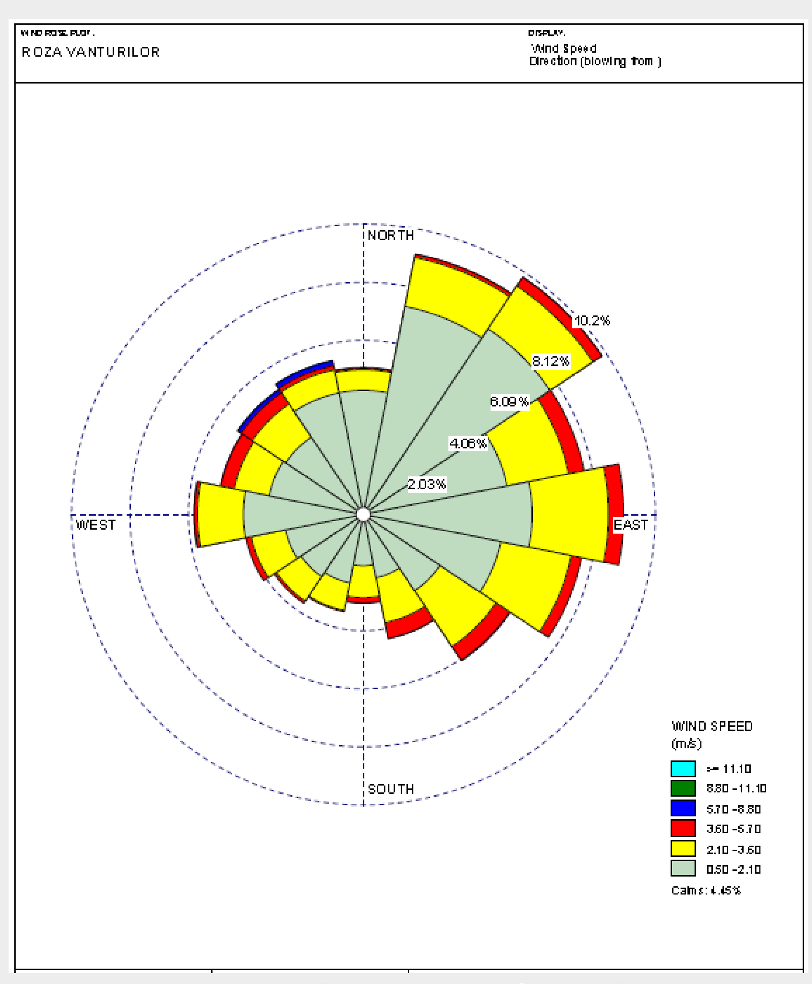

Fig. 3 The wind rose specific to the area

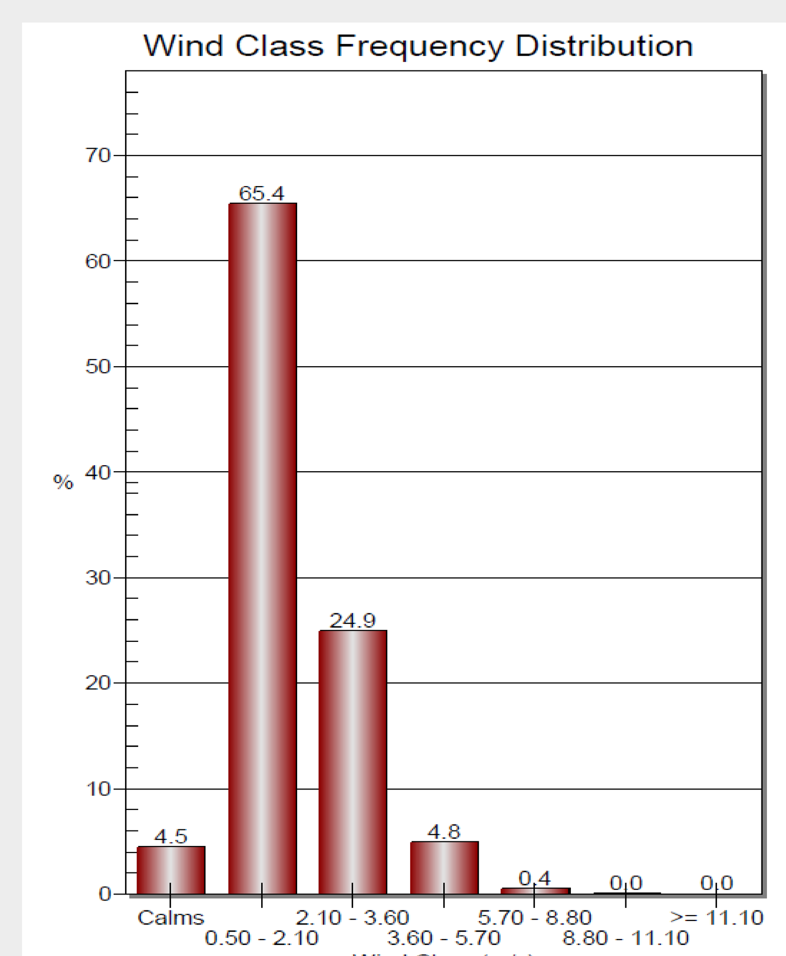

Fig.4 Frequency distribution of speed of the wind

In order to evaluate the level of odour in the surrounding air in the areas adjacent to the sampled biofilter, 2 mathematical modelings were made to illustrate:

- the odour concentration on the site and in the surrounding areas corresponding to the 98th Percentile (fig.5);
- the odour concentration on the site and in its vicinity in the most unfavorable weather conditions "Highest values" (fig.6).

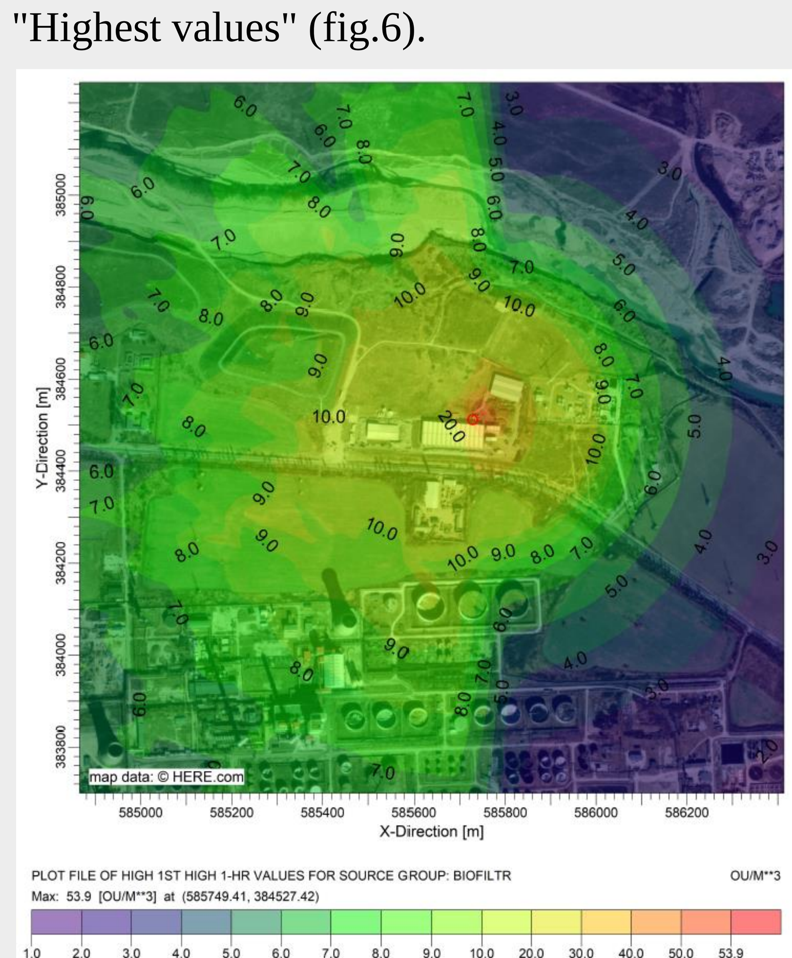

Fig.5 Highest values

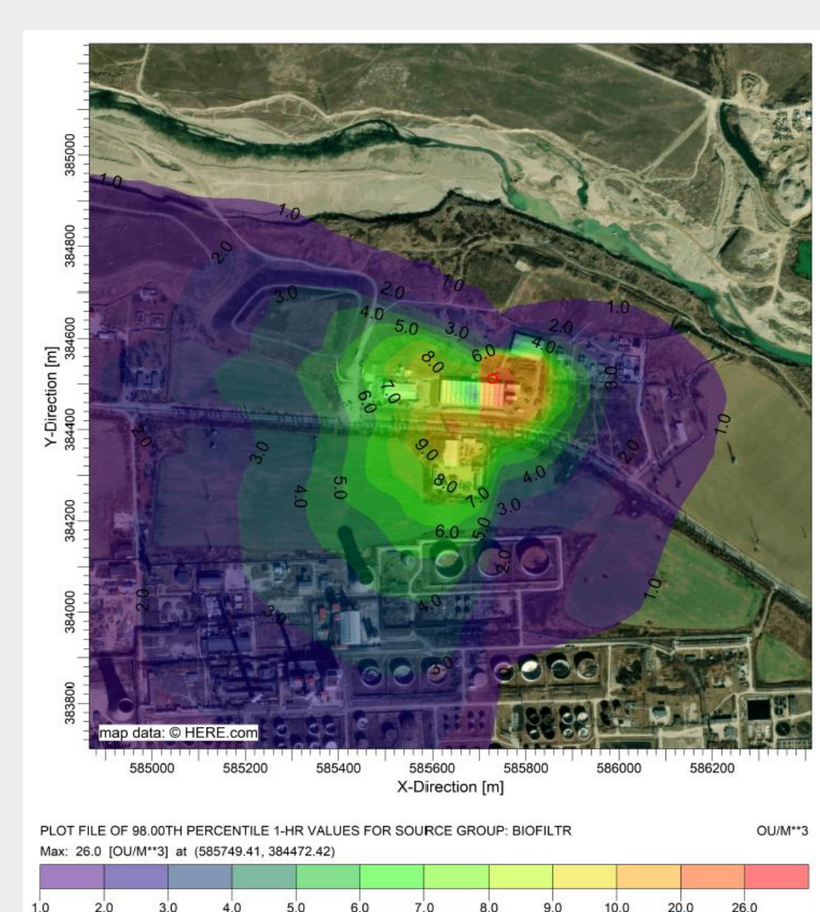

Fig.6 the 98th Percentile

RESULTS

From a technical point of view, a biofilter (fig.1) is a massive layer of moistened organic material through which the exhausted air flows slowly to be treated. It naturally contains a microflora that grows in suitable environmental conditions and adapts to degraded exhaust components. Active surface sources with air flow to the outside (biofilter) are aerated with air or residual gas that is led through the matrix below its surface through mechanical ventilation. Examples: Biofilters, aerated composting and aeration ponds in wastewater treatment.

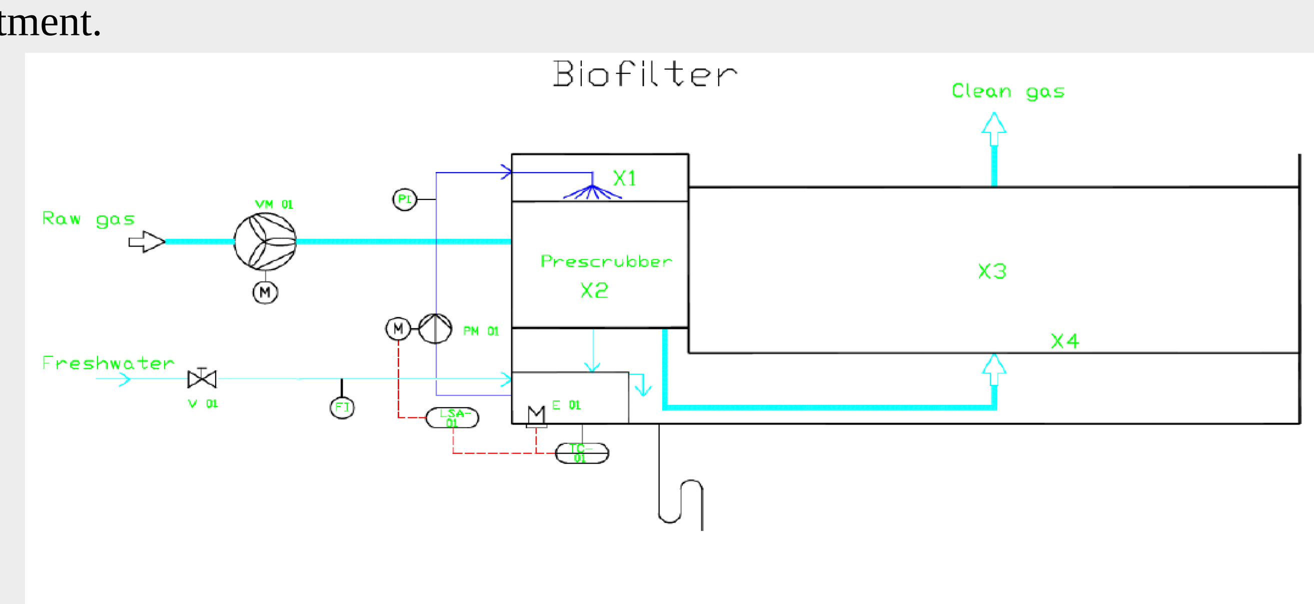

Fig.2 Biofilter operating principle

For the determination of the odour concentration in the surrounding air, the measurement of the odour concentration at the source is not sufficient. The airflow associated with the monitored odour source must also be considered, these parameters are related to each other. SR EN 13725 states that the volumetric air flow must be evaluated under normal conditions for olfactometry: 20 °C and 101.3 kPa based on humidity.

To estimate the odour concentration in the surrounding air from a active surface source, it is necessary to calculate the odour emission rate (OU_E/s) according to formula in the table 1.

The odour emission rate 41.182 ($OU_E/s/m^2$) was entered into the dispersion software for mathematical modeling to estimate the odour concentration in the surrounding air.

CONCLUSIONS

This poster provides an overview of the principles and methods used for odour sampling from active surface sources, together with emission rate estimation, which is relevant for this type of source.

Sampling is an important issue in the characterization and measurement of odours and can affect the quality of measurements to an even greater extent than the accuracy of the chosen analysis technique.

This paper provides a complete overview of odourant gas sampling from surface active sources, state-of-the-art for olfactometric analysis and odour emission rate determination for ambient air odour concentration estimation using mathematical modeling.