DOI: http://doi.org/10.21698/simi.2019.fp33

THE INFLUENCE OF EMISSION SOURCES ON PARTICULATE MATTER POLLUTION IN ADJACENT AREAS

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Abstract
Particulates generated by anthropogenic activities are found in the ambient air in varying amounts, in a wide range of sizes and in a wide variety of chemical composition. The concentration of particulates at one site, as well as their composition, are influenced by their origin and dispersion factors. By chemical and dimensional analysis of particulates in an area, we can draw preliminary conclusions about the origin and level of pollution in that area.
This paper presents the results obtained by concomitant monitoring of particulates emissions and the concentration of particulate matter in ambient air in the adjacent area of an industrial plant.
The result of the measurements obtained and their correlation with the specific conditions during the monitoring period lead us to the conclusion that the concentration of particulate matter at the emission sources directly influences the concentrations of particulate matter in the neighbouring area.

Keywords*:* *air, concentrations, emissions, particles, pollution*

Introduction
Air pollution with particulate matter from anthropogenic sources worries both the scientists, the authorities, and the regular people. A permanent concern for the reduction of particulate pollution is also provided by industrial units that in order to meet the requirements for emissions and ambient air imposed by the authorities apply the best manufacturing technologies (Danciulescu et al 2018) along with the techniques for reducing particulate emissions (Bucur & Danet 2016, Danciulescu et al 2015, Danciulescu et al 2017).
In urban areas, particulates come mainly from industrial emissions, transport, energy industry, natural sources, and gas-particle conversion processes, generally having higher mass concentrations than in rural areas; the particulates usually contain also significant quantities of specific pollutants such as heavy metals or organic compounds (Bucur et al 2018, Bratu et al 2016, Bratu et al 2018).
Immissions of particulate matter at one point represent a sum of the pollution in an area, under the influence of dispersion factors. They directly influence the concentration of particulates at a measuring point.
By measuring concentrations of particulates at emission sources and particulate concentrations in the ambient air in areas adjacent to emission sources, we examine

concentration correlations taking into account dispersion factors such as the direction and speed of the wind, temperature, pressure, etc.

Materials and methods

Measurements of particulates at emission sources were performed with isokinetic samplers for particulates, Paul Gothe, according to SR EN 13284-1:2018. The particulate matter suspended in ambient air was monitored according to STAS 10813:76. At the emission sources, a series of physical parameters were monitored with the TESTO 350 analyzer: the dynamic pressure [mbar] of the gaseous effluent from the measuring point; gas temperature [K]; chemical composition of gaseous effluent for density determination (kg/m^3); gas humidity [%]; atmospheric pressure [mbar].

Figure 1 shows the equipment that was used to measure the emission of particulates.

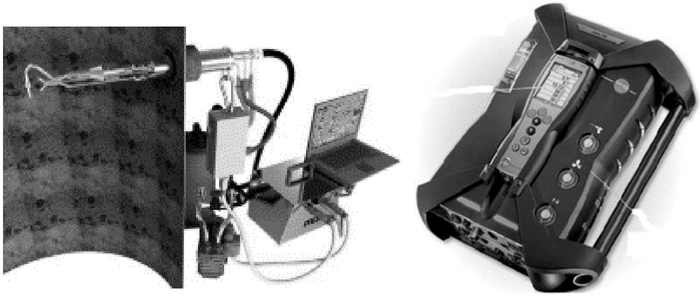


Figure 1. The equipment used for sampling/measurement of particulate matter emissions: isokinetic sampler for particulates (a), and analyzer of combustion gases (b).

The results of the measurements have been input into a dispersion program, and the highest concentration points have been obtained on the isoconcentration curves, located at various distances around the emission sources. At these points we placed particulate samplers Tecora in order to perform sampling of particulate matter from the ambient air. The values for particulate matter in the ambient air have been compared with the values obtained from the dispersion program.

To estimate the concentrations of particulates at emission sources we used the inverse dispersion method, starting from the values of particulate concentrations obtained by direct measurements in the ambient air.

Results and Discussion

The research that was the subject of this study was carried out in a June 2019 campaign that involved the measurement of the concentrations of particulates generated by a car subassemblies manufacturer, the particulate matter pollution being specific to this manufacturing unit.

As part of the measurement operations, the levels of particulate matter emissions and the concentrations of particulates in the ambient air have been determined by direct measurements. The results obtained from measurements have been compared

with the results obtained by mathematically modelling the dispersion of the particulate matter emissions.
Table 1 shows the results of the measurements: the particulate matter concentrations from six emission sources that were monitored, S1-S6, and the corresponding mass flows of the emission sources.

Table 1. The particulates concentration in the emissions from static sources.

Source	Pollutant	Unit	Measurement value			Mass flow (g/h)
			Det.1	Det.2	Average	
S1	particulates	mg/Nmc	14.80	15.74	15.27	416
S2	particulates	mg/Nmc	12.77	12.09	12.43	512
S3	particulates	mg/Nmc	13.71	12.21	12.96	614
S4	particulates	mg/Nmc	15.83	15.21	15.52	397
S5	particulates	mg/Nmc	9.42	9.02	9.22	221
S6	particulates	mg/Nmc	8.26	7.24	7.75	182

These results have been input into the dispersion program together with the weather parameters recorded at the time of the measurements and we obtained the isoconcentration curves for particulates in the area adjacent to the emission sources (Figure 3). Figure 2 shows the wind directions.

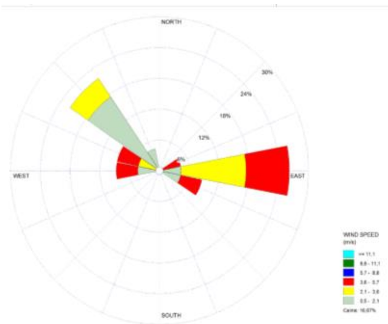


Figure 2. Wind directions

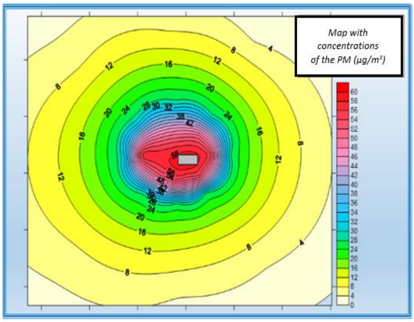


Figure 3. Isoconcentration curves for particulate matter

From the isoconcentration curve, one observes a movement of the pollution peak (area) in the direction of the wind. Consequently, there are higher concentrations of particulates at a point in the wind direction, compared with the pollutant concentration at another point at the same distance but not located in the wind direction.
Based on the results of the dispersion, 8 monitoring points were set up linearly in the direction of the wind in the West direction. The 8 points were located at 100 m intervals in the west direction from 100 to 900 meters away.
In these points, we performed three series of measurements of the concentrations of particulates in suspension in the ambient air under similar weather conditions, with

the emission sources in operation and stopped, to investigate the influence of emissions on the pollution level in the area.
The variation of particulates concentration in the ambient air at the 8 monitored points is shown in Figure 4 with the emission sources stopped and in Figure 5 with the emission sources in operation.

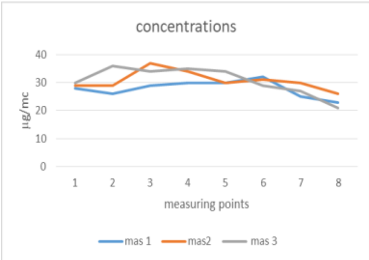


Figure 4. The variation of the concentration of particulates with the emission sources switched off.

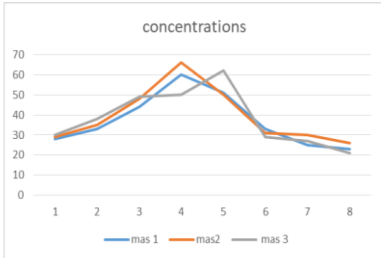
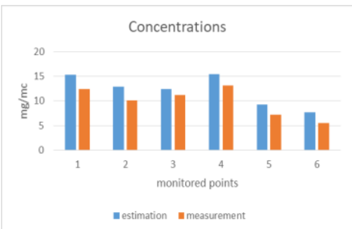
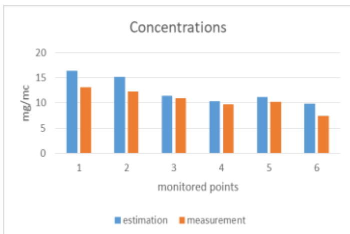


Figure 5. The variation of the concentration of particulates with the emission sources switched on.

The influence of emissions from emission sources on the pollution level of the ambient air in the vicinity and the direct correlation with the distance from the emission sources can easily be noticed; thus, the influence of the emission sources in point 8 is practically irrelevant.
The data series containing the results of monitoring the concentration of suspended particulate matter in the 8 points were used to verify a method for assessing the level of particulate emissions from static sources by inverse dispersion. The method can be useful for situations where, for various reasons, direct measurements can not be performed. The AermodView dispersion program was used for modeling. Figure 6 shows comparatively the results of the inverse modeling with the results of the direct measurements obtained in two different days (a and b).



(a)



(b)

Figure 6. The results of measurements and estimates of particulates emissions in two situations (a and b)

By comparing the results obtained by the inverse dispersion and the measured concentrations in the direct monitoring, we can constantly observe higher values by up to 30% than in the direct measurements due, we believe, to the influence of other sources of dust pollution of the ambient air (traffic, re-suspension, etc.). However, the method can be used, taking into account the value of the identified deviation that falls within the domain of uncertainty specific to mathematical modeling estimates.

Conclusions

The result of the measurements carried out, correlated with the specific conditions during the monitoring period, and leads us to the conclusion that the level of concentrations of particulates emitted from static sources directly influences the concentrations of suspended particulate matter in the adjacent area. The main factors of influence are the distance from the sources, and the weather parameters, first of all, the speed and direction of the wind.
Also, the method of estimating the level of particulates emission from static sources by inverse modeling has led to values within the error margin characteristic of mathematical modeling methods and can be used in situations that do not permit direct measurements. The method can be applied in other locations or for other pollutants using input data and weather parameters specific to the studied area.

Acknowledgements

This work was realised with the support of Operational Programme Competitiveness 2014-2020, Contract no. 55/05.09.2016, Project ID P_40_300, SMIS 105581, Subsidiary Contract no. 2142/12.02.2019.

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