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Air pollution

CONSIDERATIONS CONCERNING IMPACT ASSESSMENT OF POLLUTION WITH BREATHABLE PM2.5 PARTICULATE MATTER. PART 1. POLLUTION MONITORING IN URBAN AREAS WITH INTENSE ROAD TRAFFIC

E. BUCUR, L. IONITA, I. NICOLESCU*, M. PETRESCU

National Research and Development Institute for Industrial Ecology – INCD-ECOIND, 90–92 Panduri Street, Sector 5, Bucharest, Romania
E-mail: ecoind@incdecoind.ro; poluare.aer@incdecoind.ro

Abstract. Fine particles (smaller than 2.5 μm) penetrate more deeply into the lungs than coarse particles (2.5–10 μm). Recent health studies indicate a link between fine particle concentrations in the outdoor air and certain health effects. Adverse health effects from breathing air with a high PM2.5 concentration include: premature death, increased respiratory symptoms and disease, chronic bronchitis, and decreased lung function particularly for individuals with asthma. In an effort to reduce and control the hazards associated with PM2.5, EPA (Ecological Protection Agency) issued federal standards in 1997 to be complied on a county basis. The guidance on monitoring published by EPA emphasises placing monitors in areas impacted by fine particles that are also locations where people live, work, or play. The study covered by the present project is referred to determination over three years of the pollution level with PM2.5 particulate matter in areas with intense road traffic and assessment of this pollution on population health. This will be done by means of specific test, in a first phase for respiratory function, ventilator functions, respectively, and in a second phase the characteristic tests for the presence of poly- and mono-nuclear hydrocarbons in particulate matter. The tests in the second phase will include the tests for dosing α_1 antitripsina, 1 hydroxypyrene and S-phenylmercaptic acid on batches of exposed and control human subjects. The present paper will present the level of pollution with PM2.5 in the area of interest. This level is based on measurement conducted according with SR EN 14907/2006 standard requirements. Also, the paper will present the dynamic of daily pollution level evolution in correlation with road traffic, both for cold and hot seasons.

Keywords: PM2.5, air pollution, breathable dust, people health.

AIMS AND BACKGROUND

The paper presents the results obtained from measurements run in two important cross-roads in Bucharest, in two sapling campaigns, March and July, for PM2.5 dust fraction in ambient air. PM is an abbreviation for particulate matter and PM2.5 is the abbreviation for fine particulate matter with a diameter smaller than 2.5 μm (Ref. 1). PM2.5 is produced by combustion, including vehicle exhaust, and by chemical reactions between gases such as sulphur dioxide, nitrogen oxides, and volatile organic compounds[2].

* For correspondence.

In order to establish the optimum conditions for measurements and to verify the equipments, preliminary tests were run in the first sampling campaign (March 2008).

After preliminary test there was determined the level of PM2.5 and PM10 into ambient air, their distribution into total dust and the dynamic of PM2.5 over a period of 24 h (Ref. 3); additionally, the content of lead, cadmium, nickel and arsenic were determined in all dust fraction.

In the second sampling campaing, in July, was determined the pollution level with particulate matter PM2.5 over a period of 24 h; additionally, the content of lead, cadmium, nickel and arsenic were determined in PM2.5 fraction.

These determinations are part of a study which will last for three years. The project aims to create a database concerning the correlation between the health status of people from urban areas with intense traffic and the level of ambient air pollution with breathable PM2.5 dust.

At present, the Romanian legislation does not indicate a maximum accepted level for PM2.5 content in ambient air, but, according to the National Ambient Air Quality Standards (NAAQS) the imposed limit for PM2.5 is 35 $\mu g/m^3$ (Ref. 4).

The present study will try, through the obtained results, to aware the authorities and public about the impact of this pollution on people health, being a starting point to introduce into environment legislation limit values for PM2.5 dust fraction in ambient air as well as for setting up some measures to limit the level of dust pollution in urban areas with intense road traffic from big cities.

Analysing the obtained results for all dust types quantities we can observe a direct correlation of these quantities with meteorological conditions; the dust quantity is increasing with temperature increase and is decreasing with wind intensity increase.

EXPERIMENTAL

The air samples were sampled in two of the most crowded cross-roads in Bucharest; the samplers were placed according to the in force regulations.

The filters were exposed for 24 h, continuously, between 10–25 March 2008, and 8–16 July 2008, respectively. For those two LECKEL INGENIEURBURO GmbH particulate matter samplers were used. The samplers are equipped with impactors for dust fraction separation and filter holders for dust retaining on filters (in this case we used cellulose filters). At the same time a real time measurement system, MICRODUST CASELLA, was used. This equipment has the possibility to measure the dust concentration in real time (by means of infrared rays) and traps dust, as TSP (total suspended particles) or different fractions, in order to determine the dust content by gravimetric method. This instrument due to its memorising function of measured values in real time, was used to determine the dynamics of dust concentration and its correlation with other parameters of influence. The samplers were run at a flow rate of 2.3 m^3/h for 24 h following the requirements of SR EN 12341/2002 and SR EN 14907/2006 (Refs 5 and 6); the cellulose filters, 47 mm diameter, prior to exposure were conditioned for 24 h at 20°C and 50% humidity. They were weighted prior and after exposure with a Mettler Toledo 5 decimals analytical balance.

For dust metals content 4 filters were selected. After digestion with nitric acid the solutions were analysed by atomic absorption spectrometry with graphite furnace atomisation[6].

RESULTS AND DISCUSSION

The results of the tests made for dust content determination in ambient air in 10–25 March 2008 and 8–16 July 2008 periods are presented in Table 1 and Fig. 1 (Ref. 3) and in Table 2 and Fig. 2.

Table 1. TSP, PM10 and PM2.5 in ambient air – 10–25 March 2008

Date	Meteo conditions	TSP (μg/m³)	PM10 (μg/m³)	PM2.5 (μg/m³)
10–11.03	18°C, clear sky, no wind	308	142.3	92.6
11–12.03	15°C, clear sky, no wind	360.4	188.9	130.8
12–13.03	16°C, clear sky, no wind	254.6	116.3	82.4
13–14.03	16°C, cloudy, rain	152.4	58.8	40.2
14–15.03	16°C, cloudy, no wind	102.4	45.6	31.8
15–16.03	15°C, cloudy, windy	128.6	48.2	32.5
16–17.03	16°C, cloudy, no wind	138.5	52.4	36.6
17–18.03	14°C, cloudy, no wind	206.4	87.5	62.1
18–19.03	12°C, cloudy, windy	98.4	31.4	24.7
19–20.03	16°C, clear sky, no wind	137.4	50.2	36.6
20–21.03	16°C, clear sky, no wind	117.3	44.4	34.2
21–22.03	18°C, clear sky, no wind	156.7	58.2	46.3
22–23.03	20°C, clear sky, no wind	158.8	64.6	51.1
23–24.03	22°C, clear sky, no wind	204.9	72.8	55.5
24–25.03	12°C, clear sky, windy	175	42	24.2
Average (μg/m³)		179.9	73.6	52.1
St. dev. (μg/m³)		75.7	43.6	29.4

We observed that in 10–25 March 2008 period the particulate matter concentration in ambient air measured 179.9±75.7μg/m³ TSP; 73.6±43.6μg/m³ for PM10 fraction with frequent exceeds of maximum accepted level of 150 μg/m³ for TSP and 50 μg/m³ for PM10 fraction. For PM2.5 the results obtained in 10–25 March 2008 period are in domain 52.1±29.4μg/m³ and 49.75±27.40/m³ in 8–16 July 2008 period.

Table 2. PM2.5 in ambient air – 8–16 July 2008

Date	Meteorological conditions	PM2.5 (μg/m³)
8–9.07.2008	40°C, clear sky, no wind	110
9–10.07.2008	30°C, clouded, no wind	64
10–11.07.2008	31°C, clear sky, wind	35
11–12.07.2008	35°C, clear sky, no wind	49
12–13.07.2008	35°C, clear sky, no wind	39
13–14.07.2008	36°C, clear sky, wind	28
14–15.07.2008	35°C, clear sky, wind	25
15–16.07.2008	26°C, clouded, no wind	48
Mean (μg/m³)		49.75
St. dev. (μg/m³)		27.40

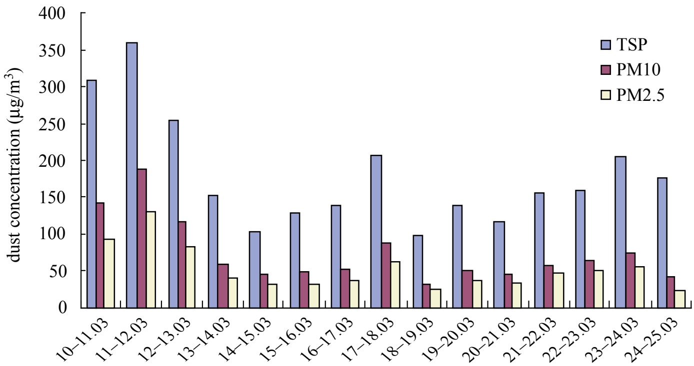

Fig. 1. Graphic representation of the evolution in time of dust concentration in ambient air between 10–25 March 2008

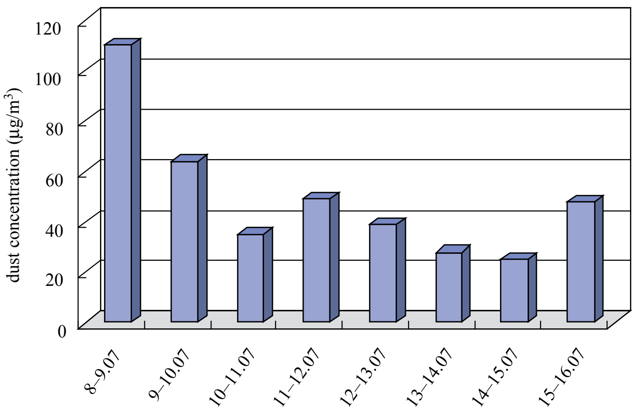

Fig. 2. Graphic representation of the evolution in time of dust concentration in ambient air between 8–16 July 2008

At present, the Romanian legislation does not indicate a maximum accepted level for PM2.5 content in ambient air, but, comparing the results obtained in the two sampling campaigns with the daily maximum accepted level according to the National Ambient Air Quality Standards (NAAQS) of 35 $\mu g/m^3$ we can consider that the PM2.5 dust pollution in those two studied areas is significant[3].

From the perspective of the meteorological parameter influence on the dusts concentration in ambient air we can observe that the biggest dust concentrations can be found in sunny periods characterised by high temperatures and the lack of the wind.

The study in which those preliminary tests were made has as an objective, like it was presented, the determination of the particulate matter pollution level of the urban areas with intense road traffic in Bucharest but also the effect which this pollution type has it on the population health state. This effect is accentuated by the presence in dusts of different organic and inorganic compounds absorbed on their surface. A special accent, from this perspective, is on the metals and polycyclic aromatic hydrocarbons content.

During those tests the dust retained on the filters was analysed also from the metal contents perspective. Thus, four were selected and analysed by atomic absorption spectrometry with graphite furnace; the content of lead, cadmium, nickel and arsenic was determined. The results of metals determinations are presented in Table 3.

Table 3. Metals content in dust (μg/g)

Sample No	Dust type	Metal content in dust (μg/g)			
		Pb	Cd	Ni	As
1	PM2.5	722	21.7	45	1.9
2		807	29.5	15.1	5.4
3		765	23.8	35.4	3.4
4		832	27.6	28.9	2.8

From these results we can observe that lead is being found in the highest quantity in the dust.

CONCLUSIONS

The tests performed reveal the high particulate matter pollution level of the area in which the sampling was done, pollution produced first of all by the intense road traffic.

On this conclusion behalf comes the big content of PM2.5 from ambient air, the presence of the lead especially absorbed on the surface of this type of particulate matter and also the variation registered in the hourly dust concentration in air which has bigger levels in the rush hours of the road traffic.

Dusts have absorbed on the surface the compounds with metals, lead in the highest quantity, but other metals, too, such as cadmium, nickel and arsenic.

Meteorological parameters influence the particulate matter pollution level from the quantity perspective. So in high temperature conditions, clear sky and lack of wind the dust concentrations reach the highest levels of PM2.5.

In the presence of the wind the concentration of PM2.5 decreases. The air humidity decreases the dust level.

REFERENCES

1. D. STANESCU, R. C. ARTENIE, M. TAT: Occupational Exposure to Dust Evaluation. Romanian Medical Life (Bucharest), 20 (2002).
2. Air Quality Management Section, Attn: PM2.5 Network, 715 Grantham Lane, New Castle, DE 19720.
3. E. BUCUR, L IONITA, M. PETRESCU: Considerations Concerning Impact Assessment of Pollution with Breathable PM2.5 Particulare Matter. In: Proc. of the International Symposium on Sanitary and Environmental Engineering, SIDISA 2008, 24–27 June 2008, Florence, Haly (INCD-ECOIND), Bucharest.
4. Information for a Healthy New Your. Department of Environmental Health, New York, 2008.
5. SR EN 14907/2006 – Ambient Air Quality. Standard Gravimetric Measurement Method for the Determination of the PM2.5 Mass Fraction of Suspended Particulate Matter.
6. SR EN 12341/2002 – Air Quality – Determination of the PM10 Fraction of Suspended Particulate Matter – Reference Method and Field Test Procedure to Demonstrate Reference Equivalence of Measurement Methods.

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