EXPERIMENTAL RESEARCH ON AIR POLLUTION IN SPECIFIC AREAS OF RAIL TRAFFIC

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REZUMAT. Traficul feroviar este o altă sursă importantă de polare a aerului. Transportul de mărfuri şi de persoane pe calea ferată este considerat, în general, ca fiind modalitatea cea mai ecologică de transport. Lucrarea prezintă o sinteză a rezultatelor măsurătorilor efectuate pe teren, şi anume, distribuţia dimensională a particulelor (PM10), concentraţia de substanţe acidifiante (în principal SOx şi NOx) şi a substanţelor anti-ozon generate de traficul feroviar în anumite zone din regiunea Banat. Cu toate acestea, poluarea aerului, în special de la traficul feroviar, rămâne un pericol major.

Cuvinte cheie: poluare, feroviar, particule în suspensie, influenţă, mediu.

ABSTRACT. The rail traffic is another important source of air pollution. Transport of goods and people with railways is generally considered as the most environmentally friendly means of transportation. Paper presents a summary of field test results on the concentration and size distribution of particulate matter(PM10), concentration of acidifying substances (mainly SOx and NOx) and ozone depletion substances generated by the railway traffic in specific areas- Banat region. Nevertheless, air pollution, in particular from rail traffic, remains a major hazard.

Keywords: pollution, railway, particulate matter, influence, environment.

1. INTRODUCTION

Transport presents real challenges as society tries to ensure a more environmentally sustainable future [1]. As per Environment (Protection) Act, 1986, environment includes all the physical and biological surroundings of an organism along with their interactions. According [2], environment is thus defined as “the sum total of water, air and land and the inter-relationships that exist among them and with the human beings, other living organisms and materials”. This is schematically presented in Figure 1[2].

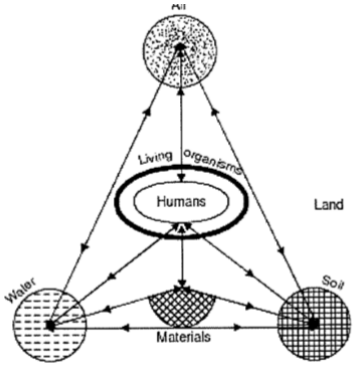

Fig. 1. Concept of Environment: air, water, land, living organisms and materials surrounding us and their interactions together constitute environment [2].

In fact, transport sector can be considered as an important source of particulate matter and/or acidifying substances into the environment. Until now, numerous studies focus on road traffic pollution, but just a little is known about rail traffic. However, regular railway operation is also associated with the diffuse release of inorganic and organic substances in the environment (Fig. 2 [3]).

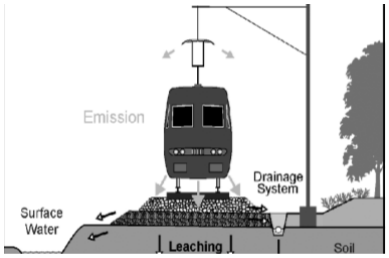

Fig. 2. Spatial distribution of substances emitted by regular railway operation and their influence to environment[3]

“Transport of goods and people with railways is generally considered as the most environmentally friendly means of transportation. The remaining environmental concerns usually focus on the emission of air pollutants and noise. The main emission source is considered to be exhaust emissions from diesel engines, mainly of NO_x, particulate matter and

green-house gases. However, the emission performance for diesel locomotives is similar as for non-road machinery and usually better than for ship engines. With the use of electrically powered engines, these emissions are not present and the concern is transferred to wear particles and emissions during electricity production. The rate of emission from vehicles of particles stemming from wear of brakes and other materials, as well as from re-suspension from the ground, can be expected to depend on train properties such as weight and on driving parameters such as speed and acceleration. Wear of various track components, catenaries, engines, and wagons generally represent a large cost for train operators and railway authorities. Further, wear causes diffusion of valuable material in nature, in the form of polluted water or airborne particles, which may affect ecosystems and human health" [4].

Also, according [5], "there are comparatively few studies that address the emission of particles from railways, probably because the impact on air quality is expected to be small. Those that have been completed normally deal with emissions from diesel engines or the air quality in coaches, but with electrical trains, the particles mainly originate from wear of rails, brakes, wheels, and carbon contact strips. The friction between wheels and rail causes metal losses from the surfaces but it is an open question what fraction of these losses results in airborne particles. It is in this context of interest to study particle emissions from railways. A number of studies have reported high concentrations of particles in underground stations and subways. There are few studies reporting levels of particles in railway environments above ground and no studies reporting emission factors or the variability in emissions with driving pattern".

PM (particulate matter) is a mass-based criterion, and many different sub-classifications have been defined for PM based on the so-called aerodynamic diameter (AD).

AD expresses the same gravitational settling velocity for a particle in standard air as if it were perfectly sphere with the unit density.

In our country have not done research in this direction and therefore we proposed an experimental study regarding concentration and size distribution of particulate matter(PM10), concentration of aicidifying substances (mainly SO_x and NO_x) and ozone depletion substances generated by the rail traffic in specific areas – Banat region – crossed by main route no.900 and the adjacent.

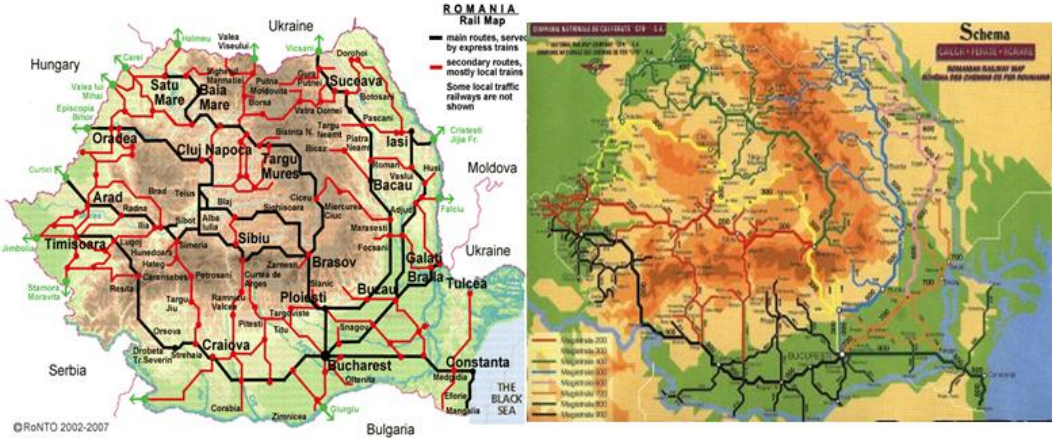

Fig. 3. Maps of romanian railway traffic and of the main routes [6].

2. METHODS AND MATERIALS

Like research method, we proposed a black-box model as presented in Figure 4 [7].

This paper presents a summary of field test results on the concentration and size distribution of particulate matter (PM10), concentration of acidifying substances (mainly SO_x and NO_x) and ozone depletion substances generated by the rail traffic.

According [10], for studying the elemental compositions of the collected particles were used 2(two) distinct instruments as follows:

– first instrument was a GRIMM 1.109 aerosol spectrometer. This instrument measured airborne particles 0.25–32 μm in diameter in 31 size intervals and at concentrations from 1 to $2x10^6$ particles. The instrument registered number concentrations with a time resolution of 6 seconds.

– the second instrument was a DustTrak 8520, photometer that reported the mass concentration as mg m³. This is a laser photometer and measures particle concentration roughly corresponding to respirable size fractions (AD = 4 μm). Thus, it registered mainly particles in the 0.1–10 μm diameter range.

For determination of the concentration of aicidifying substances (mainly SO_x and NO_x) and ozone depletion substances generated by the railway was

used SANOA multi-gas open path analyzer designated as an equivalent method EQOA – 0400 – 137 for the measurement of Ozone, EQSA – 0400 – 138 for the measurement of SO2; EQNA – 0400 – 139 for the measurement of Nitrogen Dioxide as defined in CFR 40, Part 53.

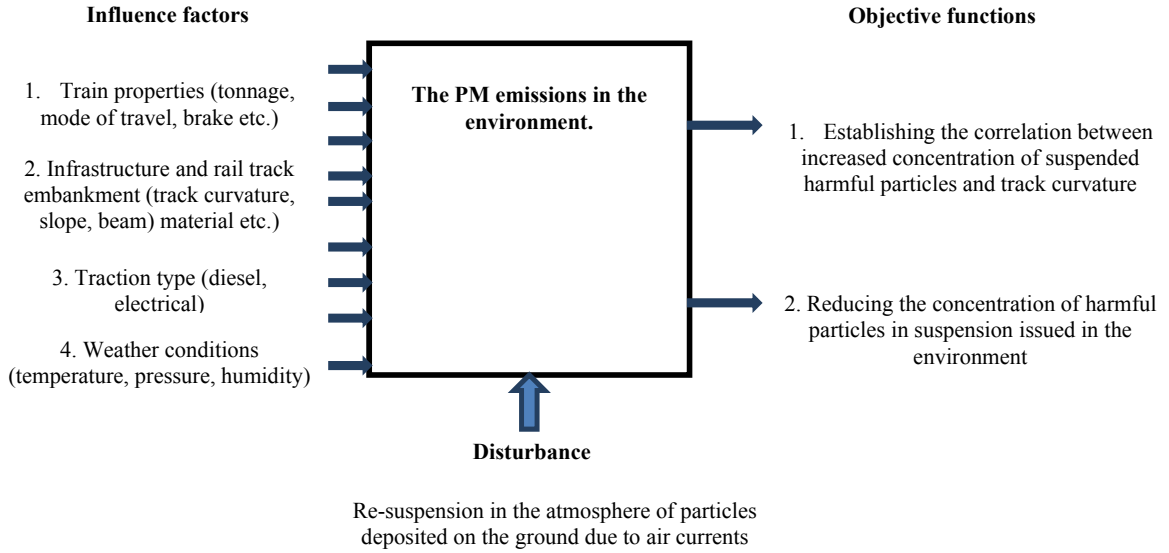

Fig. 4. Black-box model for the emission of particulate matter [7].

SANOA is an instrument for local and simultaneous measurements of minor atmospheric compounds: nitrogen dioxide, sulfur dioxide, ozone, COV -BTX included-, and potentially other absorbing compounds.

Measurement is made by Differential Optical Absorption Spectroscopy (DOAS) in the wavelength range going from ultraviolet to visible (200 to 375 nm).

The equipment is composed of a projector fitted with a Xenon vapor lamp, which sends a light beam to the receiver containing a spectrometer. The spectrum of the received light is measured and digitized by a 512 photodiode array detector and a 14 bit D/A converter. The most important feature of this device is the simultaneous measurement of all wavelengths across the measurement range and thus the independence of the process from most variations of the atmospheric transmission, provided the optical visibility exceeds the distance between the projector and the receiver.

3. RESULTS AND DISCUSSIONS

Regarding field test results on the concentration and size distribution of particulate matter, according [8], the elemental compositions of these particles are presented in Table 1.

The concentration of acidifying substances (mainly SO_x and NO_x) and ozone depletion substances generated by the railway measured with SANOA instrument are presented in the charts in Figures 5 and 6.

As can be observed from Figure 5 and Figure 6, O_3 is at high values, due to the quantity of radiation coming from the sun in sunny days. But also it can be observed in Figure 5 that between O_3, benzene, Pxylene and toluene is a correlation, when Pxylene or benzene is high the ozone is increasing and toluene is decreasing. This is due to the high reactivity of VOC (Volatile organic compounds).

In booth days toluene has high values and a certain evolution, and that is a real problem because this type of pollution is very dangerous for environment but especially for the people. All VOC components are carcinogenic. After inspecting the neighborhood of the measurement location it has observed very close a gas stations (LPG). Like it knows, LPG is a source of toluene and benzene.

Table1. **The comparative percentile weights of elements detected in the filters; all values are in percent [8]**

	Run	Fe	Cu	Zn	Ca	Mg	Al	Sb	Na	Ni	Mn	Ba	Cr
Sampling point	1	62.8	10	4.2	2.8	2	1.5	1.2	0.3	7	0.5	2.4	0.6
Sampling point	2	63.2	10.1	4.3	3.2	3.5	1.3	2.4	0.2	3.3	0.4	0.7	0.5
Sampling point	3	64	9.3	3.6	4	3.2	3.5	2.1	1	1	0.7	0.6	0.4
Sampling point	4	63.1	9.6	3.7	4.7	3287682 13111	2.3	2.6	1.1	0.4	0.3	0.3	0.3

Observation. The comparative percentile weight of each element represents the weight ratio of that element to the summation weight of all of detected elements in both filters.

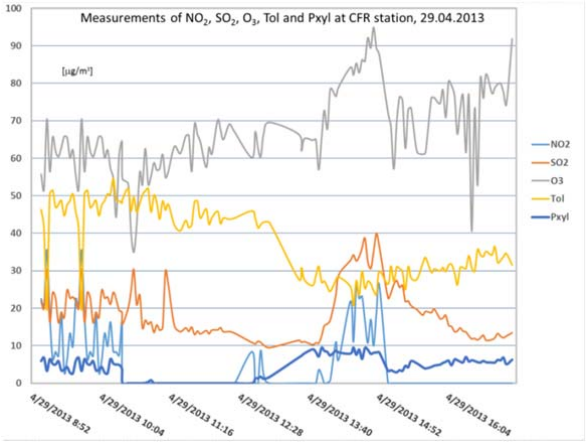

Fig. 5. Measurements in Timişoara railway station/29.04.2013.

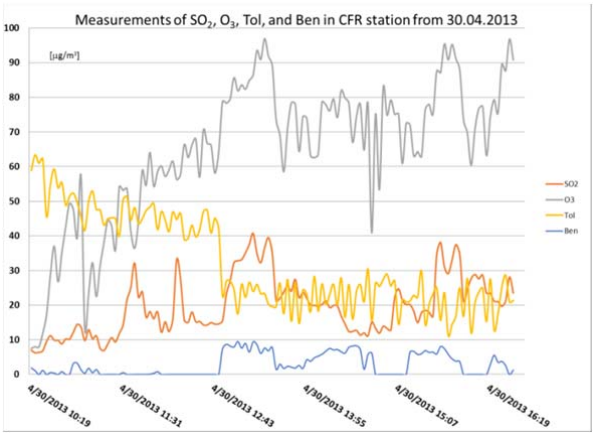

Fig. 6. Measurements in Timişoara railway station/30.04.2013.

SO_2 values are due to the activity of diesel engine locomotives and Diesel Motor Units, which are operating in the station.

For those who want to make a prediction regarding level of air pollution, especially National Agency for Environmental Protection, these values must be taken into consideration.

4. CONCLUSIONS

Dedicated equipment for pollution measurements are a must nowadays when pollution sources are becoming more diverse.

By observing the field test results and the neighborhood of the measurements location, we can make assumptions regarding the sources of air pollution but we strongly need others information. That's why, this research study will be complete with more measurements but also with a study of dispersion to see exactly the influence zone.

So, due to the lack of essential data on emissions of harmful particles in the atmosphere, it becomes clear that an environmental impact assessment cannot currently be fully established.

Taking into account the above we consider that the current research is bringing an added value by further scientific research on the influence of transport on the railway with all its implications on air pollution.

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http://www.mec.upt.ro/airq

6. REFERENCES

[1] *Rail Transport and Environment.* Facts & Figures, 2008.

[2] C.P. Kaushik, S.S. Bhavikatti, A. Kaushik *Basic civil and environmental engineering, Daryaganj, Delhi,* IND:New Age International, 2010, pp.73.

[3] M.Burkhardta, L.Rossia, M.Bollera, *Diffuse release of environmental hazards by railways,* Desalination 226 (2008) 106–113, www.elsevier.com/locate/desal.

[4] E.Fridell, A.Bjork, M.Ferm, A.Ekberg, *On-board measurements of particulate matter emissions from a passenger train*, Proc. IMechE Vol.224 Part F, J. Rail and Rapid Transit.

[5] E.Fridell, M.Ferm, A.Ekberg, *Emissions of particulate matters from railways – Emission factors and condition monitoring,* J. Transportation research part D 15(2010) 240-245.

[6] http://christianferoviarul.blogspot.ro/2009/04/hartile-magistralelor-cfr-ale-romaniei.html

[7] M.Dungan, L.Dungan, *Emissions of particulate matter from railways-an overview*, Buletinul AGIR Supliment 2011, An XVI, nr.Supliment

[8] M.Dungan, L.I. Dungan, D.Tucu, *Nanoparticles emissions from railway traffic. Analysis in Banat region,* NANOCON 2012 conference proceedings(2012), pp.659-664.