Scientific report

Regarding the implementation of the project PN-II-ID-PCE-2011-3-0762, no. 175/25.10.2011

Reduction of nanoparticle emissions by the optimization of residual combustion gases filtering processes

during the period January – October 2016

Objectives:

1. ***Substantiation of a model of public environmental policy and strategies meant to reduce nanoparticle emissions in the city of Timisoara*** *(continued from the previous stage).*

In the following we'll present the new results regarding measurements and pollution maps for the cities of Timisoara and Budapest, obtained in the frame of this objective in stage 2016 of the project.

Activities

- Estimating the scale of particulate matter suspensions emission in the city of Timisoara, part II.

Previous results obtained in Stage 2015 of the project have shown that the most air polluted parts of the city are one going North, and one going South, both being heavily circulated roads and the latter crossing an industrial zone. For this reason just the above mentioned parts of the city were chosen for analysis. The map of the dispersed airborne particles in the atmosphere was obtained as in the previous stage: measurement points were chosen on a grid drawn on the city map, in the Southern and the Northern parts of Timisoara, with an approximate resolution of 900mx900m. A number of 23 points in the North and 32 points in the South were considered. For each location, the GPS coordinates were collected together with the measurements. The coordinates were input in Google Maps in order to obtain the map of the measurement points. The measurements were performed with Air particle counter P311 in two different days: March 24 in the north side of the city and April 04 in the south side of the Timisoara city. For each point on the map, three measurements were performed, and the mean value was used. Figure 1 shows the measurement points on the map, function of local geographic coordinates, as described above.

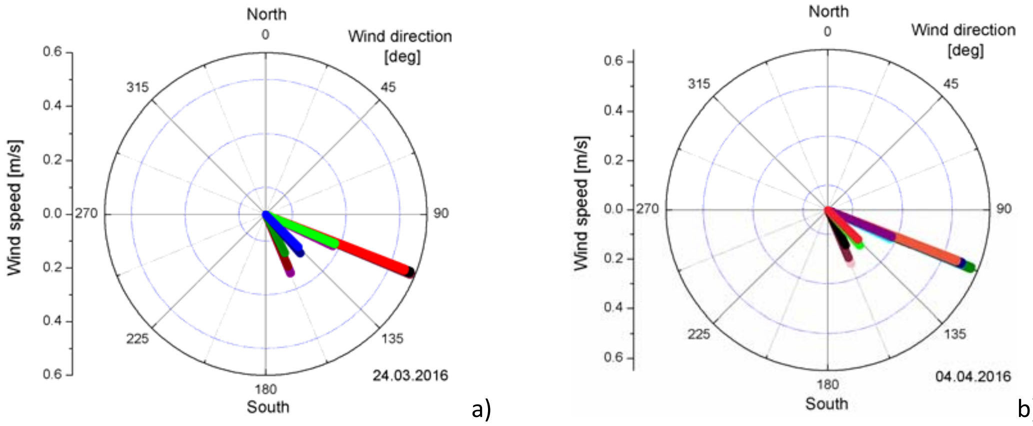
a)

b)

Figure 1: Map of measurements points for the Northern part, a) and the Southern part, b) of Timisoara city.

Three size classes were considered for the measured particulate matter: PM0.3, PM2.5 and PM5. The software SURFER 11 was used to draw the maps resulted by interpolation of the measured data, and a digital map of Timisoara was used as a base layer.

The values of wind speed and directions were also collected, from four urban air quality monitoring stations for the two measurements days: March 25 and April 04, 2016. Figures 2 are the wind roses with mean values of the wind speed taken hourly in two days of measurements, depending on the default directions; the dominant direction of the wind was on SE direction.

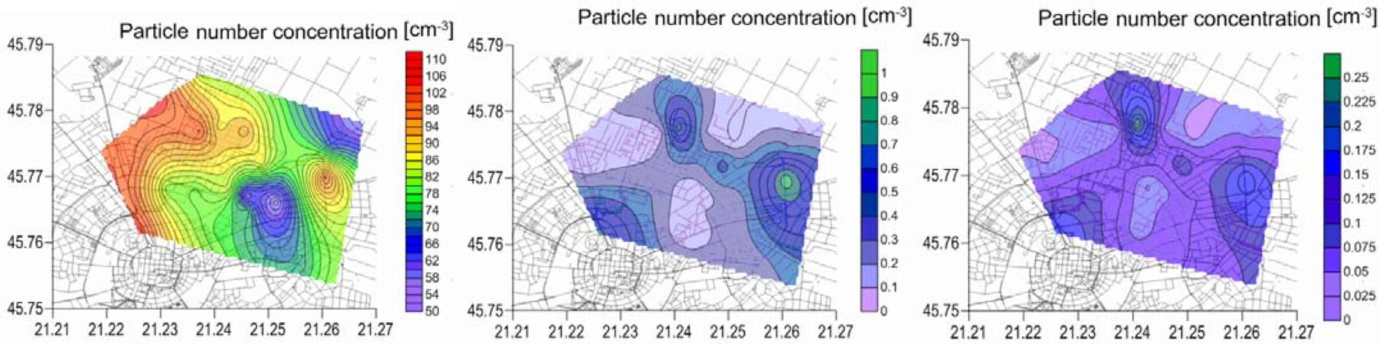


a) b)

Figure 2: Wind roses with mean values of the wind speed taken hourly in two days of measurements, depending on the default directions: March 24, a) and April 04, b).

Results and discussion

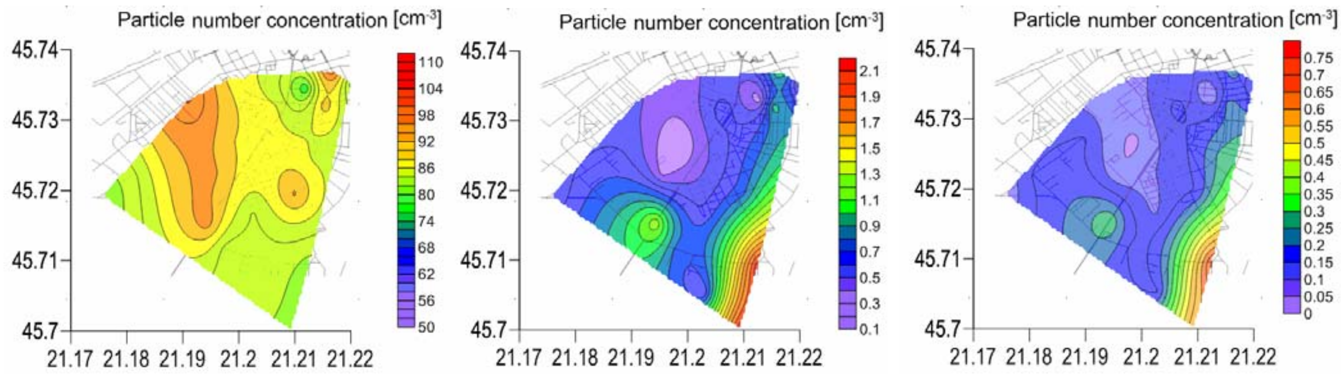
The results regarding the measurements performed with the Air particle counter P311, on March 24 2016, in the Northern part of Timisoara, for particulate matter suspensions in size ranges PM0.3, PM2.5 and PM5 are presented in graphical form in Figures 3. The unit used in the all figure legends is number of particles/cm^3. The local geographic coordinates are placed on the axes.



a) b) c)

Figure 3: Pollution map of Timisoara city for particulate matter suspensions PM0.3 a), PM2.5 b) and PM5 c), as function of geographical coordinates for the northern side of the Timisoara city.

Figures 4 show the pollution maps of Timisoara city regarding dispersion of airborne particulate matter having size ranges PM0.3, PM2.5 and PM5 as function of geographical coordinates for the Southern side of the city (measurements performed in April 04).

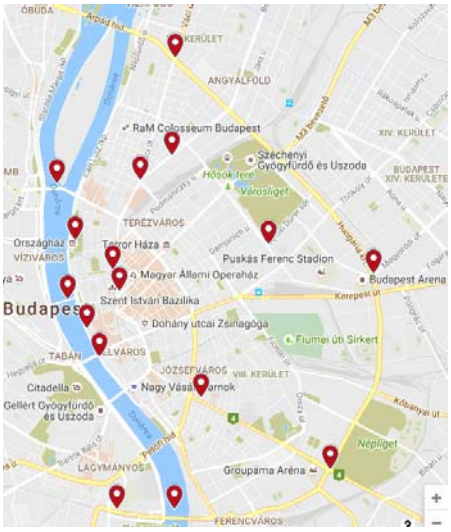


a) b) c)

Figure 4: Pollution map of Timisoara city for particulate matter suspensions PM0.3 a), PM2.5 b) and PM5 c), as function of geographical coordinates for the southern side of the Timisoara city.

By studying these maps, one can see that fine particles (PM0.3) are found in the atmosphere both in the northern and southern part of Timisoara, in the investigated days. The effect of the dominant direction of the wind (SE) on the dispersion of fine particles is evident, because all contour lines are distorted on this direction, both in the north and the south. It also can be noticed that fine particles are predominant in areas of intense traffic in the northern part and of combined intense traffic and industrial emissions in the south. This is in accordance to other findings [1], which state that suspended particles less than 2.5 μm can be generated from stable non gaseous organics, sulphur or nitrogen compounds or volatile organic compounds, which are associated to burning fuels. There is no important difference between the dispersion of larger particles (PM2.5 and PM5) neither in the north nor in the south. This is because the larger particles the smaller their number concentration. This means that these to classes can be treated together. The largest concentration in the northern region corresponds to the industrial platform and to the vicinity of the international airport. The largest values in the south correspond also to the industrial platform, the Pro Air Clean incinerator. It is worth mentioning that other industrial agents are also located in the South-Western area, including a large thermal power plant which also generates combustion particles, hence the large number of coarse particles in the south can be due to the ashes generated by the thermoelectric plant CET-Sud carried by the wind.

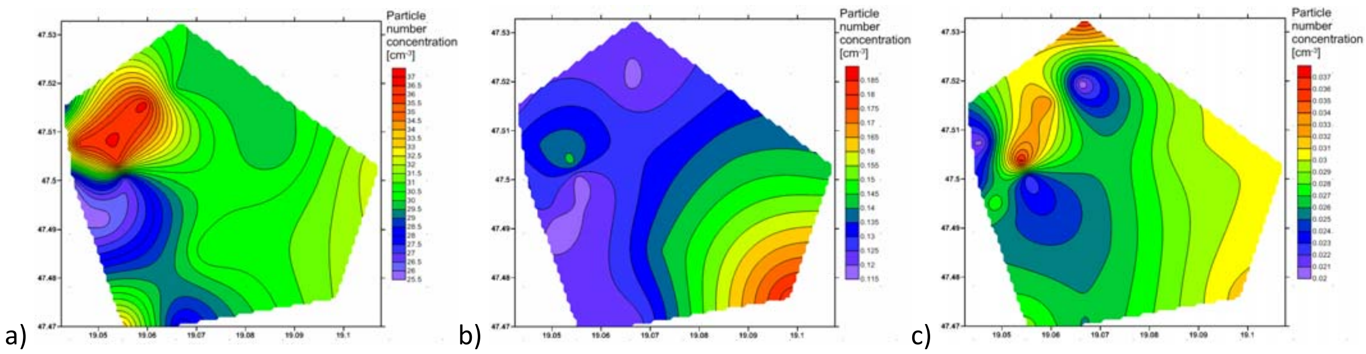
- Estimating the scale of particulate matter suspensions in the city of Budapest.



Due to some similarities with the city of Timisoara, on August 21 and 22, 2016 were conducted several measurements of air and in the city of Budapest. To evaluate the spreading of particulate matter suspensions in the atmosphere, a number of 16 points, considered important and also affordable, were chosen. For each location, the GPS coordinates were collected together with the measurements, as in previous cases. The coordinates were input in Google Maps in order to obtain the map of the 16 measurement points, as in Figure 5. The measurements were performed with the Air particle counter P311. For each point on the map, three measurements were performed with an interval of day between them, for particulate matter suspensions in size ranges PM0.3, PM2.5 and PM5, as the counter's settings allow.

Figure 5: Map of 16 measurements points for the city of Budapest, function of local geographic coordinates.

The results regarding the measurements performed with the Air particle counter P311, on August 22 2016, in the city of Budapest, for particulate matter suspensions in size ranges PM0.3, PM2.5 and PM5 are presented in graphical form in Figures 6. The unit used in the all figure legends is number of particles/cm^3.



a) b) c)

Figure 6: Particulate matter suspensions PM0.3 a), PM2.5 b) and PM5 c), as function of geographical coordinates for the Budapest city.

It is observed that, unlike Timisoara in Budapest appear much larger differences between the categories of particles, but overall values are lower, which indicates Budapest as a city more "cleaner" than Timisoara.

2. *The identification of the utility domains and of the potential users.*

<u>Activities:</u>

- Proposing an intervention model for the reduction of nanoparticle emissions in Timisoara

Based on examples of good practice in the area of intervention policies in EU countries, will propose a model intervention to limit the emission of nano-metric particles in the city of Timisoara.

- <u>*Study on good practices in policies of intervention in European Union countries.*</u>

Air quality, especially in urban areas, deteriorated with the industrial revolution and the following centuries, but it is only during the last 60 years that the health impacts of air pollution have been recognized and acted upon. The evaluation of current research within the Clean Air for Europe (CAFE) process has clearly shown that investments in further air quality improvements will have a beneficial return financially, in terms of population health, environmental improvements and in quality of life [2]. The measurement of air quality changed dramatically during the last century reflecting the concurrent knowledge about the adverse effects of air pollution, as well as through technological developments. The earliest measurement methods can be traced back to the Montsouris Observatory in Paris, where ozone was measured between 1876 and 1910 [3] and were often labor intensive, needed long analysis times and had a low time resolution. Developments in air quality monitoring techniques during the second half of the 20^{-Th} century enabled higher data quality to be obtained, with lower detection limits, using automated, continuous methods. Today, measurements of particles can vary widely, even those made for the same material and in the same place. This variation is mainly caused by the equipment used for measuring particles and the sampling procedures. According to their dimensions, the particles suspended in the atmosphere are classified as:

- *primary particles*, generated during the combustion process, that are directly emitted into the atmosphere and are composed of fine particles, with diameter less than 2.5 µm (PM2.5), and by ultrafine particles, with diameters smaller than 0.1 µm (PM0.1) [4].
- *secondary particles*, generated by mechanical or chemical reactions in the atmosphere, that ae composed of coarse particles with diameters greater than 2.5 µm and smaller than 10 µm (PM10) and total Suspended Particle Matter (TSP) [5]. However, a complete particle characterization involves study of particle morphology as well as chemical characterization.

An overview of instruments available on the market for measurement of particulate matter [6] reveals that practically one deals basically with two categories:

- *instruments and methods of measuring concentration*, using gravimetric, optical (light scattering, light absorption, light extinction), and microbalance methods, and respectively:
- *instruments and methods of measuring size distribution*, such as microscopes, impactors, diffusion batteries (EDB), mobility analyzers, Centrifugal Particle Mass Analyzer (CPMA), Differential Mobility Spectrometers (DMS), Fast Integrated Mobility Spetrometer (FIMS), Electrical Low Pressure Impactor (ELPI), Aerodynamic sizers, etc., based on specific behavior of particles (diffusion, aerodynamics, and optical and electrical mobility). Choosing the most suitable equipment for PM measurement implies a well balanced analysis of a wide range of characteristics: ability to sample particles in real time; need to dilute gas flow before collection; detection limit of the equipment; size range; accuracy of the equipment, durability, maintenance requirement, and the availability to measure the particle in humidified air stream or in the humidified environment. For example, ELPI and DMS are the suitable devices for measuring fine particles, and the ELPI works in real time; In health-related studies, an EDB is the type of equipment that best characterizes the surface of ultrafine particles. On the other hand, developments in online air quality monitoring enabled the development of public warning systems and immediate notifications if alert thresholds were exceeded, so that short-term measures could then be taken to reduce emissions during pollution episodes. Such reactive measures are now common place in new legislation [7,8], along with public information to help vulnerable people to cope with pollution episodes [2].

- *Health effects*

The effects of inhaling particulate matter that have been widely studied in humans and animals include: asthma, lung cancer, cardiovascular disease, respiratory diseases, premature delivery, birth defects, premature death. Increased levels of fine particles in the air as a result of *anthropogenic* particulate air pollution "is consistently and independently related to the most serious effects, including lung cancer and other cardiopulmonary mortality“ [11]. Short-term exposure at elevated concentrations can significantly contribute to heart disease. A 2011 study concluded that traffic exhaust is the single most serious preventable cause of heart attack in the general public, the cause of 7.4% of all attacks. PM pollution is estimated to cause 22000–52000 deaths per year in the United States (from 2000) contributed to ~370000 premature deaths in Europe during 2005 and 3.22 million deaths globally in 2010 per the global burden of disease collaboration [12]. The World Health Organization (WHO) estimated in 2005 that *"... fine particulate air pollution (PM2.5), causes about 3% of mortality from cardiopulmonary disease, about 5% of mortality from cancer of the trachea, bronchus, and lung, and about 1% of mortality from acute respiratory infections in children under 5 years, worldwide*“[11]. A 2014 analysis reported that long term exposure to particulate matter is linked to coronary events. The study included 11 cohorts participating in the European Study of Cohorts for Air Pollution Effects (ESCAPE) with 100166 participants, followed for an average of

11.5 years. An increase in estimated annual exposure to PM 2.5 of just 5 μg/m^3 was linked with a 13% increased risk of heart attacks [13]. In a 2014 metaanalysis of 18 studies globally including the ESCAPE data, for every increase of 10 μg/m^3 in $PM_{2.5}$, the lung cancer rate rose 9% [14]. In 2013, the ESCAPE study involving 312 944 people in nine European countries revealed that there was no safe level of particulates, and that for every increase of 10 μg/m^3 in PM10, the lung cancer rate rose 22%. For PM2.5 there was a 36% increase in lung cancer per 10 μg/m^3 [15].

- *Air quality monitoring today and recent progress*

In the EU, the current air quality monitoring strategy is mainly driven by the need to achieve and to comply with limit values. Consequently, monitoring sites are predominantly installed where exceednces of limits are likely to occur. In brief, the concept is based on the measurement of PM2.5 at urban background stations [2]. The average PM2.5 concentration of selected urban background sites in a given country over a period of 3 years forms the so-called Average Exposure Indicator (AEI) [9]. This AEI should not exceed a limit value of 20 mg/m^3 by 2015, and should be reduced by a percentage (depending on the initial PM2.5 concentration) by 2020. This goal can be reached by acting in the following two main directions [2]:

a. Developments in air quality monitoring techniques, such as

- small, low-cost, outdoor-installable or portable devices/sensors with low power consumption,
- automated multicomponent analyzers,
- analyzers for new particle metrics (e.g. black carbon, particle number or surface area).

b. Developments in data retrieval and analysis, e.g.

- for the determination of the spatial variability of air pollutants on urban scales based on data from multiple low-cost sensors and geographic information systems (GIS),
- integrated data systems allowing real-time interactions between pollution monitoring, public information and pollution reduction measures.

- *Recommendations for the future*

Looking forward, the recent developments in monitoring techniques, data retrieval and analysis offer the possibility for regulatory monitoring to move beyond the approach based on fixed monitoring sites [10]. The two main components of this development process are [2]:

a. Integration of air quality data from diverse sources

This can be done by performing the following main activities:

- Fixed sites: Deliver high quality and time resolved data, but at the cost of less detailed spatial information.
- Mobile and flexible installations: Allow the collection of highly spatially and temporally resolved data using small, low consumption monitoring devices.
- Modeling: Enables the calculation of the spatial and temporal variation of air pollutants in urban areas at all locations, but often with relatively high uncertainty.
- Combination of local and regional air quality information: Facilitates the assessment of regional scale and transboundary contributions to exposure levels.
- Remote sensing, including satellites: Observation of air pollutants over a wide area, but lacking height resolution that would allow for direct use in exposure/health related air quality monitoring.

In the short to medium term, the current focus of air quality monitoring in Europe needs to continue on the basis of fixed monitoring sites, while in the long term, the increased use of urban scale modeling linked to fewer fixed monitoring sites and a network of mobile, flexible monitors supplemented by remote monitoring, should be explored. Substantial gains may be realized through the future systematic development and integration of these measurement and assessment techniques into a single homogeneous information network, minimizing the risks of pitfalls, and maximizing the benefits of each information source, to produce a high quality spatially- and temporally-resolved data set in near real time.

b. Integration of air quality monitoring and research through an overarching strategy

The challenges of managing urban air pollution have evolved substantially in the last decades and will continue to evolve in the future due to changes in the causal factors and as a consequence of new scientific insights. However, delays of many years can occur before the outputs from new research are taken up and subsequently used by policy makers. To counter this lag, research and monitoring should be strongly integrated through a strategy so that the large investments are explicitly geared to addressing research questions effectively, alongside the assessment of limit value compliance and the population

exposure. One way this could be accomplished is to create dedicated areas for research and monitoring of air quality (ARMAQs), in carefully selected urban agglomerations, to facilitate research into such things as:
- new monitoring devices for fixed or mobile measurement locations, for both new and existing metrics,
- new data collection, analysis and visualization tools,
- improved exposure assessments for population-based health effect studies,
- the development and testing of alternative air quality indicators for urban air quality and health.

Future monitoring strategies should therefore include the collection and assimilation of health effects data, along with air quality data, which should also include new pollutants and alternative metrics. This would allow direct and rapid assessment of the success of air pollution abatement measures, and would greatly improve the detection of relationships and trends in air pollution health impacts. The current review of the European air quality policy (launched in 2011), upcoming research under Horizon 2020 as well as the next revision of the European air quality directive foreseen for 2018 will be an excellent framework to further develop European air quality legislation and regulation, taking climate change issues into account, and so to improve the environment, human health, and the quality of life in Europe [2].

- *Intervention model to limit the emission of nanoparticle in Timisoara city.*

In most countries special legislation is developed and applied and the air quality status is compared to limiting values. In the EU member states the Directive 2008/50/EC [16] is active, and when assessing ambient air quality, account should be taken of the size of populations and ecosystems exposed to air pollution. Due to the highly toxic health effects of particulate matter, most governments have created regulations both for the emissions allowed from certain types of pollution sources (motor vehicles, industrial emissions etc.) and for the ambient concentration of particulates. The IARC (International Agency for Research on Cancer) and WHO designates PM a *Group 1 carcinogen*. Particulates are the deadliest form of air pollution due to their ability to penetrate deep into the lungs and blood streams unfiltered, causing permanent DNA mutations, heart attacks and premature death. [17].

According to Romanian regulation (the Law on the quality of the air, no. 104/2011):
"*Pollutant is any substance present in the ambient air that can have harmful effects on human health and/or the environment as a whole"; "Ambient air is the air in the troposphere excluding the air in working places, which are subjected to other regulations".* (According to the Romanian Environment Protection Agency, volcanic eruptions, dust storms, erosion of rocks and pollen dispersal are listed as "natural sources of atmospheric pollutants).

European Environment Agency: *"volcanic eruptions, windblown dust, sea-salt spray and emissions of volatile organic compounds from plants are examples of natural emission sources"* and are also listed under "Sources of air pollution".

US Environmental protection agency (EPA) and to **Clean Air Act,** only a list of 187 specific Toxic air pollutants are regulated, also known as hazardous air pollutants, (are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects). Dust is not included on the list.

The emission standards for PM10 and PM2.5 in Europe and USA are presented as examples in Table 1.

Table 1: emission stadards for PM10 and PM2.5 in Europe and USA

EUROPEAN UNION European emission standards	PM10 since 1 Jan. 2005	PM2.5 since 1 Jan. 2015
Yearly average	40 µg/m^3	25 µg/m^3
Daily average (24-hour) Allowed number of exceedences/year	50 µg/m^3 35	None None
USA EPA has set standards for PM10 and PM2.5 concentrations. (See National Ambient Air Quality Standards)	PM10 daily limit since 1987 annual limit removed in 2006	PM2.5 daily limit since 2007 annual limit since 2012
Yearly average	None	12 µg/m^3
Daily average (24-hour) Allowed number of exceedences per year	150 µg/m^3 1	35 µg/m^3 Not applicable (3-year average of annual 98th percentile)

The monitoring sites are predominantly installed where exceeding of limits are likely to occur, based on the measurement of PM2.5 and PM10 at urban background stations. Most of the particles (80%) emitted by engines are in the ultrafine range and therefore not directly influenced by industrial emissions [18].

In urban areas, industrial pollutants and long range transport affect aerosol particle number and mass concentrations, besides vehicles fuel combustions. Due to the prevalence of ultrafine and fine particles in urban areas, which cannot pe distinguished in mass measurements, in the last few years, ***urban air-pollution studies start using number-based methods rather than mass-based.*** [19]. Based on these observations; the results presented in this study were number concentration measurement results.

- *Intervention*

Different interventions models are available to reduce exposure to ambient PM air pollution. They range from those that take effect over a long period of time to those with very short-term goals as reducing emissions. Also a reduction in ambient PM concentration could occur as a side effect of an intervention to reduce congestion and improve traffic flow. Many of the studies on air quality look at the particulate matter found at roadsides in urban, suburban or rural locations, majority being attributed to the emissions from vehicles or emissions from combustion processes. These particles range from a few nanometers to micrometers, are fewer of the larger particles but they contribute the majority to the overall mass of particulate matter. During the last three decades, many efforts have been made to protect populations from harmful exposure to outdoor pollutants. Networks of air monitoring stations have been located in strategic places and these provide information on the outdoor pollutant concentrations to which populations are exposed.

Currently in Romania 142 monitoring stations are located for control to air quality of which seven are located in Timisoara city. These are equipped with automatic measurement of main air pollutants that collect and transmit information billboards public data provided by stations, and after validation primary transmit them for certification National Laboratory reference Air quality (LNRCA) of the National Environmental Protection Agency. The national AQM monitoring network for Timisoara is responsible for the general monitoring and, presently it consists of several stationary working stations for the entire city. The disadvantage of being fixed determines that they measure only in the local area, and only if all are functional in the entire city, might determine an average attested value. All these represent potent motivation to urgently search for strategies to reduce nanoparticle concentrations in the air. In Romania, although in the last two decades important steps forward were done in controlling air quality, with positive impact on the pollutants concentration in air, still remains a number of important cities, Bucureşti, Iaşi, Timişoara, Braşov and Baia Mare, where the daily limit values for airborne particulate matter are exceeded. If a particular episode or a special site is of concern, only a mobile laboratory might perform such relevant data measuring.

Our experiments focused on air quality monitoring campaigns in the city of Timisoara, related to pollution with airborne particulate matter suspensions PM0.3, PM0.5 and PM2.5 by direct measurements during representative episodes, firstly for the entire city (Stage 2015), then only in the Northern and Southern part of the city (Stage 2016), as described in the respective stages. The results were concluded in graphs and figures, raising special concern about the pollution with airborne particles. The applied methods were standard, achieved by a portable particle counter P311 for 130 points in of Timisoara city, in order to depict the concentrations of main pollutants and make a comparison between the level of pollution in the Northern and Southern part. The distributions of different classes of particulate matter were represented on suggestive maps; the resulting data represents valid indicators of major specific pollution sources being useful tools to support the development of more refined source based models.

In summary, air quality monitoring is a necessity, not only for the sustainable development of the region and the health of the inhabitant, but also because the pollution is contributing to the climate change. The results conclude that in Timisoara the PM concentrations are over the limits, in certain location. Urban air quality in Timisoara city is influenced by traffic and thus, the most effective method to reduce its pollution is to limit the sources, by all means. A cause for this situation is considered the fact that Timisoara is crossed by two major European roads, E70 and E671 and it had, by the time of investigation, no city road rings. Higher values have been recorder in locations around the North and South Industrial area of Timisoara. A strict control of the state authorities must impose the control of emissions at the sources, in the area, directly at the emitting sources. The support of people to pay and contribute to the emission reduction of pollutants' concentration and their potential damaging, as well by implementing smart technologies, or keeping special rules such as traffic reduction or introducing clean vehicles (bicycles, hybrid cars, public transport based on renewable fuels, etc) professional cleaning of the roads, limiting the influence of bad roads or constructions, by repairing and using separation curtains, if necessary, surrounding traffic areas by green areas, with special capturing/filtering vegetations, etc. It is essential to have in place supporting complementary measures such as individualized awareness campaigns.

- Workshop, work visit, round table

Organizing of workshop regarding nanoparticle air pollution, work visit in an industrial unit generating polluting emissions possibly interested in the project in order to estimate their intention to invest in nanometric particle filters, round tables with the local decision-making authorities to inform them about the results of the project and to know their position regarding the nanoparticle emissions issue.

Workshop

Present and perspectives in airborne particulate matter pollution in city of Timisoara. Causes and potential hazards to human health and environment. Policies and strategies on air pollution control and prevention.

Held on May 27-Th in the frame of *TIM 15-16 International Physics Conference*, West University of Timisoara

Programme (more details and the Abstract book could be find at www.nanodep.com):

1. PARTICULATE MATTER DISPERSION IN TIMISOARA URBAN AREA
M. Lungu[1], N. Ștefu[1], A. Lungu[1], A. Neculae[1], N. Strambeanu[2], D. Arghiriade[2]
[1] West University of Timisoara, Faculty of Physics, Timisoara, [2]S.C. Pro Air Clean Ecologic S.A., Timisoara

2. FROM THEORY TO PRACTICE CONCERNING AIR QUALITY MONITORING
I. Ionel, D. Bisorca, D.G. Calinoiu, R.M. Balogh
Universitatea Politehnica Timisoara, Faculty of Mechanical Engineering, Timisoara

3. TUMOR CELLS DEATH INDUCED BY MAGNETITE NANOPARTICLE – *IN VITRO* STUDY
F. Bojin, A. Ivan, M. Cristea, A. Taculescu, O. Gavriliuc, G. Tanasie, C. Panaitescu, C. Tatu, V. Paunescu
"Victor Babes" University of Medicine and Pharmacy Timisoara, Romania

4. METHODS USEFUL IN BIOMONITORING URBAN HABITAT QUALITY
Nicoleta Ianovici, *West University of Timisoara; Faculty of Chemistry, Biology, Geography, Timisoara, Romania*

5. PHYTOSTABILIZATION OF SLAG AND ASH PITS THROUGH COVER CROPS
S. Mâşu, V.Nicorescu, *National R & D Institute for Industrial Ecology ECOIND, Branch of Timisoara, Romania*

6. RECOVERY OF COPPER FROM WASTE COMPLEX CATALYST USED IN COSORB PLANTS
A.M. Pană[1], L. Cseh[1], C. Creţu[1], E. Szerb[1], L. Demetrovici[2], N. Strambeanu[2], L. Andres[3], G. Simu[4], O. Costişor[1]
[1] Institute of Chemistry Timişoara of Romanian Academy, Timisoara, [2] S.C. Pro Air Clean Ecologic S.A., Timisoara
[3] INCD ECOIND, Timisoara, [4] "Victor Babeş" University of Medicine and Pharmacy, Timisoara

7. PROBABLE MECHANISMS OF ACID RAIN GENERATION THROUGH NANOPARTICLE
N. Strambeanu, L. Demetrovici, D. Gherebeanu, B. Bumbu, *S.C. Pro Air Clean Ecologic S.A., Timisoara*

8. P84 BAGHOUSE EFFICIENCY TEST RIG
Melinda Bagiu, *SC. ECO FILTRATION S.R.L. GIROC – Timișoara, Romania*

In summary, the urban air quality in Timisoara is good, only the PM concentrations are over the limits, during special episodes, in certain locations. Air quality monitoring is a necessity, not only for the sustainable development of the region and the health of the inhabitant, but also because the pollution has no borders, once emitted are contributing to the climate change. Urban air quality is mostly influenced by traffic and thus, the most effective method to reduce its pollution is to limit the sources, by all means. The support and the willingness of people to pay and contribute to the emission reduction of pollutants' concentration and their potential damaging, as well by implementing smart technologies, or keeping special rules such as traffic reduction or introducing clean vehicles (bicycles, hybrid cars, public transport based on renewable fuels, etc) cleaning the roads fervently and professional, limiting the influence of bad roads or constructions, by repairing and using separation curtains, if necessary, surrounding traffic areas by green areas, with special capturing/filtering vegetations, etc.

Work visit

Held on April 12-Th at SC SINTEZA Oradea SA, in order to perform practical measurement tests regarding the nano-micro particle emissions in the area, using the Air particle counter P311, purchased from the project funds. On this occasion, Dr. Mihai LUNGU presented the equipment and the functioning principle of measurement of suspended particles concentration in the ranges of 0.3 – 2.5μm, 2.5-5μm and larger than

5μm, then he performed a set of measurements in the area of SC SINTEZA SA. The general manager of SINTEZA SA Oradea, Eng. Catalin MARIAS, explained the technological processes implied in the obtaining of benzoic and salicylic acids, the packaging of the these powdery products, and the necessity of limiting the emissions of these fine powders from the point of view of environment protection and the reduction of production losses, and the general manager of SC PRO AIR CLEAN ECOLOGIC SA Timisoara, Dr. Eng. Nicolae STRAMBEANU presented a communication named "Study on Nanoparticulates Flow Reduction Tests to HWI Plants Using Numerical Simulation", authors Lungu Mihai, Neculae Adrian, Lungu Antoanetta, Demetrovici Laurentiu, proposed for publication, based on continuous measurements (5 years) of particle emission on the chimney of the PRO AIR CLEAN ECOLOGIC incinerator in Timisoara and the emissions in its vicinity, respectively.

Round tables

Focused on subjects related to the atmosphere pollution with nano-micro particles in suspension, problems included in the action plan for environment in the west region of Romania, PLAM.

- First was held on May 13^{-Th}, at the headquarters of Pro Air Clean Ecologic Timisoara. Participants:

- SC PRO AIR CLEAN SA Stejaru, Ialomita county, having object of activity the incineration of dangerous wastes, represented by lawyer director Marius BUZEA and the chief of technical service, Eugen POPA,
- SC VIVANI SA Slobozia, having object of activity the incineration of municipal and special wastes (electroplating sludge, slag powders, etc) represented by director Eng. Steluta COMAN
- SC FARKAS TRANS ROMANIA SA Bucuresti, having object of activity the transport of special bulk wastes, represented by director Ion TRUSCA,
- SC RO-ECOLOGIC SA Fieni, Dambovita county, having object of activity the co-incineration of special wastes in cement kilns, represented by Eng. Orlando BANICA,
- SC SEPTOX ROMANIA SRL Targu-Mures, having object of activity the management and preparation of industrial wastes for the co-incineration in cement kilns, represented by director Eng. Jenö IMREH,
- SC SINTEZA SA Oradea, having as object of activity the production of powder benzoic acid and of others intermediate chemical products, represented by general manager Eng. Catalin MARIAS,
- The Institute of Energetic Studies - ISPE Bucuresti, Timisoara Branch, specialized in (among others) the design of heaps of slag and ash from the neighborhood of power plants, represented by director Eng. Laurentiu MAIER,
- INCD ECOIND Bucuresti, institute specialized in studies and measurements of environment factors, represented by director dr. Eng. Luoana PASCU,
- GREENTECH Brasov, a cluster of nineteen firms, institutions and companies from Romania producing material goods, research institutes, consulting and design firms acting for the promotion of the production technologies tending to the "zero emissions" desideratum, represented by its president, Eng. Petru BARZAN,
- SC AZUR S.A. Timisoara, represented by Eng. Anisoara BEJINARU,
- OILFEST SRL Timisoara represented by director Eng. Mihai BORCEANU.

The project manager Dr. Mihai Lungu started with the presentation of the project, its objectives and the results achieved in the frame of this project. Then, the general manager of PRO AIR CLEAN ECOLOGIC Timisoara, and project member also, Dr. Eng. Nicolae Strambeanu presented the book entitled "Nanoparticle' Promises and Risks", published in the frame of the project in 2015 at Springer Publisher. The director of ISPE – Timisoara Branch pointed out the significance of performing a study on nanoparticle emissions due to the drifting of ashes from dumps of power plants or other highly toxic powder wastes. Also, the representative of Greentech Brasov cluster spoke about the importance of orientation to those industrial process that promote the total recovery/recycling of sub products/wastes, in order to limit the CO_2 emissions, and of nanoparticle as well. The representatives of Septox, RO-Ecologic and Vivani appreciated the high level of the meeting and also the significance of presented information, results and practical demonstration performed in front of the audience, emphasizing the importance of the project. They also declared that, in short time, they will appeal to the work team of the project for performing measurements on nanoparticle concentration in the perimeters in which they operate.

- The second was held on September 7^{-Th}, at the Physics Faculty, West University of Timisoara. At this event participated local public policy makers in order to inform them of project outcomes and to identify their position on the issue of emission of nano-micro particles in the atmosphere, as following:

- Mrs. Counselor Doina MARIN from APM Timisoara,
- Mrs. Commisar Dana MARIN from GNM Timis,
- Mrs. Fistiş GABRIELA, director of Denkstatt Romania,
- Eng. Andres LADISLAU, coordinator of INCD ECOIND Timisoara branch,

- Eng. Laurentiu Florin MAIER, chief of ISPE Timisoara branch,
- Eng. Mihai BORCEANU director of OILFEST SRL Timisoara,
- Eng. Anisoara BEJINARU, from AZUR SA Timisoara,
- Eng. Catalin MARIAS, director of SINTEZA Oradea.

The project member Antoanetta Lungu presented the maps of nanoparticle emissions in Timisoara, obtained by more than 250 measurements in years 2015 and 2016 in different points of interest from the point of view of nanoparticle emissions, represented the base of discussions that resulted new directions for the action plan for environment in west region of Romania, PLAM. During the discussions that followed, the coordinator of INCD ECOIND Timisoara branch, chief of ISPE Timisoara branch, and the director of OILFEST were interested in the costs of the measurement equipment and the corresponding costs of the measurement process, respectively.

Conclusions

The stage 2016 of the project has proposed to continue the estimation regarding airborne particulate matter emissions in the city of Timisoara. The first part of the report presents the pollution maps with nanoparticle particulate matter suspensions in size ranges PM0.3, PM2.5 and PM5 of Timisoara city, obtained from measurements carried out with air particle counter P311. Thus, 52 measurement points were chosen on a grid drawn on the city map, with an approximate resolution of 900mx900m, in the Southern and Northern parts of the city, in two different days, March 24 and April 4. It has been found that fine particles are predominant in areas of intense traffic in the North and of combined intense traffic and industrial emissions in the South. The effect of the dominant direction of the wind (SE) on the dispersion of fine particles is revealed by the presented maps. The large number of coarse particles in the south can be due to the ashes generated by the thermoelectric plant CET-South carried by the wind. In the second part, the report refers to an intervention model to limit the emission of nano-metric particles in the city of Timisoara, based on examples of good practice in the area of intervention policies in EU countries. Finally, were organized a workshop regarding nanoparticle air pollution, work visit in an industrial unit generating polluting emissions possibly interested in the project in order to estimate their intention to invest in nanometric particle filters and round tables with the local decision-making authorities to inform them about the results of the project and to know their position regarding the nanoparticle emissions issue.

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Dissemination of the obtained results.

The results obtained during the stage 2016 were disseminated by 4 participation in the frame of 3 international conferences, 12 published articles and two submitted for publication in ISI journals, one book published by Springer Publishing House, whose editors are the project manager and two of the team members, and three chapters in this book. All publications contain acknowledgment of the project. During the stage the project website was constantly updated, at the address: www.nanodep.com.

Conference participations:

[1] M. Lungu, A. Lungu, N. Stefu, A. Neculae, and N. Strambeanu: *Analysis of airborne particulate matter pollution in Timisoara city urban area and correlations between measurements and meteorological data*, TIM 15-16 International Physics Conference, Timisoara, Romania, May 26-28, 2016.
[2] J.M. Patrascu, B. Andor, I. Malaescu, A. Lungu, A. Zamfir, A. Robu and M. Lungu: *Study regarding possible correlations between synovial fluid properties and femoral head avascular necrosis*, TIM 15-16 International Physics Conference, Timisoara, Romania, May 26-28, 2016.
[3] M. Lungu, A. Neculae, A. Lungu and N. Strambeanu: *Investigations Regarding Possibility on Flue Gas Filtration by Selective Retaining of Nanoparticle using Positive Dielectrophoresis*, International Conference on Analytical and Nanoanalytical Methods for Biomediacal and Environmental Sciences *IC-ANMBES* 2016. Transilvania University of Brasov, Romania, June 29th-July 1st, 2016.
[4] M. Lungu, N. Stefu, A. Lungu, and A. Neculae: *Study on the airborne particulate matter distribution in Timisoara city urban area*, The 16-th International Balkan Workshop on Applied Physics, Constanta, July 7-9, 2016.

ISI Publications:

[1] M. Lungu, A. Neculae and A. Lungu: Positive dielectrophoresis used for selective trapping of nanoparticle from flue gas in a gradient field electrodes device, *Journal of Nanoparticle Research*, Vol. 17 (12), 1-14, 2015.
[2] A. Neculae, M. Bunoiu, A. Lungu and M. Lungu: Filtration of flue gas by retaining of nanoparticle in microfluidic devices using dielectrophoresis, *Romanian Reports in Physics,* Vol. 68, Nr. 3, 2016.
[3] A. Neculae, M. Bunoiu, A. Lungu and M. Lungu: Filtration of flue gas in microfluidic devices using dielectrophoresis, *Romanian Journal of Physics,* Vol. 61, No. 5–6, 2016.
[4] M. Lungu, N. Stefu, D. Arghiriade: Study on particulate matter dispersion by correlating direct measurements with numerical simulations. Case study: Timisoara urban area, sent to *International Journal of Environmental science and Technology*, under review, 2016.
[5] M. Lungu and A. Neculae: Eddy current separation of small nonferrous particles using a complementary air-water method, sent to *Resources, Conservation and Recycling*, under review, 2016.

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