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Monitoring of air pollution spread on the car-free day in the city of Veszprém

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Abstract

One of the major factors which adversely affect environmental quality in many cities all over the world is air pollution, with profound negative effects on human health [1]. Apart from the health risks through the inhalation of gases and particles, urban air pollution is the source of other problems such as accelerated corrosion and deterioration of materials, damage to historical monuments and buildings and damage to vegetation in and around the city [2]. In this study, we aimed to investigate the effect of the vehicle related emissions which are a significant source of air pollutants. The research was conducted during the European Mobolity Week (EMW) on the Car-Free Day (CFD). For the characterization of the air quality the generally accepted indicators – O3, CO, SO2, NO/NO2/NOx, PM10, Benzene (B), Toluol (T), Etil-benzene (E), m-, p-Xilol (MP), o-Xilol (O) concentrations – were used, which well characterizes the changes in air pollution. The average concentrations measured on the car free day for O3 was 64,5 µg/m3, for NO2 was 6,76 µg/m3, for CO was 127,12 µg/m3, for SO2 was 5,19 µg/m3, for PM10 was 10,88 µg/m3, for Benzene was 0,38 µg/m3, for Toluol was 0,58 µg/m3, for Etil-benzene was 0,22 µg/m3, for MP-Xilol was 1,64 µg/m3 and for O-Xilol was 2,93 µg/m3. The results clearly shows that the daily fluctuation of the air pollutants depending on the traffic.

Keywords: Air quality; Air pollution monitoring; Car-free day; Traffic.

1. Introduction

Nowadays the most serious atmospheric problems are the pollution of the air, the destruction of the tropical rain forests, the weather changes, the acid rain, the green house gasses, the warming up of the Earth and the breaking of the ozone layer. There has been more and more damage to the environment, which proceeds faster and faster, since the increase of the world's population and industry. The growing number of cars [3] on roads contributes much to the air pollution. Factories produce large quantities of carbon dioxide [4], sulphur and nitrogen which get into the air too. Different chemicals have damaged the ozone layer and as well as caused the green-house effect, which have led to an increase on temperature levels [5]. To summarize this changed weather has a harmful effect on human health, on flora and on fauna, and that is the reason why we need to build a monitoring system, measure the air pollution particles and deliver strict environmental regulations.

The purpose of this study was to follow the change in the urban air quality. We aimed to investigate the effect of the vehicle related emissions which are a significant source of air pollutants. The monitoring campaign of air pollutants was conducted during the European Mobolity Week (EMW) on the Car-Free

Day (CFD). For the characterization of the air quality the generally accepted indicators – O3, CO, SO2, NO/NO2/NOx, PM10, Benzene (B), Toluol (T), Etil-benzene (E), m-, p-Xilol (MP), o-Xilol (O) concentrations – were used.

2. Experimental

Our experimental design focused on the detection and assessment of the transfer of pollutants of the locality of Veszprém, in the Central Transdanubien Region (Figure 1). Veszprém is not a large urban area in Hungary. There are no factories with significant air pollutant emission. Therefore pollution originating from public transportation and domestic heating are the most representative pollution sources. The growing number of motor vehicles and the related air pollution cause an increasing problem from year to year [6].

Figure 1. M1 is the place where the mobile measurement laboratory was stand (source: Google Earth)

To the determination of the air pollutants different analyzers and measurement methods were used in the course of the research. The concentration of carbon-monoxide measured by a non-dispersive infrared analyzer. The reference measurement method of carbon-monoxide can be found in the MSZ MSZ ISO 4224:2003 standard: "Ambient air - Determination of carbon monoxide - Non-dispersive infrared spectrometric method [7, 8]".

The concentration of nitrogen-oxides measured by chemiluminescence analyzer. The reference measurement method of nitrogen-oxide and nitrogen-dioxide can be found in the MSZ ISO 7996 standard: "Ambient air. The determination of nitrogen-oxides' mass concentration. The method of chemiluminescence [9]".

The concentration of sulphur-dioxide measured by UV fluorescence analyzer, which measurement method can be found in the MSZ 21456-37 standard: "Examination of the air pollutant. The determination of sulphur-dioxide by UV fluorescence method" [10].

To the determination of ozone ultraviolet photometric analyzer was used. The reference measurement method of ozone which was used called MSZ 21456-26:1994 – Determination of ozone with ultraviolet photometric method [11].
To the measurement of the particulate matters dust filter systems were used, which working on gravimetric way (e.g.: Beta-ray particulate monitor). The MSZ ISO 10473:2003 - determination of the mass of particulate metters ona filter, Beta-ray absorption method were used as reference measurement method [12].
The concentration of benzene-toluene-xylene (BTX) measured by infrared analyzer. The reference measurement method of benzene can be found in the MSZ EN 14662-3:2005 standard: "Ambient air quality - Standard method for measurement of benzene concentrations - Part 3: Automated pumped sampling with in situ gas chromatography" [13].

3. Results and discussion

The monitoring of air pollutants was conducted on the Car-Free Day (CFD) on 20 of September and on a Control Day (CD) on 27 of September 1 week later. In Figure 2 the average hourly temperature and humidity values are visible . The temperature values are variable on the CFD between 7.8°C to 18°C and 9.5°C to 13.2°C on the CD. The humidity values are between 45.3 % to 87.6 % on the CFD and 61 % to 82.1 % on the CD.

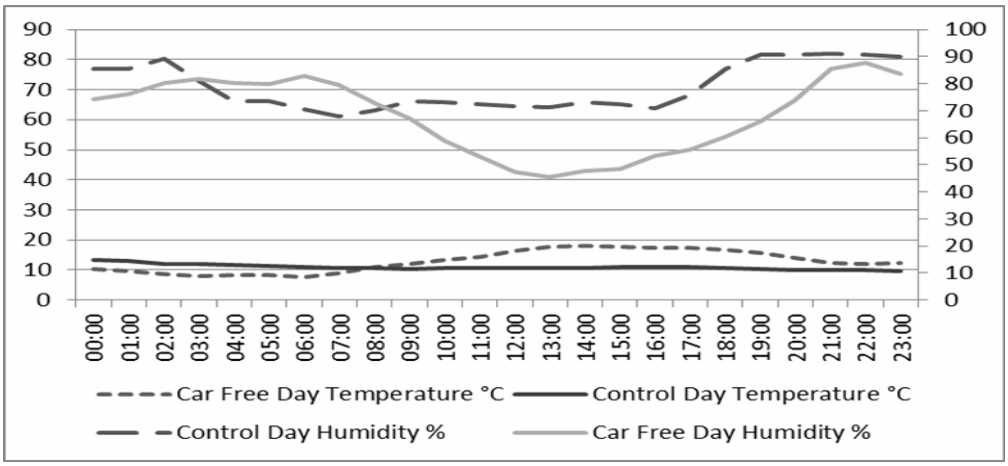

Figure 2. Average hourly temperature and humidity values on the car free day and the control day

Figures 3, 4 and 5 present the daily average concentration values of the two measurement periods. Figure 3 shows the daily average concentration values of No, No2, Nox, O3, So2, PM and Figure 4 shows the daily average concentration values of CO and Figure 5 shows the Benzene (B), Toluol (T), Etil-benzene (E), m-, p-Xilol (MP), o-Xilol (O) concentrations.
It should be noted that in case of NO_2, SO_2 the measured value on the car free day was higher than on the control day. The measured value of NO_2 was 6.76 μg/m^3 on the car free day and 6.22 μg/m^3 on the control day. On the car free day the measured value of SO_2 was 5.19 μg/m^3 and on the control day it was 3.20 μg/m^3.
The possible reason of the higher values of the car free day was that next to the Warta Vince street on the Victor Hugo Street there is an elementary school (visible at Figure 6.), and in the morning (between 7 am and 8 am) and in the afternoon (between 3 pm to 5 pm) when the parents were taking the children to school than from school at the intersection of Warta Vince Street and Hóvirág Street there were a traffic jam and the exhaust gases stemming from the machines are added to the typical air pollution level.
The measured value of the particulate matters was also higher on the car free day compare with the control day. On the car free day it was 10.88 μg/m^3 and on the control day it was 10.82 μg/m^3. On the car free day in the forenoon (between 10 and 12 o'clock) it was organized a program for elementary and high school students, called "Clean Air-Run for it" and because of that the dust concentration were increased and reached a higher level.
As it is visible on Figure 4, the measured daily average concentration of carbon monoxide was much higher on the control day (200.3 μg/m^3), than on the car free day (127.12 μg/m^3). According to the source (http://www.idokep.hu/hirek/talajmenti-fagy-is-lehetett) the reason of the higher concentration was that

in the morning the temperature was under excelsior and because of that the exhaust gases stemming from the family houses stokers increased the pollution level.
It should be noted that on the Figure 5 the case of m-, p-Xilol (MP), o-Xilol (O) the measured value on the car free day was higher than on the control day. The measured value of m-, p-Xilol (MP) was 1.64 μg/m^3 on the car free day and 1.36 μg/m^3 on the control day. On the car free day the measured value of o-Xilol (O) was 2.93 μg/m^3 and on the control day it was 1.58 μg/m^3.

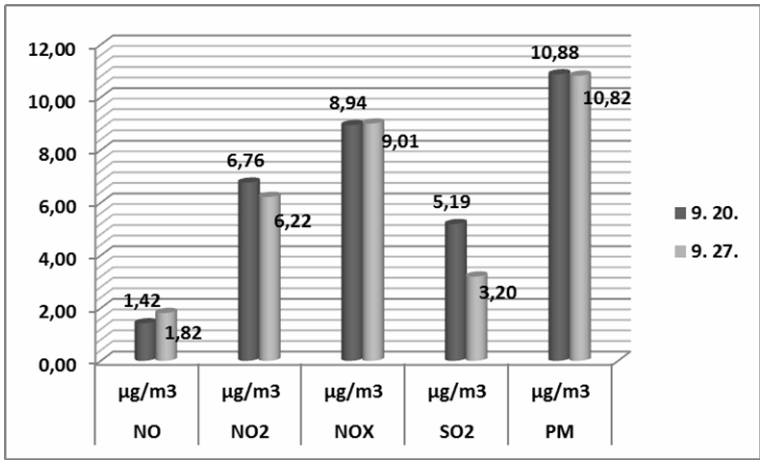

Figure 3. Daily average measured concentration of No, No_2, No_x, O_3, So_2, PM

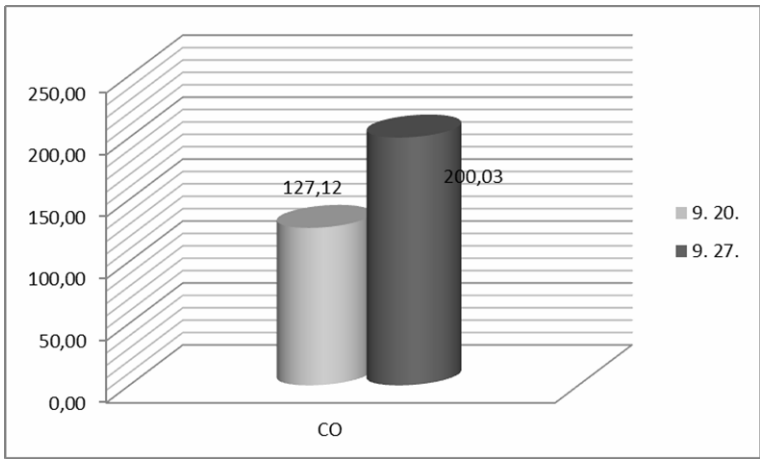

Figure 4. Daily average measured concentration of CO

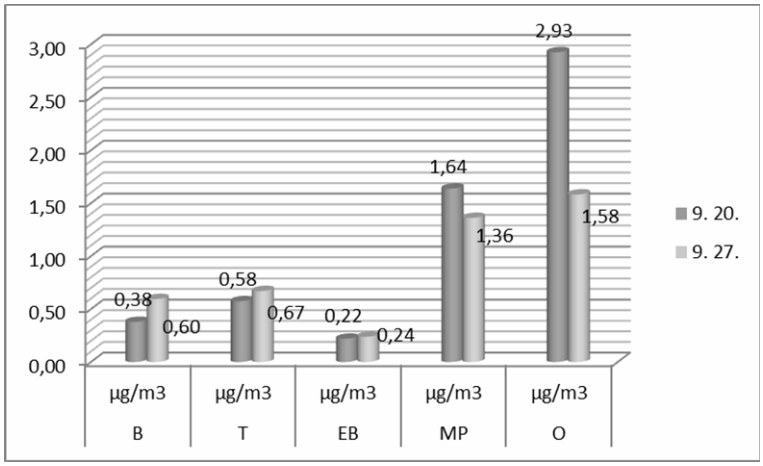

Figure 5. Daily average measured concentration of Benzene (B), Toluol (T), Etil-benzene (E), m-, p-Xilol (MP), o-Xilol (O)

Figure 6. M1 is the place where the mobile measurement laboratory was stand, the orange dashed lines signed the closed area, the green arrow shows the place of the elementary school, the white lines signed the way of the traffic and the red no entrance symbol shows where the traffic jam was (source: Google Earth)

4. Conclusion

Air quality control is one of those fields where many steps were taken by the European Union recently. Aim of the Committee is to establish a comprehensive strategy through which the air quality might be preserved for a long time [14]. These policies not only deal with technology and infrastructure, they also underline the importance of awareness-raising, citizen's engagement and people-focused planning processes [15]. European Mobility Week is an annual campaign on sustainable urban mobility, which runs from 16 to 22 September every year since 2000, organised with the support of the Directorates-General for the Environment and Transport of the European Commission. The aim of the campaign, is to encourage European local authorities to introduce and promote sustainable transport measures and to invite their citizens to try out alternatives to car use [15].

Within the confines of the Car Free Day the University of Pannonia carried out a series of air pollutant measurement with the generally accepted indicators – O3, CO, SO2, NO/NO2/NOx, PM10, Benzene (B), Toluol (T), Etil-benzene (E), m-, p-Xilol (MP), o-Xilol (O). According to the measurements it has been found that the daily average concentrations of the air pollutants are higher at those measuring times where the direct impact of traffic on the air pollutant concentrations is significant.

References

[1] Ch. Vlachokostas, Ch. Achillas, N. Moussiopoulos, G. Banias (2011): Multicriteria methodological approach to manage urban air pollution, Atmospheric Environment, Volume 45, Issue 25, Pages 4160-4169.

[2] Ch. Vlachokostas, S. Nastis, Ch. Achillas, K. Kalogeropoulos, I. Karmiris, N. Moussiopoulos, E. Chourdakis, G. Banias, N. Limperi (2010): Economic damages of ozone air pollution to crops using combined air quality and GIS modelling, Atmospheric Environment, Vol.44, pp.3352–3361.

[3] Ralf Kurtenbach, Jörg Kleffmann, Anita Niedojadlo,Peter Wiesen, 2011. Primary NO2 emissions and their impact on air quality in traffic environments in Germany. Environmental Sciences Europe, Volume 23.

[4] Roelof D Schuiling, Poppe L de Boer, 2013. Six commercially viable ways to remove CO2 from the atmosphere and/or reduce CO2 emissions. Environmental Sciences Europe, Volume 25.

[5] Wilhelm Kuttler, 2011. Climate change in urban areas, Part 1, Effects. Environmental Sciences Europe, Volume 23.

[6] Csom V., Kovács J., Szentmarjay T. (2009), Urban air quality, in view of the characteristics of suspended particulate matter, published in Chemical Engineering Days, 21-23th of April, 2009.
[7] MSZ ISO 4224:2003 standard: "Ambient air - Determination of carbon monoxide - Non-dispersive infrared spectrometric method".
[8] MSZ ISO 7996 standard: "Ambient air. The determination of nitrogen-oxides' mass concentration. The method of chemiluminescence.
[9] MSZ 21456-37 standard: "Examination of the air pollutant. The determination of sulphur-dioxide by UV fluorescence method".
[10] MSZ 21456-26:1994 – "Determination of ozone with ultraviolet photometric method".
[11] MSZ ISO 10473:2003: "Determination of the mass of particulate metters ona filter, Beta-ray absorption method".
[12] MSZ EN 14662-3:2005 standard: "Ambient air quality - Standard method for measurement of benzene concentrations - Part 3: Automated pumped sampling with in situ gas chromatography".
[13] Csom V., Kovács J., Szentmarjay T. Doomokos E. (2010), Study of traffic-related urban PM pollution at different locations, Hungarian Journal of Industrial Chemistry, Volume 38, pp.15-19.
[14] European Union offcial webpage, available at: http://europa.eu/citizens-2013/en/news/european-mobility-week-citizens-and-local-authorities-join-forces-create-new-urban-mobility-cul.
[15] European mobility week official webpage, available at: http://www.mobilityweek.eu/join-us/about/.

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