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THE INFLUENCE OF CO ON THE AIR QUALITY IN THE SURROUNDING OF THE FACULTY OF OCCUPATIONAL SAFETY IN NIŠ

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Milena Stanković, Milena Jovanović

Faculty of Occupational Safety in Niš, University of Niš, Serbia

Abstract. *Air quality in urban environments is determined by the concentrations of pollutants. The Air Quality Index (AQI) is used for assessment of air quality. The aim of this paper is to presents the quality of ambient air in the surrounding of the measuring point the Faculty of Occupational Safety in Niš, by using AQI and its comparison to CO concentrations. Measurements of CO concentrations were performed in the period from April to June, and in the period from September to November by the automated measuring station "Airpointer".*

Key words: *carbon monoxide; Air Quality Index; air quality; measuring station "Airpointer"*

1. INTRODUCTION

Air pollution is one of the most important environmental problems. This is particularly the case in urban areas where the majority of people live. With increasing population, there is an increasing need for production and spending of energy. Still, the biggest problem in some parts of the world is an air pollution caused by industrial pollution, while in some parts the pollution comes largely from traffic. The air quality in the surrounding us directly affects our quality of life. It is very important that air pollution can have negative affects for human health and the environment. Particles and other contaminants, have negative effects on the quality of life of critical groups such as children and the elderly, and may also lead to a significant reduction in lifetime [6].

The quality of urban environment is determined by the concentration of pollutants. One of the pollutants that extremely influence the air quality is carbon monoxide (CO). Carbon monoxide is one of the most widespread pollutants in the air. Carbon monoxide is a colorless gas with no taste or smell, which has a lower density compared to air and mixes evenly with the air. It arises from incomplete combustion of fossil fuels in power

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Corresponding author: Milena Stanković
Faculty of Occupational Safety in Niš, Čarnojevića 10A, 18000 Niš, Serbia
Phone: +381 18 529 821• E-mail: milena.stankovic1@znrfak.ni.ac.rs

plants, cars and homes, as well as in various industrial processes [1]. Carbon monoxide affects the transfer of oxygen in the blood. Considerable amounts of CO in the air can cause reactions with hemoglobin in the blood.

Assessment of air quality is very important and the methods for assessing air quality are numerous and varied. For this reason, and due to complex influence of the factors that affect the ambient air quality, different methods of measurement and prediction are used to determine the concentrations of ambient air pollutants. Monitoring of ambient air pollution in Serbia, is regulated by the Law on Air Protection ("Official Gazette of RS", No. 36/2009) [8] and Regulation on Air Quality Requirements and Monitoring Conditions ("Official Gazette of RS", No. 11/2010) [7], which define limit and tolerant values of pollutants concentration, the period measurement, the measuring process, etc. Monitoring of pollutants emitted from these sources in ambient air is performed in order to determine the concentration of: NO_x (nitrogen oxides), SO_2 (sulfur oxides), CO (carbon monoxide) and particulate matters.

Faculty of Occupational Safety in Niš is located near the district heating plant "Jug", it is also surrounded by the households using individual heating systems, e.g. furnaces. In order to determine the influence of CO on the air quality of the vicinity of the Faculty of Occupational Safety, the Air Quality Management Laboratory of the Faculty has designed a plan for monitoring ambient air in relation to the concentration of CO in the period from April to June and from September to November 2011., direct measurement with automated monitoring system "Airpointer" was performed at the measurement point "Faculty", using the air quality index (AQI) to the air quality.

The objective of this research was:

- To determine the concentrations of CO direct measurements with measuring station "Airpointer" at the measuring point;
- To see the status of air quality using the AQI;
- To determine the assessment of air quality in the vicinity of the measuring point using the AQI compared to the CO concentrations.

2. METHODS

The parameters analyze were obtaining by measuring CO concentrations with an automated measuring station "Airpointer", owned by the Laboratory for air quality management at the Faculty of Occupational Safety in Niš.

The measuring point was located on the flat roof of the Faculty outside the zone of influence of physical barriers. CO concentrations are measured by a standardized non-dispersive infrared spectrometry method (standard EN 14626).

Measuring station is designed to monitor pollution levels in residential - commercial zone, which stems primarily from traffic, furnaces and individual point sources. In addition, data are available for nitrogen oxides (NO, NO_2 and NO_x), particulate matters ($PM_{2.5}$ and PM_{10}) and total suspended particles (TSP), which can be generated at 1 minute, 30 minutes and 60 minutes.

The analysis has taken into account that most of the people or the largest number of students and Faculty working staff are present there in the morning, or from 08 - 16 pm, for that reason the CO particle concentrations were observed for 8 hours. Measuring station is designed to generate a minute values, after which averaged hourly and eight-hour values per month.

The period of measurements included the months of April, May, June, September, October and November.

To evaluate the air quality, EPA (Environmental Protection Agency) established Air Quality Index, as well as air quality standards for particulate matter, ground level ozone, CO, SO_2 and NO_2, which are considered harmful to public health and the environment.

AQI indicates whether the air is clean or contaminated, and what are the health effects that can be expected. AQI shows the health effects that may manifest within a few hours or days after breathing polluted air. To perform an assessment of air quality, air quality index approach, it is necessary to precisely define the index.

Air Quality Index comprises six classes. The first two classes cover a range of up to half of LVE, a third to half of the total value of LVE, and the fourth and fifth value is characterized by polluted air. The sixth class is the class of warnings and dangers. Classes are divided by the names of excellent, good, acceptable, polluted, heavily polluted and dangerous for the environment. Also, for each class EPA has awarded the category that refers to the possible health effects that may occur depending on the color classes (Table 1).

Table 1 Overview of AQI by category in relation to the LVE for CO (mg/m^3) [6]

AQI rating			LVE **for CO (mg/m^3)**
Excellent	**0 – 50**	**Air quality is considering to be satisfactory, and air pollution presents little or no risk**	**5 mg/m^3**
Good	**51 – 100**	**Air quality is superb, but there may be a moderate health concern for a small number of sensitive people**	
Acceptable	**101 – 150**	**Members of sensitive groups may experience consequences**	
Contaminated	**151 – 200**	**Unhealthy conditions for all**	
Very contaminated	**201 – 300**	**Unhealthy conditions for all the emergencies**	
Dangers	**301 – 500**	**Hazardous and everyone can get serious health consequences**	

When it comes to AQI for carbon monoxide, it should be taken into account that it is possible to calculate the AQI for a period of 8 hours, which corresponds to the monitoring plan in this paper.

3. Result Discussion

Test results show the impact of CO concentrations on the ambient air quality in the vicinity of the Faculty of Occupational Safety, as shown in the following table and figures.

Table 2 shows the average values of the eight-hour concentration of carbon monoxide in the air in the vicinity of the Faculty of Occupational Safety in Niš for the measurement period April, May, June, September, October and November 2011.

Table 2 The values of the concentration of CO on automated measuring station "Airpointer" for the measurement period April, May, June, September, October and November 2011

CO (mg/m^3)						
Date 1	**April 2011**	**May 2011**	**June 2011**	**September 2011**	**October 2011**	**November 2011**
	0,66222	1,482222	1,403333		1,082222	2,43
2	0,71222	1,311111	1,642222	0,707778	0,985556	2,947778
3	0,63667	1,413333	1,478571	0,482222	1,147778	2,552222
4	0,77222	1,323333		0,522222	1,26	2,455556
5	0,576667	1,16		0,546667	1,336667	2,404444
6	0,71222	1,258889		0,468889	1,433333	2,636667
7	0,798889	1,244444		0,556667	1,396667	3,09
8	0,767778	1,171111	2,81	0,574444	1,071111	2,665556
9	0,825556	1,306667	5,952222	0,6	1,116667	2,64
10	0,71222	1,341111	1,848889	0,627778	1,198889	3,112222
11	0,80444	1,357778	1,891111	0,693333	1,127	2,113333
12	1,234444	1,333333	1,797778	0,638889	1,627778	2,253333
13	0,968889	1,376667	1,73	0,8875	1,333333	2,442222
14	0,978889	1,401111	1,681111	0,677778	1,163333	2,438889
15	1,001111	1,434444	1,721111	0,754444	1,148	3,048889
16	1,017778	1,351111	1,528889	0,816667	1,213333	3,707778
17	1,043333	1,483333	1,73	1,031111	1,522222	4,457778
18	0,957778	1,615556	1,878889	0,948889	1,625556	5,123333
19	1,092222	1,508889	1,792222	0,912222	1,99	5,478889
20	1,10875	1,497778	1,774444		1,923333	4,3
21	1,07	1,458889	1,854444		1,917778	4,228889
22	1,073333	1,7025	1,692222		1,77	5,295556
23	1,11111	1,53	1,585556	1,144	2,301111	6,172222
24	1,12222	1,553333	1,754444	1,028889	2,04	7,523333
25	1,065556	1,571111	1,882222	0,986667	1,884444	7,757778
26	1,07889	1,398889	1,864444	1,103333	1,762222	6,275556
27	1,20889	1,353333	1,82	1,011111	1,585556	8,365556
28	1,24	1,286667	1,851111	1,016667	1,701111	9,142222
29	1,151111	1,562222	1,87	1,015556	1,966667	9,058889
30	1,15	1,483333	2,323333	1,133333	1,977778	11,19333
31		1,411111			2,65	
The maximum value	1,24	1,615556	5,95222	1,144	2,65	11,19333
The average monthly eight-hour value	0,95518055	1,409149	2,027585	0,803348	1,556756	4,577074

Monthly average eight-hour average of carbon monoxide in the month of April was 0.955180555 mg/m^3, and in May 1.40915 mg/m^3, which is far below the limit values in the air. For the month of June the average value of concentration was 2.02759 mg/m^3, in September it was 0.80335 mg/m^3 and in October 1.55676 mg/m^3, which was also below the limit values. In November, the concentration was 4.57707 mg/m^3 which was the highest measured value during the measurement, but lower than the limit values of carbon monoxide 5 mg/m^3.

From the diagram that shows the average daily eight-hour CO concentration values for the month of April (see Fig. 1) we can see that the concentration of CO during the month of April were still below the threshold, with a small upward trend on April 28th. Assessing the same values using the method of air quality, we came to the conclusion that the air in the vicinity of the Faculty of Occupational Safety mainly due to a good amount of mean daily concentrations of CO.

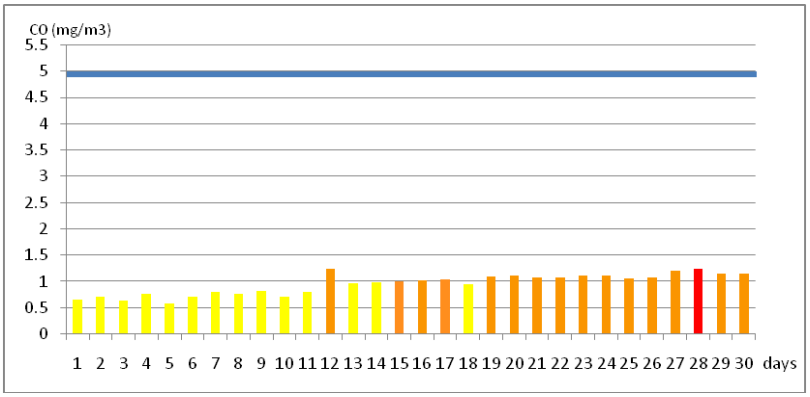

Fig. 1 The monthly average eight hour values of the CO in April 2011.

In the month of May (see Fig. 2) CO concentrations were below the limit values, but on the basis of AQI it can be seen that the air during this period was contaminated until June 18th when the air becomes very polluted, as well as on 22nd, 24tth, 25th and 29th of June, and that trend continued throughout the month of June.

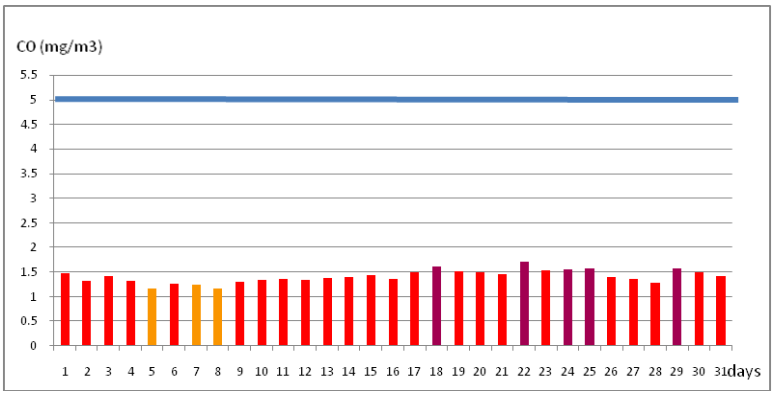

Fig. 2 The monthly average eight-hour values of CO in May 2011.

Figure 3 shown the average eight-hour values for the month of June, and we can see that the CO concentration were below the limit values, until 9th June, when there was a sudden increase in the concentration which were above the limit values and amounted to 5.9522 mg/m^3, and then rapidly declined. Also, based on the diagram and AQI we can see that the air during June was very polluted, and that the largest concentration or concentration above the limit value was recorded on 9th June which indicated that the air was very polluted and was considered hazardous to human health.

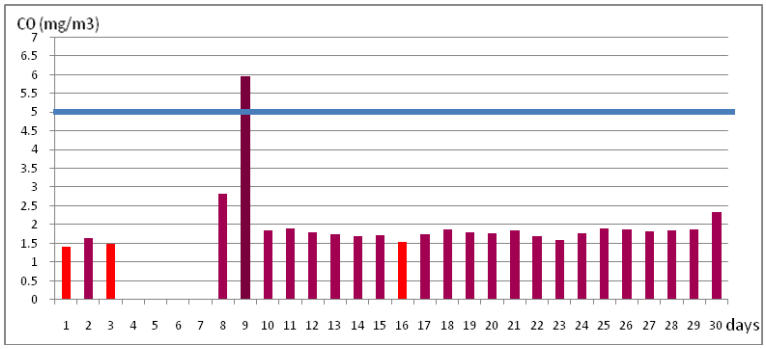

Fig. 3 The monthly averaged eight-hour values of CO in June 2011.

During September, we can see that the CO concentration was below the limit values based on the amount of mean daily concentrations of CO and the AQI we could conclude that air quality in that period was good (see Fig. 4).

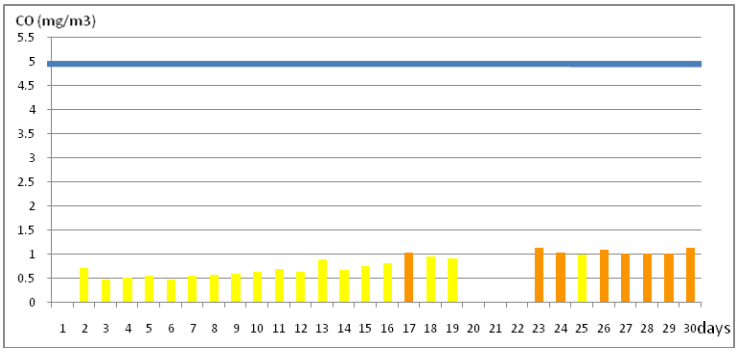

Fig. 4 The monthly averaged eight-hour values of CO in September 2011.

In October, the concentrations remained below the limit values, and the air quality was good, until 12th October, when the air was classified as very polluted air. The trend continued from the 18th of October to the end of October, with fast growth of the concentration of CO in this period (see Fig. 5).

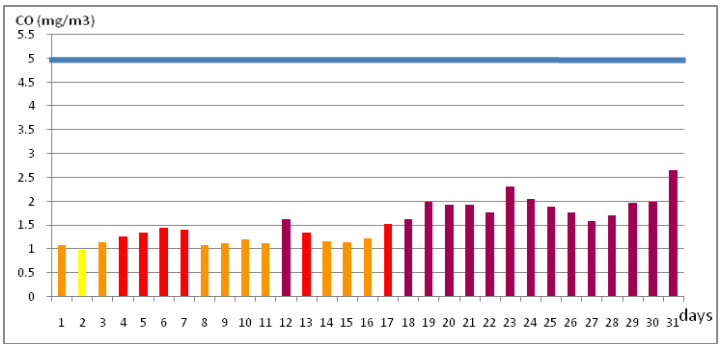

Fig. 5 The monthly averaged eight-hour values of CO in October 2011.

The highest concentrations of CO were record during the month of November. Based on the methods of air quality index it can be observed that during the month of November the air was very polluted, until 22nd November, when the concentrations exceeded the limit value concentrations and the air became risky and hazardous. The highest concentrations were recorded at the end of November and amounted to approximately 9 mg/m^3, whereas on 30th November CO concentration amounted to 11,193 mg/m^3, which was two times more than the permissible limit values (see Fig. 6).

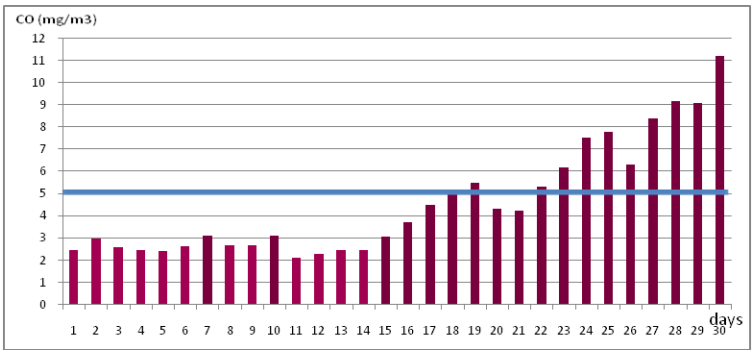

Fig. 6 The monthly average eight-hour values of CO in November 2011.

There of measurement of carbon monoxide in the air show that throughout the measurement period, the average values were within acceptable limits. Assessing the same values using the method of air quality, we came to the conclusion that the air in the vicinity of the Faculty of Occupational Safety was mainly good, except the amount of mean daily concentrations of CO in the winter months.

4. CONCLUSION

The air quality in the vicinity of the Faculty of Occupational Safety was evaluated by direct measurement with an automated measuring station "Airpointer", and the method of air quality index (AQI).

Based on the results of measurements and AQI it can be concluded that:

- The trend of the measured values of CO increases from April to June and from September to November, in line with the general trend of falling ambient air temperature.
- The measured CO concentration during the months of April, May, June, September and October is always less than the limit value, while in November the concentrations increase above the limit value.
- Measured concentrations of CO from mid November were constantly below the limit values until the end of the measurement, which suggests that in the period of lower temperature of ambient air pollution contributes to ambient air CO in the vicinity of the Faculty.
- AQI method shows satisfying results of the assessment of air quality on the basis of which we can conclude that the condition of ambient air quality during April, May and September was good, while in June and October it was characterized as polluted, as in the first half of November. In the second half of November it turns into a risky situation, when the concentrations of CO were two times higher than the allowable limit values.

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REFERENCES

1. Arsić Kokić A., Milivojević J., Savović I. (1991). Uticaj kvaliteta vazduha na zdravlje i kvalitet života ljudi.
2. Đukanović M. (1991). Ekološki izazov, ELIT, Beograd.
3. Đuković, J. (2001). Hemija atmosfere, Rudarski institut Beograd.
4. Đuković J., Bojanić V. (2000). Aerozagađenje: pojam, stanje, izvori, kontrola i tehnološka rešenja, Institut zaštite i ekologije, Banja Luka, str. 45.
5. Živković N., Đorđević A. (2001). Zaštita vazduha – teorijske osnove predviđanja zagađenosti vazduha, Fakultet zaštite na radu, Niš.
6. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors. Volume I: Stationary Point and Area Sources, Fifth Edition, AP-42., Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, 1995.
7. Uredba o uslovima za monitoring i zahtevima kvaliteta vazduha ("Sl. glasnik RS, br.11/2010).
8. Zakon o zaštiti vazduha ("Sl. glasnik RS, br.36/2009).
9. Đorđević A., Živković N., Todorović B., Anđelković B. (2006). Kartografski prikaz polja kvaliteta vazduha, Prva Nučno-stručna konferencija sa međunarodnim učešćem, Banja Luka, 339-347.

UTICAJ CO NA KVALITET AMBIJENTALNOG VAZDUHA U OKOLINI FAKULTETA ZAŠTITE NA RADU U NIŠU

Kvalitet vazduha urbanih sredina određuju koncentracije zagađujućih supstanci u njemu. Ocena kvaliteta vazduha vrši se korišćenjem indeksa kvaliteta vazduha (AQI). Cilj ovog rada je da prikaže kvalitet ambijentalnog vazduha u okolini mernog mesta Fakulteta zaštite na radu u Nišu korišćenjem AQI u odnosu na koncentracije CO. Merenja koncentracija CO su vršena u periodu od aprila do juna, kao i u periodu od septembra do novembra automatizovanom mernom stanicom "Airpointer".

Ključne reči: *ugljen monoksid; indeks kvaliteta vazduha; kvalitet ambijentalnog vazduha, merna stanica "Airpointer"*