CHEMICAL POLLUTION PRODUCED BY THE HEAVY VEHICLES IN URBAN AREAS

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KEYWORDS – Heavy vehicles, Chemical, Pollution, Measurement, Traffic.

ABSTRACT - In this paper it is presented a study of the experimental researches about the influence of the increasing of the heavy vehicles over the air quality in urban areas. There were studied several intersections of the Brasov City, for a hour interval according with the current Environmental legislation from the European Union. This study includes road traffic measurements effectuated in 2009 and chemical emissions measurements. The measurements of the pollutant emissions specific to the zone studied were realized with a portable gas detector MultiRAE IR. It was analyzed the concentration variation of three chemical pollutants (CO [ppm], VOC [ppm], SO_2 [ppm]) and CO2 concentration, specific to the areas near the road' infrastructure for one time interval when the measurements were made. Also, there ware made meteorological conditions measurements, using a portable anemometer, AIRFLOW TA460. The selected time interval was 15.00-16.00, when the traffic flow density is high. The study was realized taking into account the pollutants mentioned in the Environmental legislation from the European Union and the conditions of the World Health Organization (W.H.O.).

MAIN SECTION - Automotive Vehicles and Environment

1. INTRODUCTION

Numerous studies have found vehicles to be the major source of emissions in many of the world's mega cities. Also, the traffic noise is probably the most serious and pervasive type of noise pollution. In the central area of the Brasov City can be found the biggest concentration of the carbon monoxide, where the majority in traffic is composed by the vehicles equipped with gasoline engines, where the traffic conditions are admitting their functioning frequently at uneconomical regimes, with partial loads, low engine speeds and uncompleted burnings of the fuel.

The problem has been compounded by increases in traffic volumes far beyond the expectations of our early urban planners. At low speeds, most traffic noise is caused by vehicle engines, transmissions, exhausts and brakes. The stop-start braking and acceleration during peak-hour congestion also increases noise levels.

2. THE ANALYZED INTERSECTIONS

The three analyzed intersections form a route linking the four Brasov entrances, resulting the city's main route for light and heavy vehicles in transit but also for public transport. In the following picture is presented the emplacement for this intersections regarding to the Brasov civic centre.

Figure 1. The chosen transit route

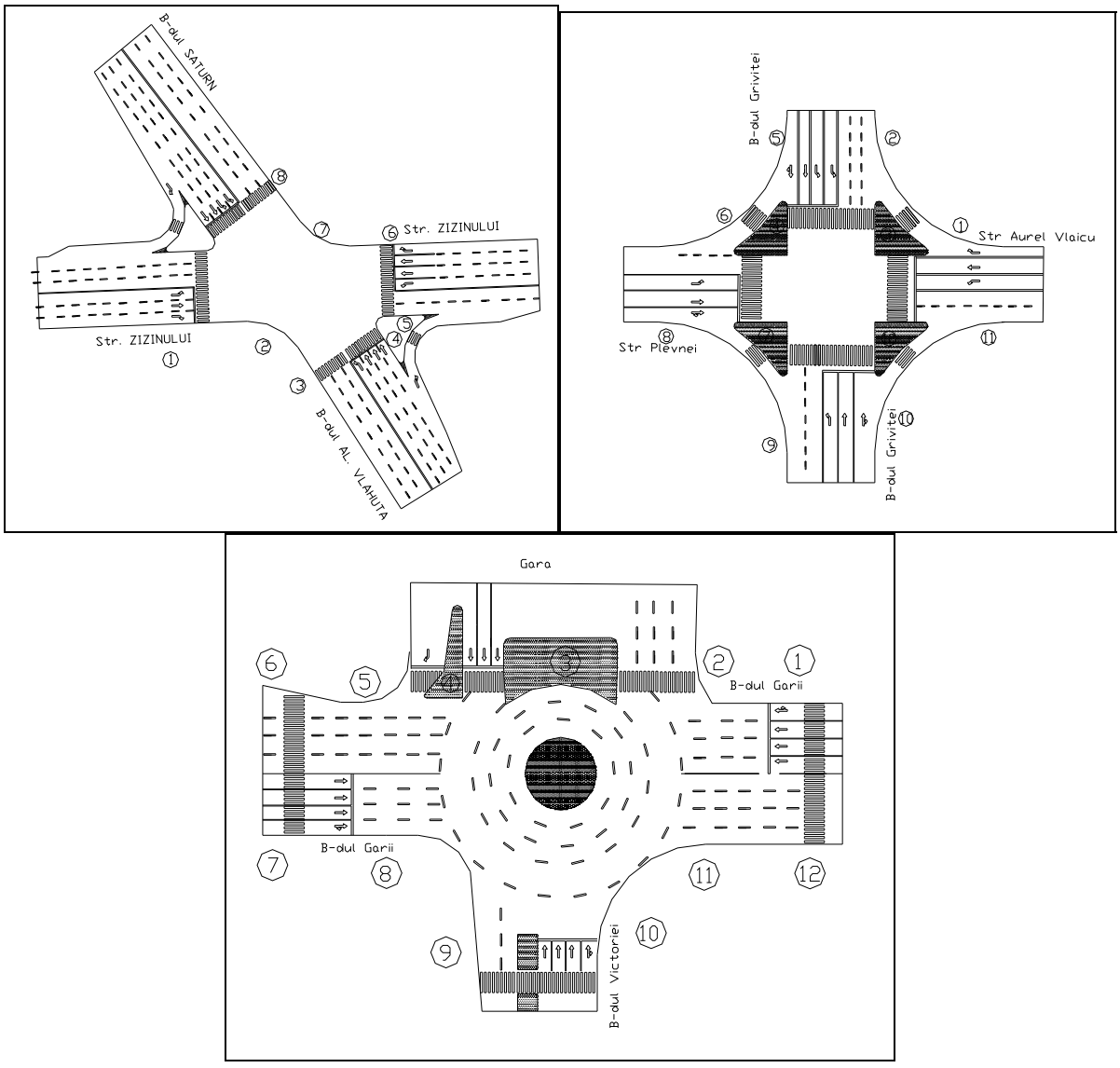


Figure 2. The analyzed intersections

In the above figure it is presented the geometrical scheme of the intersections and the points were the chemical and noise pollution measurements were made. The first intersection that

was analyzed is the Saturn Boulevard + Zizinului Street + Al. Vlahuță Street intersection. The second intersection that was analyzed is the Gării Boulevard + Victoriei Street intersection. The third intersection that was analyzed is the Griviței Boulevard + Aurel Vlaicu Street + Plevnei Street intersection.

For each intersection were determined several measuring points where concentrations of specific pollutants vehicles ware registered: carbon monoxide, volatile organic compounds, sulfur dioxide and the combustion product, carbon dioxide. The measurements registered in Brasov were made regarding to the Romanian norms. The measurement points were chosen to determine the chemical pollution level, which was influenced by three factors:

- composition and size of the vehicles flow passing through intersections;
- engine functioning regimes, when passing through intersections (operating conditions);
- meteorological conditions at the time of measurements.

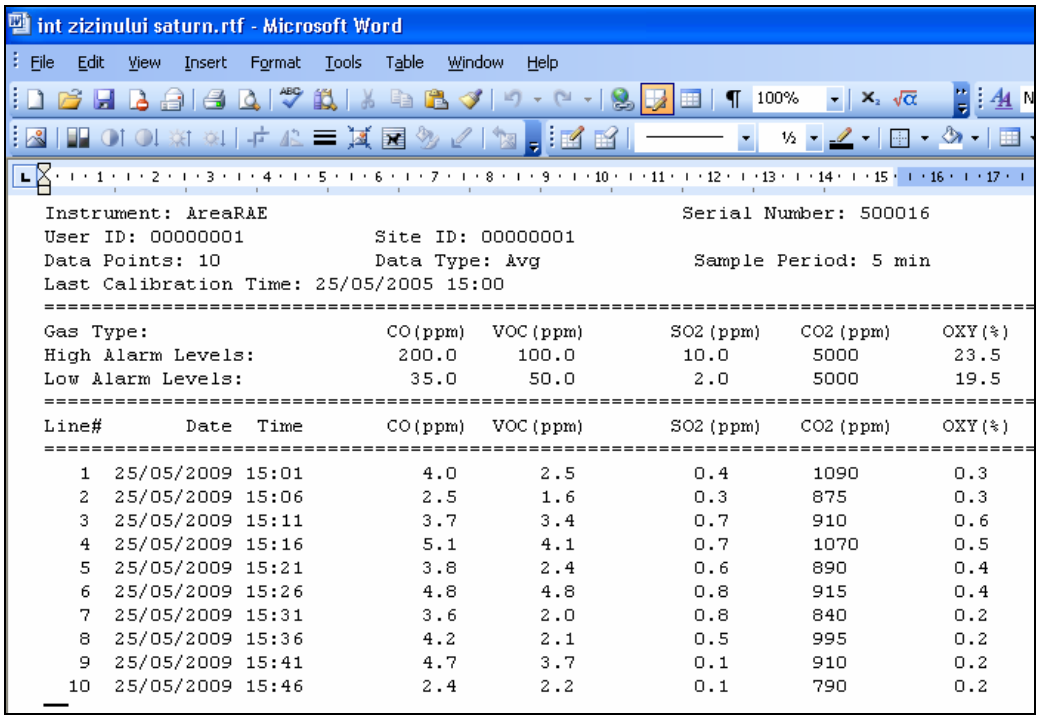
Under these conditions the measurement points were strategically chosen for each intersection. They watched the main vehicles flows, most of the points being positioned on the main access routes at intersections. Also, points were located in access and escape areas of crossing the intersection, where vehicles are braking and accelerating.

3. ROAD TRAFFIC AND CHEMICAL POLLUTION VALUES

For intersection's analysis there were collected data about the road traffic and data about the chemical and noise pollution in the neighborhood of the road (the values of some pollutants resulted from the fuel combustion). The volume of the traffic flow was determined by counting the total number of the vehicles, which passed through the intersection during one hour (15.00-16.00) in all ways. For measuring the concentration of the chemical pollutants the studied intersections it will be used a team of three persons. The three persons will use the necessary equipment (one portable gas analyzer and one anemometer) and will write the specific values of the measurement points.

In order to carry out measurements in the three studied intersections, after the choosing of measurement points there were established positioning schemes for equipment positioning. The used device will be moved to all measurement points to record levels of CO_2, VOC, CO and SO_2. The user can use the IR MultiRAE device with a harness. The device is designed so that the cells are directed outwards. This makes the holes for measuring cells to be visible during the measurement. The measurements were made at the afternoon rush hour (time interval 15.00-16.00), simultaneously with the traffic flow measurements. The traffic and chemical pollution measurement conditions: type of source: line source; distance from source = 1 meter to 5 meters; measurement interval = 60 seconds. The meteorological conditions of the area where the measurements were done: weather: good (Atmospheric temperature, T_{atm} = 30-31 °C; Humidity, H = 57%, Wind speed, w = 11-14 km/h (Wind direction - N, NV), Atmospheric pressure, P_{atm} = 1.015 KPa).

After data collection, they have been downloaded to the computer using dedicated software, called ProRAE-Suite.: After configuring the files, they will download in a Rich Text format. Pages downloaded in these formats and each intersection will have the following form:



int zizinului saturn.rtf - Microsoft Word

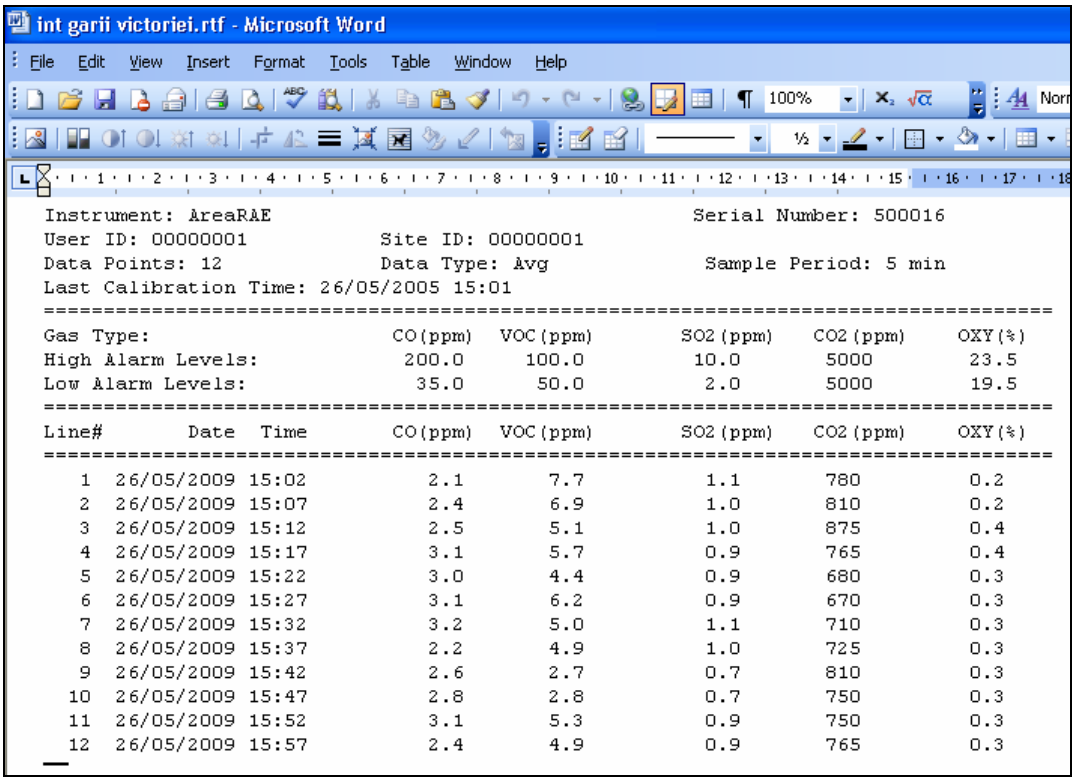
File Edit View Insert Format Tools Table Window Help

Instrument: AreaRAE Serial Number: 500016
User ID: 00000001 Site ID: 00000001
Data Points: 10 Data Type: Avg Sample Period: 5 min
Last Calibration Time: 25/05/2005 15:00

Gas Type:		CO(ppm)	VOC(ppm)	SO2(ppm)	CO2(ppm)	OXY(%)
High Alarm Levels:		200.0	100.0	10.0	5000	23.5
Low Alarm Levels:		35.0	50.0	2.0	5000	19.5

Line#	Date	Time	CO(ppm)	VOC(ppm)	SO2(ppm)	CO2(ppm)	OXY(%)
1	25/05/2009	15:01	4.0	2.5	0.4	1090	0.3
2	25/05/2009	15:06	2.5	1.6	0.3	875	0.3
3	25/05/2009	15:11	3.7	3.4	0.7	910	0.6
4	25/05/2009	15:16	5.1	4.1	0.7	1070	0.5
5	25/05/2009	15:21	3.8	2.4	0.6	890	0.4
6	25/05/2009	15:26	4.8	4.8	0.8	915	0.4
7	25/05/2009	15:31	3.6	2.0	0.8	840	0.2
8	25/05/2009	15:36	4.2	2.1	0.5	995	0.2
9	25/05/2009	15:41	4.7	3.7	0.1	910	0.2
10	25/05/2009	15:46	2.4	2.2	0.1	790	0.2

Figure 3. Zizinului Street + Al. Vlahuță Boulevard + Saturn Boulevard intersection corresponding page



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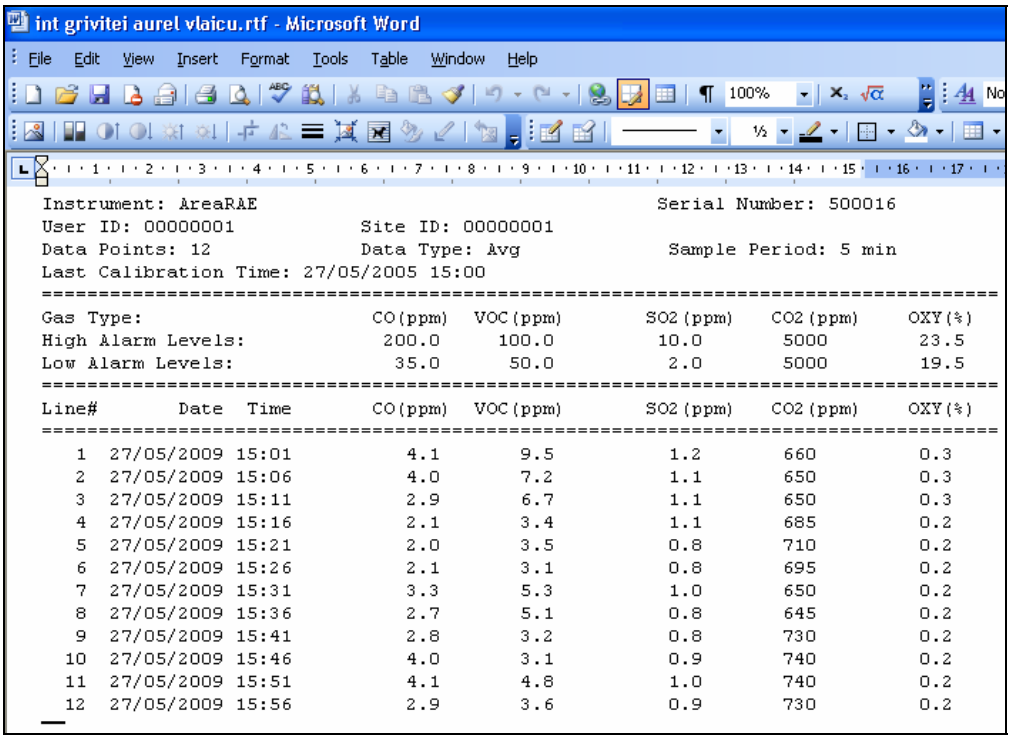
Instrument: AreaRAE Serial Number: 500016
User ID: 00000001 Site ID: 00000001
Data Points: 12 Data Type: Avg Sample Period: 5 min
Last Calibration Time: 26/05/2005 15:01

Gas Type:		CO(ppm)	VOC(ppm)	SO2(ppm)	CO2(ppm)	OXY(%)
High Alarm Levels:		200.0	100.0	10.0	5000	23.5
Low Alarm Levels:		35.0	50.0	2.0	5000	19.5

Line#	Date	Time	CO(ppm)	VOC(ppm)	SO2(ppm)	CO2(ppm)	OXY(%)
1	26/05/2009	15:02	2.1	7.7	1.1	780	0.2
2	26/05/2009	15:07	2.4	6.9	1.0	810	0.2
3	26/05/2009	15:12	2.5	5.1	1.0	875	0.4
4	26/05/2009	15:17	3.1	5.7	0.9	765	0.4
5	26/05/2009	15:22	3.0	4.4	0.9	680	0.3
6	26/05/2009	15:27	3.1	6.2	0.9	670	0.3
7	26/05/2009	15:32	3.2	5.0	1.1	710	0.3
8	26/05/2009	15:37	2.2	4.9	1.0	725	0.3
9	26/05/2009	15:42	2.6	2.7	0.7	810	0.3
10	26/05/2009	15:47	2.8	2.8	0.7	750	0.3
11	26/05/2009	15:52	3.1	5.3	0.9	750	0.3
12	26/05/2009	15:57	2.4	4.9	0.9	765	0.3

Figure 4. Gării Boulevard + Victoriei Boulevard intersection corresponding page



int grivitei aurel vlaicu.rtf - Microsoft Word

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Instrument: AreaRAE Serial Number: 500016
User ID: 00000001 Site ID: 00000001
Data Points: 12 Data Type: Avg Sample Period: 5 min
Last Calibration Time: 27/05/2005 15:00

Gas Type:	CO (ppm)	VOC (ppm)	SO2 (ppm)	CO2 (ppm)	OXY (%)
High Alarm Levels:	200.0	100.0	10.0	5000	23.5
Low Alarm Levels:	35.0	50.0	2.0	5000	19.5

Line#	Date	Time	CO (ppm)	VOC (ppm)	SO2 (ppm)	CO2 (ppm)	OXY (%)
1	27/05/2009	15:01	4.1	9.5	1.2	660	0.3
2	27/05/2009	15:06	4.0	7.2	1.1	650	0.3
3	27/05/2009	15:11	2.9	6.7	1.1	650	0.3
4	27/05/2009	15:16	2.1	3.4	1.1	685	0.2
5	27/05/2009	15:21	2.0	3.5	0.8	710	0.2
6	27/05/2009	15:26	2.1	3.1	0.8	695	0.2
7	27/05/2009	15:31	3.3	5.3	1.0	650	0.2
8	27/05/2009	15:36	2.7	5.1	0.8	645	0.2
9	27/05/2009	15:41	2.8	3.2	0.8	730	0.2
10	27/05/2009	15:46	4.0	3.1	0.9	740	0.2
11	27/05/2009	15:51	4.1	4.8	1.0	740	0.2
12	27/05/2009	15:56	2.9	3.6	0.9	730	0.2

Figure 5. Aurel Vlaicu Street + Griviței Boulevard + Plevnei Street intersection page

The volume of the traffic flow was determined by counting the total number of the vehicles, which passed through the intersection during one hour in all ways.

Table 1. Traffic flows on the studied route

Intersection number	Cars	Heavy vehicles	Public transportation
Intersection 1	4360	92	125
Intersection 2	4584	495	210
Intersection 3	4409	585	83

4. ANALYSIS OF THE CHEMICAL POLLUTION FOR THE STUDIED INTERSECTIONS

From the four parameters for which were made measurements, there were analyzed only three and these are: carbon monoxide (CO), volatile organic compounds (VOC) and sulfur dioxide (SO_2). The concentration variation of three chemical pollutants (CO [ppm], VOC [ppm], SO_2 [ppm]), specific to the areas near the road' infrastructure for the two analyzed time intervals is presented in the next analysis.

Zizinului Street + Al. Vlahuță Boulevard + Saturn Boulevard intersection:

Carbon monoxide, CO, values were recorded between 2 and 5 [ppm], specific to traffic that consists a number of vehicles equipped with spark ignition engines. The registered volatile organic compounds values, VOC, were between 1 and 5 [ppm], relatively small, due to the reduced weight of the composition of heavy vehicle traffic. Sulfur dioxide, SO_2, values were recorded between 0,1 and 0,8 [ppm], specific to traffic that consists a number of vehicles equipped with compression ignition engines.

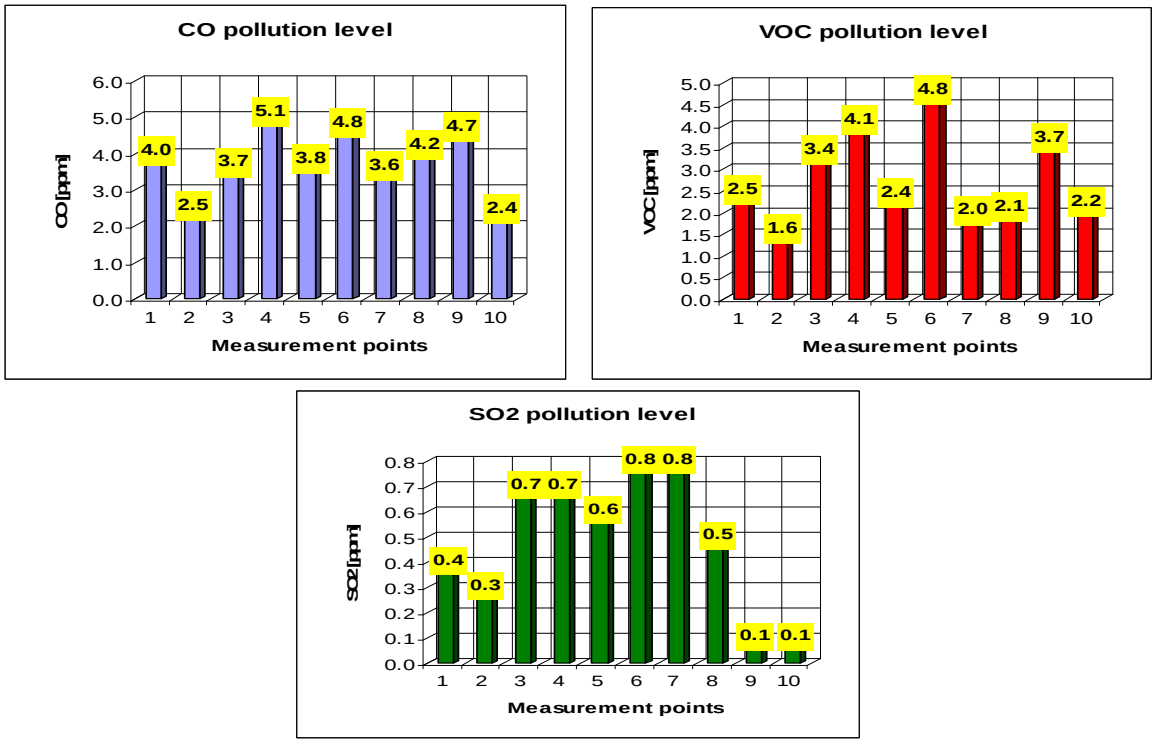

Figure 6. CO, VOC and SO_2 concentrations for Zizinului Street + Al. Vlahuță Boulevard + Saturn Boulevard intersection

Gării Boulevard + Victoriei Boulevard intersection:

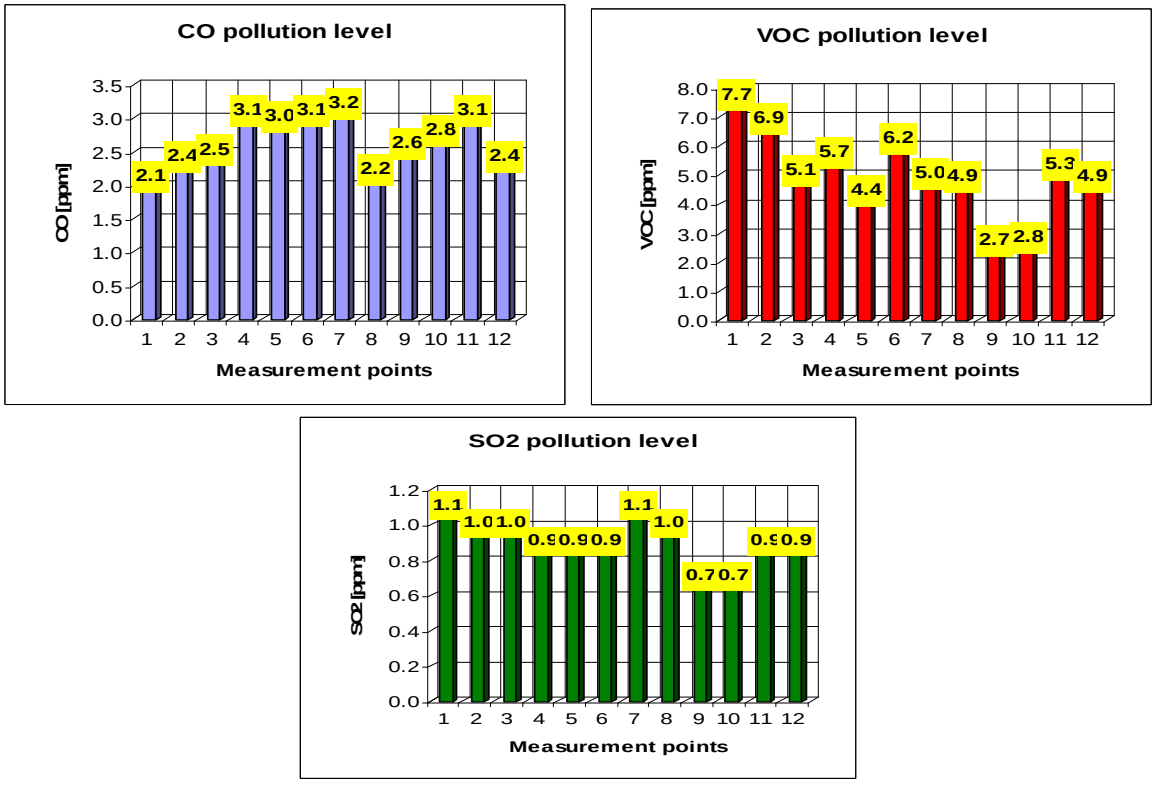

Figure 7. CO, VOC and SO_2 concentrations for Gării Boulevard + Victoriei Boulevard intersection

Carbon monoxide, CO, values were recorded between 2 and 3 [ppm], which is lower than in previous intersection. Volatile organic compounds, VOCs, levels were recorded between 3

and 7.7 [ppm], through a large composition of heavy vehicle traffic passing that intersection. Sulfur dioxide, SO_2, values were recorded between 0,1 and 0,8 [ppm], specific to traffic that consists a number of vehicles equipped with compression ignition engines, present in large numbers in this area.

Aurel Vlaicu Street + Griviței Boulevard + Plevnei Street intersection:

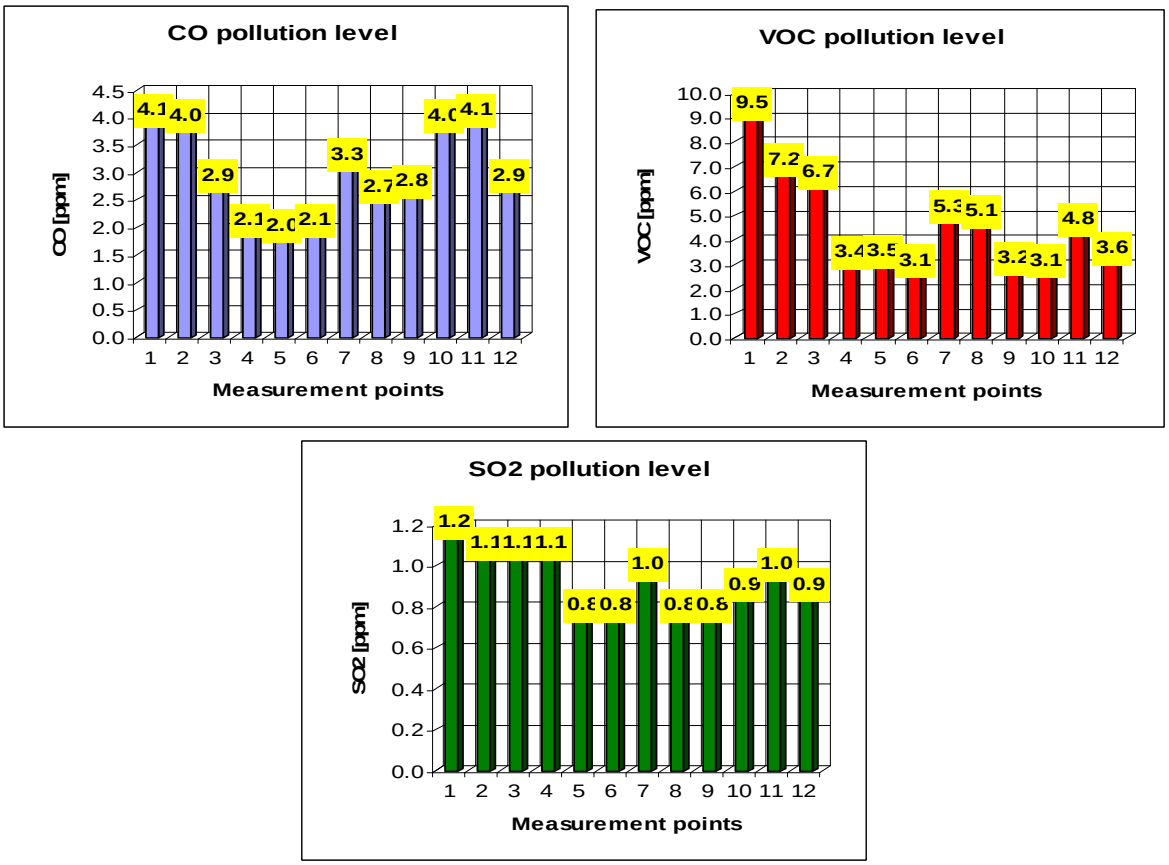

Figure 8. CO, VOC and SO_2 concentrations for Aurel Vlaicu Street + Griviței Boulevard + Plevnei Street intersection

Carbon monoxide, CO, values were recorded between 2 and 4 [ppm], because a number of vehicles equipped with ignition relatively large. . Volatile organic compounds, VOCs, levels were recorded between 3 and 9.5 [ppm], through a large composition of heavy vehicle traffic passing that intersection. The pollution level of volatile organic compounds is higher than previous intersections. Sulfur dioxide, SO_2, values were recorded between 0,8 and 1,2 [ppm], specific to traffic that consists a number of vehicles equipped with compression ignition engines, present in large numbers in this area.

5. CONCLUSION

From this study which as realized on the base of the data obtained experimentally can be observed some characteristics of the pollution made by traffic flow:

- substantial increments of the chemical compounds concentrations resulted from the fossil fuels burning are in the case of transitory functioning of internal combustion engines;
- the traffic's flow composition (cars, trucks, buses, trolleybuses) but also the traffic volume values (expressed by the Traffic capacity = etalon vehicles \ hour) have a

determinant role over the city's pollution level; the common transportation vehicles, especially the buses are a very important source of chemical and noise pollution;
- the biggest impact over the air quality, from the areas designated to pedestrians, is given by the traffic road (in the most of the cases the nearest vehicles to the sideways are the transportation vehicles); the pollutant emissions from the vehicles being maximal near the roads, at the height of the human respiratory organs.

The main contributions given by this research about the chemical pollution from the road traffic are the following:

- there were identified the major problems about the organization of the road traffic from Brasov District which contributes to the chemical and noise pollution from the urban areas;
- there were made road traffic and environment measurements, aiming to locate the levels of chemical and noise pollution from the traffic road;
- there was analyzed the local vehicles park, its structure, perspectives, the level of pollutant emissions from this one and the causes of the pollutant emissions generation.

REFERENCES

1. Cofaru, C. – Legislaţia şi Ingineria Mediului în Transportul Rutier, Editura Universităţii Transilvania, Braşov 2002.
2. Florea, D., Cofaru, C., Şoica, A. – Managementul traficului rutier, Editura Universităţii Transilvania, Braşov 1998.
3. UZUREANU, K., "The monitoring and air quality diagnosis", Technical editor, Bucuresti 2007.
4. ZABALZA, J., OGULEI, D., "Study of urban atmospheric pollution in Navarre", Environmental Monitoring and Assessment, Vol. 134, Springer, Netherlands, 2007.
5. Tarulescu, S.; Tarulescu, R.; Soica, A. (2008). Mathematical model of pollution compounds calculus in function of traffic capacity from urban areas, WSEAS International Conference on Multivariate Analysis and its Application in Science and Engineering, ISBN: 978-960-6766-65-7, Istanbul, Turkey.
6. Ţârulescu, S., Ţârulescu, R., Şoica, A., Approximation of the carbon monoxide concentration resulting from the road traffic using experimental measurements, The 20 th International DAAAM Symposium, 25-28 nov. 2009, Viena, ISSN 1726-9679.