

# САОБРАЋАЈ И КОНТРОЛА КВАЛИТЕТА ВАЗДУХА

## TRAFFIC AND AIR QUALITY CONTROL

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### АПСТРАКТ

Рад приказује начин контролисања квалитета ваздуха са свим полутантима које закон дефинише. Подаци који се редовно прате и анализирају показују да је утицај на животну средину значајан. Поред саобраћаја на квалитет ваздуха утичу и следећи параметри: метеоролошки параметри који се континуално прате, конфигурација терена и густина становништва. Праћењем значајних параметара можемо да сагледамо када је неопходно променити параметре и на тај начин утицати на квалитет ваздуха. Рад приказује податке који су анализирани и представљени јавности. У раду су приказани сви значајни утицаји транспорта на животну средину у случај великог града. Анализирана је законска регулатива и приказана неопходна пројектна документација која обрађује ову важну област.. Дефинише се као мерење загађујућих материја (прашина, сумпордиоксид, оксиди азота, угљенмоноксид и угљоводоници) који су саставни део стратешких студија за утврђивање значаја саобраћаја у дефинисању утицаја града на животну средину. То су проблеми који се јављају у великим градовима са високим интензитетом саобраћајних токова.

**Кључне речи:** *саобраћај, квалитет ваздуха, полутанти*

### ABSTRACT

The paper presents a method of controlling air quality with all pollutants defined by law. Data that is regularly monitored and analyzed shows that the impact on the environment is significant. In addition to traffic, the following parameters also affect air quality: meteorological parameters that are continuously monitored, the geography of the environment, and population density.

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By monitoring significant parameters, we can see when it is necessary to change the parameters and thus influence air quality. The paper presents the latest data that have been analyzed and presented to the public. Paper presents all the significant impacts of transport on the environment in the case of a major city. Analyzed the legal regulations and displayed the necessary project documentation that discusses this important area. Defined as the measurement of pollutants (dust, sulfur dioxide, nitrogen oxides, carbon monoxide and hydrocarbons) which are an integral part of strategic studies to determine the importance of traffic in the definition of the environmental impact of the city. These are problems that arise in large cities with high intensity traffic flows.

**Keywords:** *transport, air quality, pollutants*

## **INTRODUCTION**

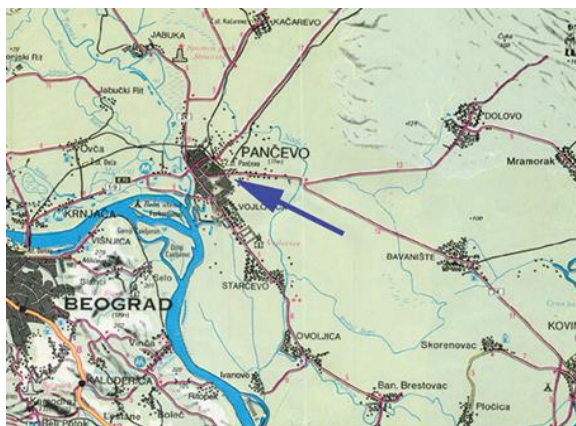
Expansion network, and followed by the occurrence of traffic pollution of the atmosphere, which is in correlation with the degree of industrialization of a given region, and the density of traffic. The car has become an integral part of the life of modern man. Car exhaust is the most important component of air pollution of large cities. The aerosol urban air is several thousand particles per cubic centimeter, according to a few hundred in rural areas. Aerosols automotive origin are particles of 0.5  $\mu$ m and consist of particles of carbon, lead compounds, coal, gasoline and the combustion products of hydrocarbons. Two primary pollutants CO and NO<sub>2</sub> are regularly present in the exhaust fumes of cars and air of large cities, and are among the most toxic substances that pollute the air intake.

The biggest problem of atmospheric pollution from exhaust gases from motor vehicles, in countries with developed automotive industry and traffic. The first survey, in order to evaluate the impact of exhaust emissions from motor vehicles on the pollution of the atmosphere, were initiated in 1958 in the United States for the first time are regulated by law in 1968. Emissions in Europe were first legally regulated in 1970. From then until now, all the tougher regulations on the control of emissions. The current regulations on the control of emissions did not give the expected reduction in overall pollution of the atmosphere.

### **Location Pancevo**

At the south of Vojvodina, at the mouth of the river Tamiš into the Danube, just 17 km from the capital of Serbia-Belgrade, is the town of Pancevo, economic, cultural and administrative center of South Banat district. It is located near the Corridor 10 (Salzburg-Ljubljana-Zagreb-Belgrade-Niš-Skopje-Thessaloniki), with arms from Belgrade to Horgos and from Nis to Dimitrovgrad. Corridor 7 (Danube transversal) which directly connects

Pančevo with central and southeastern Europe. This corridor represents the lifeline of river transport in Europe and part of the naval basin (the North Sea-Rhine-Main-Danube-Black Sea-further east).



**Graph 1.** *Pancevo on the Danube has a 1 port and 2 port*

In most developed countries, transport is a significant source of environmental pollution. Increasing the standard of living has led the traffic influence the increase number of cars that the transport networks can hardly serving in the existing frameworks. This leads to congestion in the traffic system. Necessary improvement must eliminate a discrepancy between evident necessity and existing congestion and quality services according to appropriate environment protection.[1]

Traffic is a consequence of the need for transportation of people and cargo and as such is an indispensable part of the market. However, transport, especially freight one, greatly contributes to environmental pollution, since 1/3 of all emitted harmful gases in the atmosphere originates from traffic (other aspect I the use about 30% of total energy consumption on that occasion). In the last decades, there has been a good trend in the growth of ecological solutions for all major issues of global environmental sustainability.[2] In this regard, particular attention has to be dedicate to "greening" of the freight transport through the introduction of ecological alternatives. The use of rail transport as the most energy-efficient type of land transport and as the smallest polluter of the environment is leading to a reduction level of gas emission with effect of greenhouse. Rail transport, on average, emits three times less carbon dioxide than road traffic and that also is five times less than airborne. In relation to road traffic it occupies less than 50% of the scope. In freight traffic, rail traffic is more than 8 times more energy efficient than road transport.[3]

The only way to ensure environmental protection from the evident negative impacts of traffic (according to reports) lies in changing the structure of the transport system itself. This presupposes directing the

transport to those sectors of transport have minimum negative consequences for the environment. The need for the implementation of a number of systemic measures (particular at the development of the public transport system) is confirmed that numerous examples of good practice of the expressed countries of Europe and the world.

## **EXPERIMENT**

Traffic impact on the environment in Serbia reflected as [4] dispersed air pollution caused by traffic (CO, NO<sub>x</sub>, VOC, lead, heavy metals, particles and O<sub>3</sub>), hydrocarbon emissions (including VOC) during the loading and unloading of the fuel, pollution from oil and oil products on inland waterways, noise pollution and vibrations caused by diffuse sources, mainly passenger and aircraft traffic and soil and water pollution from traffic (dust, soot, lead).

The causes of pollution in the transport sector in Serbia [4] and the obsolescence of technical malfunction of the vehicle, insufficient use of gas and other alternative fuels, excessive orientation on road traffic, lack of urban and rural networks of roads for increased traffic volume, including the poor No detours, poor enforcement of regulations on exhaust emissions from motor vehicles, inadequate standards for fuel quality permitting excessive content of sulfur, lead and PAH, the lack of technology for the recovery of vapors from evaporating when handling fuel on, terminals, filling stations, tanks and tankers and insufficient representation of public transport and obsolete fleet in practical public transportation companies. Air pollution and the environment at urban level is a source of many problems the health risks generally associated with the inhalation of gases and particles, the environmental consequences in the form of degradation of parts of the environment and damage to vegetation within and near cities. To properly address these problems it is necessary to identify the characteristics of the quality of urban air and other part of the environment, pollution sources and determine the concentration of which may have negative consequences for the environment.

Detected improvements is the first and most important step in the strategy and actions to improve the specification of the new product unleaded benzina-exclusion of lead anti-knock additives such components. Motor vehicles poisonous (Pb, CO, HC and NO<sub>x</sub>) and suffocating (CO<sub>2</sub> and H<sub>2</sub>O) components in the exhaust gases threaten the environment. In certain urban areas, in particular with colder climatic conditions, in concentrations of some toxic and of limited components from the exhaust gas is not reduced. New European regulations on exhaust emissions from motor vehicles can not be satisfied with existing systems for exhaust gas aftertreatment and electronic systems for regulating engine ignition and fuel supply.

It has good road and railway connections with Belgrade is situated on the main road E70 (Belgrade-Pancevo-Vrsac-Romania). Corridor 10 (Salzburg-Ljubljana-Zagreb-Belgrade-Niš-Skopje-Thessaloniki), located close to the city, with arms that stretch from Belgrade to Horgos and from Nis to Dimitrovgrad. The position at the confluence of the Tamis Pancevo in Dunav (Danube Corridor transferzala, makes the city more attractive position for a good business, because it directly links the city with Central and Eastern Europe. The documentation that discusses the impact of traffic in cities is the general plan of Pancevo, 2005 The strategic environmental impact assessment, in 2008, the Development Strategy of the Municipality of Pancevo, Traffic Institute CIP Belgrade, 2005, strategy of development of the local economy, the Municipality of Pancevo, 2005 Action Plan to reduce pollution , 2007 Research and pollution of Italian experts, 2007.

Report on Strategic Environmental Assessment Master Plan of Pancevo on the environment is done by the Institute "Kirilo Savić" Belgrade. Planed emissions by the transport means. Pancevo has developed a high speed road, the main 2 at the periphery of the collecting center 4 and roads, 17 regulated road without the ecological semaphore, 5 taxi stations, bus stations 1 and 66 in the center of the bus stops. The industry is also a source of transmission of pollutants (oil refinery, Petrochemical and Fertilizer). Italian experts have done a study that analyzed the impact of the industrial zone, sobračaja and other emissions in Pancevo.

In the database, the physical and chemical characteristics of the pollutant (in our case, benzene) are taken and the concentration values of the highest and lowest values, as well as the mean value, are monitored. Pollutant concentration values are observed in open and closed spaces.

### **Characteristics of benzene**

Benzene  $C_6H_6$  is a significant ingredient of gasoline (from <0.7 to > 5%), and it is also produced petrochemically in large quantities as a raw material for other petrochemical syntheses. It is also widely used as a solvent. Due to its relatively high thermodynamic stability, benzene is found in all gases produced by spontaneous combustion or cracking of organic materials. In this regard, the most important are vehicle exhaust gases [5]. It is also a component of waste gas from the production and processing of asphalt bitumen, as well as the gas of some waste material landfills.

The melting point of benzene is at 5.5 1 a.t.klj. at 80.1°C. Solubility in water at 200 C is 178  $\mu\text{g m}^{-3}$ , and Fb is 28.6. Unfavorably affects a number of enzymes. Thus, depending on the concentration in the air and the duration of exposure, it can cause a series of disorders in the body, sometimes with a latent period of 3 to 9 years. [6]

In humans, symptoms of the disease appear after a one-hour exposure to a concentration of 500 ppmv (1630 mg m<sup>-3</sup>). Chronic gasoline poisoning is manifested by non-specific symptoms: fatigue, headache, loss of appetite. Later, there may be a decrease in the number of erythrocytes and disorders of the leukocyte formula, and finally leukemia and malignant tumors. Benzene is a reliable human carcinogen (group 1, IARC), where it is relatively quickly activated by its epoxidation. Benzene is known to cause mammary gland cancer in test animals [7,6]

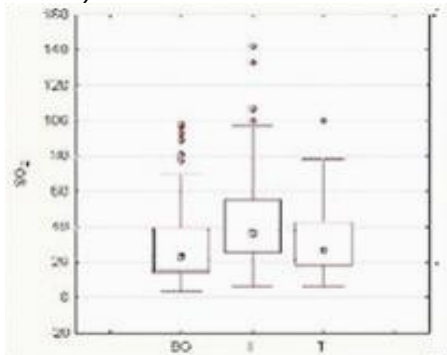
## RESULTS

From Pancevo annually draw at least 2 million tonnes of petroleum products and petrochemical products, which represents about 300 trucks a day, for a capacity of 20 tons. Ie 109 500 trucks a year, carrying over 20 tonnes. In "Luka Dunav" is performed turnover of goods, concrete steel, building the material of and others. Through Pancevo passing transit routes from Smederevo according to Vrsac and Romania, and to Subotica and Hungary. Through Pancevo for the transport of agricultural products, silos "Graneksport" on the Danube, transport beets from eastern parts of South Banat to the sugar refinery in Kovačica.

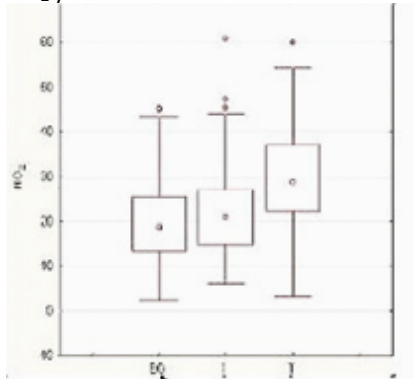
Registered impact on air pollution as: blow out the gas and solid particles and the main pollutants (carbon monoxide (CO), hydrocarbons Partially degraded, particulate matter, nitrogen oxides (NO<sub>x</sub>), sulfur dioxide (SO<sub>2</sub>) and lead (Pb)). The negative impact of emissions on the health of human population growth and development of vegetation material and cultural goods (facades of buildings and monuments), reduces visibility and solar radiation, causes a change in the distribution of wind and temperature in the lower layer of air and have a significant impact on the overall climate city. The research results are presented in graphs 2, 3,4 and 5.

The exhaust gases of motor vehicles comprising about 180 the organic components, of which 47% of unsaturated hydrocarbon, 7% of various aromatic compounds, 4% of aldehydes and ketones, 1% phenol and 0.7% alcohol. Most of these gases is carcinogenic, and all occur as a result of incomplete combustion of fuel in Moton vehicles. The most common are unburt hydrocarbons, nitrogen oxides and carbon monoxide. Inorganic compounds are the most common carbon oxides and lead compounds. The highest concentration is at intersections and other roads in the city center, because of the large number of vehicles with engines work and standing in the vehicle (intersections and traffic lights). The same situation exists in other travel hubs.

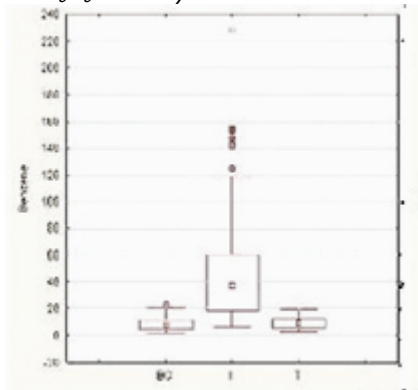
**Graph 2.** The impact of transport (T) for  $SO_2$  annually



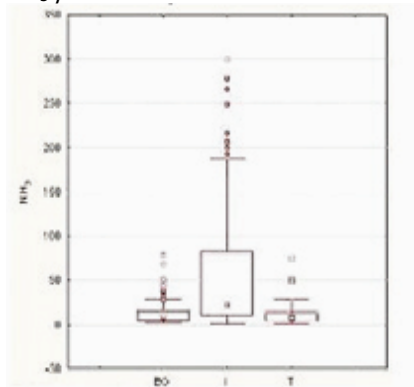
**Graph 3.** The impact of traffic (T) for  $NO_2$  per annu



**Graph 4.** The impact of traffic (T) for  $C_6H_6$  annually



**Graph 5.** The impact of traffic (T) for  $NH_3$  per annum



It is contemplated that the 1.000 liters of leaded fuel, which burn in the engine, emitted into the atmosphere 98 kg of carbon monoxide, from 6 to 8 kg of nitrogen oxides, from 4 to 5 kg of an aldehyde, about 4.5 kg of sulfur compounds and about 0.5 kg of lead.

Assessment of annual emissions level in Pancevo from road vehicles for 2002 and 2003 was made on the basis of Studies "Pancevo - healthy city", the report on systematic measurement of noise and traffic volumes in Pancevo in 2001 and 2005, calculated daily emissions, based on the number of vehicles. Statistical Yearbook were used for the calculation of empirical data for the Serbian city of 100 000 inhabitants. It assumes the ratio of the number of cars on petrol / diesel or = 2.33. (70: 30)%. Table 1 shows the research level emissions from road vehicles for 2002 and 2003.

**Table 1.** Assessment of annual emissions level in Pancevo from road vehicles for 2002 and 2003.

Type of vehicle	Type of fuel	Number of vehicles		Mean length of driving in the city
		2002	2003	
Passenger cars	Petrol	17995	18615	7000
Passenger cars	Diesel	7712	7978	7000
Trucks, Towing vehicles, Working vehicle, buses	Diesel	6699	7120	45000
Dust		SO <sub>2</sub>		
2002	2003	2002	2003	2002
12.6	13.03	25.2	26.06	252
53.98	55.85	107.9	111.69	53.98
452	480.6	904	961.2	904
518.58	549.48	1036.9	1099	1210
0.0041	0.0043	0.0082	0.0086	0.0095

Type of vehicle	Emission factors, g/km				
	Dust	SO <sub>2</sub>	NO <sub>x</sub>	CO	Hydro carbons
Passenger cars	0.1	0.2	2	32.88	2.1
Passenger cars	1	2	1	32.82	0
Trucks, Towing vehicles, Working vehicle, buses	1.5	3	3	0	0
CO					
2002	2003	2002		2003	
12.6	260.6	4141.7		4284.4	
53.98	55.85	1772		1832.9	
452	961.2	0		0	
518.58	1277.7	5913.7		6117.3	
0.0041	0.01	0.047		0.048	

Significant evaporation of liquid fuel occurs when handling or during refilling of fuel from the tank to the gas station tanks and the issue of fuel buyers. Ambient air pollution contributes to gas stations and exhaust fumes of internal combustion engines. During combustion of the liquid fuel is no separation of whole classes of hydrocarbons originating from incomplete combustion, in particular aldehydes, ketenes, organic acids, alcohols and other harmful substances. At the incomplete combustion of liquid fuel leads to the separation of carbon monoxide and soot, which is particularly harmful because it also contains carcinogenic substances such as benzo-a-pyrene? It is believed that the road vehicles in a major air polluter in the world, especially in larger cities.

Significant fraction of the exhaust gases of cars has non-combustible hydrocarbon oil and derivatives thereof (PAHs). In addition, a significant environmental threat is the lead produced at the combustion of gasoline in automobile engines, which is deposited in the soil along the roads. The exhaust gases are released SO<sub>2</sub>, CO, NO<sub>x</sub>, O<sub>3</sub>, and particles of lead into the atmosphere. Sulfur and lead pollution is particularly problematic in Serbia because of poor fuel quality (high sulfur diesel and leaded petrol). The concentration of nitrogen oxides and carbon monoxide, and lead, regularly exceed the permissible level of Belgrade (especially in the center). Air pollution caused by traffic has increased over the last five years due to the large number of imported used cars [4]

The monitoring of benzene concentrations in different areas (where everything was measured) is shown in table 2.

**Table 2** *Data on the air pollution of some environments with benzen hourly median during the day*

Middle(unit of measurement)	Concentration
Air in cities (µg m-3)	0.0 -348[9,10]
Concentration in the vehicle (µg m-3)	9.2-27.5a [11]
Indoor air (µg m-3)	
Garages with 1-2 cars (En Arbor, SAD)*	36.6±38.5* 0.0-21.0**
Apartments (SAD, Kanada)**	3.6-3.9#
Living rooms in non-smoking apartments, 48-hour range (SAD)	[9,12,13]

Table 3 shows the concentrations of benzene in the main cities where the highest concentration is expected.

**Table 3.** *Concentration of benzene from individual gas of various cities, causes of air for analysis were taken in places that were polluted practically only from exhaust gases [8]*

City	Concentration (µg m-3)
Athens (Greece)	1-20a [14]
Baltimore(USA)	1-35b [15]
Belgrade (Despota Stefan Street)	19c [16]
Brussels (Belgium)	>3d [11]
Bucharest (Romania)	>8d [11]
Dublin (Ireland)	2d [11]
Izmir (Turkey)	0.1 →20a [17]
Lisbon (Portugal)	4d [11]
Los Angeles(USA)	>3e [13]
Ljubljana (Slovenia)	<4d [11]
Ljubljana (Slovenia)	>3d [11]

### *legend*

- A 30-minute minimum and maximum
- B 24-hour minimum and maximum
- C monthly median, one measuring point
- D annual median
- E 48 -- hourly average

According to the EU Directive 2000/69, the annual average limit value for the concentration of benzene in populated areas is  $5 \mu\text{g m}^{-3}$ , and this norm applies to most countries, including Serbia.

## **DISCUSSION OF RESULTS**

Based on the presented data from several references, we can compare that the concentration of benzene is measured in all major European cities. All authors define this as the necessity of monitoring in closed spaces (garages, apartments) and open spaces (big cities and exhausts from cars). Also, we see that there are several methods of measurement depending on the time monitoring of the concentration (A-E).

## **CONCLUSION**

The impact of emissions from the transport means can be reduced by using better quality fuels and vehicles with more complete combustion and lower fuel consumption and reconstruction system for refueling and vehicle adaptation for a new kind of streaming. Investments in the oil refinery Pančevo (production of unleaded gasoline of low sulfur fuels as well as the Euro Diesel) and reconstruction of the decanting tank (tank trucks, rail tankers, and decanting with water the barge) and HIP-Petrochemical (reconstruction decanting pyrolysis. The introduction of new European standards in Serbia fuel and standards for motor vehicles to be phased reduction of emissions of harmful substances in the air. [18-26]

Monitoring the concentration of pollutants (for example benzene) is a necessity, as well as meteorological data (pressure, temperature, humidity...), the geography of the terrain and the number of inhabitants in a certain region in order to be able to determine the risk that the pollutant can bring to the observed area. Ways to overcome this problem are listed in the further conclusion as an experiential measure.

Increasing traffic volume leads to an increase in congestion in the traffic process, achieving a lower level of service than optimal, lowering the level of safety of participants in traffic, air pollution, increasing noise levels and environmental damage. It is obvious that the basic measures for reducing harmful effects is in the diversion of goods flows towards more environmentally friendly transport branches.[18-26]

The use of modern transport technologies, especially combined land transport, which optimally emphasizes the advantages of two different types of rail and road transport, it gets more and more important. Combined land transport is an ecologically "friendly" mode of transport and the positive effects of its application are numerous. To the eliminate pollution in urban areas, the conceptual model has been defined in order to create the optimal conditions for reducing the impact of traffic. This is emphasizing the importance of greater representation of sustainable transport modes in the system, as well as application modern transport technologies, public transport of passengers, as well as to introduce new, flexible measures for the improvement of traffic - buses with flexible route, public transport on demand, shared use of taxis etc.[18-26]

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