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Anna V. Yakovleva, student

IMPACT OF AUTOTRANSPORT PARK OF KYIV ON STATE OF ATMOSPHERIC AIR

The problem of atmospheric air pollution in Kyiv is described in the article. Such questions as motor transport emissions, health effects of components of exhaust gases, qualities of different kinds of fuel, levels of atmospheric air pollution in various districts of Kyiv are considered here.

Описано проблему забруднення атмосферного повітря у Києві. Розглянуто питання викидів від автотранспорту, вплив на здоров'я людини компонентів відпрацьованих газів, якість деяких видів палива, рівні забруднення атмосферного повітря в різних районах Києва.

atmospheric air, carbon dioxide, carbon monoxide, density of emission, gaseous poluttants, formaldehyde, lead compounds, maximal permissible concentration, nitrogen oxide, sulfur oxide, suspended matter

Introduction

Discussion of environmental problems made us search the ways of providing balanced development of separate countries and the whole Earth in the conditions of growing technogenic people's activity. A careful analysis of present environmental conditions showed the strategy of socio-economical development, which is based on usage and exploitation of natural and people resources on some specific territories for enrichment of others, which have already become exhausted. So, the one of the main questions is providing of balanced economic and social development of Earth's regions, separate territories and its settlements. Due to this, many tasks concerning the preserving of environment and renewing of resources can be successfully fulfilled [1].

Grounds for such an assertion are today's environmental conditions of the capital of Ukraine. Nowadays Kyiv is the capital of a European country. It is a large city with the area about 800 km^2 and the population of more than 3 million. At the same time Kyiv has more than 1 thousand of industrial enterprises, which produce various goods: from famous Kyiv's cakes to aircrafts and excavators. Nowadays Kyiv is also a great transport nodal point. The city has a powerful transport complex: airport, underground, hundreds of trams, trolleybuses, buses and more than a million of other vehicles with appropriate infrastructure. It is known that Kyiv has many ecological problems. By the amounts of total pollution, Kyiv is one of the 15 cities with the worthiest ecological situation. Namely, there are results of Chernobyl' catastrophe, emissions from industrial factories and especially motor transport and unsolved problems with wastes.

One of the most important problems of Kyiv is the pollution of environment. Industrial enterprises, the biggest autopark in the country and municipal complex are the largest sources of emissions of different substances into environment. Characterizing the state of pollution of Kyiv's environment it can be said that from the one hand ecological situation in the city is normal in general, indexes of ecological activity are better than on the average in country, that determines the capital of Ukraine as one of the most appropriate places for living and working in the country. But on the another hand Kyiv has various problems with pollution of atmospheric air, water and land resources in amount that can be essentially reduced as a result of well-planned, effective, purposeful work. So the level of pollution of capital's environment is not determined objectively and for its reducing there are great potential and abilities.

Problem forming

Atmospheric air plays a significant role in all natural processes. To preserve and to keep it clean means to preserve the life on the Earth. Each year thousands of tons of various polluting substances are emitted into atmospheric air of Kyiv. This promotes constant worsening of ecological state of city's environment. As it was said Kyiv is the capital of Ukraine in all aspects of this notion. Taking into consideration the status of Kyiv, the ecological state of atmospheric air isn't only environmental problem. The question of solving of this problem is of equal value.

Analysis of researches and publications

Quality of atmospheric air in our city depends greatly on the amounts of emissions from two main sources of pollution: stationary and mobile. The main pollutant of atmospheric air in Kyiv is mobile source – motor transport. Stationary sources play secondary role [2].

The state of atmospheric air in Kyiv is a question of interest of many scientists. M. Ivanov, A Fadin, N. Guseva, M. Movchan, M. Melnichenko try to investigate properly the problem of atmospheric air pollution and ways of solving this question. They help to develop programs and policies in order to reduce atmospheric air pollution in Kyiv. The government in its turn try to find ways of implementation of these policies.

Task forming

Now auto transport park in Kyiv grows day by day. As a result amounts of emissions of polluting substances increases as well. In these conditions it is necessary to consider the impact of emissions from auto transport on atmospheric air. One more question to be discussed is the development of policies and measures to reduce pollution of atmospheric air.

Main material

Motor transport is the biggest and the most powerful source of atmospheric air pollution. Every year it's impact on the environment growths. Concentration of motor transport in the capital of Ukraine and its intensive development, high rate of increasing of cars number, increasing of engines' power, worsening of technical conditions of autopark, inappropriate quality of fuel, functioning of existing and paving of new highways, insufficiently developed legislative and juristic base for effective regulation of motor transport usage, all these factors unavoidably lead to worse pollution of atmospheric air in Kyiv. The number of cars per hundred of residents is several times higher than the average quantity in the country. The total number of motor vehicles in our city (except transit transport) is more than one million. On some parts of city roads the intensity of cars movement is about 2,5 thousand cars per hour, although the maximal carrying capacity of one traffic lane is two times lower. The average speed of cars moving by Kyiv roads is almost the highest in comparison to other European capitals.

The following fig. 1 represents the structure of auto transport park in Kyiv. The data are given for 2002.

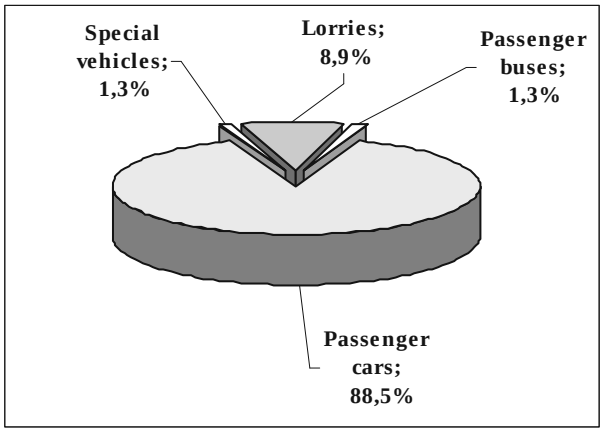

Fig. 1. The structure of motor transport in Kyiv

Transit motor vehicles and those which come to Kyiv for a long period also considerably pollute atmospheric air. The total number of such cars is about 80−100 thousand of units per day. Their emissions are not controlled and are not taken into account by bodies of statistics.

Such rapid increasing the number of cars can be explained by several factors. One of them is put off demand and unstable situation in country and in politics, especially variation of exchange rate. These make Ukrainians to be more active on housing and car market. Another factor is crediting programs; moreover, many banks offer deferred paying purchase without the first call. Such innovation has lead to increasing of car buying on 10−15 %. Another factor of this problem is a decreasing of demands for secondhand cars. But in spite of the paradoxicality, the principal push for increasing of car selling was expected rise in customs fees.

One thinks that car market would be able to keep such high rate of growth for at least 2−3 years. This was caused by decreasing of custom fees by 20 % few years ago and by 10 % after entering Ukraine in WTO. And in 2006 50 % dynamics of growth was observed. Other experts suppose that dynamics of growth in car industry will gradually decrease. Ukraine will go through the stage of total mobilization, after which just renewal of car park and changing of its structure will take place. On the base of such forecast, 20 % growth of selling can expected [3].

So, taking into account these data it can be said that the number of cars will constantly grow. However the upcoming economical crisis has changed the situation cardinally. Future increasing of amount of vehicles probably will go slower or even stop for some time. Obviously, the amount of pollution from motor transport will be decreased to some level.

Emissions of harmful substances from motor transport are almost 5 times higher than from stationary sources of pollution. Together with exhaust gases of cars in 2007, 190,8 thousand of tons (84,3 %) of polluting substances from all mobile sources got into atmospheric air of Kyiv [4]. In 2004, however, just 165,1 thousand of tons of exhaust gases have been emitted into atmospheric air. This number is on 7,3 thousand tons (4,6 %) bigger than in the previous year. At the same time 109,8 thousand tons (66,5 %) of polluting substances is from private vehicles.

On the fig. 2 the dynamics of emissions of polluting substances from auto transport during 1985−2007 are presented.

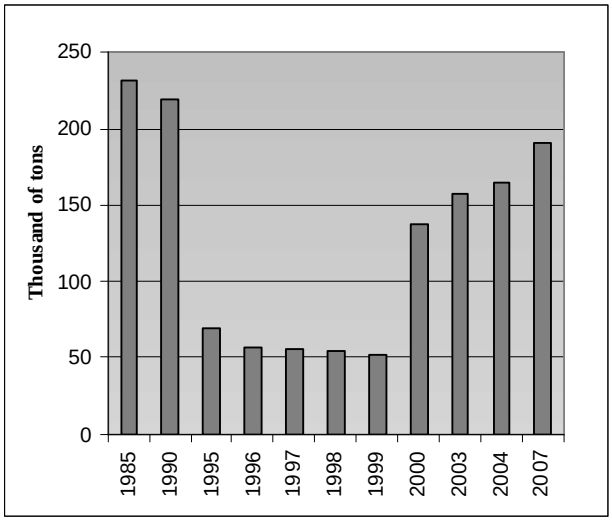

Fig. 2. Emissions of harmful substances from auto transport during 1985−2007

Among enterprises' vehicles 22,6 thousand tons (40,9 %) of polluting substances come into atmospheric air from lorries, 14,6 thousand tons (26,4 %) – from passenger cars, 8,8 thousand tons (15,9 %) – from buses, 7,9 thousand tons (14,3 %) – from special nonpassenger cars, 1,4 thousand tons (2,5 %) – from special passenger cars [5].

Motor transport is one of the main sources of many harmful substances.

In 2004 were exhausted in Kyiv 65,8 kg of polluting substances per one person. In comparison in 2003 this number was 59,5 kg, in 2004 – 62,2 kg [6]. Vapors from oil products and exhaust gases from motor transport contain more than 200 chemical compounds – products of fuel combustion. Among them are carbon oxide, nitrogen oxide, sulfur oxide, heavy metals oxides, carcinogenic and mutagenic compounds, hydrocarbons, aldehydes, aerosols, sulfureous anhydride, soot and others. Carbon oxide constitutes the biggest amount of emissions makes (131,5 thousand tons).

Car takes 4350 kg of oxygen from air per year, and emits 3250 kg of carbon dioxide, 530 kg of carbon monoxide and up to 1 kg of lead. 96 % of carbon oxides, 30 % of nitrogen oxides, 68 % of hydrocarbons get into atmospheric air though exhaust pipes of motor transport. Emissions of polluting substances from motor transport are divided into the following groups. Schematically these groups are presented in fig. 3.

Almost all motor transport in Kyiv city uses internal-combustion engines. Nowadays toxic components of exhausted gases from such engines is the main problem that arises from the question about the pollution of atmospheric air by motor transport. Pollution of atmospheric air from motor transport occurs mainly due to the hydrocarbons of fuel that evaporate from carburetor fuel tanks, pipes. And also air is polluted by exhaust gases that go through exhaust pipe and by carter gases.

Component composition of exhaust gases is mainly determined by the content of fuel. Among 500 identified compounds in exhaust gases, the largest part is not combusted hydrocarbons.

As it was said earlier motor transport emits more than 500 various chemical compounds. All of them have a specific negative impact on environment. Among these substances it is necessary to mention the following pollutants:

Carbon monoxide CO is a colorless gas, without any odor. It is formed in a result of incomplete combustion of petroleum at conditions of insufficient amount of oxygen and at low temperature. Maximal one-time MPC of CO is 5 mg/m^3, average daily MPC is 3 mg/m^3. 14 mg/m^3 can cause myocardial infarction.

Carbon dioxide CO_2 is a colorless gas with lightly sour odor and taste. It is a product of full oxidation of oxygen. Carbon dioxide is one of the green-house gases.

Sulphur dioxide SO_2 (sulphureous anhydride) is a colorless gas with specific odor. It is formed in a result of combustion of sulphur containing fuel. Maximal one-time MPC of SO_2 is 0,5 mg/m^3, average daily MPC is 0,05 mg/m^3.

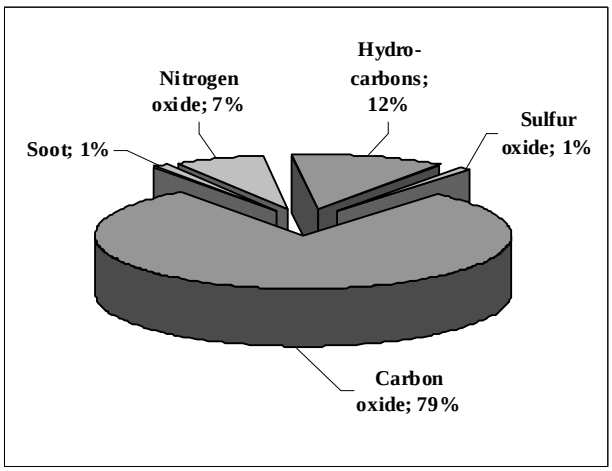

Fig. 3. Kinds of polluting substances from motor transport

Nitrogen monoxide NO and nitrogen dioxide NO_2 are gaseous substances. In all types of combustion mainly nitrogen monoxides are formed. That it is oxidized to dioxide which is white-red gas with unpleasant smell. It has great effect on human mucus. Maximal one-time MPC for nitrogen dioxide is 0,085 mg/m^3, average daily MPC is 0,04 mg/m^3.
At concentrations more than 0,15 mg/m^3 acute diseases of respiratory system occur.
Hydrocarbons are gaseous compounds of hydrogen and carbon. They are thousands of polluting substances that come from unburned gasoline; liquids used in dry-cleaning, industrial solvents, etc. many hydrocarbons are dangerous for health. In urban pollution, these components along with NOx and sunlight – all contribute to the formation of tropospheric ozone and greenhouse gases [7].
Lead Pb is a metal toxic in any of its forms. It is widely used for paints, solders, ammunition, gasoline additives, etc. For lead and its compounds (except tetraethyl lead) average daily MPC is 0,0003 mg/m^3. For tetraethyl lead the approximate safe level of impact is $3 \cdot 10^{-6}$ mg/m^3.
Benzapyrene $C_{20}H_{12}$ is a five-ring polycyclic aromatic hydrocarbon that is mutagenic and highly carcinogenic. It looks like a crystalline yellow solid formation. Benzapyrene is a product of incomplete combustion at temperatures between 300 and 600^{o}C. Benzapyrene is found in coal tar, in automobile exhaust gases (especially from diesel engines), tobacco smoke, wood smoke and some others. MPC established for benzapyrene is $1,0 \cdot 10^{-6}$ mg/m^3.
Formaldehyde can be toxic, allergenic and carcinogenic. Because formaldehyde resins are used in many construction materials it is one of the most common indoor pollutants. MPC established for formaldehyde is 0,003 mg/m^3.
The main parameter that characterizes suspended particles is their size, which varies in wide range: 0,1−850 mkm. The most harmful and dangerous for human health are particles of size 0,5−5 mkm, because they don't set on mucus of breathing organs and get into the organism.
In a content of motor fuel ecologically pure fuel takes minor part: compressed natural gas and gas propane-butane. Specific emissions of polluting substances into atmospheric air from cars internal-combustion engines which use petroleum, diesel oil, compressed gas and propane-butane gas per 1 ton of used fuel are given in tab.1 [8].

As it can be seen from the table the most ecologically acceptable for the motor fuel is using of compressed natural gas and gas propane-butane. This is the most rational kind of gaseous fuel. Gas combustion causes less formation of solid particles and soot (they lead to the deterioration of cylinders and pistons of engine). Gas is more pure than gasoline that's why there is less pollution of carburetor. There are no problems with increased level of CO in exhaust gases. Internal combustion engine that uses gas mixture at idling mode has in 4 times less carbon oxide emissions, than gasoline engine. At working mode emissions are in 10 times less [9].
However, nowadays various kinds of bio-fuel became more and more popular. The most widely known fuel of this kind is bio-diesel. It has good ignition quality, which is provided by high cetane unit. For mineral diesel this index is equal to 50–52%, but for bio-diesel it is equal to 56–58 %. It allows using it in diesel engines without any additional additives that stimulate ignition. Moreover, comparing to content of sulfur in mineral diesel(< 0,2 %), biodiesel has even < 0,001 %. Generally biodiesel has many advantages (including ecological properties) comparing with mineral one. So in nearest future some percent of mineral oil will be replaced with such alternative.
Analyzing the developed transport structure in Kyiv city, we can observe some peculiarities in different level of air pollution. Regions that are situated near the biggest arterial road suffer from highly polluted air most of all. Last year governmental Sanitary-Epidemiological service made investigations near 195 roads. In 46,5 % of observed areas, MPCs of harmful substances in atmospheric air were exceeded. Overdose of polluting substances goes from exhaust gases of motor transport.

Table 1

Specific emissions of polluting substances from different kinds of fuel

Name of polluting substance	Specific emissions of polluting substances, kg/t			
	Lead-free gasoline	Diesel oil	Compressed natural gas	Gas propane-butane
Carbon oxide	230−350	42−100	90−200	230
Hydrocarbons	60–115	7−30	30–50	50−100
Nitrogen oxides	18–40	30–40	20–25	17,5−40
Sulphureous anhydride	—	3,8−15	—	—
Soot	0,6	5–20	—	—
Benzapyrene	$0,23 \times 10^{-3}$	$0,3 \times 10^{-3}$	—	—

There are quit difference in displacement of highways and arterial roads in our city. That is why the distributions of polluting substances from motor transport also show great variety. This can be illustrated in tab. 2.

Table 2

Emissions of harmful substances from city motor transport in districts in 2004 year

Districts of the city of Kyiv	Amount of emitted polluting substances			Density of Emissions, t/ km^2
	Total	Including		
		from enter-prise cars	from private cars	
City of Kyiv	165,1	55,2	109,8	197,4
Golosiivskyi	14,6	5,8	8,7	93,6
Darnitskyi	14,3	2,2	12,1	107,5
Desnyanskyi	15,3	1,2	14,1	103,7
Dniprovskyi	17,1	3,4	13,8	255,8
Obolonskyi	16,9	4,2	12,7	154,3
Pecherskyi	13,5	8,1	54,2	678,1
Podilskyi	15,5	7,9	7,5	456,2
Svyatoshinskyi	18,8	5,6	13,2	186,7
Solom'yanskyi	18,5	6,1	12,5	463,6
Shevchenkivskyi	20,1	10,5	9,7	748,1

During the last 10 years pollution of atmosphere in Kyiv has decreased in some way. Mainly it is a result of industrial emissions shortening. Concentrations of benzapilene have decreased due to the better gasoline quality. Also it is connected with building of new road junctions. At the same time the content of carbon monoxide increased. Except reducing of separate substances concentrations, there is a tendency to improving the quality of atmospheric air in Kyiv.

Conclusion

Kyiv is a capital of Ukraine. It is economical, political, business, cultural center of our country. And as a result of such position Kyiv is obviously one of the largest transport nodal points in our country. Kyiv has trend toward becoming the real European city. But the proper economical and political development is not enough for this purpose. Our capital must be ecologically clear city as well.

Contamination of the atmospheric air is the problem that concerns everyone. Air is vital for us. We breathe the air and its quality doesn't depend on our financial status. It is our common problem. Because we live in polluted environment and we have to do all our best to leave for our children clear, healthy surrounding.

Nowadays air in Kyiv is polluted in two ways: by motor transport and by industrial enterprises. This pollution is connected with exhaust gases from motor transport, emissions from power industry, and chemical, petrochemical and building industries. And every year atmospheric air becomes more and more polluted, especially because of constant increasing of amount of motor transport.

The problem described in this article needs further and more detailed consideration. Another task is search of new ways to reduce atmospheric air pollution and its implementation in life.

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