IMPACT OF VEHICLE EXHAUST EMISSIONS ON URBAN AIR POLLUTION

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ABSTRACT

The authors give an environmental assessment of the effect of emissions of exhaust gases and vehicle pollutants on the quality of atmospheric air. It is known that their massive release into the environment is increasing every year. This is especially true for such large cities as Moscow, St. Petersburg, Yekaterinburg, etc. Taking into account the information of the Federal Service of Hydrometeorology and Environmental Monitoring[1] of Russia (Roshydromet) in 2015 average annual concentration of one or several substances exceeded maximum permissible concentration in almost 150 cities.

At the same time, in 34 of them the maximum concentrations reached 10 MPC or more. The situation with environmental safety and the role of motor transport in it cause serious concern for specialists.

Keywords: vehicle, atmospheric air, emissions, exhaust gases, pollutants, environment, toxic substances, ecological safety.

Background. *Road transport, being the most popular means of transportation, is the main source of exhaust gases that pollute the atmosphere. It consumes oxygen and throws fuel oxidation products into the environment, significantly worsening the quality of air.*

Emissions of vehicles, in addition to products of partial oxidation of fuel, which consist of carbon monoxide II, carbon monoxide IV, nitrogen oxide, sulfur oxide, hydrocarbons and soot, contain also products of wear of brake linings, tires and fuel vapors [1].

Objective. *The objective of the authors is to consider impact of vehicles' exhaust emissions on the atmosphere of cities.*

Methods. *The authors use general scientific methods, comparative analysis, statistics methods.*

Results.

According to the data of the research [2], a middle class car emits about 120 mg/m³ acetylene, 400 mg/m³ paraffin, 200 mg/m³ aromatic and 300 mg/m³ olefinic hydrocarbons in the atmospheric air. It is worth noting the high toxicity of aromatic hydrocarbons.

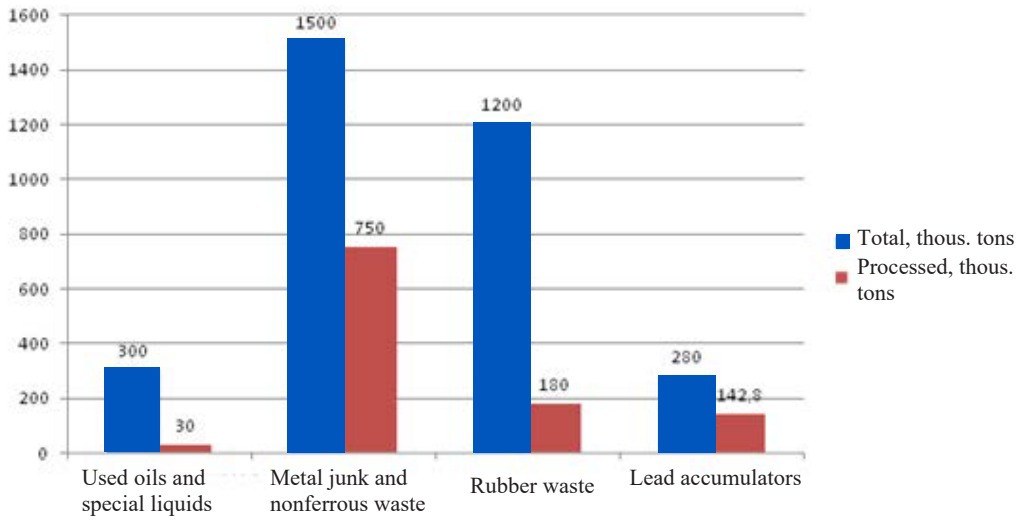
Intensive development of road transport infrastructure and industrial facilities contributes to formation of a large number of toxic substances in the air, dilution of which by natural means up to the normative level of concentrations is impossible. The rapid dispersal of such pollution is hampered by urban buildings.

Typically, the degree of air pollution in certain areas depends on factors such as presence of traffic and density of traffic of vehicles, wind speed, width and topography of the street, proportion of buses and trucks in the total flow of vehicles. Such factors are constantly present in the urban environment, and that fact further exacerbates the situation.

The share of vehicles in the amount of all emissions of harmful and dangerous substances from all man-made sources accounts for about 43 %.

Particularly alarming is the fact that, despite preventive work on environmental safety, emissions of the cars into air are increasing every year – by an average of 3,1 % [3]. As a result of this negative trend, the annual environmental damage caused by road transport in the country is about 170 billion rubles.

[1] Annual report on air pollution in the cities of Russian Federation in 2016. Roshydromet, Main geophysical observatory, St. Petersburg, 2017.



Pic. 1. Mass of annual waste from motor complex functioning

Table 1

Emissions of pollutants into the atmosphere by vehicles in 2015, thousand tons [3]

Mode of transport	CO	C_nH_m	NO_x	C	SO_2	Pb	Total
Road	12162,8	1704,3	2202,2	65	296,4	1,43	16432,13
River	19,37	11,1	54,99	5,85	19,37	–	99,58
Water	15,08	8,0	38,22	10,4	39,65	–	103,35
Air	43,55	6,0	75,4	–	16,25	–	135,2
Railway	47,71	22,7	193,7	11,7	–	–	253,11
Industrial railway	10,14	4,5	42,9	2,08	–	–	55,12
Road vehicles	166,4	25	84,5	7,15	11,83	0,12	270
Total	12465,05	1704,3	2691,91	102,18	383,5	1,55	17348,49

The comparative volume of emissions of pollutants into the atmosphere by various vehicles is given in Table 1.

According to it, in Russia as a whole, emissions of pollutants into the atmosphere from vehicles and functioning of transport infrastructure amount to about 17,3 million tons a year.

It is worth to note particular danger of waste coming from the motor transport complex. The mass of used oils and special liquids is more than 300 thousand tons, of which only 10% will be processed. At the same time, the mass of rubber emissions reaches 1,2 million tons (of which 15% are processed), waste of ferrous metals is up to 1,5 million tons (50% is processed), lead accumulators are about 280000 tons (51% are processed) (Pic. 1) [3].

Annually about 1,2 million tons of recycled emissions and cars (which makes about 5% of the entire car fleet) are disposed. As a result of insufficient organization of collection and disposal, such vehicles are stocked, posing a serious threat to the urban environment.

About 60% the environmental damage is caused by passenger transportation by cars, cargo transportation occupies about 26% and buses occupy about 14% [4].

It can be noted that management of environmental safety of road transport in Russia is at a very low level, the amount of damage is growing every year. Imperfection of environmental management is caused by the following factors [5]:

• lack of an effective regulatory framework for environmental regulation of functions and responsibilities of road transport infrastructure organisations;

• absence of «working» financial mechanisms (fines, sanctions, etc.) to stimulate environmentally friendly production of vehicles and components;

• absence of targeted state control over compliance with environmental norms and rules established by the current legislation.

To reduce the volume of emissions by motor vehicles of polluting substances into the environment, effective measures on the part of the state are required, implying application of harsh economic sanctions for violation of environmental legislation.

In the search for practical measures to reduce emissions and to improve the environmental situation in the country, it is useful to use foreign experience. In the EU and US, similar problems are addressed at the level of legislative regulation and through implementation of special long-term targeted programs that provide for development of optimal emission standards and financing of waste collection, recycling and processing activities [6–9].

One of the most effective ways to improve environmental friendliness of road transport is linked today to a massive shift to natural gas fuel, which provides for a multiple reduction in harmful emissions by an automobile engine, which corresponds to maximum permissible concentration of pollutants in the air in populated areas [10].

In Russia, today there is a transfer of cars to gas fuel, but this is of a local nature and does not affect the overall picture. Mass transition to gas fuel assumes:

• creation of a system of gas filling complexes;

• launch of mass production of gas-cylinder vehicles;

• creation of a network of service for re-equipment of road transport;

• legal, personnel, information and advertising support.

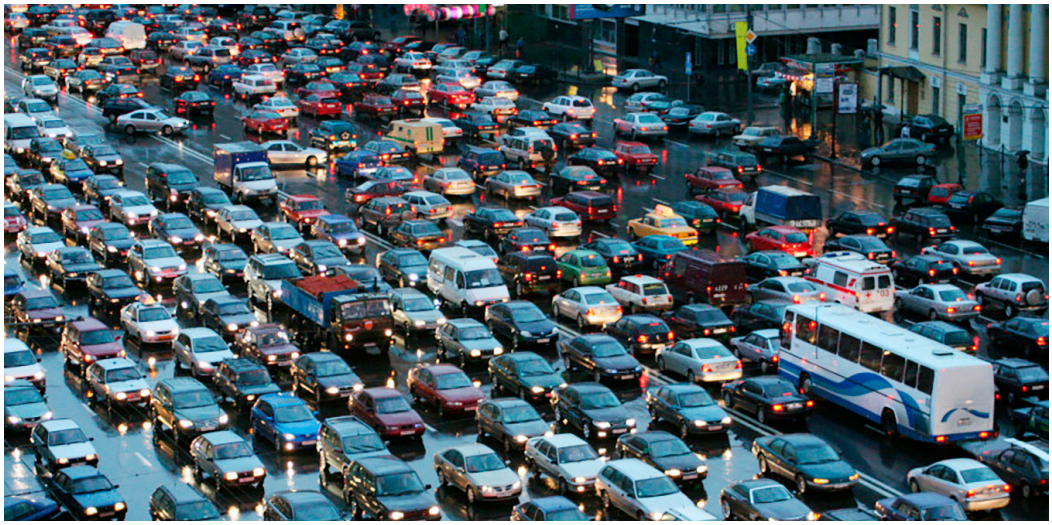
Development and implementation of the program of mass gasification can be carried out not only at the federal level, but also by regional and local authorities within the framework of implementing environmental safety programs.

In addition to positive environmental characteristics, natural gas (methane) has other advantages: it is much cheaper than gasoline, diesel fuel and liquefied gas (LPG). To compare the

Table 2

Efficiency of application of various types of fuel [2]

Parameters	Gasoline	Diesel fuel	LPG (propane)	Natural gas
Engine capacity, litres	2,0	2,0	2,0	2,0
Emission of harmful substances, g/km	2,4	2,7	1,8	1,3
Fuel consumption per 100 km run (when calculating 10 litres– 100%)	100%	90%	115–120%	110%
Cost of fuel, rub./l	9,2	7,1	4,3	3,6
Total cost of fuel for run of 100 km, rub.	92	63,9	49,4	39,6
Economic benefits in relation to gasoline per 100 km of run, rub.	0,0	28,1	42,6	52,4



effectiveness of various types of fuel, we turn to Table 2, which shows that the use of gas motor engines allows for significant savings.

The most accessible way to reduce toxicity of vehicles in major cities is rationalization of traffic, which implies full or partial prohibition of entry of trucks to certain areas. Optimum planning and regulation of traffic will also help reduce the number and duration of car stops, reduce the duration of their work in toxic modes and accelerate their departure from the crossroads.

To streamline traffic in large cities, work is underway to build road junctions, tunnels for pedestrian crossings. Organisation of non-stop traffic significantly reduces level of toxic emissions.

Conclusions. *To solve the problem of environmental safety, including elimination of the negative impact of vehicles on the environment, compound measures are required that provide for legislative regulation of compliance with environmental standards by motor transport owners, stimulate the transition of car owners to more environmentally friendly fuels, promote methods of regulating optimal modes of operation of vehicles and optimizing road traffic.*

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