Influence of transport on the ecology of big megapolis

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Abstract. In this paper we consider the causes of environmental problems of large cities, the impact of transport and technological activities on air pollution. The comparative dynamics of changes in the number of cars in Russia and other countries. The approximate component composition of exhaust gases for carburetor and diesel engines and the conditions of formation of the most toxic substances are analyzed. The reasons of the greatest pollution of the atmosphere by activity of transport and technological infrastructure in the Russian Federation in comparison with the Western countries are revealed. The structure of the automobile fleet of the Russian Federation on norms of toxicity. The ways of minimizing the impact of vehicles on the ecology of megacities by improving the quality of fuel and abandoning the no-alternative monopoly on diesel fuel are proposed. The necessity of modern technologies of oil and gas processing, expansion of opportunities of the fuel market of the country, improvement of its quality and environmental friendliness is revealed. Prospects of use of gas motor fuel are defined.

1. Introduction
Environmental problems of large megacities are often associated with the pollution of the atmosphere by the activities of industrial enterprises, heat power facilities, transport, housing and communal services and other sources of pollution. According to environmental experts, the largest amount of harmful emissions into the atmosphere is accounted for by heat power and ferrous and non-ferrous metallurgy enterprises. Wt-headquarters production facilities and production volume corresponds to the influence of these objects on the environment. But the activities of these enterprises are under the control of environmental structures. The situation is much worse for the control of the total volume of emissions into the atmosphere of combustion products of motor fuels of road transport. Unlike industrial pollution sources tied to certain sites and separated from residential buildings by sanitary protection zones, the car is a moving (non-stationary) source of pollution.

2. Results and discussion
The number of cars registered in Russia is approaching 60 million according to the traffic police of the total number of vehicles more than 45 million cars, 6.4 million trucks, 890 thousand buses and about 2.3 million motorcycles. On average, each year their number increases by 1.5 million units, most of which are passenger [1], [2], [3], [4].
Figure 1. Comparative dynamics of the number of vehicles.

The number of vehicles in large Metropolitan areas exceeded the ratio of 300-400 units per 1000 inhabitants and continues to increase. On average, in Russia, this figure corresponds to 280-300 units per 1000 inhabitants, and most likely, the limit in this indicator will not be reached. For comparison, in France there are 640 cars per 1000 inhabitants, in the USA – 800 [5]. The share of pollution from the total amount of emissions of harmful substances into the atmosphere by road is up to 70-80%. It would seem that there is nothing terrible in the fact that exhaust pollution in Russian cities covers emissions of all industrial enterprises, because in the West a similar situation. But, in fact, vehicles in major cities in Europe, America and Asia in 2-3 times more than we have, and the environment in most cities is better. The reason for this is obviously toxic car exhaust gases.

Exhaust gases - a mixture of components consisting of nitrogen, oxygen, water vapor, nitrogen and carbon dioxide, hydrocarbons, etc. The process of formation of a complex composition of a large group of substances is reduced to several stages of thermal decomposition of fuel into a number of simple hydrocarbons and free radicals and the formation of complex cyclic and semi-cyclic structures [6].

The composition of the exhaust gases of internal combustion engines depends on the type of engine, its mode of operation and load, technical condition, fuel quality, qualification and experience of the driver.

The approximate component composition of the exhaust gases of gasoline and diesel internal combustion engines is presented in table 1.

Table 1. Composition of automobile exhaust gases, vol. %.

| Component                        | Gasoline engines | Diesel engines |
|----------------------------------|------------------|----------------|
| Nitrogen                         | 74 – 77          | 76 – 78        |
| Oxygen                           | 0.3 – 0.8        | 2 – 18         |
| Water vapor                      | 3.0 – 5.5        | 0.5 – 4.0      |
| Carbon dioxide                   | 5.0 – 12.0       | 1.0 – 10.0     |
| Carbon monoxide                  | 0.5 – 12.0       | 0.01 – 0.5     |
| Nitrogen oxides                  | 0.0 – 0.8        | 0.0002 – 0.5   |
| Hydrocarbons, non-carcinogenic   | 0.2 – 3.0        | 0.009 – 0.5    |
| Aldehydes                        | 0.0 – 0.2        | 0.001 – 0.009  |
| Soot                             | 0.0 – 0.4 g/m³   | 0.01 – 1.1 g/m³|
| Benz(a)pyrene                    | up to 10-20 µg/m³| up to 10-20 µg/m³|
Most of the toxic substances enter the atmosphere with exhaust gases. The reasons for their formation are related to the dynamics of operation and structural solutions of internal combustion engines:

- carbon monoxide (CO) – formed by the combustion of fuel with a low concentration of oxygen in the fuel-air mixture (rich mixture);
- nitrogen oxides (NOx or NO) – are formed due to high engine forcing, the use of high-octane fuels, low fuel consumption and low CO and CH content in exhaust gases. These engines are characterized by high combustion temperature and poor fuel-air mixture;
- sulfur dioxide – is formed in the exhaust gases in the case when sulfur is contained in the original fuel (diesel fuel);
- carbon dioxide (CO2) – is formed by the combustion of fuel containing carbon when combined with air oxygen;
- hydrocarbons-hydrocarbon compounds fuel-air mixture is not completely burned in the combustion chamber of the engine (depending on the design of the engine and the power system and is a constant). The greatest amount of emissions of unburned hydrocarbons from gasoline engines with low compression ratio.

Analysis of the data given in the table. 1 shows that the highest toxicity has exhaust gasoline internal combustion engine due to the large you-Bros co, NOx, etc. Diesel engines emit large amounts of soot, which is pure non-toxic. However, soot particles, having a high adsorption capacity, carry on their surface particles of toxic substances, including carcinogenic ones. Soot can be suspended in the air for a long time, thus increasing the time of exposure to toxic substances in humans [7].

But why in our country automobile exhaust gases are more toxic than in the West?

According to the analytical Agency "AUTOSTAT", Russian road transport consumes more than 65.5 million tons of fuel. Approximately 60.6 % of this amount is gasoline, 32.2 % - diesel and 2.2 % - gas motor fuel. Approximately 47 per cent of the fuel is used by passenger transport, 39 per cent by freight transport, 15 per cent by light commercial transport and about 5 per cent by bus.

Providing fuel for the domestic market of the country is carried out by the activities of 32 major oil refinery and network of mini-oil refineries (according to various estimates around 230). The depth of oil refining is on average about 75 %, the modernization of production, aimed at increasing the secondary processing and increasing the depth of processing up to 85 %. All ongoing reconstruction activities are aimed at improving the quality of fuels, which according to the existing plans will be completed by 2020 and will affect only large refineries. Much greater problems are associated with the quality of fuels produced at mini-refineries. Production of fuels according to the technical conditions in the production, it is a deviation from the existing requirements of GOST, and hence lower quality. Inspections of fuel sold at gas stations, conducted on behalf of the President of the Russian Federation in 2015 by the Prosecutor General's office and Rosstandart, revealed that about 34 % of the fuel taken for laboratory analysis does not meet the quality indicators. In 2017, this figure fell to 18 %, which almost halved the presence of low-quality fuels in the fuel market. However, the annual turnover of such fuels on the market can reach up to 10 million tons. According to experts of the international center for fuel quality, the quality of fuels of the Russian Federation is classified as the third of the four groups of countries. The criterion for assessing the quality of gasoline and diesel fuel is the chemical stability and sulfur content. It should be noted that the assessment of fuel quality is not carried out in the complex, out of sight are all sorts of options for the production and sale of low-quality fuels.

The low quality of fuels is not only a problem of production, but also a sign of imperfection of the oil products market in Russia. Of the more than 25,000 gas stations registered in the Russian Federation, about 45 % belong to the Winks, and the remaining 55 % to independent owners. And if the gas station of large oil companies is provided with fuel in the first place and high quality fuel coming from their factories producing and owned by them, the remaining part of the gas station solves its problems on the principle – wholesale supply with a minimum price and no matter what quality, and retail sale at
prevailing market prices of petroleum products. And it is difficult to argue, pouring fuel into the tank, with a gas station worker about its quality [8].

For all reason, this explains the presence of low-quality fuel at the gas station.

The technical condition of the car and its "age" is also the cause of more toxic emissions. Historically, we have an old car Park. The number of cars older than 10 years is about 49%. The fleet of trucks is more age. The share of trucks older than 10 years is slightly less than 70%. It is difficult to say at once that the age of the car is decisive, old age is not a sentence, but a state of mind. Therefore, in good hands and age the car is always "young", that is technically sound, well-groomed, neat. And if the head and hands "problem", and the new car in a short period of time is experiencing serious problems of rapid aging. Technical serviceability of transport is primarily safety on the road, but not only. The technical condition of transport plus low-quality fuel-this is an environmental problem.

About 38% of the car fleet does not meet the toxicity standards for EURO-2, and EURO-4 and above corresponds to about 33%. In the truck segment, almost 70% of the fleet does not meet EURO-2 standards, and only slightly more than 10% corresponds to EURO-4 and above.

The amount of harmful substances entering the atmosphere as part of the exhaust gases depends on the General technical condition of the cars and especially on the engine — the source of the greatest pollution.

In the process of engine aging, its emissions increase due to the deterioration of all characteristics that affect the composition of exhaust gases: excess air ratio, load, ignition torque control, formation of carbon in the combustion chamber, exhaust back pressure, valve adjustment, intake manifold pressure, cylinder displacement, compression ratio, exhaust gas recirculation, combustion chamber design, the ratio between the piston stroke and cylinder diameter, etc.

Operational and design parameters affecting diesel engine emissions: excess air ratio, injection advance, inlet air temperature, fuel composition (including additives), turbocharging, air turbulence, combustion chamber design, injector and jet characteristics, exhaust gas recirculation, crankcase ventilation system, etc. [9].

3. Conclusion

In our country, automobile exhaust is more toxic than in the West and there are a number of reasons for this. Gasoline and diesel fuel remain virtually exclusive fuels in Russia. But the world practice shows the development of alternative fuels. And here it should be noted a sharp interest in the development of vehicles powered by gas motor fuel (GMT) and electricity of modern batteries. No alternative fuel monopoly and dependence on the price of it forces to look for new types of energy sources and technologically developed countries, with a low reserve of natural resources of energy carriers, do it. Russia, with its enormous natural resources, cannot be only a source and supplier of energy. We need modern technologies, not only in the processing of oil and gas, but also advanced technologies of tomorrow. The tasks of the oil product supply system are to become the world leaders in the creation and development of advanced technologies and equipment, expansion of the country's fuel market, improvement of their quality and environmental friendliness.

In this regard, I would like to focus on the prospects of the GMT. The expansion of the GMT market is reflected in a number of regulatory documents of the Russian Government. This is promising and the arguments in favour of the GMT are clear. Economic and environmental benefits of expanding the market locus is associated with high environmental friendliness of this fuel type, low price, large natural resources, the development of the petrochemical industry of the country, the reduction of financial expenses for the repair and reconstruction of obsolete physical-ski and the moral enterprises of oil refining and the production of liquid fuels, perspective technical and technological solutions to transport problems [10].

Both specific companies and the state are interested in the development of the GMT market. This allows us to hope that the current wave of development of transport infrastructure and transport will be successful and will solve many problems, including large cities.
References
[1] Nikonorov S 2016 *The Economist* **11** 60-8
[2] Bityukova V R 2017 *Ecology and industry of Russia* **4** 4-11
[3] Bezborodov Yu N, Kovaleva M A, Sokolnikov A N, Shram V G and Tsygankova E V 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **537** 062019
[4] A D Kurbatova, M A Kovaleva, N N Lysyannikova, E G Kravtsova and A V Tsygankova 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **537** 062059
[5] Shram V G, Lissynnikov A V and Kovaleva M A 2016 *J Procedia engineering* **2016** 458-63
[6] Bezborodov Yu N, Kovaleva M A and Karkashenko A O 2019 *Environmental protection in oil and gas complexes* **4** 34-7
[7] Chernetsov D A 2010 *Questions of modern science and practice. University them. V. I. Vernadsky* **10** 54-8
[8] Bradley H B 1992 *Petroleum engineering handbook* (Richardson: Society of Petroleum Engineers)
[9] Dmitriev A L and Milyutina O E 2012 Scientific notes of Russian state hydrometeorological University **26** 190-6
[10] Gryaznov M B 2013 *Vestnik of financial University* **4** 21-31