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Environmental impact of transport and technological activities in Krasnoyarsk, prospect of using gas-motor fuel

Yu N Bezborodov, M A Kovaleva, A N Sokolnikov, V G Shram and E V Tsygankova

Siberian Federal University, 82/6 Svobodny pr., 660041 Krasnoyarsk, Russia

E-mail: Lera0727@yandex.ru

Abstract. The present study describes environment impact of motor transport in Krasnoyarsk. The negative effects of annually increasing vehicle fleet on the city atmosphere are revealed. Harmful (polluting) substances emissions into atmospheric air from motor transport (2014-2017) have been analyzed, it is calculated that their quantity for this period has increased by three times. Change dependencies of fixed substances concentration in recent years: SO₂, NO_x, light organic compounds (LOC), CO, C, NH₃ are given. Parameters on which emissions of pollutants in the atmosphere depend are considered. The prospects of using gas motor fuel, economic and ecological effect of the market expansion are defined.

Year of Ecology has ended. The Ministry of Ecology was established in Krasnoyarsk during this time, the authorities purchased devices for atmospheric pollution monitoring, and social activists held several meetings. But, judging by a response from inhabitants of Krasnoyarsk, it hasn't become easier to breathe in the city.

The sources of atmospheric pollution are of many different kinds in Krasnoyarsk, and emissions composition is multicomponent, the city is considered to be a megacity characterized by ultra-high pollution level of atmospheric layers by I and II hazard class pollutants.

The number of cars has significantly increased in Krasnoyarsk over the past few years. The city ranks only second in Russia in terms of relative motorization level where there are 380 cars per thousand inhabitants. Nowadays any of the industries takes place without increased car use: ranging from construction sector to agriculture. Transport-related services play a crucial role in people's daily lives therefore its use is constantly increasing. The State Road Traffic Safety Inspectorate data testifies that Krasnoyarsk vehicle fleet increases by 3.5% annually mainly due to passenger cars. Motor transport makes the most essential negative impact on the environment, mainly, atmosphere [1].

According to the annual state report data concerning the current environment in Krasnoyarsk Krai, a share of motor transport emissions in total contaminated material emissions has amounted more than 30% in 2014 and 10.9% in 2017 [2]. At first sight, not a bad trend, but in more detailed analysis, it is obvious that the number of motor transport emissions increased, figure 1 clearly demonstrates.



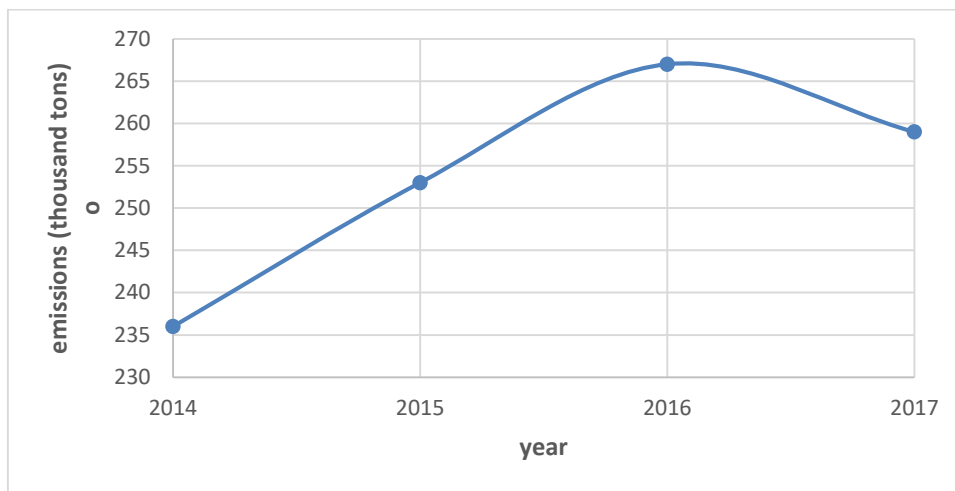


Figure 1. Motor transport emissions (2014-2017).

The percentage reduction of total recorded regional emissions indicates an impending ecological catastrophe in our city. Having carried out simple calculations, we can make the following conclusion that the total amount of emissions has increased by 3 times since 2014.

It is also necessary to take into account that emissions volume of contaminated material are obtained as a result of calculations according to the methodology used since 2013. Some changes have occurred, in connection with this, the values of motor transport emissions calculations are 1.5 times lower than by the previously used method.

The motor transport share accounts for about 90% of the total harmful substances amount emitted to the atmosphere from all types of transport. Automobile exhausts contain about 300 pollutants, including those with carcinogenic effects. The main pollutants emitted by motor vehicles include: - carbon monoxide (CO); - nitrogen oxides NO_x (in terms of nitrogen dioxide); - hydrocarbons (CH); - soot; - sulfur dioxide (SO₂); - formaldehyde; - benzo (a) pyrene; - lead [3-4].

Our task was to analyze the trend in concentrations of fixed substances in recent years. As a result, the data presented in figures 2-8 were obtained.

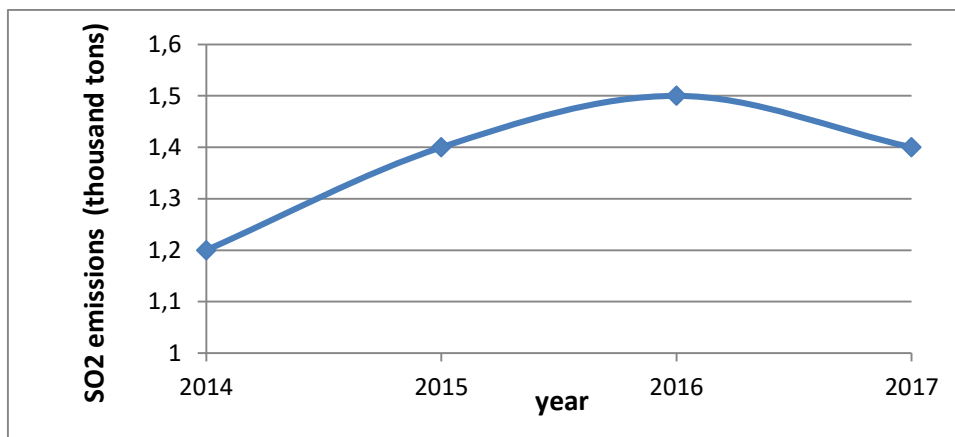


Figure 2. SO₂ emissions from motor transport (2014-2017).

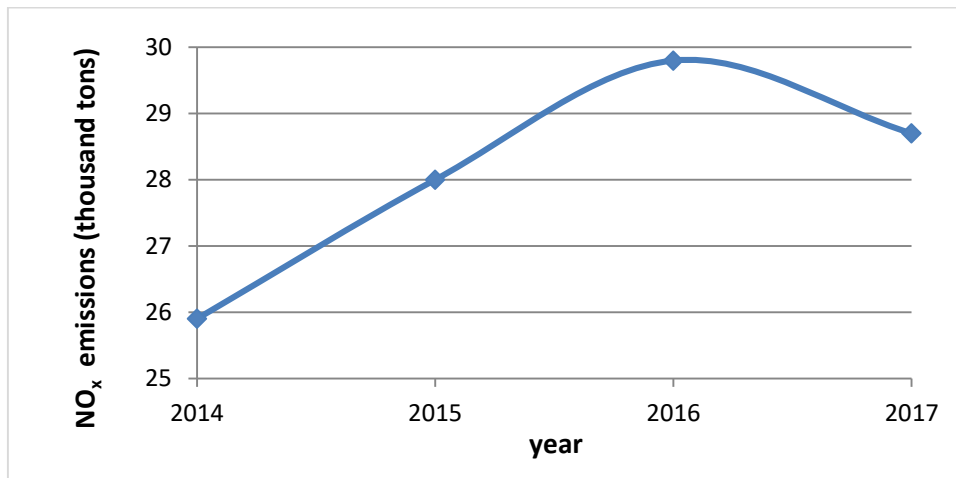


Figure 3. NO_x emissions from motor transport (2014-2017).

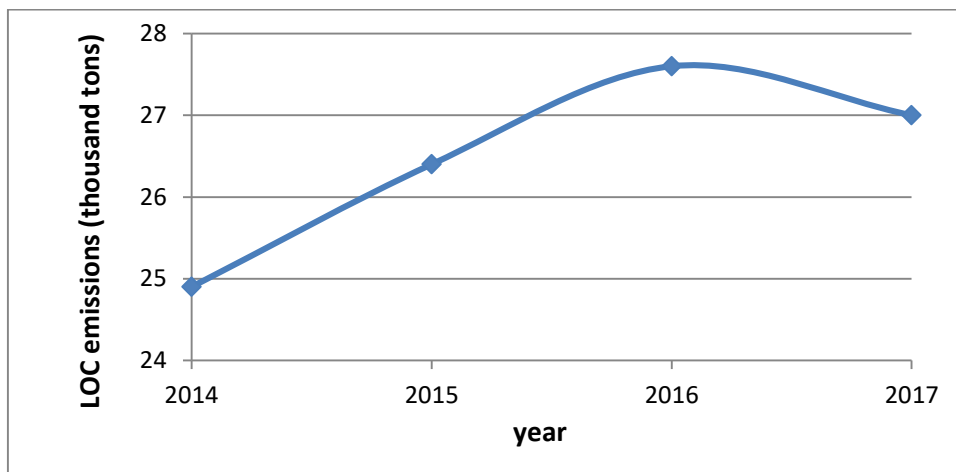


Figure 4. Light organic compounds emissions from motor transport (2014-2017).

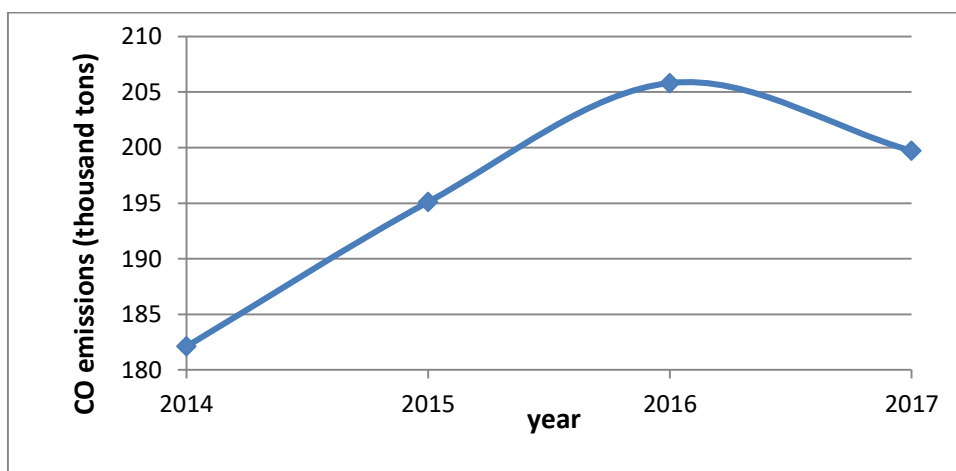


Figure 5. CO emissions from motor transport (2014-2017).

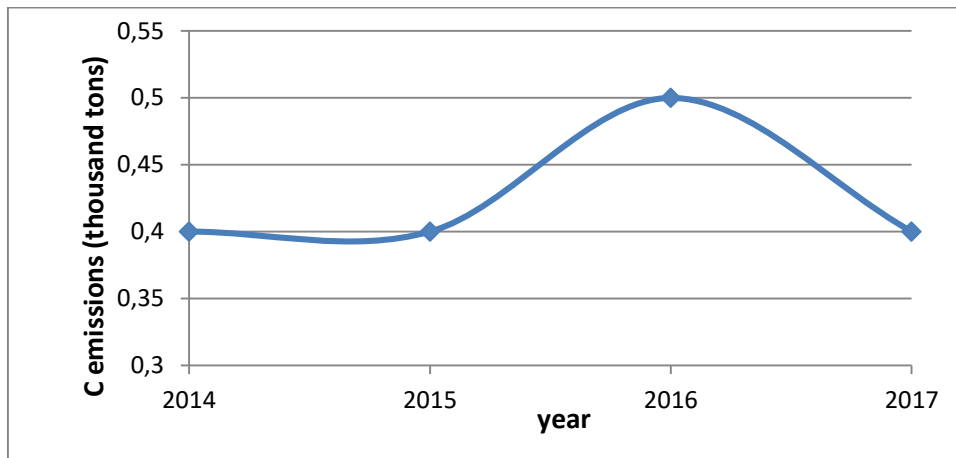


Figure 6. C emissions from motor transport (2014-2017).

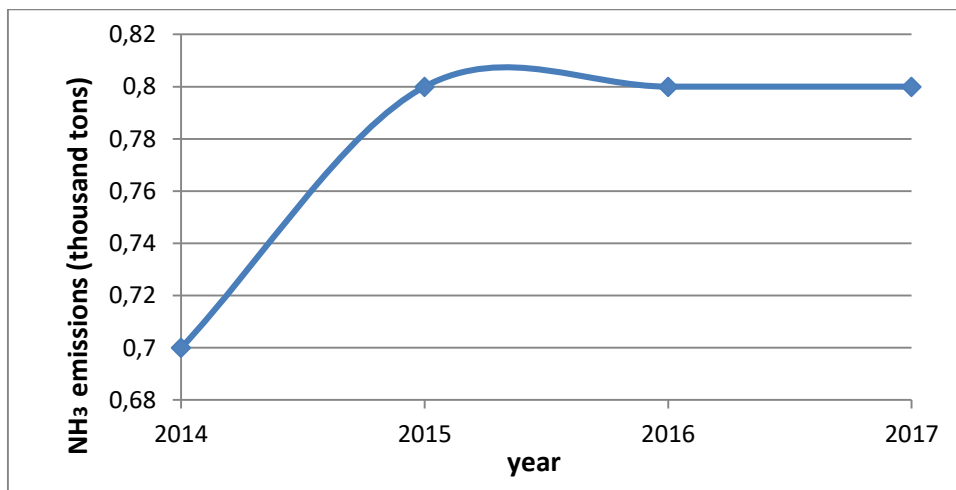


Figure 7. NH₃ emissions from motor transport (2014-2017).

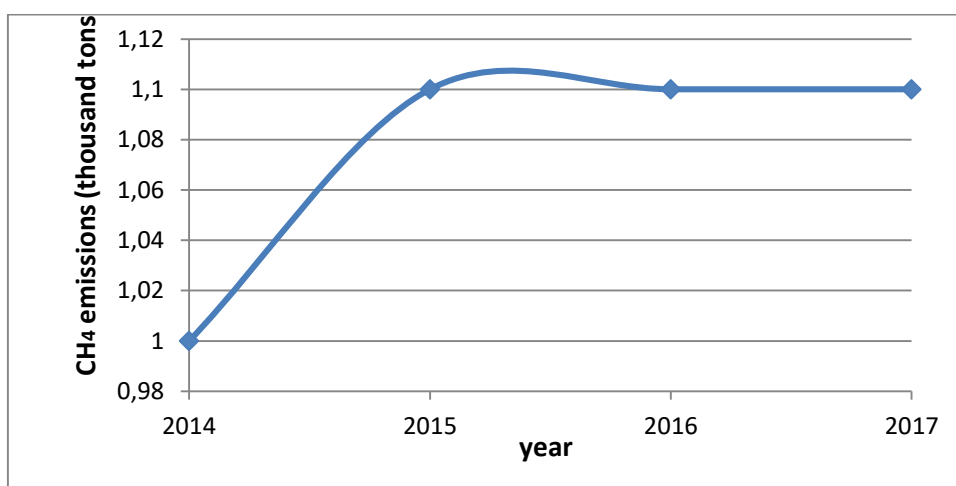


Figure 8. CH₄ emissions from motor transport (2014-2017).

Analyzing the obtained results, it should be noted that the volumes of fixed substances have increased over the past few years, there has been a certain downward trend in 2017, but compared to 2014, the data looks disappointing.

Pollutants emission into the atmosphere depends on a number of parameters: fuel quality, engine wear degree, vehicle power and movement speed. Thus, the minimum pollutants emissions are observed at a constant speed of 60-80 km / h. With high-density traffic, the road user's speed drops significantly, which leads to an increase in fuel consumption, which means an increase in emissions. As for extremely worn out engines, the emission increases up to 40%, and if the power of an automotive vehicle is increased, the amount of harmful substances in the vehicle exhaust gases also increase in emissions. In Krasnoyarsk Krai only one car emits a huge amount of pollution - 244.5 kg into the atmosphere annually. We believe that this makes it essential to take greater account of engine operation analysis in different modes, using environmentally friendly fuel [5].

To overcome that situation, the president Putin has expressed his continuing willingness to launch a project connecting with transition to gas-motor fuel. "For places like Krasnoyarsk Krai, it's very significant. The Russian president noted that Public Joint Stock Company "Gazprom" has a whole program. The transition must be carried out quietly, calmly and with minimal load on car owners."

In the Russian market, car owners are offered the equipment intended for two types of natural gas - propane (propane - butane) and methane. The fuel itself in the first alternative is slightly more expensive and is in liquid state, in the second alternative - it is cheaper and in gaseous state. Converting a car to gas fuel does not require constructive engine modifications (neither gasoline nor diesel engine): it is enough to install gas equipment. The advantages of gas motor fuel are the following:

- Compressed and liquefied gas has a high octane number (110 units), which virtually eliminates detonation and reduces the load on engine parts.
- Gas does not wash the oil film off the surface of the cylinders, which allows to increase engine life by an average 40%.
- Due to minimum impurities content and oxidizing substances in combustion products service life of engine oil increases by 50%, spark plugs, combustion chambers walls and valves are not covered by carbon deposits.
- Having installed compressed natural gas equipment, a multi-fuel vehicle with two independent fuel supply systems is obtained, respectively; a backup fuel supply system substantially increases vehicle reliability. Total mileage for one vehicle refueling doubles.
- In general, when correctly operating the overhaul period before rubber products replacement is needed will be at least 5 years.
- Gas is approximately half the price of gasoline.
- The possibility of fuel substitution with cheaper and low-quality analogs is limited (for diesel fuel it is ship low-viscous fuel and gas condensate distillate; for high-octane gasolines these are "semi-finished products" of commodity gasolines using additives increasing octane number (octane number boosters).

In the longer term, the ecological constraint becomes more significant. Harmful substances content in exhaust gases of cars with a gasoline engine, converted to gas operating - 70% less than a pure gasoline engine has, and diesel engine - 53% less. Moreover such exhaust gases contain ten times less carbon monoxide, half the amount of nitrogen oxides and practically there is no fuel soot. The environmental friendliness of gas motor fuel is a strong argument in its favor when compared to gasoline and diesel fuel [6-7].

Gas motor fuel market expansion is reflected in a number of regulatory documents of the Government of the Russian Federation. It's promising and the arguments in favor of gas motor fuel are clear. Economic and environmental effect of gas motor fuel market expanding is associated with high environmental friendliness of this fuel type, low price, large natural reserves, development of country's petrochemical industry, reduced financial costs required for repair and reconstruction of physically and morally outdated oil refineries, production of liquid fuels, and promising technical and technological solutions to address transport challenges [8].

Both specific companies and state are interested in the development of gas motor fuel market. This leads us to hope that the current wave of transport infrastructure and transport modes development will be successful and help to overcome many environmental problems in Krasnoyarsk.

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