ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Assessment of Urban Air Pollution Caused By Motor Vehicle Complex and Industrial Facilities.

Ilnar F. Suleimanov*, Gennady V. Mavrin, Damir A. Kharlyamov, Eduard I. Belyaev, Vadim G. Mavrin, Lira M. Gabdullina, Liliya R. Ardashirova, and Dmitrii V. Iamaletdinov.

Kazan (Volga region) Federal University, Syuyumbike Ave., 10A, Naberezhnye Chelny, 423812, Republic of Tatarstan, Russia.

ABSTRACT

This paper deals with the collected, processed and systematized information about the existing sources of air pollution caused by the facilities of Naberezhnye Chelny, their physical properties, qualitative and quantitative composition, as well as full-scale survey of the composition and intensity of traffic environment. Based on these data the summary calculation of emissions from factories and motor vehicles was performed. The content of pollutants was instrumentally measured in ambient air and the graphs of correlation between calculated and measured concentrations were constructed.

Keywords: ambient air, pollutants, dispersion calculation, the maximum allowable concentration, dispersion maps, motor transport, industrial facilities.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

The problems of air pollution in the urban residential area has become enormous due to a growing number of vehicles. Low location level, spatial distribution, and proximity to residential areas of mobile sources create extensive and stable zones in the urban atmosphere, where the sanitary standards for the content of harmful substances, which causes significant damage to the environment, are exceeded by several times.

The situation connected with urban air pollution by road transport emissions is complicated by aeration conditions of localities that define the dispersion process of pollutants, which significantly differs from the dispersion of emissions of stationary sources. Emission of harmful substances from road transport in the lower layer of the atmosphere causes the high level of surface concentrations, the maximum content of emissions is fixed at a height of 50-200 cm above the ground, i.e. is in the breathing zone of the person. The level of concentration of oxides of nitrogen, carbon and other harmful ingredients in the streets of Russian cities is 10-20 times higher than the MPC [1, 2, 3].

The city of Naberezhnye Chelny with the population of more than half a million people is the largest city in the Zakamsk region of the Republic of Tatarstan. The city is characterized by a high level of development of industrial and transport networks. Today, the city has mainly a rectangular street grid. The most intensive vehicular traffic is in the main highways of the city: Naberezhnochelninsky Ave, Musy Jalilya Ave, Mira Ave, Highway No 1, Sarmanovsky path, Hasan Tufan Ave, Vakhitov Ave, Akademik Korolev Str.

These thoroughfares run through the whole city and connect the city center with residential areas and industrial zone, performing thereby the function of intracity distribution of passenger and freight transport flows, as well as service of the surrounding areas and transfer of workers to their working areas.

Total length of Naberezhnye Chelny road network with asphalt coating is 568 km, the length of the main urban and district roads is 358 km.

Construction and design of the existing system of transport infrastructure of the city of Naberezhnye Chelny was laid in the 80s. Given the development of the city, increase in the number of production facilities and the growth of road transport, the existing urban road network has gradually started to fail, resulting in worse road capacity, which, in turn, led to traffic jams in rush hours [4, 5, 6].

TECHNIQUE

To assess the quality of urban air pollution, we have collected, processed and systematized information provided by the city enterprises about the existing sources of atmosphere pollution, their physical characteristics and emission volume, as well as qualitative and quantitative composition of the pollutants emitted [4, 5, 6].

We have investigated the characteristics of the moving vehicular traffic in 43 highways, drawn up 154 reports on investigation of the composition and intensity of moving vehicular traffic for each section of motorway road [7, 8, 9].

The analysis of data of the reports on investigation of traffic composition and intensity in the main roads of Naberezhnye Chelny showed that the main contribution to the total traffic volume in urban highways located in the residential area of the city is made by passenger cars (85-95%), while the contribution of freight transport is not more than 3-4%.

Contribution of freight transport to the total traffic volume in the industrial zone and federal and republican roads can be 10-20% due to the purpose of these objects. Respectively, the contribution of passenger vehicles to the total traffic volume is 60-80%.

Summary calculation of dispersion of 143 pollutants, including those forming 28 groups of summation, was performed based on the data obtained. Performing the calculation, the influence of local weather conditions and terrain on the character of impurities distribution was considered [10, 11, 12, 13, 14,

15, 16]. The calculations performed have provided a picture of the distribution of air pollution level throughout the city of Naberezhnye Chelny. (Fig. 1 - Map of nitrogen dioxide dispersion.)

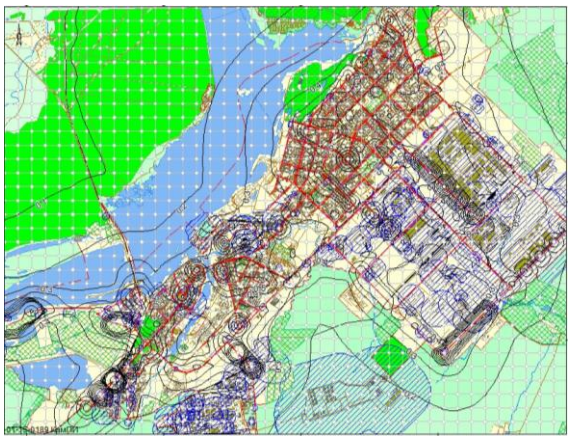

Figure 1: Map of nitrogen dioxide dispersion

To confirm the results of calculations, we have conducted experimental studies of the content of pollutants in ambient air.

A modern and certified equipment was used during the experiment. Five road sections were defined under this experiment. The basis for the allocation of plots was the investigation of the road purpose, the plan of the road network, as well as the analysis of information on the traffic load in its separate sections.

The content of pollutants was instrumentally measured in ambient air within the roadside clear zone of Naberezhnye Chelny. The following substances were measured for 5 roads selected with different traffic density, at least 30 times on each road: carbon oxide, nitrogen oxide, nitrogen dioxide, sulphur dioxide, ammonia and suspended substances.

Air sampling was carried out in accordance with GOST 17 2.3.01-86, RD 52.04.186-89, and the requirements described in the selected indicators measurement procedures (Table 1). During the measurement, data on sampling conditions were recorded.

Table 1: Measurement procedures

Name of substance	Measurement procedures	Technique
Nitrogen dioxide	PND F 13.1:2:3.19-98	Ion chromatography
Nitrogen oxide	PND F 13.1:2:3.19-98	Ion chromatography
Ammonia	RD 52.04.186-89, p. 5.2.1.1.	Photometric
Suspended substances	РД 52.04.186-89, p. 5.2.6	Gravimetric
Sulphur dioxide	PND F 13.1:2:3.19-98	Ion chromatography
Carbon oxide	ПНД Ф 13.1:2:3.27-99	Gas chromatography

We also measured the conditions of atmospheric air at the border of the sanitary protection zone of industrial facilities (Fig. 2). In accordance with the Guidelines for the control of air pollution [RD 52.04.186-89], as well as measurement procedures [FR.1.31.2009.05509, FR.1.31.2009.05508, PND F 13.1: 2: 3.27-99, PND F 13.1: 2 : 3.25-99, MM-M-34-04 of LLC "Monitoring", attestation certificate FSUE “D.I. Mendeleyev Institute for Metrology” (VNIIM) No 242/140-2004 of 08.12.2004], the sampling and analysis of ambient air was carried out on the following substances: benzene, toluene, acetone, butanol, butyl acetate, ethyl acetate, xylene, isopropyl alcohol, ethyl cellosolve, carbon oxide, methane, the amount of saturated hydrocarbons C6 and higher - at 75 points, chromium, copper, iron, manganese, nickel, lead, zinc - at 92 points (Figure 2). At the same time with sampling, the air temperature and atmospheric pressure were continuously measured.

ISSN: 0975-8585

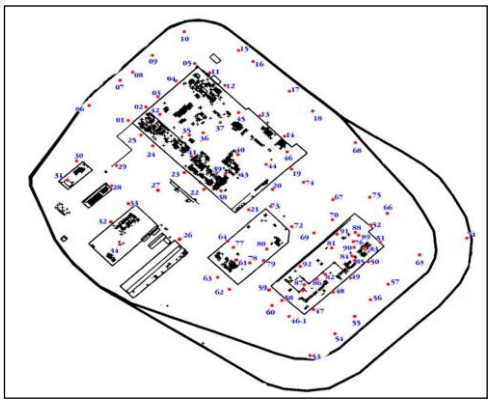

Figure 2: Schematic map of air sampling

RESULTS

Analysis of the results of on-site investigations of the structure and intensity of the moving vehicular traffic of Naberezhnye Chelny showed that the highways of the city are characterized by varying load, that is the highest traffic density on different highways is observed at different time of day.

The results of calculation of the pollutant dispersion predict exceedance of concentrations of carbon monoxide, nitrogen dioxide and groups of summation formed by these substances in a residential area of the city. Zones with maximum ground level concentrations of carbon oxide and nitrogen dioxide of more than 1 MPC are observed along the main highways and road junctions. No exceedance of maximum permissible concentration of the pollutants contained in the emissions of urban facilities is assumed at the boundary with the residential area. The highest concentrations in the MPC proportions are predicted for the following substances and groups of summation: manganese and its compounds 0.66 MPC; sodium hydroxide 0.6 MPC; carbon (soot) 0.31 MPC; dimethylbenzene (xylene) 0.7 MPC; butan-1-ol 0.35 MPC; phenol 0.26 MPC; butylacetate 0.6 MPC; acetone 0.2 MPC; triethanolamine 0.22 MPC; petroleum-based mineral oil 0.8 MPC; solvent naphtha 0.6 MPC; abrasive dust 0.2 MPC; summation group 6015 (acetone, furfural, formaldehyde and phenol) 0.55 MPC; summation group 6017 (aerosols of vanadium pentoxide and manganese oxides) 0.65 MPC; summation group 6038 (sulfur dioxide and phenol) 0.35 MPC; summation group 6052 (acetic acid, phenol and ethyl acetate) 0.3 MPC.

The content of pollutants was instrumentally measured in ambient air within the roadside clear zone of Naberezhnye Chelny, and the measurements of the condition of atmospheric air at the border of the sanitary protection zones of industrial facilities have provided actual concentrations of pollutants in ambient air. Based on the results obtained, the graphs of correlation between calculated and measured concentrations were constructed.

The calculated results agree well with the results of instrumental measurements ($R = 0,6 \div 0,9$), indicating the possibility of using the model to determine the concentrations of the pollutants.

CONCLUSION

This paper deals with the collected and analyzed information about the existing stationary sources of air pollution, their qualitative and quantitative characteristics, actual emissions, as well as on-site investigations of structure and intensity of the moving vehicular traffic on the main highways of Naberezhnye Chelny.

Based on data obtained, a summary calculation of 143 pollutants, including those of the 28 groups of summation, was performed for Naberezhnye Chelny for the first time ever, and each substance was presented in the constructed and analyzed maps of distribution of air pollution throughout the city.

The results of calculation of the pollutant dispersion were taken to draw up a forecast of pollutant concentrations in a residential area of the city and to identify substances and groups of summation that may

exceed MPC: carbon oxide, nitrogen dioxide and groups of summation formed by these substances. Zones with maximum ground level concentrations of carbon oxide of more than 1 MPC are observed along the main highways and road junctions.

The relative proportion of emissions from stationary and mobile sources was assessed by the calculation, which excluded motor vehicles and motor complex facilities. It has been established that the estimated emissions of carbon monoxide and nitrogen dioxide from stationary sources are insignificant compared with moving ones and cause no more than 0.1 MPC.

The content of pollutants was instrumentally measured in ambient air within the roadside clear zone of Naberezhnye Chelny, and the measurements of the condition of atmospheric air at the border of the sanitary protection zones of industrial facilities have provided actual concentrations of pollutants in ambient air. Based on the results obtained, the graphs of correlation between calculated and measured concentrations were constructed. The calculated results agree well with the results of instrumental measurements (R = 0.6 ÷ 0.9), indicating the possibility of using the model to determine the concentrations of the pollutants.

REFERENCES

[1] Milyaev V.B., Golovina N.M., Selyakova A.N., 2010 Analysis of pollutant emissions from stationary and mobile sources within Saint-Petersburg and Leningrad Region / Proceedings of Problems of Air Protection SRI "Atmosphere", Saint-Petersburg.

[2] Europe's polluters will pay their way. - New Sci. - 1989 - 122. - N 1678. - p.20.

[3] Review of National Strategies and policies for the abatement of air pollution. Economic commission for Europe. Eighth session, Geneva (20-23 November 1990).

[4] Suleimanov, I.F. The Assessment of the City Air Pollution by Automobile Transportation and Industrial Enterprises Basing on Calculation Methods. World Applied Sciences Journal 23 (4): 480-485, 2013.

[5] Suleimanov, I.F. The Study and Management of Reliability Parameters for Automotive Equipment Using Simulation Modeling./ Khabibullin R.G., Irina Viktorovna Makarova I.V., Belyaev E.I., Suleimanov I.F., Pernebekov S.S., Ussipbayev U.A., Junusbekov A.S., Balabekov Z.A.// Life Science Journal 2013; 10 (12s), 828-831, 2013.

[6] Suleimanov, I.F. Modeling of traffic flows with due regard to ecological criteria./ Khabibullin R.G., Irina Viktorovna Makarova I.V., Belyaev E.I., Suleimanov I.F., Pernebekov S.S., Ussipbayev U.A., Junusbekov A.S., Balabekov Z.A.// Life Science Journal 2014; 11 (5s), 300-302, 2014.

[7] Milyaev V.B. et al / Methodological manual for summary calculations of air pollution emissions from industrial facilities and vehicles of the city (region) and their application in the regulation of emissions / approved by the order of the Russian State Committee for Environmental Protection No 66 of February 16, 1999 / St. Petersburg, 2000. - 25 p.

[8] Guidelines for traffic safety on the motor roads: industrial road guidance document: approved by the order of Russian Ministry of Transport No OS-557-r of 24.06.2002 - 284.

[9] Calculated instructions (methods) for inventory of P24 pollutant emission from motor vehicles and road construction machines in the air / JSC NIIAT. - M.: Avtopolis-Plus, 2008. - 84 p., table.

[10] Suleimanov I.F. Methods of assessment of air basin in the city. / Suleimanov I.F., Mavrin G.V., Harlyamov D.A. / Publishing House LAP LAMBERT Academic Publishing, 2012. - 116 p.

[11] Suleimanov I.F. Assessment of urban air pollution caused by motor vehicle complex and industrial facilities based on calculation methods: III International scientific-practical conference "Technologies, Materials, Transportation and Logistics: Prospects for Development" TMTL'13 (September 12-13, 2012); Suleimanov I.F., Mavrin G.V., Makarova I.V. - Scientific Journal "Bulletin of Volodymyr Dahl East Ukrainian National University" - Lugansk, No 9 (198), 2013 part 1, 2013 p.139-144.

[12] Amann, M., Gyarfas, F., Schopp, W., Boudri, J.C., 2000. Prévision d'air- un système de modélisation de la contamination atmosphérique, Emep., 87 p. 170.

[13] Gourbay, C., Miege, C., Tusseau-Vuillemin, M.Y., 2002,. Numerical simulation of gazphase atmospheric model // Atmos. Environ. #36. - p. 873-879

[14] Gram, F., Gronskey, K.E., 1980. Program «TFKJEMI» Modell-beregninger av fotolgemiske oksydanter I Grenland. Lielestrom. - (NILU TN 15/79). -P.47- 53. 170.

[15] Kajino, M., 2003. Modelling Liquid Water Content of Atmospheric Aerosols. IIASA IR 03-046.

[16] Klaassen, G,, Amann, M., Berglund, C., 2004. The Extension of the RAINS Model to Greenhouse Gases. IIASA IR 04-015.