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# THE ASSESSMENT OF CITY AIR POLLUTION BY VEHICLES AND INDUSTRIAL ENTERPRISES INVOLVING THE COMPREHENSIVE COMPUTATIVE AIR POLLUTION INDEX

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**ABSTRACT**

Within the framework of current study the authors conducted monitoring of the traffic flow structure and intensity on the highways, as well as collected the information on existing industrial air pollution sources in the city of Naberezhnye Chelny, implemented a system of computative monitoring of atmospheric pollution on the basis of the summary calculations of emissions from industrial plants and motor vehicles. The authors defined a list of priority polluting agents and determined the comprehensive computative air pollution index (CCAPI).

**Keywords:** atmospheric air, polluting agents, pollutant dispersion maps, the comprehensive computative air pollution index.

## 1. INTRODUCTION

Production and consumption of huge amounts of energy, road network and transport sector, industrial enterprises located on the territory of cities cause large-scale anthropogenic pollution of all urban environment components, and primarily - the atmosphere.

City of Naberezhnye Chelny, inhabited by more than half a million people, is the largest city of the Trans-Kama region of the Republic of Tatarstan. The city is characterized by high level of industrial development and transport networks. The level of air pollution in Naberezhnye Chelny, as in many other cities of the Russian Federation, is determined by instrumental monitoring, which includes regular observations of the atmospheric air condition on fixed monitoring stations and, additionally, by means of mobile laboratories. The degree of atmospheric air pollution of the city is determined based on measurements of pollutant concentrations, carried out at fixed monitoring stations and mobile laboratories. Nevertheless, obtained information is insufficient to describe the city air pollution by all harmful substances and does not give a complete dispersion pattern of polluting agents. To effectively address the issue of maintaining the air basin purity, the integrated approach is needed, which includes a summary calculation of air basin pollution in cities (regions) caused by industry and transport emissions [1, 2, 3, 4, 5, 6].

## 2. METHOD

In the framework of the current research the authors carried out monitoring of the traffic flow structure and intensity on the highways in 2014. Also, the information on existing sources of air pollution by the enterprises is processed and systematized, including determination of their physical parameters, qualitative and quantitative composition of polluting agents, and actual amount of emissions. The following sources were used when collecting data: the results of the emission inventory, data on industrial emissions from enterprises according to the departmental and state laboratory control, statistical statements, and drafts of maximum permissible emissions standards. The authors calculated pollutant dispersion based on the data obtained and employing a unified air pollution calculation program. The priority substances, which cause pollutions in the city, were determined based on the calculated polluting agents dispersion [7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21]. The comprehensive computative air pollution index (CCAPI) is determined by the formula:

$$I_5 = \mathrm{CCAPI}_5 = \sum_{i=1}^{5} \left(C_i\right)^{\beta_i} \quad (1)$$

where i - is the impurity, βi - is a constant for different classes of hazard reduced to the sulphur dioxide harmfulness degree, Ci - is the calculated concentration of i-th impurity.

In accordance with the existing assessment methods, the level of pollution is assessed in accordance with Table-1.

**Table-1.** The level of air pollution depending on the air quality indicator values.

| The level of air pollution | $CCAPI_5$ |
|---|---|
| Low | 0–4 |
| Excessive | 5–6 |
| High | 7–13 |
| Very high | ≥14 |

## 3. RESULTS

The calculations of polluting agent dispersions allowed obtaining the atmospheric air pollution distribution pattern for 143 polluting agents throughout the city of Naberezhnye Chelny. Figure-1 presents the manganese and its compounds dispersal map.

**Figure-1.** Dispersal map of manganese and its compounds.

According to the results of dispersion calculation of polluting substances, the authors predict the excess in concentrations of carbon monoxide, nitrogen dioxide and groups of summation, formed by these substances, in a residential area of the city. For carbon oxide the zones with maximum ground level concentrations of more than a unit of maximum permissible concentration (MPC) are observed along major highways and junctions. The excess of nitrogen dioxide and carbon oxide is expected to be over more than 50% of the territory of Naberezhnye Chelny. For polluting agents contained in emissions of city enterprises, the MPC at the boundary with residential area is not detected. Based on the analysis of the dispersion results, five priority polluting agents were identified: manganese and its compounds, carbon monoxide, nitrogen dioxide, xylene, and mineral petroleum oil. The CCAPI of atmosphere was defined for all above listed substances. Spatial distribution of CCAPI is shown in Figure-2. The values of CCAPI for the city residential areas adjacent to the roads with high traffic intensity are characterized as "high", while for roads with low intensity they are identified as "excessive".

**Figure-2.** The CCAPI spatial distribution map.

## 4. CONCLUSIONS

In the framework of the current study, the information on existing stationary sources of air pollution, their qualitative and quantitative characteristics, and actual emissions were collected and analyzed, as well as field examinations of the traffic flow structure and intensity on the main highways of Naberezhnye Chelny were carried out.

On the basis of the data obtained, a summary calculation of 143 polluting substances dispersion over the territory of Naberezhnye Chelny was carried out for the first time, and air pollution distribution maps throughout the city were constructed and analyzed for each polluting agent.

According to the calculation results of polluting agents dispersion, the concentration distribution was predicted for the city residential area, and the polluting agents and summation groups were identified, for which the excess in MPC was the most probable.

Based on the analysis of the calculated polluting agent dispersions, five priority polluting agents were identified and the comprehensive air pollution index was calculated. The value of CCAPI within the territory of the city residential area adjacent to roads with high traffic intensity is characterized as "high", while for roads with low intensity it is "excessive".

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