

HYGIENE

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On the issue of improving the assessment of atmospheric air quality in the area of industrial enterprisesG. B. Yeremin¹, O. L. Markova¹, S. N. Noskov^{1,2}, O. V. Mironenko^{2,3}¹ Northwest Public Health Research Center,

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In the Russian Federation, since 2018, the implementation of the Federal project “Clean air” has begun, planned until 2024. Within the framework of this project, a set of works is planned to reduce the level of atmospheric air pollution and improve the quality of monitoring of harmful substances in the atmosphere. Our research was aimed at improving the monitoring of the quality and condition of atmospheric air in the city of Volkhov, Leningrad region, in the industrial zone of which modern production facilities are dynamically developing. Pollutants of 78 types are released into the atmosphere of the city from 13 enterprises. The total emission of pollutants into the atmosphere from these enterprises is 9.12 thousand tons/year. The most significant contribution is made by the following enterprises: JSC “metachem” (JSC “Apatit”) — 23.7%; JSC “pikalevskaia soda” (LLC “Glatsem”) — 62.6 %, located on the same industrial site.

Keywords: federal project “Clean air”, the health of the population, monitoring, sanitary and epidemiological regulation, atmospheric air.

Introduction

Air pollution is one of the main health risks associated with the environment. According to who experts, 4.2 million deaths worldwide each year are caused by the negative impact of air pollution. Air pollution is one of the leading causes of death from noncom-

municable diseases (NCDS). In the structure of NCDS, 24% are heart diseases, 25 — stroke, 43 — chronic obstructive pulmonary disease, 29 — lung cancer¹ [1].

According to the presidential Decree, currently in the Russian Federation, 74% of the country's population lives in cities and adjacent territories, where the environment is exposed to significant negative impacts, the sources of which are industrial, energy and transport facilities, as well as capital construction projects. 17.1 million people live in cities with high levels of air pollution, which is 17% of the country's urban population².

Therefore, ensuring the quality of the environment necessary for a favorable human life is the most important goal of state policy in the field of environmental safety.

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Purpose and objectives

The purpose of this study was to substantiate and develop an algorithm for conducting in-depth monitoring of atmospheric air quality, which allows to objectively assess the state of atmospheric air in the territory of residential development adjacent to the industrial site.

To achieve this goal, it was necessary to solve the following tasks::

- develop an algorithm for specifying the list of priority harmful substances released into the atmosphere, taking into account gross emissions and the degree of danger;

¹ 9 out of 10 people worldwide breathe polluted air, but more countries are taking action. WHO, 2018. Available at: <http://www.who.int/news-room/detail/02-05-2018> (accessed: 28.03.2019).

² Decree of the President of the Russian Federation no. 176 of April 19, 2017 “On the strategy of environmental safety of the Russian Federation for the period up to 2025”. Available at: <http://docs.cntd.ru/document/420396664> (accessed: 19.01.2021). (In Russian); *The population of the Russian Federation for municipalities on January 1*, 2018. Available at: http://www.gks.ru/free_doc/doc_2018/bul_dr/mun_obr2017.rar (accessed: 23.11.2019). (In Russian)

³ On the state of sanitary and epidemiological welfare of the population in the Russian Federation in 2018: State report. Moscow, Federal service for supervision of consumer rights protection and human welfare Publ., 2019. 254 p. (In Russian)

⁴ *Official Internet portal of the Department of the Federal state statistics service for St. Petersburg and the Leningrad region (Petrostat)*. Available at: <http://petrostat.gks.ru> (accessed: 17.11.2019). (In Russian); Materials for the State report “On the state of sanitary and epidemiological welfare of the population in the Leningrad region in 2017”. Available at: <http://47.rospotrebнадзор.ru/document/doclad> (accessed: 20.01.2021). (In Russian); Form of Federal statistical observation No. 18 “Information on the sanitary condition of the subject of the Russian Federation” for 2008-2018. (In Russian)

- conduct laboratory and instrumental studies of atmospheric air;
- develop an algorithm for assessing the impact of enterprises' emissions on the environment, taking into account the forecast of enterprises' development.

Materials and methods

Industrial emissions of enterprises are a complex gas-aerosol mixture. The dispersed phase mainly consists of aerosols of salts and oxides, alkali metals, and acid aerosols. The gas component is a mixture of acid gases formed as a result of the technological stages of synthesis, Gorenje, drying. The multicomponent composition of emissions is a chemically active, time-varying aerosol. When conducting field studies of atmospheric air, the following pollutants were selected: nitrogen dioxide, sulfur dioxide, ammonia sulfuric acid, diphosphorus pentoxide, hydrochloride, hydrofluoride, inorganic fluorides, highly soluble; dialuminium trioxide, potassium chloride, calcium carbonate, pentanatri triphosphate, suspended substances. Laboratory and instrumental studies were carried out at the following control points.

1. The control point of observation No. 1 (vol. 1) was chosen in the sanitary-protective zone of the studied enterprises on the address: street railway, in a North-easterly direction from the source (coordinates: N. lat. 59055.107, V. D. 32021.245).
2. The control point of observation No. 2 (vol. 2) — apartment building at the address: Novgorodskaya street, D.8-10, to the South of the territory sanitary-protective zone (coordinates: N. lat. 59055.193 I, V. D. 32021.525), the nearest point of the residential area to the border of the SPZ, where it was recorded the highest number of complaints from residents on the periodic smell.

Simultaneously with sampling and measuring the concentrations of pollutants at the control points, meteorological observations of wind direction and speed, air temperature and humidity were carried out. Hourly meteorological data were updated using the site www.gismeteo.ru. Field studies of atmospheric air quality were carried out in the period from 08.10.2019 to 28.10.2019.

Laboratory research of atmospheric air is made by experts of its research Institute "North-Western scientific center of hygiene and public health" KHATS "Arbitration" FGUP VNIIM im. D. I. Mendeleeva. The selection and research of the selected air samples was carried out in accordance with the approved regulatory and methodological documents. In order to assess the air environment, 130 chemical analyses were performed for the content of harmful substances and aerosols. Statistical processing of the obtained data was carried out using the Microsoft Excel package using generally accepted methods.

Results

At the first stage of research, we proposed measuring the concentrations of pollutants in the atmospheric air on the territory of the sanitary protection zone. The purpose of these studies was to:

- in the study of atmospheric air quality to clarify the list of priority harmful substances proposed in the draft MPV and SPZ;

- comparison of the obtained values of concentrations of pollutants with the calculated values of concentrations presented in the PDV and SPZ projects, in order to obtain objective information about the activities of the enterprise in the declared field of production.

The choice of the observation point coincides with the calculated isolines of pollutants according to the PDV project data. Air sampling at point No. 1 was carried out with wind directions from the enterprise-South, South-West direction, wind speed of 3.0–5.1 m/s.

It should be noted that the quality of the air environment on the territory of industrial sites is not normalized and the measurement of harmful substances in the atmospheric air is not carried out.

Despite the short period of observation, it can be noted that the obtained concentrations of pentanary triphosphate and nitrogen dioxide correlate with the calculated values presented in the project of PDV for the industrial site of JSC “metachem” (JSC “Apatit”). Some of the controlled substances were significantly lower than the calculated ones, including: hydrochloride, fluoride gas compounds, and soluble fluorides.

During the observation period, high concentrations of ammonia, diphosphorus pentoxide, suspended solids, and potassium chloride were observed, exceeding the calculated values in relation to the MPC. The concentrations of the listed substances obtained in field studies are 3-10 times higher than the calculated values given in the project of the 2018 PDV for the industrial site of JSC “metachem” (JSC “Apatit”), which is an indirect evidence of an increase in emissions by industrial enterprises. At the second stage of the research, the concentrations of pollutants in the atmospheric air were measured on residential buildings adjacent to the sanitary protection zone. Observation point No. 2 was selected in accordance with the atmospheric air quality monitoring program under the SPZ project of JSC “metachem” (JSC “Apatit”). The purpose of these studies was:

- to confirm non-compliance with the hygienic standard — the maximum permissible concentration of pollutants for the atmospheric air of populated areas;
- introduction of a criterion for comparing the obtained concentrations of harmful substances in the atmosphere of residential buildings with the calculated values of concentrations in the PDV project;
- in the comparison of the values of the pollutant concentrations with the calculated concentrations presented in the draft MPE for obtaining objective information about air quality at nearest buffer zone of residential development.

Air sampling at control point No. 2 was carried out in the wind directions — South, South-West (from the residential area to the industrial site) and North-West (from the industrial site, partially capturing residential buildings), wind speeds of 1.0–5.2 m/s. It should be noted that during the research, we were not able to measure the concentrations of pollutants in an unfavorable wind direction (North), as well as adverse weather conditions (temperature inversions). The work was carried out with the most characteristic wind rose for g. Volkhov: the frequency of wind directions according to the hydrometeorological service is: for the South-East — 14 %, South-West — 16 %, South — 22 %, North-West — 9 % of winds. During the observation period, the presence of marker components of emissions of enterprises in the residential area was recorded. As a result of the conducted studies, it was found that the concentrations of the studied substances in all

selected samples are lower than the corresponding MPC according to GN 2.1.6.3492-17. When comparing the obtained concentrations of pollutants with the calculated concentrations presented in the project of JSC “metachem” (JSC “Apatit”), it can be noted that the values of the MPC shares for the maximum single concentrations for two of the thirteen indicators exceed the design values. The excess of the calculated values for suspended solids and calcium carbonate is 6–13 times. When comparing the obtained average daily concentrations, there is a 3–23-fold excess of the design values for such indicators as sulfuric acid, sulfur dioxide, potassium chloride, calcium carbonate, petnanatrium triphosphate, suspended solids. The analysis of the obtained data showed that the content of alkali metal salts in the aerosol of atmospheric air is 0.3–0.5 MPC at the specified project < 0.01–0.15, which indicates an additional significant load on the sanitary protection zone. The content of suspended solids is 0.7 MPC for a given design range: 0.01–0.03 MPC, sulfur dioxide is 0.6 MPC for a given range: 0.05–0.08 MPC. The analysis of the obtained values in the values of the MPC of harmful substances allows us to conclude that the further increase in the capacity of enterprises located on this industrial site will lead to a deterioration in the quality of atmospheric air on the territory of residential development.

As a warning of the occurrence of an unfavorable situation, we propose to review the program for monitoring atmospheric air, taking into account the selected marker chemicals of these industries and the results of studies conducted on the territory of the sanitary protection zone. At the moment, monitoring of atmospheric air quality is carried out according to the following indicators: suspended solids, nitrogen dioxide, sulfur dioxide, hydrofluoride and carbon oxide. As a result of the in-depth analysis of the data, we propose to Supplement the control program with the following indicators: ammonia, sulfuric acid, diphosphor pentoxide, pentanatrium triphosphate, calcium carbonate, potassium chloride.

Conclusions

In connection with the development of the industrial potential of the city of Volkhov, field studies were carried out to assess the impact of emissions from the main enterprises of the industrial hub in the composition of: JSC “metachem” (JSC “Apatit”), JSC “pikalevskaia soda” (LLC “Glatsem”) on the quality of atmospheric air.

According to the results of field studies of atmospheric air in the city of Volkhov, conducted under the main operating mode of technological equipment of enterprises, no excess of the established hygienic standards of atmospheric air quality at the nearest normalized objects was revealed.

The content of pollutants in the atmospheric air on the territory of residential development (based on the results of field studies), mainly correlates with the calculated levels of concentrations given in the SPZ project for the industrial site of JSC “Metachem” (JSC “Apatit”) for 2019, with the exception of 6 indicators of average daily concentrations exceeding the calculated values, which in cases of natural temperature inversions can lead to a sharp increase in the concentrations of harmful pollutants and the emergence of complaints (appeals) from the population about unpleasant odors.

The results of the evaluation of air pollution Volkhov subject of exceeding the design values of shares \times for a number of substances indicate that without implementation of possible deterioration of the current state sanitary-epidemiological well-being.

An in-depth analysis of the content of harmful substances in atmospheric air on the territory of the sanitary protection zone and the nearest residential area taking into account design characteristics takes into account the multi-pollutant exposure, selects the most critical pollutants from a controlled list, which you need to pay attention or to limit the availability of this component in the atmosphere.

The proposed algorithm allows you to create a program for monitoring harmful substances based on evidence of the presence of these components detected directly near the enterprise, and indicate those components that exceed the design values.

We can recommend this algorithm for analyzing atmospheric air quality when analyzing the impact of emissions from industrial enterprises with a wide list of pollutants and a complex chemical complex.

The proposed method of analysis of field data of concentrations of harmful substances in the air makes it possible to develop timely management decisions to prevent an unfavorable situation in the quality of atmospheric air.

Conflict of interest. The authors declare no conflict of interest.

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