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CHEMICAL POLLUTION OF THE AIR AROUND THE OIL AND GAS REFINING COMPLEX

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ABSTRACT

The article investigates the chemical pollution of the atmosphere around the oil and gas refining plant with polluting emissions. Integral assessment of air pollution was carried out on priority pollutants: sulfur dioxide, nitrogen dioxide, nitrogen oxide, carbon monoxide and hydrogen sulfide. Atmosphere of controlled areas, where air sampling was performed refers to a low level of air pollution in terms of air pollution index (API) calculated on annual average concentrations of pollutants determined. According to the integral API level, high degree of air pollution falls on the industrial center of gas processing plant (GPP). In this controlled area API is 8.5. In controlled areas, where air sampling was carried out located on the territory and outside the sanitary protection zone (SPZ) GPP is estimated by the integral indicator as increased pollution. The integrated API score in these areas ranges from 5 to 8.5. Atmosphere in controlled areas located in the center of Zhanazhol oil fields and territories of SPZ, the integral API refers to a low level of contamination. The integral API level in these controlled areas varies from 1.4 to 5.

Key words: Chemical pollution, Air, Oil, Gas, Refining.

INTRODUCTION

Producing and refining oil and gas is of strategic importance and is a key area of the economy for the Republic of Kazakhstan. Large-scale development and production of oil and gas is mainly conducted in Western Kazakhstan. Volume of hydrocarbon production is growing rapidly every year.

According to the Ministry of Oil and Gas of the Republic of Kazakhstan, in 2013 the volume of oil and gas condensate in Kazakhstan amounted to 81.8 million tons. Natural gas

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production in the country amounted to 42.3 billion cubic meters. By 2015, oil production in Kazakhstan is forecasted to be over 100 million tons per year. Today in Kazakhstan, more than 208 oil and gas fields have been discovered. Along with the production and transportation of oil and gas, there is a trend to increased environmental pollution by pollutants of oil industry.

While producing and refining petroleum, natural gas, condensate, especially when using their various derived products in atmosphere, a significant amount of pollutants is allocated. The most common atmosphere pollutants during producing, preparing, transporting and refining oil and gas, as well as during their combustion are sulfur dioxide (SO_2), hydrogen sulfide (H_2S), nitrogen oxides (NO_x), hydrocarbons (C_nH_m), carbon monoxide (CO) and carbon dioxide (CO_2) emissions. As part of pollutants other than those mentioned are also mercaptans (RSN), components of the associated gas.

Furthermore, the petroleum refineries and petrochemical plants are the largest sources of air pollution in the region. Their operation is associated with the emission of various organic compounds into the atmosphere[1,2].

A variety of gaseous pollutants (e.g. SO_2, CO, NO_x, and H_2S), hydrocarbons, fly ashes and metalliferous particles are released into the atmosphere during the refining of crude oil and processing of its downstream products in petrochemical[3].

Among chemical industries, petroleum refineries have been identified as large emitters of a wide variety of pollutants. Benzene, toluene, ethylbenzene, and xylene (BTEX) form an important group of aromatic volatile organic compounds (VOCs) because of their role in the troposphere chemistry and the risk posed to human health[4].

One of the main environmental problems of Kazakhstan is the burning associated gas in flares, Flare systems of oil refineries designed for flaring toxic gases emitted into the atmosphere gases such as types of hydrocarbons and other emission *CO, CO_2, NO* and SO_x. Flare systems of oil refineries have a serious impact on the air quality in industrial area and urban localities in the vicinity of industrial refining complex, subsequently air temperature increases, and air is polluted[5].

Now-a-days, the associated gas burning in the oil industry is a global problem.

Industry and petroleum refineries are among the largest contributors to anthropogenic CO_2 emissions, accounting for nearly 40% of these emissions globally[6].

In the global petroleum and natural gas industry, flaring of unwanted flammable gases via combustion in open atmosphere flames is regarded as a major environmental concern in addition to wasting the valuable source of energy. Recent estimates from satellite data indicate that more than 139 billion m^3 of gas are flared annually[7], an amount equivalent to 4.6% of the world natural gas consumption, which totaled 3011 billion m^3 in 2008[4]. This amount of flaring produces approximately 281 million tons of CO_2 emissions annually[8]. Emissions from flaring also contribute to the heating of the earth and enhance the natural greenhouse effect of the atmosphere and even climate changes[9-12].

Atmosphere pollution by various air pollutants released into the atmosphere during the processing of hydrocarbons is investigated in the research works of some authors[13-15].

Gas production and oil refinement leads to an increase in air pollution by hydrogen sulfide, sulfur dioxide, nitrogen oxides and mercaptans. The aim of this paper is an integral estimation using ESRI Geograpic Information System (GIS) software of the spatial pollution by air pollutants around Zhanazhol oil and gas refining plant located in the Western Kazakhstan region.

Volumes of production, transportation and refinement of hydrocarbons in Kazakhstan are growing rapidly every year. Therefore, environmental assessment of air pollution by air pollutants in oil and gas industry, arising in conditions of prolonged exposure to an integrated oil and gas refining complex, is urgent and has a strong practical significance. Application of GIS in the integral estimation of the degree of pollution of the atmosphere by various air pollutants allows reliably evaluate in the visual form the level of air pollution and create GIS maps of the spatial atmosphere pollution of the territory under study.

The results of these environmental studies allow us to estimate the contribution of a specific refinery into pollution in surrounding areas, as well as to determine the limits within which its effect is particularly strong.

EXPERIMENTAL

Methods and data

Object of investigations

The object of this study is Zhanazhol oil and gas processing refinery, which is a part of the oil company JSC CNPC-AMG.

JSC CNPC-AMG is one of the largest oil and gas companies in Kazakhstan, engaged in the exploration, production, preparation for transportation of oil and gas. This company, which develops oil and gas fields Zhanazhol, Kenkiyak-over-salt and Kenkiyak-under-salt and engaged in oil exploration in the central territory of the eastern part of the Caspian Basin, is in the "top five" major oil and gas operators in Kazakhstan by hydrocarbon production.

Zhanazhol GPP is located in the Western Kazakhstan, Mugaldzhar area in the Aktobe region. The composition of Zhanazhol oil includes (in %): 0.7-1.2 of sulfur, 6.2-10.2 of paraffin, 3.7-4.8 of silicagel resin, 0.13-1.26 of asphaltenes. The composition of gas of raw oil has a high content of hydrogen sulfide (1.5-3.0%). A significant amount of natural gas in the plant is burnt in flares, as due to the low power, it is not fully utilized.

Currently, Zhanazhol oil and gas processing refinery prepares more than 5 million tons of oil per year and 1574 million cubic meters of gas per year.

Gross annual oil production increased from 2.5 million tons in 1997 to 6.15 million tons in 2012. In 2012, 236.7 thousand tons of condensed gas and 50.6 thousand tons of gas sulfur were produced. The volumes of gas and sulfur production in 2006-2013 are shown in Fig. 1.

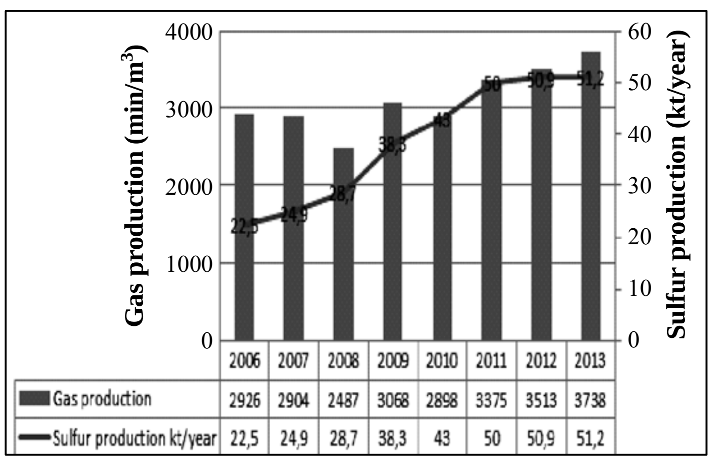


Fig. 1: The volumes of gas and sulfur production

In 2012, in the company's fields, new 102 wells were put into operation, including 78 wells in the Zhanazhol field. The coming years, the company plans to increase oil production to 6.7 mt/year and gas production to 6.3 billion cubic meters.

Now the company has started the construction of the second and third stages of the third Zhanazhol GPP. These new facilities are parts of an integrated program for gas utilization, environmental protection, and rational use of natural resources. Total power of Zhanazhol Gas Refining Plants considering entering the third plant will be increased to 8 billion cubic meters of gas per year.

Methods of air monitoring

For the integral estimation of the level of air pollution in the monitoring observation points were determined concentrations of the following air pollutants: SO_2, NO, NO_2, CO and H_2S.

Air sampling was carried out at 32 points on the boundaries of the sanitary protection zone (SPZ), in the heart of industrial facilities GPP, oil preparing equipment, around the organized and unorganized sources of air pollutants emission and under flare area, and on the territory of the field, where oil wells and gas compressor shops are accumulated. 130 sources were examined. A number of measurements per year reached up to 5000. Air measurements were made once per quarter (four times per year).

Estimation of concentrations of pollutants in the atmosphere has been determined on the basis of instrumental measurements.

To obtain accurate measurements at each point, measurements were carried out three times per day in the morning, midday and evening periods (number of measurements for each period was three at an interval of 20 minutes). When measuring the air, the meteorological characteristics of the environment were taken into account: temperature, humidity, wind speed and direction, the general state of the weather, clouds and the presence of precipitation. Sampling was carried out at a height of 1.5-2.5 m from the ground.

For concentrations of NO oxide and NO_2 nitrogen dioxides in air were measured with a chemiluminescence analyzer containing in M42-34164-246 gas analyzing complex with a measurement range from 0.001 to 2700 mg/m^3. The concentration of CO, carbon monoxide was measured with an automatic analyzer (M48-34337-247). The analyzer work is based on the method of non-dispersion infrared spectrometry. This automated method of the continuous operation with measurement range from 0.5 to 200 mg/m^3. Measurement of the concentration of SO_2 and H_2S were conducted by P-310, CB-320, K-100, THC-2000 gas analyzers.

Methods of data processing

Statistical processing of the data, obtained during the study, were carried using the Microsoft® Excel software. Construction of GIS maps of the spatial distribution of the pollution level in accordance with the calculation of the integral index of pollution by air pollutants was made using of the software ArcGIS 10.1.

Definition of the integral air pollution level around oil and gas processing complex is made by calculating the air pollution index (API). Index calculation is based on the assumption that at the maximum permissible concentration (MPC) level, all harmful substances are characterized by the same influence on the person, and a further increase in concentration increases the degree of their harmfulness at different speeds, which depends on the class of hazardous substances. Integral estimation of air pollution degree was made using the total index - the air pollution index (API).

The computation of the API is based on the assumption that, when the values are at the MPC level, all harmful substances are characterized by an identical influence on humans and that, with a further increase in concentration, the degree of their harm increases with a different rate, which depends on a hazard class of a given pollutant.

In fact, two air pollution indices are used: the API for each pollutant, and an integral API that takes into account atmospheric air pollution by the sum of pollutants. For computing an integral API, the API is calculated preliminarily for each component. The computation for one *i*-th pollutant (I_i) is done by the formula[16]:

$$I_i = \left(\frac{q_{mean.i}}{MPC_{dm.j}} \right) K_i \qquad \text{…(1)}$$

Where $q_{\text{mean.i}}$ is mean annual (or mean monthly) concentration of the *i*-th pollutant, $MPC_{dm.i}$ is its daily mean maximum concentration, and K_i is a dimensionless coefficient allowing the degree of air pollution by sulfur dioxide. The values of K_i are 0.85, 1.0, 1.3, and 1.5, respectively, for hazard classes 4, 3, 2 and 1 of a given pollutant.

Next, a deereasing variational series is generated for the value of I_i. The integral API that takes into consideration m pollutants present in the atmosphere is calculated by formula:

$$I(m) = \sum_{i=1}^{m} \left(\frac{q_{d.m.i}}{MPC_{dm.j}} \right) K_i \qquad \text{…(2)}$$

Where $q_{d.m.i}$ is the daily mean concentration of the *i*-th pollutant.

The API, calculated by formula (2), shows the particular atmospheric pollution level (in terms of the SO_2 MPC) to which the actually observed concentrations *m* of pollutants correspond, i.e. It shows how many times the aggregate air pollution level exceeds the allowable value for the relevant set of pollutants as a whole ?

RESULTS AND DISCUSSION

Zhanazhol GPP (Gas Processing Plant) is located in the Zhanazhol field. On the ecological status of ambient air in the surrounding areas of the gas processing plant is influenced not only the by emissions but the industrial activity of the oil field in hydrocarbon production. The main sources that emit pollutants into the atmosphere are located in the area of 12 thousand hectares.

Atmospheric pollution of the controlled area is measured by the integrated air pollution index (API); API calculations are made on annual average concentrations of SO_2, NO, NO_2, H_2S and CO in comparison with the daily average MPC, the maximum one-time MPC for H_2S by taking into account the hazard class of pollutants.

Integrated index of API in controlled areas are related to different categories of atmospheric pollution.

There are four categories of air quality, depending on the level of contamination. The level of pollution is considered to be low when the API is less than 5, increased, when the API is from 5 to 8, high with API from 8 to 13 and very high, when the API $\geq$ 13.

The largest number of emissions is located on the territory of the gas processing plant. The main sources of releasing SO_2, CO, NO_x and H_2S into the atmosphere from Zhanazhol oil and gas processing plant objects are: gas-processing complex, flares, chimneys, oil heaters in the complex gas and oil treatment unit, oil wells, compressors, gas compressor plant, gas drying unit, gas and sulfur treatment unit, diesel units for drilling oil wells**,** boilers, and other ancillary facilities**.**

The annual average concentration, the share of pollutants MPC and indicators of integrated API in the controlled sampling points are shown in Table 1.

In the air sampling points located in the center of the industrial site of the GPP, the average concentration of pollutants varies at: SO_2–0.1-0.11 mg/m^3, NO–0.1-0.12 mg/m^3, NO_2–0.095-0.1 mg/m^3, H_2S–0.09-0.1 mg/m^3 and CO–4.5-5.0 mg/m^3.

Table 1: The annual average concentration, the share of pollutants MPC and indicators of API and integrated API in the controlled sampling points

Sampling points	SO_2			NO			NO_2			H_2S			CO			Integrated API
	Concentration mg/m^3		API	Concentration mg/m^3		API	Concentration mg/m^3		API	Concentration mg/m^3		API	Concentration mg/m^3		API	
	Aver.	Share of MPC		Aver.	Share of MPC		Aver.	Share of MPC		Aver.	Share of MPC		Aver.	Share of MPC		
1	0.11	2.6	**2.6**	0.1	2.1	**2.1**	0.095	2.4	**3.1**	0.1	1.2	**1.6**	5.0	1.6	**1.5**	**10.9**
2	0.11	2.5	**2.5**	0.1	2.1	**2.1**	0.092	2.4	**3.1**	0.09	1.2	**1.6**	5.0	1.6	**1.5**	**10.8**
3	0.1	2.5	**2.5**	0.1	2.1	**2.1**	0.091	2.3	**3.1**	0.08	1	**1.4**	5.0	1.7	**1.56**	**10.6**
4	0.1	2.5	**2.5**	0.1	2.1	**2.1**	0.096	2.4	**3.1**	0.09	1.1	**1.4**	4.9	1.6	**1.5**	**10.6**
5	0.1	2.3	**2.3**	0.1	1.9	**1.9**	0.08	2	**2.6**	0.08	1	**1.3**	3.1	1.1	**1.05**	**9.1**
6	0.1	2	**2**	0.09	1.5	**1.5**	0.091	2.2	**2.9**	0.08	1	**1.3**	3.5	1.2	**1.1**	**8.8**
7	0.1	2	**2**	0.09	1.6	**1.6**	0.082	2.0	**2.6**	0.08	1	**1.4**	3.7	1.2	**1.13**	**8.7**
8	0.096	1.9	**1.9**	0.08	1.4	**1.4**	0.075	1.8	**2.4**	0.08	1	**1.3**	3.9	1.3	**1.18**	**8.1**
9	0.085	1.6	**1.6**	0.08	1.3	**1.3**	0.074	1.8	**2.4**	0.06	0.83	**1**	3.6	1.2	**1.08**	**7.3**
10	0.09	1.5	**1.5**	0.09	1.3	**1.3**	0.073	1.8	**2.3**	0.06	0.75	**0.97**	3.3	1.1	**1**	**7.0**
11	0.09	1.6	**1.6**	0.08	1.3	**13**	0.076	1.9	**2.4**	0.06	0.83	**1**	3.6	1.2	**1,1**	**7.4**
12	0.061	1.1	**1.1**	0.05	0.94	**0.93**	0.06	1.5	**1.9**	0.06	0.79	**1**	3.8	1.2	**1.16**	**6.0**
13	0.068	1.2	**1.2**	0.06	0.88	**0.88**	0.053	1.3	**1.7**	0.06	0.77	**1**	3.4	1.1	**1.03**	**5.8**
14	0.06	1.2	**1.2**	0.07	0.94	**0.94**	0.056	1.4	**1.8**	0.06	0.83	**1**	3.8	1.2	**1.15**	**6.0**
15	0.07	1.3	**1.3**	0.07	0.94	**0.93**	0.06	1.5	**1.9**	0.05	0.71	**0.92**	3.8	1.2	**1.15**	**6.2**
16	0.07	1.3	**1.3**	0.06	0.94	**0.93**	0.056	1.4	**1.8**	0.06	0.75	**0.97**	3.7	1.2	**1.12**	**6.1**
17	0.067	1.2	**1.2**	0.07	0.88	**0.88**	0.061	1.5	**2**	0.06	0.75	**0.96**	3.7	1.2	**1.13**	**6.1**

Cont…

Sampling points	SO_2			NO			NO_2			H_2S			CO			Integrated API
	Concentration mg/m^3		API	Concentration mg/m^3		API	Concentration mg/m^3		API	Concentration mg/m^3		API	Concentration mg/m^3		API	
	Aver.	Share of MPC		Aver.	Share of MPC		Aver.	Share of MPC		Aver.	Share of MPC		Aver.	Share of MPC		
18	0.06	1.2	**1.2**	0.06	0.98	**0.98**	0.056	1.4	**1.8**	0.05	0.71	**0.92**	3.2	1	**0.96**	**5.8**
19	0.071	1.3	**1.3**	0.05	0.94	**0.93**	0.047	1.1	**1.5**	0.05	0.7	**0.93**	3.2	1	**0.98**	**5.6**
20	0.1	2.5	**2.5**	0.1	2.1	**2.1**	0.09	2.3	**3.0**	0.08	1	**1.3**	3.7	1.2	**1.12**	**10.0**
21	0.095	1.8	**1.8**	0.09	1.55	**1.5**	0.08	2.1	**2.8**	0.07	0.95	**1.2**	3.1	1	**0.95**	**8.3**
22	0.094	1.8	**1.8**	0.09	1.56	**1.5**	0.08	2.0	**2.6**	0.06	0.79	**1**	3.2	1	**0.96**	**7.9**
23	0.094	1.8	**1.8**	0.09	1.53	**1.5**	0.08	2.1	**2.8**	0.05	1.4	**0.97**	3.2	1	**0.98**	**8.0**
24	0.063	1.2	**1.2**	0.07	1	**1.01**	0.06	1.5	**2.0**	0.05	0.7	**0.93**	3.2	1	**0.98**	**6.1**
25	0.057	1	**1**	0.06	0.88	**0.88**	0.06	1.5	**1.9**	0.06	0.75	**0.97**	3.2	1	**0.98**	**5.7**
26	0.057	1.1	**1.1**	0.05	0.94	**0.94**	0.06	1.5	**2**	0.06	0.79	**1**	3.2	1	**0.98**	**6.0**
27	0.055	0.93	**0.93**	0.06	0.77	**0.77**	0.037	0.92	**1.2**	0.05	0.62	**0.82**	2.6	0.85	**0.78**	**4.5**
28	0.047	0.86	**0.86**	0.04	0.72	**0.72**	0.03	0.9	**1.1**	0.05	0.62	**0.81**	2.2	0.74	**0.67**	**4.1**
29	0.042	0.83	**0.83**	0.05	0.66	**0.66**	0.04	1	**1.3**	0.04	0.58	**0.75**	2.3	0.78	**0.71**	**4.2**
30	0.047	0.86	**0.86**	0.04	0.72	**0.72**	0.036	0.91	**1.1**	0.04	0.58	**0.75**	2.3	0.78	**0.71**	**4.1**
31	0.037	0.73	**0.73**	0.03	0.61	**0.61**	0.036	0.91	**1.1**	0.05	0.62	**0.81**	2.1	0.72	**0.65**	**3.9**
32	0.035	0.71	**0.71**	0.04	0.67	**0.67**	0.021	0.58	**1.0**	0.04	0.57	**0.75**	2.3	0.78	**0.71**	**3.5**

Aver. = Average

In these controlled areas, API in the atmosphere varies in the range of SO_2 – 2.5-2.6; NO – 2-2.1; NO_2–3-3.1; H_2S – 1.4-1.6 and CO–1.5. Spatial distribution of contamination level by various pollutants in accordance with the pollution index is shown in Fig. 2.

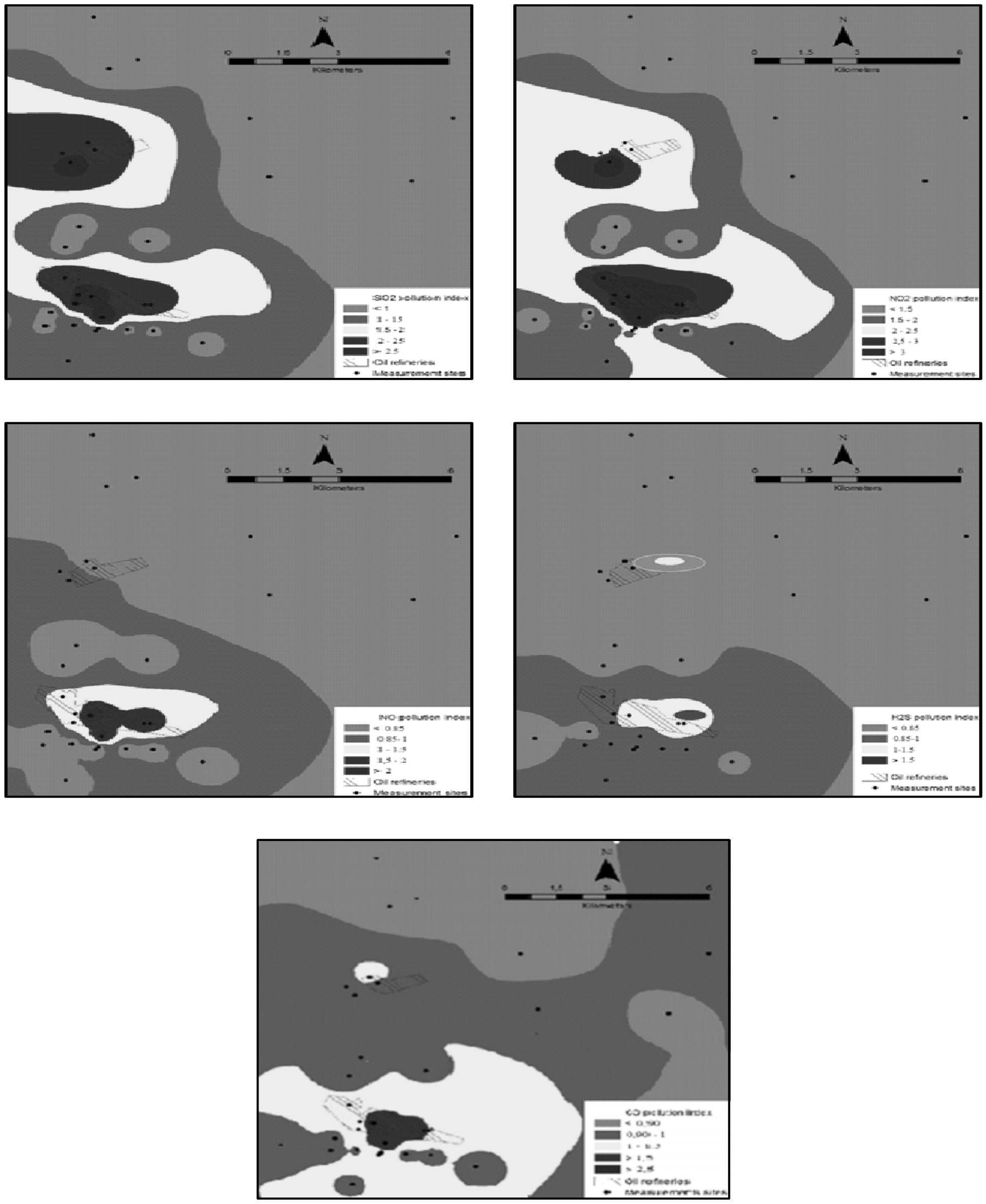


Fig. 2: Spatial distribution of pollution level of different pollutants according to the index of pollution

On the territory of the sanitary protection zone (SPZ) GPP in the controlled areas, the average annual concentration of air pollutants changes at the level of: SO_2–0.087-0.1 mg/m^3, *NO* – 0.085-0.1 mg/m^3, NO_2–0.081-0.095 mg/m^3, H_2S – 0.08-0.09 mg/m^3 and CO–3.7-4.5 mg/m^3.

Index of *API* changes in the interval: SO_2 – 2-2.5; *NO* –1.5-2; NO_2– 2.5-3; H_2S–1-1.5 and *CO* –1-1.5 (see Fig. 2).

In the points of air sampling in the controlled areas outside the SPZ GPP, the content of annual average concentrations of pollutants varies in the level of: SO_2–0.057-0.065 mg/m^3, *NO*–0.052-0.071 mg/m^3, NO_2–0.05-0.075 mg/m^3, H_2S–0.05-0.06 mg/m^3 and *CO*–3.1-3.8 mg/m^3. Index of *API* ranges: SO_2–1.5-2; *NO* –1-1.5; NO_2– 2-2.5; H_2S – 0.85-1 and *CO*– 0.85-1.

In the center of the field, in the controlled areas, where there are oil wells and gas compressor stations, the content of annual average concentrations of air pollutants varies: SO_2–0.055-0.095 mg/m^3, *NO* – 0.044-0.05 mg/m^3, NO_2 – 0.041-0.065 mg/m^3, H_2S – 0.05-0.06 mg/m^3 and *CO*–*3*.1-3.5 mg/m^3.

Index of *API* changes in the ranges: SO_2–1-1.5; *NO* – 0.85-1; NO_2–1.5-2; H_2S – 0.75-0.85 and *CO*–0.65-0.75.

In the points of air sampling located in the SPZ deposits, the average concentration of pollutants varies: SO_2–0.035-0.057 mg/m^3, *NO* – 0.03-0.04 mg/m^3 and NO_2–0.021-0.038 mg/m^3.

Index of *API* varies within the limits: SO_2– 0.70-1; *NO* – 0.60-0.85; NO_2–0.65-1.5; H_2S – 0.57-0.85 and *CO*– 0.50-0.65.

In the points of air sampling in the above mentioned controlled areas for all found air pollutants, API are less than 5. This indicates that in the controlled areas, the level of pollution of the atmosphere refers to a category of low air pollution.

The spatial distribution of the pollution level in accordance with the total pollution index is shown in Fig. 3.

Fig. 3 on the integrated pollution index shows that in the areas of human impact of the GPP, the integrated index API of air, highlighted in red, and was ≤ 8.5-10. These results are evident of high level of air pollution.

On the territory of the SPZ GPP in the points of sampling air, the integral indicator

API changes in the intervals from 6.5 to 8.5. These results allow us to assess the state of the atmosphere, as increased contamination. In the controlled areas outside the SPZ GPP, the integral API degree changes in the ranges from 5 to 6.5. These results also allow estimating the state of the air, as far as increased pollution, as the level of air pollution is ≤ 5.

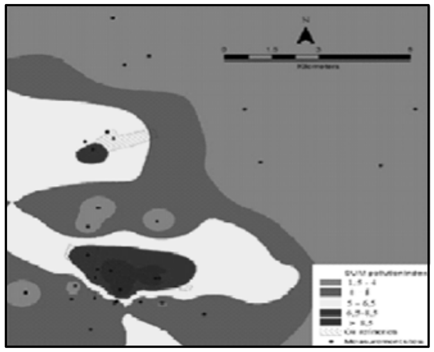


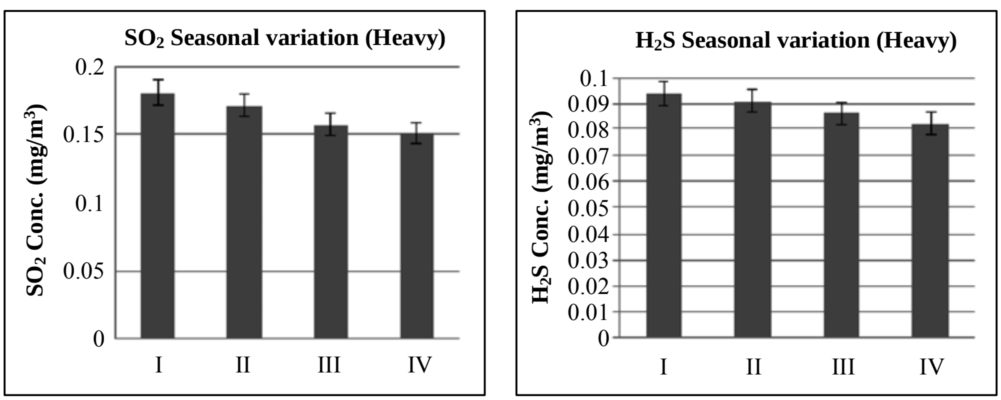
Fig. 3: Spatial distribution of pollution level according to the integrated pollution index

In the center of the field of the controlled air zones, the integrated index of the API changes in intervals of 4-5.

In the zones of controlled points located in the SPZ fields, the integrated API index is at level of 1.4-5. In these areas, the air condition refers to the low degree of air pollution.

Seasonal fluctuations in air pollution by sulfur compounds in various areas of contamination are shown in Fig. 4.

As seen in Fig. 4, in different controlled areas seasonal fluctuations of high concentrations of SO_2 vary from 0.15 to 0.12 and of H_2S from 0.1 to 0.08 every quarter.



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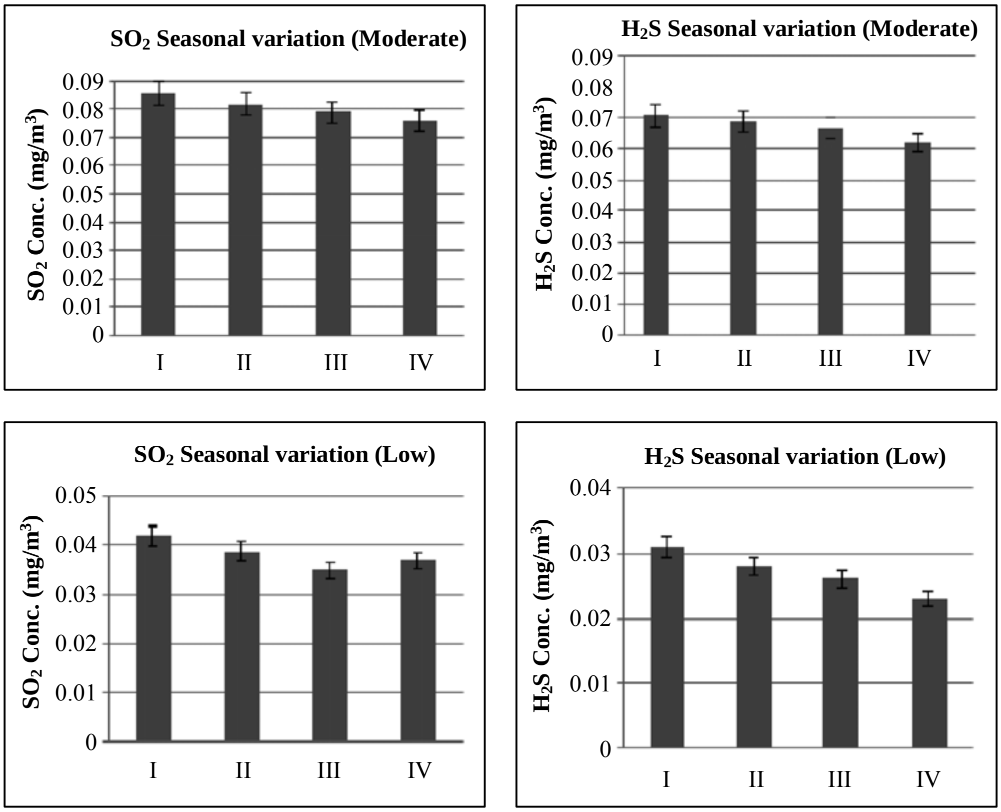


Fig. 4: Seasonal variation of air pollution by sulfur compounds in different pollution zones

Moderate concentration of SO_2 varies from 0.095 to 0.06 mg/m^3 and H_2S from 0.07 to 0.06 mg/m^3. Low SO_2 concentration varies from 0.042 to 0.035 mg/m^3 and H_2S – from 0.01 to 0.03 mg/m^3.

Seasonal fluctuations in air polluted with nitrogen compounds in different areas of contamination are shown in Fig. 5.

Seasonal fluctuations in heavy NO concentrations are from 0.17 mg/m^3 to 0.12 mg/m^3 and NO_2 from 0.15 to 0.059 mg/m^3 (Fig. 5).

Moderate NO concentration varies from 0.073 mg/m^3 to 0.062 mg/m^3 and NO_2 from 0.071 to 0.058 mg/m^3. Low NO concentration varies within the limits of 0.035 mg/m^3 to 0.031 mg/m^3 and NO_2 from 0.031 to 0.028 mg/m^3. As can be seen from the results, shown in Figs. 4 and 5, the high concentration of pollutants in the air, in the first quarter, followed by 2-nd and 3-d quarters, gradually decreases.

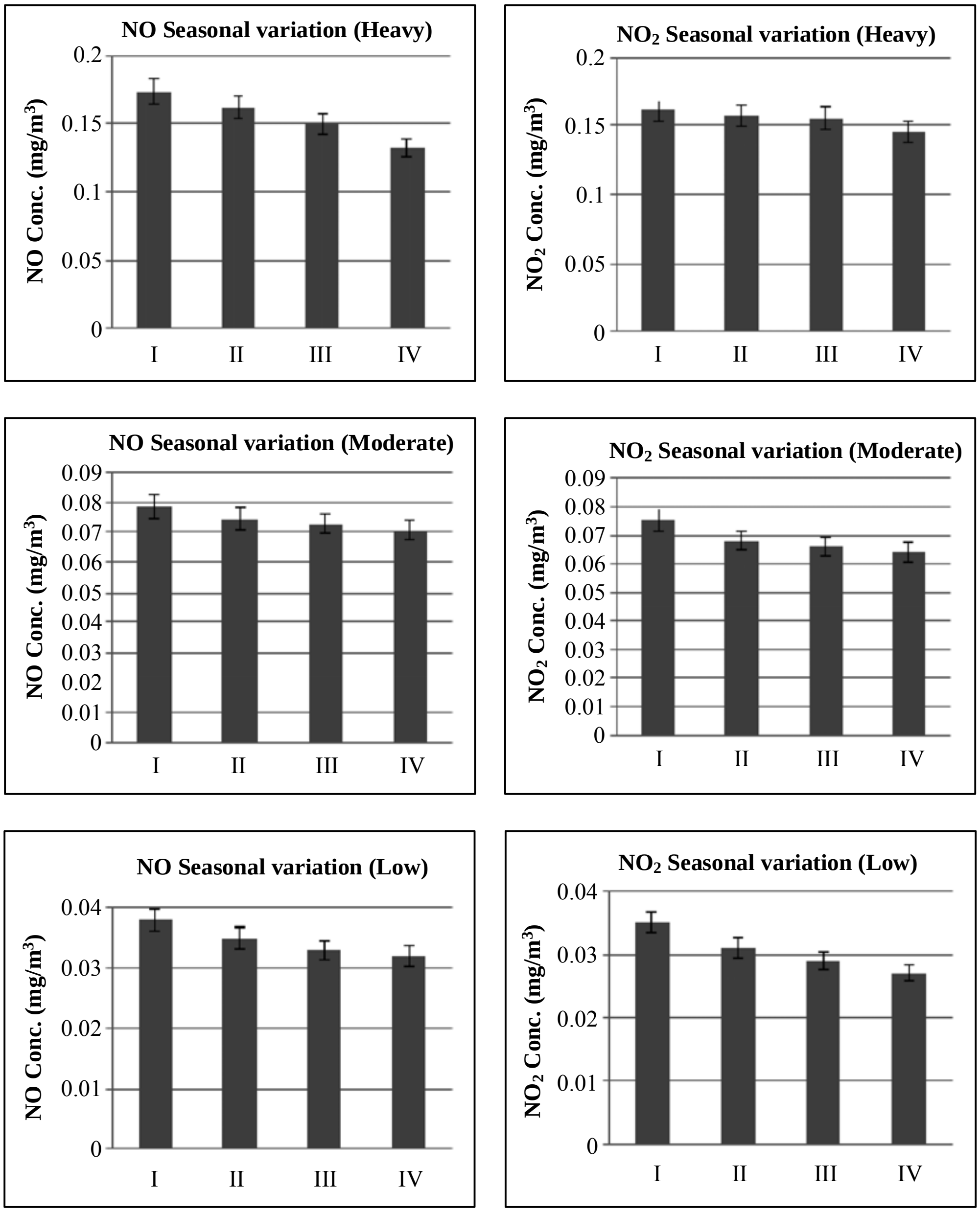


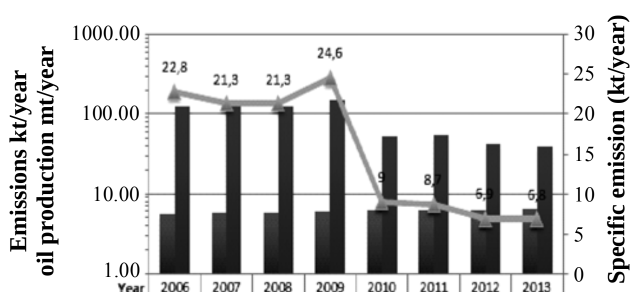
Fig. 5: Seasonal variation of air pollution by nitrogen compounds in different pollution zones

The increase of concentration of pollutants in the atmosphere in the first quarter occurs due to the increase in heating facilities, installation of crude oil heating and motor vehicles in the winter season; respectively. In these periods, emissions of air pollutants are increasing. In the spring and summer months, an increase in wind velocity to an average of 5-6 m/s helps to dissipate air pollutants in the atmosphere. Respectively, concentration of air pollutants in the atmosphere decreases.

Emissions from drilling rigs that emit pollutants, as well as emissions by GPP affect the polluted air zones of study. For example, during a year, a diesel unit of a borehole emit up to 2 tons of hydrocarbons and carbon black and 30 tons of NO_x, up to8 tons of CO, and 5 tons of SO_2. In winter, the dispersion of pollutants is within 2 Km around drilling rigs. An anthropogenic area is formed in this zone, with in which the total mass of chemicals is 2.4-3.4t/Km^2.

According to the results of monitoring studies conducted for the purpose of obtaining information on ambient air quality and assessment of the impact of the GPP production activities, the concentration of pollutants in the air of the controlled areas does not exceed the maximum one-time MPC indicator. But in some points of air sampling, the concentration of analyzed air pollutants exceeds the daily average MPC indicator.

Despite the increase in oil production from the Zhanazhol field, oil and gas processing, sulfur treatment at Zhanazhol GPP, by means of introduction of modern technological methods of production, for preparation and transportation of crude oil, as well as the implementation of environmental protection measures for the protection of the environment, reducing the combustion of associated gas the flare and other measures, there has been a steady decline in the amount of total and specific emissions released into the atmosphere. The specific and total volumes of air emissions and the volumes of oil production in 2006-2013 are shown in Fig. 6.



Year	2006	2007	2008	2009	2010	2011	2012	2013
Oil production	5,565	5,857	5,844	6,05	6,121	6,209	6,095	6,5
Total emissions	126,8	124,9	124,476	148,5	53,2	55,8	41,9	39,7
Specific emission	22,8	21,3	21,3	24,6	9	8,7	6,9	6,8

Fig. 6: The specific and total volumes of air emissions and the volumes of oil production in 2006-2013

It shows that for the last years (2006-2013) annual oil production has increased from 5.565 million tons to 6.5 million tons. If the specific emission of pollutants into the atmosphere per ton of oil produced in 2006 was 22.8 kg/t, then in 2013, it was reduced to 6.8 kg/t. In these years, the total amount of emissions reduced almost by 3 times, from 126.8 thousand tons to 39.9 tons. Despite the increase in production and processing of hydrocarbons, a steady decline in the total and specific volumes of emissions per ton of extracted oil is connected with an increase in the utilization of associated gas. The volume of associated gas utilization in 2010 was 2.6 million m^3, in 2011 – 3.2 million m^3 and in 2012 -3.67 million m^3. Year after year, the concentration of pollutants in the air is reduced by about 10-15%, due to improvement of technological processes and environmental protection measures.

CONCLUSION

In the controlled areas of monitoring studies atmospheric pollution by API index, calculated on the base of average annual (2011-2013 years), concentrations of SO_2, NO_x, CO and H_2S, is characterized as slight.

However, an analysis of the atmospheric air in the surrounding area of GPP, considering anthropogenic impact sources of GPP, suggests that by the integrated (total) API level, the center of the industrial site of the GPP has heavy polluted air. Elevated levels of air pollution are concentrated in the remaining GPP area, where there are main sources of air pollution. Over the rest territory of the field outside the GPP, the low level of air pollution is observed. Thus, the greatest contribution to the pollution of the atmosphere in the surrounding area contributes emission sources of GPP.

Moreover, the study revealed seasonal fluctuations of air pollution, namely a relatively high content of pollutants in the atmosphere during the winter period, with a gradual decrease in the remaining periods.

Proceeding from the above, it is necessary to reduce the volume of emissions of pollutants into the atmosphere from sources GPP by improving the purification process of waste gases, as well as to increase the number of associated gas utilization in flares.

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