International Information and Engineering Technology Association
Advancing the World of Information and Engineering

International Journal of Sustainable Development and Planning
Vol. 17, No. 6, October, 2022, pp. 1789-1796
Journal homepage: http://iieta.org/journals/ijsdp

Monitoring Study of the Effect of Atyrau Evaporation Fields on the Content of Hydrogen Sulfide in the Air

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https://doi.org/10.18280/ijsdp.170613

Received: 9 July 2022
Accepted: 16 September 2022

Keywords:
hydrogen sulfide, maximum permissible concentrations, pollution observation point, evaporation fields

ABSTRACT

In this article, a monitoring study was conducted on the content of hydrogen sulfide in the air of the city of Atyrau, the exceeded content of which is associated with reclamation work in the evaporation fields, where industrial wastewater from the Atyrau oil refinery and household water from all over the city have been drained for decades. Monitoring was carried out for the period from September 2021 to June 2022 on 15 observation points recorded by the Republican State Enterprise "Kazhydromet" through the mobile application “Air Kz". The measurements were carried out by the GANK-4AR gas analyzer. The data were analyzed taking into account the maximum permissible concentrations, the repeatability of concentrations of impurities in the atmosphere, the standard index, taking into account the average sample values of hydrogen sulfide content at 10 points out of 15, where increased hydrogen sulfide content was noted. Of the remaining these 10 points, the highest value was noted in the Drag and drop AOR (Atyrau Oil Refinery) point, the hydrogen sulfide content in which, according to the average maximum values, exceeded more than 36.5 MPC (maximum permissible concentration). In general, by month, we note that high values for the average values of the maximum hydrogen sulfide indicators were noted in September, April and June months. Especially strong increase is characterized during warm periods in industrial areas and residential areas as NCOC No. 109 (Vostok), NCOC No. 110 (Privokzalny), NCOC No. 112 (Akimat), NCOC No. 111 (Zhilgorodok), NCOC No. 113 (Avangard) and NCOC No. 114 (Zagorodnaya) points.

1. INTRODUCTION

The problems of atmospheric pollution with various pollutants, including such as PM2.5, PM10, SO_2, NO_2, CO, etc., are widely studied. The study of the PM2.5/PM10 ratio allowed for a detailed analysis of spatial pollution migration, including source diferentiation included in the works of Tomasz Adamek [1], Liu [2] and Suriya [3]. However, there are very few studies on atmospheric pollution with hydrogen sulfide. Whereas hydrogen sulfide (H_2S) is one of the dangerous and toxic gases that have a pungent “rotten egg” smell and come from both natural and industrial sources. Industrial sources of hydrogen sulfide are oil and gas production and processing facilities, etc. types of chemical production. There are works on the study of the accumulation of hydrogen sulfide in the air in the works of Yessenamanova [4], Esenamanova [5] and etc. However, a complete study of the hydrogen sulfide content in the city of Atyrau was not conducted for the entire calendar year. This study is very relevant, since the population of Atyrau is subject to severe hydrogen sulfide pollution, which leads to an increase in the incidence of the central nervous system and respiratory function described in the works of Eunjung [6], cardiovascular diseases, studied in the works of Kenessariyev [7], respiratory diseases, considered in the works of Efimova [8], allergic diseases and others. In addition, there are studies on the study of air pollution of the city of Atyrau and its impact on public health [9], where hydrogen sulfide is indicated as the most important air pollutant, therefore, in this work we were interested in studying in more detail the accumulation of hydrogen sulfide in all observation sites in the city of Atyrau throughout the year.

In the city of Atyrau, located in the west of the Republic of Kazakhstan, the sources of hydrogen sulfide entering the atmosphere are an industrial source that is associated with oil refining [10]. This source is the Atyrau Oil Refinery. However, there is another source that was formed as a result of the discharge of household and industrial wastewater in the territory called the "Rotten Beam" evaporatio field.

In July 2021, specialists of the Department of Ecology of the Atyrau region, together with specialists of the Department of Sanitary and Epidemiological Control, conducted atmospheric air samples in Atyrau, in particular, in the «Drag and drop» point, evaporation fields in the left bank (Rotten Beam) and in the right bank, sampling was carried out for excess of hydrogen sulfide and hydrocarbon ingredients.

These days, the north, north-west wind direction was noted, the temperature was +32, humidity was 15, wind speed was 4 m/s. The northern and north-western directions contribute to the spread of hydrogen sulfide gases towards residential areas, since the sources of these gases are located in the southern and south-eastern parts of the city. At high temperature and low humidity, hydrogen sulfide spreads easily in the atmosphere. For example, on July 21 and 22, when the atmospheric air monitoring stations No. 114 "Zagorodnaya" and No. 109 "Vostok" recorded air pollution, the wind direction was north, north-west. Evaporation fields are located in this direction in the right part of the city of Atyrau.

The evaporation fields in Atyrau, known as the Rotten Beam, have been operating since 1945. Drains from city sewers and enterprises, including AOR, are drained here. From the plant to the place of discharge there is an open channel 3.5 km long. In 2021, AOR built a dam separating the factory part of the Rotten Beam from the one belonging to the city, and divided its territory of 860 hectares into four sections. The total area of evaporation fields is 1336.2 hectares, of which 476.2 hectares is on the balance sheet of the city of Atyrau (Figure 1).

Figure 1. Location of evaporation fields in Atyrau city

The evaporation fields are leased from the Atyrau Oil Refinery. About 70 thousand cubic meters of sewage water are drained there every day. In addition to the waste of Atyrau Su Arnasy, recycled waste from AOR LLP is also sent there.

Fetid fields have been inconveniencing the townspeople for several years. To solve the problem, AOR undertook the reconstruction of treatment facilities. "The purpose of recultivation of evaporation fields is to phase out the discharge of wastewater from the plant to the pond "Rotten Beam" and its further operation. This will eliminate the negative impact on groundwater, flora and fauna of the Atyrau region. The implementation of the environmental project "Tazalyk" for the drainage of evaporation fields in Atyrau began in April 2021.

The plant AOR, together with NC Kazmunaygas, has developed the TAZALYQ project, which provides for the reconstruction of mechanical and biological treatment facilities, as well as the reclamation of evaporation fields. According to the memorandum signed with AOR LLP, the entire cycle of work on the project should be completed in 2023.

2. MATERIAL AND METHODS

2.1 Study area

The residential area of Atyrau city closest to the AOR is located about 450 m to the west and 730 m to the northwest. The Project objects are more than 1000 m away from the nearest residential area.

Atyrau is the regional center of Atyrau region. The territory of Atyrau city is divided into the following functional zones: residential area; public (public-business) area; recreational area; engineering and transport infrastructure zones; industrial (production) zones; special purpose zones; sanitary and protective zones; reserve territories (urban planning resources).

The housing sector in the region has 7.3 million square meters of total area, of which 7.1 million square meters or 97.2% of housing is privately owned. The territory of the city of Atyrau is 13,186 hectares.

The city of Atyrau is divided into the following microdistricts:

Akzhar, Tomarly, Zhuldyz, Geolog, Bereke, Privokzalny microdistrict, Almagul, Central, Residential complex, Residential town Balykshi, Kurilkino, Avangard, Vostok. Nursaya, Samal, Zheruik, Zhumysker, Sarykamys, Zhilgorodok, Himposylok and much more (Figure 2).

On the map we can see the points where the 15 observation Points for monitoring the state of the atmospheric air of Atyrau city, which can be seen in Table 1. All 15 points are located in the territories of the main microdistricts of the city, where the urban population lives and in the territories near the Atyrau oil refinery, which allows us to determine how possible the impact of this plant and the wastewater basin on the spread of hydrogen sulfide.

Table 1. Locations of observation Point for the state of atmospheric air in the city of Atyrau, Republic of Kazakhstan

Point title	Point address	The location
Steaming AOR	Atyrau, Steaming AOR	47.0726660,51.9508610
Himposylok AOR	Atyrau, Himposylok AOR	47.0887220,51.9352780
Mirny AOR	Atyrau, Mirny AOR	47.0754720,51.9107500
Drag and drop AOR	Atyrau, Drag and drop AOR	47.0685280,51.9052210
POP (Pollution Observation Point) No. 1 (manual Point)	Atyrau, Samal microdistrict, A.Kekilbayev Street No. 15	47.1261210,51.8708850
POP (Pollution Observation Point) No. 5 (manual Point)	Atyrau, Kursay, Karabau Street, building 12	47.0668460,51.8864240
POP (Pollution Observation Point) No. 6 (manual Point)	Atyrau, Zhuldyz microdistrict, 6th street, 29	47.1558350,51.9814530
POP NCOC No. 103	Atyrau, Shagala	47.1117740,51.9221670
POP NCOC No. 108	Atyrau, TKA	47.1645230,52.0275220
POP NCOC No. 109	Atyrau, Vostok	47.0947250,51.9250130
POP NCOC No. 110	Atyrau, Privokzalny	47.1261730,51.9472360
POP NCOC No. 111	Atyrau, Zhilgorodok	47.0988520,51.9006170
POP NCOC No. 112	Atyrau, Akimat	47.1050630,51.9164730
POP NCOC No. 113	Atyrau, Avangard	47.0930470,51.8869910
POP NCOC No. 114	Atyrau, Zagorodnaya	47.1415560,51.8959480

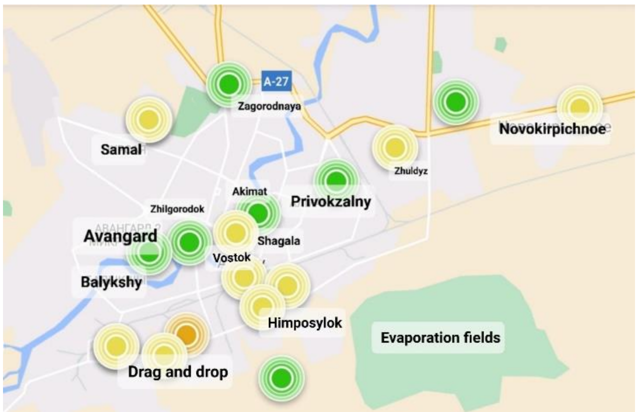

Figure 2. The map of Atyrau city

2.2 Methods

Measurements of atmospheric air pollution were carried out by the GANK-4AR gas analyzer (NPO Pribor Russia, Head No. 1566, inv. No. 000000962 - 02/21/2018 Self-adhesive label HMS No. 5405921 1 time per year) designed for continuous automatic measurement of concentrations of pollutants in atmospheric air and in the air of the working area. As a result of this study, an analysis was carried out on the content of hydrogen sulfide in the atmosphere in the city of Atyrau based on the results of round-the-clock monitoring of the Republican State Enterprise "Kazhydromet" through the mobile application “Air Kz” [11]. This application allows you to monitor the quality of atmospheric air. In this application, we have analyzed hydrogen sulfide, the content of which reaches maximum values in different periods. The increase in the content of hydrogen sulfide is associated with reclamation works in the territories where for many years the wastewater of all enterprises has been drained without treatment. The mobile application "Airkz" online displays the actual concentrations of pollutants in micrograms/m^3 according to international practice (previously concentrations were displayed in mg/m^3, however, at the request of the public, the units of measurement were converted to micrograms/m^3.

Hydrogen sulfide is palpable at an H_2S concentration of 1.4 - 2.3 mg/m^3, highly palpable at 4 mg/m^3 and difficult to tolerate at concentrations above 7 mg/m^3.

Acute poisoning occurs already at concentrations of 0.2 - 0.3 mg/l, a concentration of more than 1 mg/l (0.1% concentration of gas in the air) is fatal to humans [12].

The maximum permissible concentration (MPC) of H_2S in the air in the working area is 10 mg/m^3 [13], mixed with hydrocarbons - 3 mg/m^3.

The maximum permissible concentration of H_2S in the air of populated areas is 0.008 mg/m^3 [14].

To study the content of hydrogen sulfide in the city of Atyrau, data from this application was analyzed for 10th months and then the data was processed.

To assess atmospheric pollution, taking into account the maximum permissible concentration values, the following characteristics are calculated:

- repeatability g, %, of single concentrations of impurities in the atmosphere above the MPC (maximum permissible concentration) of this impurity:

$$g = \frac{m}{n} \cdot 100 \qquad (1)$$

- repeatability gi, %, single impurity concentrations in the atmosphere above 5 MPC (maximum permissible concentration):

$$g_i = \frac{m_i}{n} \cdot 100 \qquad (2)$$

where, n is the number of observations for the period under review (n>50).

m, m_1 are the numbers of exceedances by single concentrations at the post (station) or at all posts of the city at the level of 1 MPC (maximum permissible concentration), 5 MPC (maximum permissible concentration), 10 MPC (maximum permissible concentration);

- the greatest repeatability (GR), %, of exceeding the maximum permissible concentration by any polluting substance in the city;

- the number of days m^2 with the concentration of impurities in the atmosphere exceeding 10 MPC (maximum permissible concentration);

- the highest single concentration of any pollutant measured in the city, divided by maximum permissible concentration — standard index (SI):

$$SI = \frac{g_m}{MPC} \qquad (3)$$

The greatest repeatability is defined as the highest of all the values of the frequency of exceeding the maximum permissible concentration according to measurement data at all posts (stations) for one impurity, or at all posts (stations) for all impurities, respectively, for a month or a year. If the number of observations of each pollutant per month was less than 50, then the calculation of g values is carried out only according to the data for the year. The greatest repeatability value is also selected only for the year. The standard index SI is determined from the measurement data at all posts ((stations) for one impurity or at all posts (stations) for all impurities. SI is established by comparing all the values obtained for the day for all impurities for all observation periods, and for the city - all SI (standard index) values at all posts (stations) and highlighting the highest SI value. Thus, SI is the largest single index for a single post (station) or for the city as a whole. SI values > 1 are calculated up to tenths. If SI > 10, then instead of greatest repeatability, the number of days with SI > 10 is determined, at least from one observation period [13].

For the analysis, an algorithm was used for grouping sample data when constructing an interval series. To do this, we found the smallest and largest values of the hydrogen sulfide content in the aggregate and determined the scope of variation:

$$R = x_{max} - x_{min} \qquad (4)$$

Then the number of intervals k was determined by the Sturgess formula [15]:

$$k = 1 + 3.322 \cdot lgn \qquad (5)$$

We count the number of sample data that will fall into each of the obtained intervals: n_1, n_2, ...

From the obtained research data, a sample mean xb was used for each month, that is, the arithmetic mean of the hydrogen sulfide content of the sample population. At the same time, if the values of the sign x_1, x_2, ..., x_k have frequencies n_1, n_2, ..., n_k, respectively, and $n_1 + n_2 + ...+ n_k = n$, then:

$$\overline{x} = \frac{n_1 \cdot x_1 + n_2 \cdot x_2 + \cdots + n_k \cdot x_k}{n} = \frac{\sum_{i=1}^{k} n_i \cdot x_i}{n} \qquad (6)$$

3. RESULTS AND DISCUSSION

From 2021 in the city of Atyrau, there are 15 observation Points for monitoring the state of the atmospheric air. Data on 15 items were taken in the periods September 2021-June 2022 in the evening from 10 to 12 hours for the period of one day. Only the parameters of hydrogen sulfide were studied, taking into account its lower, upper and middle parameters. Figure 3 shows the average minimum and maximum indicators for 15 research points.

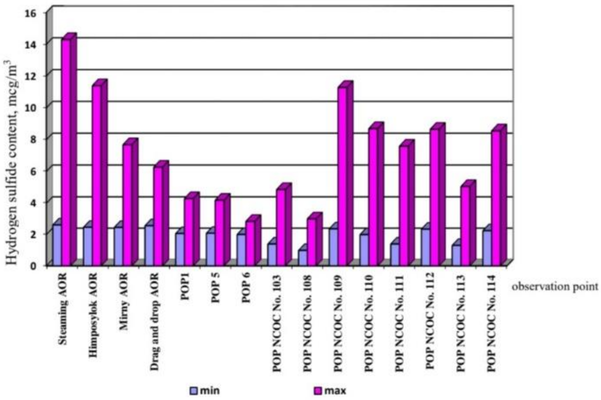

Figure 3. The content of hydrogen sulfide of the air in the points of Atyrau city

This diagram shows that out of the 15 points studied, only 5 points have hydrogen sulfide content at maximum values in the range of 2.85-4.3 mcg/m^3 (the maximum single concentration of hydrogen sulfide is equal to 8 mcg/m^3) [16]. These include points POP (Pollution Observation Point) No. 1, 5, 6, NCOC No. 103 and 108, therefore, these points are not described in this work.

In Figure 4, you can see the indicators for 1-st point of Steaming AOR, which is located at the farthest distance from the Atyrau oil refinery.

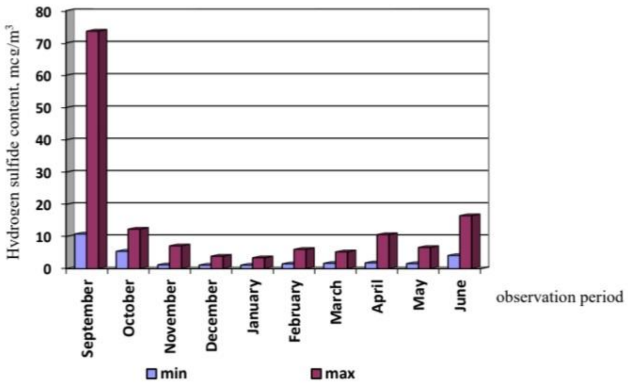

Figure 4. The content of hydrogen sulfide of the air on the Steaming AOR point

Steaming AOR point showed extremely high values in the content of hydrogen sulfide during the period of September to June. In September there was an excess of the maximum as well as minimum values by 36.8 times (up to 73 mcg/m^3) and 5.4 times (up to 10 mcg/m^3) of MPC respectively. It was observed that with the rise of temperature the indicators went up significantly. In the period from September 21 to September 25, the hydrogen sulfide content was noted from 119 to 432 mcg/m^3, which indicates a high content of hydrogen sulfide exceeding the MPC of more than 59.5-216 MPC. In June the maximum value was greater than the MPC by 8.25 times (16.5 mcg/m^3), while in October the figure was greater by 6.15 times (12.3 mcg/m^3). Although there was gradual decrease in the content of H_2S in cold period, the overall exceeding still remained at about 1.6-3.5 MPC.

Figure 5 shows the indicators for item 2 of Himposylok AOR point.

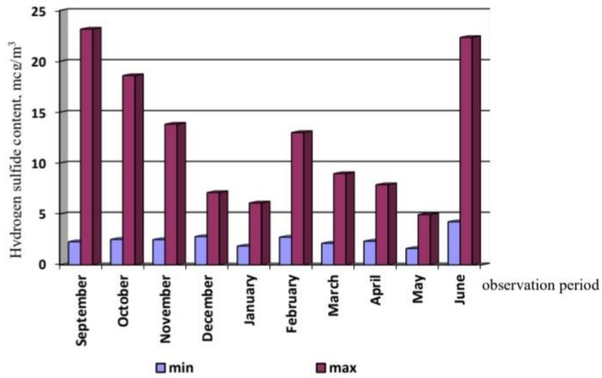

Figure 5. The content of hydrogen sulfide of the air on the Himposylok AOR point

There was a significant fluctuation in the content of hydrogen sulfide through the considered period in Himposylok AOR point.

In September H_2S maximum average concentration peaked at 11.5 MPC (23.17 mcg/m^3). As for daily indicators from 18th to 20th of September the maximum value of hydrogen sulfide reached almost 50 mcg/m^3, which is 25 times more than daily MPC and 6,25 times more than maximum one-time MPC in residential areas.

Similarly, June observed exceeding of hydrogen sulfide content by 11 times of MPC (22,35 mcg/m^3).

Hydrogen sulfide concentration declined gradually from September to January to 3 MPC (6.08 mcg/m^3). However, there was a sudden growth in February, 13 mcg/m^3. Following that, spring period experienced a steady decrease and in May hit a low of 2.47 MPC (4.94 mcg/m^3). According to the minimum values, the content of hydrogen sulfide was from 2 to 2.8 mcg/m^3, which was in the range from 1 to 1.4 MPC.

Figure 6 shows the indicators for item 3 of Mirny AOR point.

According to the results, the highest level of air pollution with H_2S was recorded in September and June, 12.33 mcg/m^3 and 16.35 mcg/m^3 respectively. That is 6 and 8 times as much as maximum permissible concentration of the hydrogen sulfide. October and April also showed similar indicators, which exceeded MPC approximately 4 times. In other periods on average the content of hydrogen sulfide varied in the range of 2.3-3.3 MPC (4.7-6.7 mcg/m^3).

Turning to the minimum values, hydrogen sulfide concentration sulfide is from 2 to 5 mcg/m^3, which is in the range from 1 to 2.5 MPC. Overall, summer season experienced the greatest level of air pollution.

Figure 7 shows the indicators for item 4 of the Drag and drop AOR point.

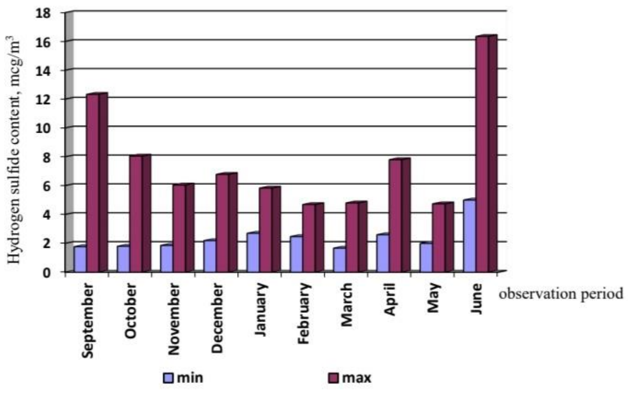

Figure 6. The content of hydrogen sulfide of the air on the Mirny AOR point

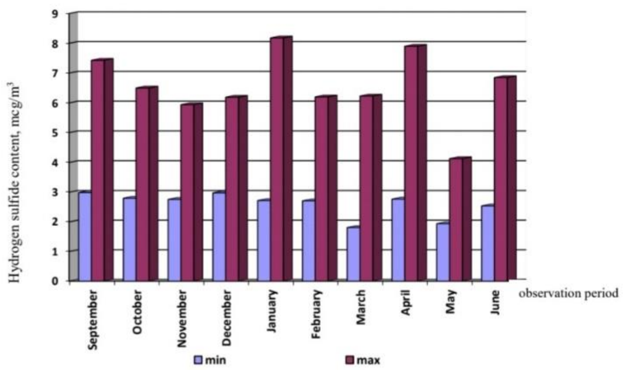

Figure 7. The content of hydrogen sulfide of the air on the Drag and drop AOR point

There was an exceedance of the maximum as well as minimum values of H_2S in Drag and drop AOR point, which remained relatively stable throughout the period. The highest concentration of the gas was observed in January and April, about 4 MPC or 8 mcg/m^3. In May the hydrogen sulfide values decreased twice to 4 mcg/m^3, despite this increased pollution level exceeded the MPC by 2 times. In terms of minimum values, the content of hydrogen sulfide was within 1.5 MPC during the whole period.

Figure 8 shows the indicators for item 10 NCOC No. 109 (Vostok) point.

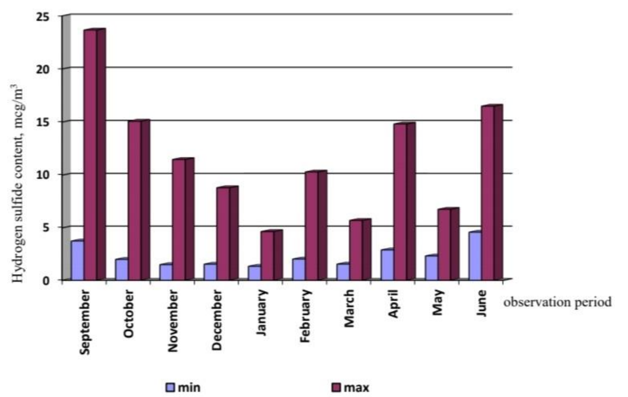

Figure 8. The content of hydrogen sulfide of the air on the NCOC No. 109 (Vostok) point

The data for NCOC No. 109 (Vostok) point show significant exceedances of hydrogen sulfide content for considered period. It is important to note that Vostok point is mainly a residential area, and it is often exposed to dramatic jump of H_2S level. In September the 6th the gas concentration was about 216.78 mcg/m^3, which is 108.39 times more than MPC. The average value for September was up to 11 MPC (23.67 mcg/m^3). Following that, in October, April and June the maximum permissible concentration exceeded to 15 mcg/m^3 or 7.5 MPC. The lowest values were observed in January, March and May, from 2.3 to 3.3 MPC (4.65 – 6.77 mcg/m^3). By the minimum value, the data exceeded MPC by 1-1.5 times. Overall, it should be noted that the figures fluctuated during the whole period regardless of temperature.

Figure 9 shows the indicators for item 11 of NCOC No. 110 (Privokzalny).

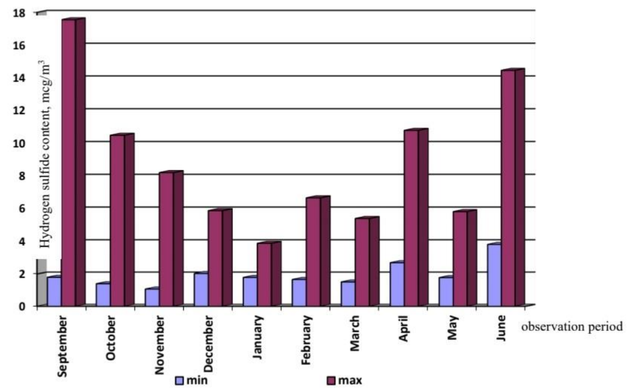

Figure 9. The content of hydrogen sulfide of the air on the NCOC No. 110 (Privokzalny) point

According to the results in Privokzalny point, there was an exceedance of the maximum values of the hydrogen sulfide from September to June. September saw the highest level of gas concentration almost 18 mcg/m^3, that is 9 times as much as the maximum permissible concentration. In October the H_2S content declined almost twice to 10 mcg/m^3 and continued to decrease gradually till January by 3.9 mcg/m^3 or 1.9 MPC. However, starting from February to June the level of hydrogen sulfide fluctuated dramatically from 3.3 MPC (6.68 mcg/m^3) to 7 MPC (14.46 mcg/m^3) respectively.

By the minimum value, the data did not exceed the MPC with the exception of June with the concentration of 1.9 MPC (3.83 mcg/m^3).

Figure 10 shows the indicators for item 12 NCOC No. 111 (Zhilgorodok) point.

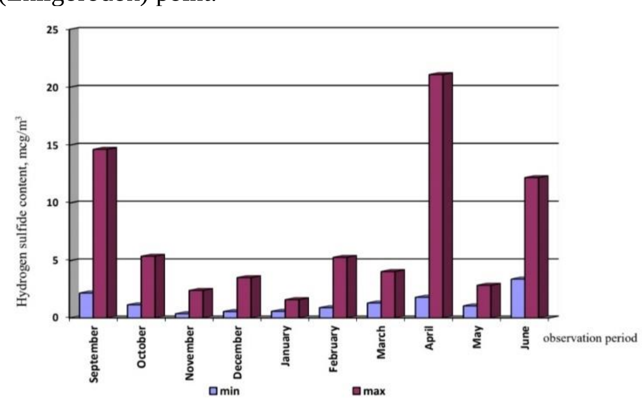

Figure 10. The content of hydrogen sulfide of the air on the NCOC No. 111 (Zhilgorodok) point

The bar chart illustrates the average maximum and minimum values of the hydrogen sulfide content from September to June. It can be seen that in April the H_2S level increased to 10.5 MPC (21.1 mcg/m^3). On April 21st the gas concentration reached a peak of 420 mcg/m^3, that is 210 times as much as H_2S MPC. In June and September hydrogen sulfide content exceeded MPC by 6.1 and 7.3 times respectively (12.2 mcg/m^3 and 14.64 mcg/m^3). By the minimum value, the data did not exceed the MPC.

Figure 11 shows the indicators for item 13 of NCOC No. 112 (Akimat) point.

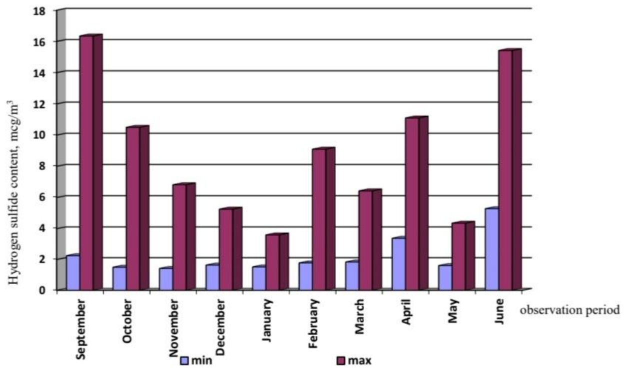

Figure 11. The content of hydrogen sulfide of the air on the NCOC No. 112 (Akimat) point

NCOC No. 112 (Akimat) point is the closest to the city center. According to the chart, there was an exceedances of hydrogen sulfide content throughout the period. September and June experienced the highest levels of H_2S concentration of approximately 8 MPC or 16 mcg/m^3. From October to May the figures fluctuated significantly from 2 to 6 MPC. Turning to the minimum value, the hydrogen sulfide content varied from 2 to 5 mcg/m^3.

Figure 12 shows the indicators for item 14 NCOC No. 113 (Avangard) point.

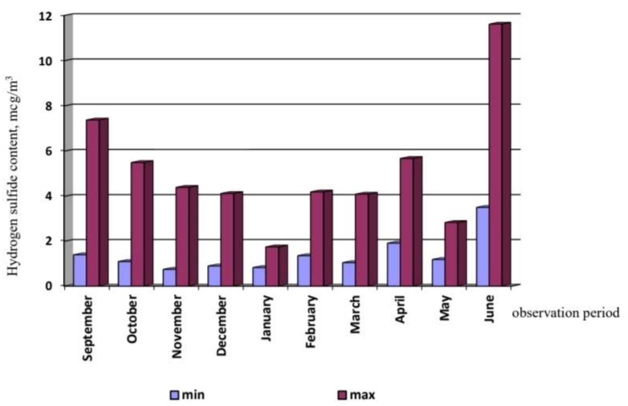

Figure 12. The content of hydrogen sulfide of the air on the NCOC No. 113 (Avangard) point

Results of Avangard point show the changes of the hydrogen sulfide content between September and June. Overall, it can be noted that most period the level was high and remained stable on the average level of approximately 5 mcg/m^3. In June the maximum value reached a peak of almost 6 MPC (11.62 mcg/m^3). The minimum value in June exceeded MPC by 1.7 times, while in other months the hydrogen sulfide level was below 2 mcg/m^3.

Figure 13 shows the indicators for item 15 NCOC No. 114 (Zagorodnaya) point.

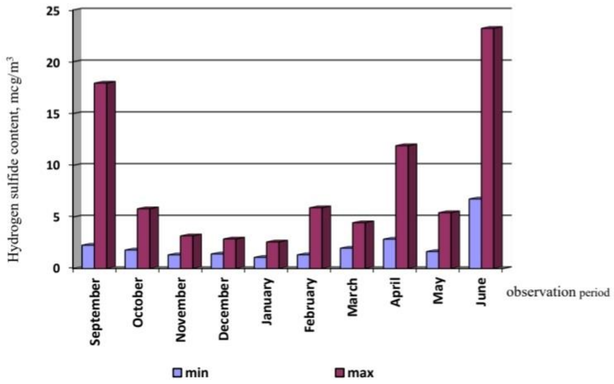

Figure 13. The content of hydrogen sulfide of the air on the NCOC No. 114 (Zagorodnaya) point

There was marked increase in hydrogen sulfide level across different time periods. In June the average level of the gas in residential areas was about 24 mcg/m^3 or 12 MPC. April and September experienced a considerable rise of hydrogen sulfide content to 6 MPC and 9 MPC accordingly (11.9 mcg/m^3 and 17.94 mcg/m^3). In other months the maximum figure varied from 1.2 to 2.95 MPC. The minimum value in June was substantial about 6.75 mcg/m^3, whereas other period there was no exceedance in hydrogen sulfide concentration.

Figure 14 shows a comparative analysis of 8 points for the indicators for two years (summer-spring 2020-2021 and 2021-2022).

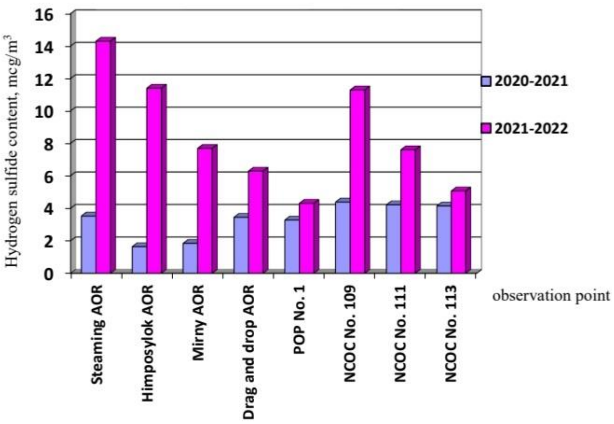

Figure 14. Comparative analysis of 8 research items on hydrogen sulfide indicators for two years (summer-spring 2020-2021 and 2021-2022)

Overall, it can be seen that in 2021-2022 the content of hydrogen sulfide was much higher than the previous year in most of points observed.

There was a dramatic increase in maximum values of hydrogen sulfide in Steaming AOR point: 7.15 MPC – three times as much as last year. Himposylok AOR and NCOC No.109 experienced similar level of pollution with H_2S at about 5.7 MPC. In Mirny point the level of hydrogen sulfide grew considerably by 3.8 times. The same situation took place in NCOC No.11 point – the maximum value of the gas reached 7.6 mcg/m^3. In Drag and drop AOR, POP No.1 and NCOC

No.113 points there were less changes in the values of the hydrogen sulfide in comparison with the previous year.

4. CONCLUSIONS

In conclusion, it should be noted that out of 15 monitoring points in Atyrau, only four do not exceed the content of average values of hydrogen sulfide in Atyrau. For the remaining eleven points, the highest rates are observed in the Steaming AOR point up to 73 mcg/m^3 according to the average values of the maximum hydrogen sulfide indicators, more than 20 mcg/m^3 in the Himposylok AOR, POP NCOC No. 109 (Vostok), POP NCOC No. 111 (Zhilgorodok) and POP NCOC No. 114 (Zagorodnaya). More than 15 mcg/m^3 in Mirny AOR, POP NCOC No. 110 (Privokzalny) and POP NCOC No. 112 (Akimat) and more than 10 mcg/m^3 in POP NCOC No. 113 (Avangard).

In general, by month, we note that high values for the average values of the maximum hydrogen sulfide indicators were noted in September, April and June months. For example, in September, the maximum permissible concentration in the Steaming AOR points is up to 73 mcg/m^3 (or up to 36.5 MPC), in the Himposylok AOR at 11.5 MPC (23.17 mcg/m^3), OP NCOC No. 109 (Vostok) – 11 MPC (23.67 mcg/m^3), POP NCOC No. 110 (Privokzalny) - 18 mcg/m^3, that is 9 times as much as the maximum permissible concentration, POP NCOC No. 114 (Zagorodnaya) - 11.9 mcg/m^3 or 6 MPC. In the period from September 21 to September 25, the hydrogen sulfide content was noted from 119 to 432 mcg/m^3 on the Steaming AOR point, which indicates a high content of hydrogen sulfide exceeding the MPC of more than 59.5-216 MPC. In April, there are small exceedances in NCOC No. 109 (Vostok), NCOC No. 110 (Privokzalny), NCOC No. 112 (Akimat), NCOC No. 111 (Zhilgorodok) and NCOC No. 114 (Zagorodnaya). More than 10 mcg/m^3 was noted in all these points, except NCOC No. 111 (Zhilgorodok), where the content of the average values of the maximum hydrogen sulfide indicators exceeds 20 mcg/m^3. If we look at the days, the excess is observed from April 16 to April 21. In June, exceedances are typical for Himposylok AOR, Mirny AOR, Steaming AOR, NCOC No. 109 (Vostok), NCOC No. 110 (Privokzalny), NCOC No. 112 (Akimat), NCOC No. 111 (Zhilgorodok), NCOC No. 113 (Avangard) and NCOC No. 114 (Zagorodnaya) points. In most of these points, the excess is more than 10 mcg/m^3 and only in 2 points the content is about 20 mcg/m^3, these are Himposylok AOR and NCOC No. 114 (Zagorodnaya) points. In June, high values from 50 to 100 mg and above were observed from 3 to 5, 9 and 10, 20-24, 27-28 June.

A comparative analysis with last year shows that all 8 items that testified in the past years showed an increase in the content of hydrogen sulfide, this is especially typical for Himposylok AOR, where it is exceeded by 6.9 times, Mirny AOR and Drag and drop AOR by more than 4 times and NCOC No. 109 (Vostok) by 2.6 times.

In general, it can be concluded that in connection with the intensified work on the restoration of evaporation fields, all the household waste water accumulated for decades has led to the accumulation of hydrogen sulfide in them, which enters the air, which leads to an increase in the content of hydrogen sulfide in areas located in the direction of the wind from these evaporation fields. Especially strong increase is characterized during warm periods in industrial areas and residential areas as NCOC No. 109 (Vostok), NCOC No. 110 (Privokzalny), NCOC No. 112 (Akimat), NCOC No. 111 (Zhilgorodok), NCOC No. 113 (Avangard) and NCOC No. 114 (Zagorodnaya) points.

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NOMENCLATURE

H_2S	hydrogen sulfide
MPC	maximum permissible concentration
AOR	“Atyrau Oil Refinery”
POP	Pollution Observation Point
NCOC	North caspian operating company