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Assessment of atmospheric air pollution by coal and fuel oil combustion products and fuel oil on the example of neighborhood boiler plants in Ulan-Ude

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Abstract. The city of Ulan-Ude is annually included in the priority list of cities with the highest level of atmospheric air pollution. The main stationary sources of pollutant emissions into the atmosphere of Ulan-Ude are heat and power enterprises. Their contribution to the total air pollution of the city by stationary sources is about 45%. As fuel they use hard and brown coal and fuel oil. The purpose of the presented work was to study the influence of different types of fuel on atmospheric air pollution based on the results of computational modeling and experimental assessment of snow cover quality. The objects of the study were neighborhood boiler plants located in Ulan-Ude (Aeroport settlement, Glass Factory settlement). The computational modeling was carried out using the Unified program of atmospheric pollution calculation “Web-Prisma-Enterprise”. Analysis of microelement composition of melted snow water was performed by inductively coupled plasma method on Agilent 7500ce quadrupole mass spectrometer. The results of pollutant dispersion in the atmosphere showed an excess of the calculated surface concentrations at coal combustion for solid and gaseous substances compared to similar concentrations produced at fuel oil combustion by 2,45–141,4 times. In contrast, according to the experimental snow cover studies, the fuel oil-fired boiler plant contributes more pollution (Zc = 1563,80 – very high pollution level) compared to the boiler plant using coal as fuel (Zc = 107,61 – average pollution level). The reasons for this discrepancy may be imperfections in the methodology of calculating emissions of pollutants into the atmosphere: particulate matter (coal or fuel oil ash) is subject to regulation without taking into account their chemical composition; the algorithm of dispersion of emissions does not take into account the density of buildings around the source of emissions into the atmosphere.

Keywords: boiler house, atmospheric pollution, coal, fuel oil, dispersion of pollutants, snow cover

Authors' contributions. *Chudinova O.N.* – research concept, planning of the experimental part, literature review, generalization of the research results, general scientific editing; *Cheredova T.V.* – processing, analysis and interpretation of the results of the analysis of the elemental composition of the liquid phase of snow; *Butakova A.A.* – carrying out calculations of pollutant dispersion in the atmosphere, their processing and interpretation; *Besprozvannykh A.P.* – snow sampling, preparation of samples for laboratory analysis.

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Оценка загрязнения атмосферного воздуха продуктами сгорания угля и мазута на примере квартальных котельных г. Улан-Удэ

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Аннотация. Улан-Удэ ежегодно входит в приоритетный список городов с наибольшим уровнем загрязнения атмосферного воздуха. Основными стационарными источниками выбросов загрязняющих веществ в атмосферу г. Улан-Удэ являются предприятия теплоэнергетики. Их вклад в общее загрязнение атмосферы города стационарными источниками составляет около 45 %. В качестве топлива используются каменный и бурый уголь, мазут. Целью исследования было изучение влияния различных видов топлива на загрязнение атмосферного воздуха по результатам расчетного моделирования и экспериментальной оценки качества снежного покрова. Объектами исследования являлись квартальные котельные, расположенные в г. Улан-Удэ (пос. Аэропорт, пос. Стеклозавод). Расчетное моделирование проведено с использованием Унифицированной программы расчета загрязнения атмосферы «Web-Призма-предприятие». Анализ микроэлементного состава талой снеговой воды выполнен методом индуктивно-связанной плазмы на квадрупольном масс-спектрометре Agilent 7500ce. Результаты рассеивания загрязняющих веществ в атмосфере показали превышение расчетных приземных концентраций при сжигании угля по твердым и газообразным веществам по сравнению с аналогичными концентрациями, создаваемыми при сжигании мазута, в 2,45–141,4 раза. По экспериментальным исследованиям снежного покрова, напротив, котельная, работающая на мазуте, вносит больший вклад в загрязнение (Zc = 1563,80 – очень высокий уровень загрязнения) по сравнению с котельной, использующей в качестве топлива уголь (Zc = 107,61 – средний уровень загрязнения). Причинами такого расхождения могут являться несовершенства методики расчета выбросов загрязняющих веществ в атмосферу: нормированию подлежат твердые частицы (угольная или мазутная зола) без учета их химического состава; алгоритм рассеивания выбросов не учитывает плотность застройки вокруг источника выбросов в атмосферу.

Ключевые слова: котельная, загрязнение атмосферы, уголь, мазут, рассеивание загрязняющих веществ, снежный покров

Вклад авторов. *Чудинова О.Н.* – концепция исследования, планирование экспериментальной части, обзор литературы, обобщение результатов исследования, общая научная редакция; *Чередова Т.В.*– обработка, анализ и интерпретация результатов анализа элементного состава жидкой фазы снега; *Бутакова А.А.* – проведение расчетов рассеивания загрязняющих веществ в атмосфере, их обработка и интерпретация; *Беспрозванных А.П.* – отбор проб снега, подготовка проб к лабораторному анализу.

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Introduction

For a number of years Ulan-Ude, located within the boundaries of the Baikal natural territory, has been on the priority list of cities with the highest level of atmospheric air pollution. According to the air monitoring data of the Buryat Centre for Hydrometeorology and Environmental Monitoring, the average annual concentration of benz(a)pyrene in 2022 was 8.7 MAC, suspended solids PM10 – 1.48 MAC, suspended solids PM2.5 – 1.68 MAC, phenol – 1.33 MAC[1].

The main stationary sources of pollutant emissions into the atmosphere of Ulan-Ude city are heat power enterprises: 'Generation of Buryatia' PJSC 'TGC-14' (CHPP-1, CHPP-2), 'Ulan-Ude Energy Complex' PJSC 'TGC-14', which has

[1]State Report «On the state and protection of the environment of the Republic of Buryatia in 2022».

33 boiler plants operating on coal, fuel oil and electricity. The contribution of heat power facilities to the total air pollution of the city by stationary sources is about 45%.

To assess atmospheric air pollution in winter, many scientists [1–3] propose to use snow cover, which is a good depositing medium for various types of pollutants. Studies of snow cover are relevant for determining the chemical composition of pollutant emissions into the atmosphere by various sources, studying the processes of their distribution over the territory and deposition.

The purpose of the presented work was to study the influence of different types of fuel on atmospheric air pollution based on the results of computational modelling and experimental assessment of snow cover quality.

Objects and methods of the study

Two neighbourhood boiler plants of Ulan-Ude close in capacity were selected as objects of the study. Ulan-Ude is operating on different types of fuel: boiler plants of Aeroport settlement and Steklozavod settlement. When selecting the objects under study, one of the selection criteria was the absence of other stationary sources of air pollution on the windward side, as well as remoteness from transport highways. The boiler plant of the Aeroport settlement with the capacity of 16.245 Gcal/h is located in the south-western part of Ulan-Ude. The nearest residential building is located at a distance of 12 m in the north-eastern direction from the boiler plant. Coal is used as fuel, the total consumption of which is 33 thousand tonnes/year. Emission of pollutants into the atmosphere is carried out through a 30 m high pipe with a diameter of 1.5 m. Battery cyclones BC-2-7*(5+3) with cleaning efficiency 85,47-88,03 % (3 pcs.) and cyclone CN-11-02 with cleaning efficiency 81,07 % (1 pc.) are installed as dust and gas cleaning equipment. The boiler plant of Steklozavod settlement with the capacity of 11.943 Gcal/h is located in the north-western part of Ulan-Ude and provides heat and hot water to the residential neighbourhood of the same name.

The nearest residential buildings are located at a distance of 109 m in the north direction from the boiler plant. The fuel used is fuel oil, annual consumption of which is 8.48 thousand tons. Emission of pollutants into the atmosphere is carried out through a pipe 45 m high, 1.0 m in diameter. There is no dust and gas cleaning equipment. Both boiler plants under consideration belong to category III of objects of negative environmental impact[2].

To obtain information on possible maximum concentrations of pollutants in the atmospheric air during fuel combustion, calculations of pollutant dispersion

[2] Decree of the Government of the Russian Federation No. 2398 dated 31.12.2020 «On approval of the criteria for attributing objects with negative environmental impact to objects of I, II, III and IV categories».

in the atmosphere from emission sources were carried out using the Unified Programme for Atmospheric Pollution Calculation 'Web-Prisma-Enterprise', approved in accordance with the order of the Ministry of Natural Resources of Russia[3] and implementing the methodology for development (calculation) and establishment of standards for permissible emissions of pollutants into the atmospheric air[4].

Data on the meteorological regime of the area, meteorological characteristics and coefficients necessary for atmospheric pollution calculations (value of the atmospheric stratification factor, average maximum outdoor air temperature of the hottest month of the year, average outdoor air temperature for the coldest period, wind speed u* (m/s), the frequency of exceedance of which according to long-term average data is not more than 5%) are taken from the data of the Buryat Centre for Hydrometeorology and Environmental Monitoring.

Calculations of the fields of surface concentrations of pollutants were carried out in accordance with the methods of calculations of dispersion of harmful (pollutant) emissions in the atmospheric air[5] in a conditional design rectangle 600×600 m with a grid spacing of 50×50 metres.

Snow samples in the impact zone of the boiler plants under consideration were taken at the end of the snow accumulation period in accordance with the Methodological Recommendations[6] from pits for the entire thickness of the snow cover, except for a five-centimetre layer above the soil, to avoid contamination of samples with lithogenic component during snow cover formation. During snow sampling, the area and depth of the pits were measured. The weight of each sample is about 10 kg. For the study 5 samples were taken in the zone of possible impact of each boiler plant: 4 samples were taken around each boiler plant (in rhumbas) at a distance of 50 to 150 m from the facility boundary, the fifth sample was taken at the boundary of the nearest residential area. As a background sample was taken in the forest area of Ulan-Ude suburb, where there are no anthropogenic sources of pollution.

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[3] Order of the Ministry of Natural Resources of Russia No. 779 dated 20.11.2019 «On approval of the procedure for expert examination of the programme for electronic computers used for calculations of dispersion of emissions of pollutants in the atmospheric air (except for emissions of radioactive substances)».

[4] Order of the Ministry of Natural Resources and Environment of Russia No. 581 dated 11.08.2020 «On approval of the methodology for the development (calculation) and establishment of standards for permissible emissions of pollutants into atmospheric air».

[5] Order of the Ministry of Natural Resources and Environment of Russia No. 273 dated 06.06.2017 «On approval of methods for calculating the dispersion of emissions of harmful (polluting) substances in the atmospheric air».

[6] Methodical recommendations for assessing the degree of pollution of atmospheric air in populated areas by metals on their content in snow cover and soil (approved by the Chief State Sanitary Doctor of the USSR from 15.05.1990 № 5174-90). (In Russ.)

The trace element composition of snow melt water was analysed by the inductively coupled plasma method on an Agilent 7500 ce quadrupole mass spectrometer at the Limnological Institute of the Siberian Branch of the Russian Academy of Sciences (Irkutsk) according to the methodology [4].

To assess the degree of snow cover pollution, geochemical indicators were selected that consider the distribution of both individual elements involved in pollution and their associations associated with the polyelemental chemical composition of anthropogenic flows. These include the chemical element concentration factor (K_c) and the total pollution index (Z_c). Calculation of K_c and Z_c was carried out in accordance with the methodological recommendations[7] using formulas (1, 2):

$$K_c = \frac{C_i}{C_\Phi}, \quad (1)$$

where K_c – concentration coefficient of the *i*-th substance;

C_i – concentration of the *i*-th element in the examined medium, mg/l;

C_Φ – background concentration of the *i*-th element, mg/l;

$$Z_c = \sum_{i=1}^{n} (K_{ci} - (n-1)) , \quad (2)$$

where *n* – number of investigated elements.

According to the indicator Z_c four levels of snow cover pollution are distinguished: low (Z_c = 32–64), medium (Z_c= 64–128), high (Z_c= 128–256), very high (Z_c> 256).

Discussion and results

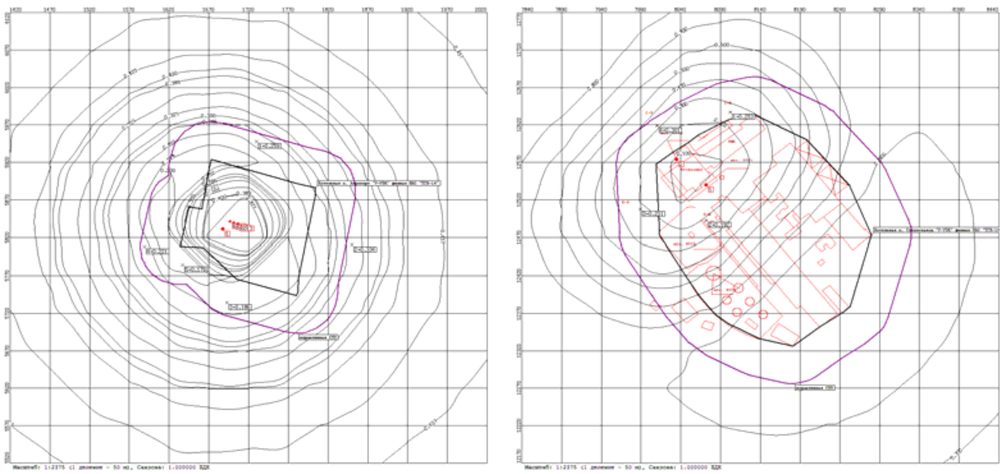
The composition of pollutant emissions at thermal power enterprises depends on the size (for solid fuel), moisture content, ash content, and chemical composition of fuel, which, in turn, is related to the hydrocarbon raw material deposit. As a rule, heat power enterprises of the Republic of Buryatia use, as a rule, hard coal of Tugnuyskoye coal deposit, brown coal of Borodinskoye, Zagustayskoye, Okino-Klyuchevskoye, Gusinoozerskoye, Daban-Gorkhonskoye deposits [5; 6]. A distinctive feature of the above-mentioned coals is the increased ash content, which reaches 22 % [7–11].

According to the approved methodology of rationing[4] of pollutant emissions into the atmosphere, during coal combustion benz(a)pyrene, coal ash (inorganic dust containing 70-20 % of silicon dioxide), black carbon, nitrogen di-oxide, nitrogen oxide, sulphur dioxide, carbon oxide enter the atmospheric air with flue gases. At combustion of low-sulphur fuel oil, benz(a)pyrene, fuel oil ash from

[7] Methodical recommendations for assessing the degree of pollution of atmospheric air in populated areas by metals on their content in snow cover and soil (approved by the Chief State Sanitary Doctor of the USSR from 15.05.1990 № 5174-90). (In Russ.)

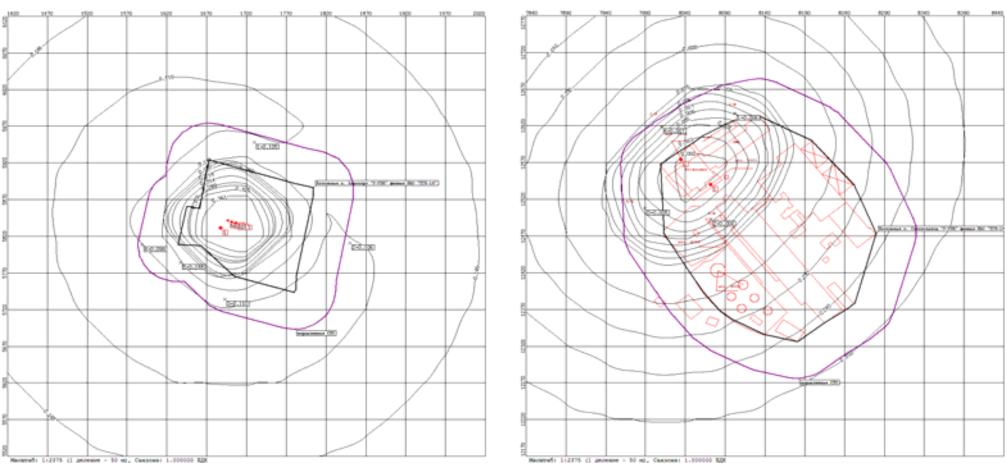
thermal power plants, black carbon, nitrogen dioxide, nitrogen oxide, sulphur dioxide, carbon oxide enter the atmospheric air.

According to the results of calculations of surface concentrations of pollutants in the atmospheric air, uneven distribution of the fields of these concentrations was revealed.



a *b*

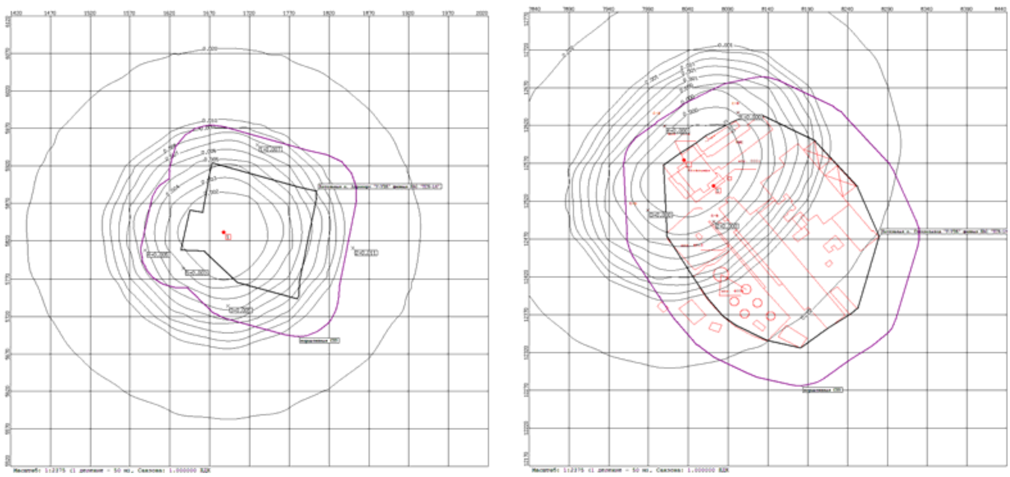
Figure 1. Calculated ash concentrations:
a – boiler plant of Airport settlement (coal ash); *b* – boiler plant of Glass Factory settlement (fuel oil ash)
Source: compiled by the authors.



a *b*

Figure 2. Calculated black carbon concentrations.
a – boiler plant of Airport settlement; *b* – boiler plant of Glass Factory settlement
Source: compiled by the authors.

Concentration of coal ash from the boiler plant of Aeroport settlement varies from 0.0538 to 0.1002 mg/m^3 (average content is 0.0707 mg/m^3). The fields of coal ash concentrations with maximum values are concentrated in the eastern part from the boiler plant, the maximum was 0.333 MAC. The values of detected concentrations of fuel oil ash of thermal power plants in the atmospheric air from the boiler plant of Steklozavod settlement vary in the range from 0.0003 to 0.0006 mg/m3 (average content – 0.0005 mg/m^3). The fields of concentrations of this substance with maximum values are concentrated in the north-western part from the boiler plant, the maximum was 0.301 MAC.



a *b*

Figure 3. Calculated benz(a)pyrene concentrations:
a – boiler plant of Airport settlement; *b* – boiler plant of Glass Factory settlement
Source: compiled by the authors.

Concentration values of black carbon (soot) in the atmospheric air from the boiler plant of Steklozavod settlement range from 0.0006 to 0.0009 mg/m^3 (average value – 0.0008 mg/m^3), from the boiler plant of Aeroport settlement – from 0.0149 to 0.0222 mg/m^3 (average value – 0.0171 mg/m^3). The fields of black carbon concentrations with maximum values are concentrated from the boiler plant of Steklozavod settlement in the north-western part, and from the boiler plant of Aeroport settlement – in the south-western part (maximum – 0.148 MAC). The average calculated concentration of this substance from the boiler plant of Aeroport settlement exceeds the similar concentration from Steklozavod settlement by 21.38 times.

The values of benz(a)pyrene concentrations in the atmospheric air from the boiler-house in Steklozavod settlement vary from 2.209×10^{-9} to 3.331×10^{-9} mg/m^3 (average value – 2.718×10^{-9} mg/m^3), from the boiler-house in Aeroport settlement – from 2.601×10^{-8} to 1.124×10^{-7} mg/m^3 (average value – 6.199×10^{-8} mg/m^3). The average calculated concentration of benz(a)pyrene from the boiler plant of the Aeroport settlement exceeds the similar concentration from the Steklozavod settlement by 22.81 times.

Table 1. Calculated concentrations of gaseous substances created by emissions into the atmosphere during combustion of various fuels

Name of the object to be researched	Calculated concentration of gaseous substances, mg/m^3			
	NO_2	NO	SO_2	CO
Boiler plant of Airport settlement (coal ash)	0.0049–0.0215 0.0119	0.0008–0.0035 0.0019	0.0165–0.0712 0.0392	0.0284–0.1229 0.0678
Boiler plant of Glass Factory settlement (fuel oil ash)	0.0024–0.0036 0.0029	0.0004–0.0005 0.00047	0.0128–0.0200 0.0160	0.0026–0.0041 0.0034

Note. The numerator shows the range of calculated concentrations, the denominator shows the mean value.
Source: compiled by the authors.

The analysis of calculated concentrations of gaseous substances emitted into the atmospheric air by the investigated objects (tab. 1) showed that for all substances the average values of concentrations created in the atmosphere during coal combustion are higher than the concentrations formed during fuel oil combustion: for nitrogen dioxide – 4.06 times, nitrogen oxide – 4.07 times, sulphur dioxide – 2.45 times, carbon oxide – 20.23 times.

To study the impact of atmospheric pollution by thermal power enterprises, studies of the elemental composition of snow cover were carried out. When establishing the list of analysed indicators of elemental composition of snow water, information on chemical composition of the initial fuel was used.

According to the inventory report in the boiler plant of the Aeroport settlement hard coal of DR grade of Tugnuyskoye deposit and brown coal of 2 BPKO grade of Borodinskoye deposit are used. Petrographic composition is represented mainly by vitrinite (84%), semivitrinite (2%), liptinite (1%), inertinite (5%). The averaged elemental composition of the coal in working condition includes macronutrients: C, H, N, N, O, P, Cl, As, F and trace elements: Zn, Cr, Co, Ni, Mn, Mo, Cu, Ba, Sr. The chemical composition of coal fly ash is a mixture of oxides of lithophilic (Si, Al, Ca, Mg, Ti, P, Na, K), chalcophilic (S) and siderophilic (Fe) elements (according to the classification of V.M. Goldschmidt). Coal fly ash also contains rare-earth metals. According to studies [13], the content of rare-earth elements in fly ash can be (g/t): Y – 37.4, La – 53.5, Xe – 141.8, Pr – 9.7, Nd – 42.8, Sm – 9.9, Eu – 1.4, Gd – 9.7, Tb – 1.31, Dy – 8.2, Ho – 1.66, Er – 5.4, Yb – 4.2. Also Sr – 2176 g/t, Hf – 6,6 g/t were found in fly ash.

The greatest distribution among liquid fuels at the enterprises of heat power engineering of Ulan-Ude, including fly ash, was found. Ulan-Ude, including boiler plant of Steklozavod settlement, is low-sulphur fuel oil of M-100 grade. Macroelement composition of fuel oil of the West Siberian field [13] includes C (87.4 %), H (8.8 %), S (2.51 %), N (0.1 %), O (1.5 %). The chemical composition of ash residues formed at combustion of fuel oil M-100 [14] consists mainl y of Fe – 63 %, V – 18,4 %, S – 11,5 %, Ni – 5,9 %, Ca – 0,7 %, Zn – 0,2 %, Mo – 0,2 %.

Thus, the list of monitored indicators to be analysed comprised 36 elements: P, Cl, As, Zn, Cr, Co, Ni, Mn, Mo, Cu, Ba, Sr, Si, Al, Ca, Mg, Ti, Na, K, S, Fe, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Yb, Hf, V. Based on the potential increased radioactivity of hydrocarbon raw materials, confirmed by a number of studies [15–17], U was added to the list of controlled indicators (Table 2).

Table 2. Characterization of snow cover in the area of the objects under study

Element	Background concentration C_{Φ}, µg/l	Boiler plant of Airport settlement		Boiler plant of Glass Factory settlement	
		Concentration ranges in snow water, µg/l	Concentration factor $K_{c(Max)}$	Concentration ranges in snow water, µg/l	Concentration factor $K_{c(Max)}$
Na	450	1550–1820	4.04	1190–1740	3.87
Mg	230	1390–2100	9.13	590–1710	7.43
Al	12.7	12.4–37	2.91	36–1560	122.83
Si	200	1040–1290	6.45	230–520	2.60
P	30	27–29	0.97	10.5–18.7	0.62
S	770	3600–5300	6.88	4400–17800	23.12
Cl	950	1630–1730	1.82	950–1830	1.93
K	350	600–870	2.49	610–3700	10.57
Ca	2100	10400–15400	7.33	4400–10900	5.19
Ti	0.74	0.31–0.51	0.69	0.42–0.85	1.15
V	0.56	3.2–3.7	6.61	5.5–16.4	29.29
Cr	0.16	0.13–0.18	1.13	0.2–2.8	17.50
Mn	8.6	0.89–0.97	0.11	59–122	14.19
Fe	24	14.1–23	0.96	28–1800	75.00
Co	0.116	0.066–0.089	0.77	0.76–2.9	25.00
Ni	0.32	0.42–0.56	1.75	20–148	462.50
Cu	1.61	0.19–1.4	0.87	1.11–4.4	2.73
Zn	17.5	8.1–17.2	0.98	22–64	3.66
As	0.33	3.1–3.5	10.61	0.32–0.62	1.88
Sr	11.9	200–320	26.89	41–97	8.15
Y	0.016	0.01–0.024	1.50	0.015–0.73	45.63
Mo	0.88	2.2–3.4	3.86	0.54–1.04	1.18
Ba	9.2	39–48	5.22	29–62	6.74
La	0.011	0.0058–0.013	1.18	0.012–1.9	172.73
Ce	0.018	0.0028–0.018	1.00	0.018–1.65	91.67
Pr	0.0024	0.0007–0.0024	1.00	0.0027–0.159	66.25
Nd	0.006	0.0009–0.008	1.33	0.008–0.52	86.67
Sm	0.007	0.007–0.019	2.71	0.006–0.12	17.14
Eu	0.0005	0.0035–0.0037	7.40	0.0016–0.022	44.00
Gd	0.0024	0.00019–0.0026	1.08	0.0022–0.111	46.25
Tb	0.0005	0.00015–0.0005	1.00	0.0006–0.017	34.00
Dy	0.0016	0.00039–0.0024	1.50	0.0023–0.09	56.25
Ho	0.0009	0.00019–0.0005	0.56	0.0008–0.018	20.00
Er	0.0014	0.00029–0.0013	0.93	0.0018–0.056	40.00
Yb	0.0012	0.0005–0.0012	1.00	0.002–0.042	35.00
Hf	0.0009	0.0011–0.0013	1.44	0.0007–0.0036	4.00
U	0.01	0.063–0.175	17.50	0.025–0.131	13.10
Total pollution index Z_c		107.61/average		1563.80/very high	

Source: compiled by the authors.

The results of calculations showed that boiler emissions have a significant impact on the chemical composition of the snow cover. The boiler plant of Steklozavod settlement makes a greater contribution to pollution in comparison with the boiler plant of Aeroport settlement, which is confirmed by the total indicator of snow cover pollution, which was for the boiler plant of Steklozavod settlement Z_c = 1563.80 (very high level of pollution), for the boiler plant of Aeroport settlement Z_c = 1563.80 (very high level of pollution). Steklozavod Z_c = 1563,80 (very high level of pollution), for the boiler plant of Aeroport settlement – Z_c = 107,61 (average level of pollution). The high degree of snow pollution around the boiler plant of Steklozavod settlement can be explained by a number of reasons: firstly, there is no dust and gas cleaning equipment installed in the boiler plant, which contributes to the emission of pollutants into the atmosphere without preliminary cleaning; secondly, fuel oil is one of the 'dirty' types of fuel in terms of formation of combustion products without special preparation before combustion, which is confirmed by some works [18; 19]; thirdly, dense building around the boiler plant prevents the dispersion of pollutants, and this is the main reason for the high level of pollution. Among the elements, the concentrations of which maximally exceed the background values at fuel oil combustion, we should single out Al (K_c = 122.83), S (K_c = 23.12), V (K_c = 29.29), heavy metals: Ni (K_c = 462,50), Fe (K_c = 75,00), Co (K_c = 25,0), Cr (K_c = 17,50), Mn (K_c = 14,19), Zn (K_c = 3,66), Cu (K_c = 2,73), group of rare earth elements (K_c = 172,73 for La).

The concentration coefficients of most elements in the snow cover sampled around the coal-fired boiler plant of the Aeroport settlement vary in a relatively narrow range: from 1.13 (for Cr) to 9.13 (for Mg). Abnormally high concentrations are observed for As (K_c = 10.61), Sr (K_c = 26.89). These elements belong to impurity elements of coals. Strontium content in coals [20] reaches for brown coals (g/t): 120 ± 10 (coal) and 740 ± 70 (ash); for hard coal: 100 ± 7 (coal), 730 ± 50 (ash). Coals with elevated average Sr contents of 240–320 g/t are distinguished on the near-clark background. At combustion of coals at TPPs arsenic contained in them forms orthoarsenates flying with flue gases and partially deposited on fly ash particles [21]. Insignificant coefficients of chemical element concentrations in the snow cover around this boiler plant can be related to the favourable orographic conditions of the area, contributing to the dispersion of pollutants in the atmosphere.

Snow around both boiler plants contain high U values: at the boiler plant of Steklozavod settlement the excess over background is 13.1 times, at the boiler plant of Aeroport settlement – 17.5 times.

Conclusion

The results of dispersion of pollutants in the atmosphere from neighborhood boiler plants of Ulan-Ude. Ulan-Ude, operating on solid and liquid fuels, revealed that the calculated surface concentrations of solid and gaseous substances, created in the atmosphere by coal combustion, exceed the similar concentrations created by fuel oil combustion by 2.45 (sulphur dioxide) – 141.4 (ash) times. However, the experimental study of the elemental composition of the liquid phase of snow, sampled at the same points, where the calculated modelling of pollution was carried out, showed the opposite picture: the boiler plant of Steklozavod settlement, operating on fuel oil, makes a greater contribution to pollution (Z_c = 1563.80 – very high level of pollution) compared to the boiler plant of Aeroport settlement, using coal as fuel (Z_c = 107.61 – average level of pollution). The reasons for this discrepancy can be imperfections in the methodology of calculating emissions of pollutants into the atmosphere: solid particles (coal or fuel oil ash) are subject to regulation without considering their chemical composition; the algorithm of emissions dispersion does not take into account the density of buildings around the source of emissions into the atmosphere.

The conducted studies have shown that only calculated methods of determining the concentrations of pollutants in the atmosphere are not sufficient for assessing the quality of atmospheric air. In addition to calculations, it is necessary to carry out laboratory studies of chemical composition of atmospheric air and snow cover in the zone of influence of pollution sources.

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