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Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

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ASSESSMENT OF ENVIRONMENTAL DAMAGE OF NON–FERROUS METALLURGY WASTE TO THE ENVIRONMENT

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Abstract. In this article, indicators up to the amount of sanitary standards requirements for the elimination of lead — mixed slag dust rising into the atmosphere from waste collectors of Kazygurt settlement were determined and a map-scheme of the distribution of slag dust in the atmosphere was drawn. When the release of environmentally harmful substances into the atmospheric air by lead production, their distribution in the air from the seeding to the maximum permissible standard level, together with adiabatic and meteorological factors of the atmosphere, the relief conditions of the production location also have a great impact. In this regard, in the work on protecting the environment from pollution from production emissions, the development of an environmental map-scheme of the territory where the enterprise is located is the initial condition for the study and assessment of environmental pollution by industrial emissions. The map-scheme of the area where the sources of pollution are located is also necessary to analyze and take into account the impact of the terrain on the conditions of distribution of pollutants in the atmospheric air, as well as to determine the location of neighboring sources of pollution, the emissions of which are combined with the emissions of the source of pollution in question. The hydrographic network of the lead plant originates in the almond River.
Keywords: slag, warehouse, granule, landfill, front, lead

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ТҮСТІ МЕТАЛЛУРГИЯ ҚАЛДЫҚТАРЫНЫҢ ҚОРШАҒАН ОРТАҒА ЭКОЛОГИЯЛЫҚ ЗИЯНЫН БАҒАЛАУ

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Аннотация. Бұл мақалада Қазығұрт елді мекені қалдықтар жинағыштарынан атмосфераға көтерілетін қорғасын аралас қож шаңдарының ауада сейілуі арқылы санитарлық норматив талаптары мөлшеріне дейін көрсеткіштері анықталып, қож шаңдарының атмосферада таралуының карта — схемасы сызылды. Қорғасын өндірісі тарапынан атмосфера ауасына қоршаған ортаға зиянды заттарды шығарған кезде, олардың ауада таралуы себеінен шектік рұқсат етілген норматив деңгейіне дейін сейілуіне атмосфераның адиабаталық және метеорологиялық факторларымен бірге өндіріс орналасқан жердің рельефтік жағдайы да үлкен әсерін тигізеді. Осыған байланысты өндіріс шығарындыларынан қоршаған ортаны ластанудан қорғау жұмыстарында кәсіпорын орналасқан аумақтың экологиялық карта-схемасын жасау қоршаған ортаның өндріс шығарындыларымен ластануын зерттеу мен бағалаудың бастапқы шарты болып табылады. Ластау көздері орналасқан ауданының карта-схемасы жер бедерінің атмосфералық ауадағы ластаушы заттардың таралу жағдайларына әсерін талдау және есепке алу үшін, сондай-ақ шығарындылары қаралып отырған ластану көзінің шығарындыларымен қосылатын көрші ластану көздерінің орналасқан жерін анықтау үшін де қажет. Қорғасын зауытының гидрографиялық желісі Бадам өзенінен бастау алады. Бадам өзені Арыс өзенінің сол жақ саласы болып табылады да, ол Талас жотасының сілемдерімен жалғасып, Бадам тауларынан (Ақ Бастау) басталады. Сол себепті Бадам өзені басталатын жоғарғы ағысында ол таулы жіңішке аңғармен ағып өтіп, ал аңғардан шыққан кезде тұрақты арнасы жоқ өз шөгінділері арасында сейіледі. Бадам өзені арнасының ені металлургиялық кәсіпорын орналасқан жер ауданында 0,5 — тен 38 м-ге дейін ауытқиды, өзеннің орташа тереңдігі 0,22-ден 0,75 м-ге дейін екендігі анықталған. Өзендегі су деңгейінің жоғарылауы қардың қарқынды еруінен және қатты жауын-шашыннан болатындығымен түсіндіріледі.

Түйін сөздер: қож, қойма, түйіршік, террикон, фронт, қорғасын

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ОЦЕНКА ЭКОЛОГИЧЕСКОГО ВРЕДА ОКРУЖАЮЩЕЙ СРЕДЕ ОТХОДОВ ЦВЕТНОЙ МЕТАЛЛУРГ ИИ

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Аннотация. В данной статье определены показатели рассеивания свинцово-шлаковой пыли, поднимающиеся в атмосферу из шлакохранилища свинцового завода, граничащего с поселком Казыгурт, до величины санитарных норм и по ним составлена экологическая карта-схема рассеивания свинцово-шлаковой пыли в атмосфере. При выбросах свинцовым производством в атмосферу экологически вредных веществ на их рассеивание в воздухе до предельно допустимого нормативного уровня большое влияние оказывают адиабатические и метеорологические факторы атмосферы, а также рельеф местности, где расположено производство. В связи с этим, в работах по охране окружающей среды от загрязнения производственными выбросами, создание экологической карты-схемы рассеивания шлаковой пыли в атмосферном воздухе территории, на которой расположено предприятие является исходным условием изучения и оценки загрязнения окружающей среды производственными выбросами. Карта-схема рассеивания выбросов, где расположены источники

загрязнения, необходима для анализа и учета влияния рельефа местности на условия распространения загрязняющих веществ в атмосферном воздухе, а также для определения расположения соседних источников загрязнения, выбросы которого сочетаются с выбросами рассматриваемого источника загрязнения. Гидрографическая сеть свинцового завода берет начало от реки Бадам. Река Бадам — левый приток реки Арысь, продолжается отрогами Таласского хребта и начинается с Бадамских гор (Ак Бастау). Поэтому вверх по течению, где начинается река Бадам она течет по узкой горной долине, а выходя из долины, рассеивается среди ее отложений, не имея постоянного русла. Ширина русла реки Бадам колеблется от 0,5 до 38 м в районе расположения металлургического предприятия, а средняя глубина реки составляет от 0,22 до 0,75 м.

Ключевые слова: шлак, склад, гранула, террикон, фронт, свинец

Introduction

In the Republic of Kazakhstan, there is almost no state system of waste management, which includes monitoring, storage, recycling and disposal of industrial and household waste. More than 20 billion tons of production and consumption waste, including 6.7 billion tons of toxic waste, are accumulated in the territory of Kazakhstan. As a result of these, soil, underground and surface water in many regions are subject to intense pollution by industrial waste. The constant increase in the amount of waste stored in warehouses creates new man-made landscapes. With the increase in the height of heaps and terricones, they are becoming intensive sources of dust generation (concept of environmental safety of the R.K., 2003: 8–9).

Due to the low availability of useful components in deposits, the production of non-ferrous metals is accompanied by the generation of many man-made wastes. One of the ways of rational use of mineral raw materials and saving of natural resources is to improve the technology of complex recycling of production waste, to create low-waste and zero-waste technologies, to use out-of-balance ores poor in useful components, beneficiation waste and solid metallurgical waste as raw materials for production processing. It is known that the use of waste from this industry in the republic is currently at a low level (Zharkenov, 1997: 14–17).

Today, about 20 tons of raw materials are produced per year for each inhabitant of the planet, and during the consumption of 800 tons of water and 2.5 kW of energy, about 90–98 % of them are collected as waste. If in developed countries 90 % of agricultural waste, 98 % of car bodies, and 90 % of used oils are disposed of, on the contrary, a significant part of industrial and construction waste, mining and metallurgical production waste is practically not fully disposed of. In this regard, humanity's use of environmental resources on a huge scale in order to improve their lives, and the incalculable use of unknown waste created from it without making it harmless, causing environmental disasters such as global climate warming, depletion and depletion of the ozone layer.

Thus, literature data shows a continuous increase in the amount of non-recyclable industrial waste during the work of global enterprises. Most of the world's waste, including hazardous waste, is collected in landfills or buried, depending on the degree of hazard. Currently, it is known that the amount of recycling of industrial waste does not exceed 20 % of their total volume (Lavrov, 1993).

Until now, only one-tenth of ash and slag has been taken into the economic circulation, including less than 4 % of phosphogypsum and coal enrichment waste, one-fifth of non-ferrous metallurgy slag, and the waste of the mining industry complex is not processed and sent to the places where the waste is stored unchanged. In particular, more than 200 million tons of phosphogypsum wastes, 600 million tons of metallurgical slags, flotation enrichment wastes of non-ferrous and rare metal ores, pyrite burns, phosphate and vanadium slags containing titanium require special attention (Wozniak, 1994).

Relevance of research.

According to the data of "Kazgidromet" hydrometeorological center in Turkestan region, Southern Polymetal Closed Joint Stock Company “SouthPolimetall” JSC is the main source of atmospheric air pollution.

The open storage of granulated slags of Yuzhpolymetal JSC is located on a specially allocated land plot of the territory of "SouthPolimetall" JSC metallurgical complex, on the right bank of the Badam River. Dimensions of the open storage: the granulated slag is placed in the form of 6 individual terricones. The total area is 1.5 hectares, the distance from granulated slag storage warehouses to residential buildings is 1.5 km, to the border of the sanitary protection zone – 1.0 km, to the Badam river – 100 m, the size of the sanitary protection area is 1000 m. As of 2007, 966,631 tons of granulated slag were stored there. According to Safety Regulations and Norms (SR&N) 2.01–82, the climatic characteristics of the area where the slag heap is located corresponds to the IV-g area, the average monthly temperature in the coldest months - January is –2 oC –16 oC. On some days, the temperature here can drop to –34°C. In the warmest month - June, the average monthly temperature ranges from +25°C to +28°C, and sometimes the air temperature can reach +45°C. In the area where waste is located, the annual amount of precipitation is 490 mm, and its minimum amount is 322 mm. In addition, the maximum amount of precipitation here is 648 mm, the average barometric pressure is 718 mm, and the average wind speed in January and June is 2.8 m/s in all directions. The magnitude of seismic movement of the place where the slag waste storage warehouses of the lead factory are located is 7 points according to the KNzE. Average relative air humidity: 67 % in the coldest winter months, 21 % in the hottest summer months.

Cold winds blowing from the west and north-west in the summer months do not bring precipitation to this place and prevent a significant decrease in the surface temperature. The opposite front of such a wind is mostly dry, and only in special cases precipitation falls here, that is, the passage of wind currents during this period mainly contributes to the strengthening of the wind and the formation of dust storms. That is, the meteorological conditions here are not suitable for self-purification of the atmosphere, on the contrary, it worsens the rapid self-purification of the air pool of slag dust rising into the air from waste storage areas, and the high air temperature of 40–45 oC in summer makes it difficult for the slag dust to dissipate in the air and has a negative effect on human health.

The hydrographic network of the Lead Plant originates from the Badam River. The Badam River is the left tributary of the Arys River, and it continues with the spurs of the Talas Ridge, and "Ak Bastau" begins from the Badam Mountains. That's why in the upstream, where the Badam River begins, it flows through a narrow mountain valley, and when it leaves the valley, it dissipates among its sediments without a permanent channel. The width of the Badam river channel varies from 0.5 to 38 m in the area where the metallurgical enterprise is located, and the average depth of the river is from 0.22 to 0.75 m. The increase in the water level in the river is explained by the rapid melting of snow and heavy rainfall. In May, the average monthly maximum consumption of water is 5.42 m3/second, but its minimum consumption is 0.16 m3/second. When the water flows in this area, it is ensured that its bottom consists of alluvial sediments. The general direction of the flow of these waters from east to west is part of Sairam - Badam Hill. According to the results of the inspection on the effect of industrial wastes on the quality of surface waters of the Badam River, the concentration of lead in the upper and lower reaches of the Badam River is from 0.0063 mg/l to 0.0187 mg/l, copper is 0.005 mg/l. from to 0.0006 mg\l, and iron from 0.03 mg\l to 0.05 mg\l.

Research materials and methods.

The results of the inspection on the effect of industrial waste on the qualitative composition of surface waters of the Badam River showed that the concentration of lead in the surface water of the Badam River in the channel in the upper and lower parts of the enterprise was from 0.0063 mg/l to 0.0187 mg/l, copper 0.005 From mg\l to 0.0006 mg\l, iron increases from 0.03 mg\l to 0.05 mg\l.

In atmospheric air, heavy metals exist in the form of organic and inorganic compounds in the form of dust and aerosols.

At the same time, lead, cadmium, copper and zinc aerosols mainly consist of their submicron particles with a diameter of 0.5–1 μm, and nickel and cobalt aerosols mainly consist of large dispersed particles (more than 1 μm) formed during the burning of diesel fuel.

Technogenic release of heavy metals into the environment occurs in the form of gases and aerosols (sublimated metals and dust-like particles) and in wastewater.

In high-temperature technological processes, heavy metals are released into the atmosphere in the form of submicron aerosol particles, which dissolve relatively easily in sediments. This shows that heavy metals in precipitation can participate in migration processes of the ecological system: soil-plant, soil-water, etc. (Danilov, 1997).

During precipitation, heavy metals migrate in different forms: Mo, Au in the form of anions, and Zn, Co, Cd, Cr elements in the form of cations change places in water and soil. The intensity of heavy metals entering water surfaces and soil through atmospheric precipitation is as follows: (Fe>Mn)>>Pb>Zn>Cu>Ni>Cr>Ag (Korabeva, 1991).

In 2001, the highest level of atmospheric air pollution of the factory territory was determined in the south-west direction, where the concentration of lead aerosol was 29.7 times its maximum permissible concentration (0.0003 mg/m3), in the north-east direction 9.7 times, in the south- It was determined that it exceeds 2.7 times in the eastern direction, and 10.3 times in the central region. The average annual concentration of lead aerosol in the atmospheric air of the factory territory reaches from 0.002 to 0.0074 mg/m3. At the same time, the highest average annual concentration of lead aerosol is observed in the southwestern part of the factory territory, where its concentration reaches 0.0074 mg/m3, and its lowest average annual concentration is in the southeastern part of the factory territory (0.0008 mg/ m3) is registered.

In this work, an ecological map-scheme of waste accumulators was drawn to determine the influence of open warehouses storing slag wastes of the Shymkent lead factory on the level of environmental pollution.

Creating such an ecological map is the initial condition for the study and assessment of environmental pollution. A map-scheme of the location of pollution sources is necessary to analyze and take into account the influence of the terrain on the conditions of distribution of pollutants in the atmospheric air, as well as to determine the location of neighboring sources of pollution, the emissions of which are combined with the emissions of the considered pollution source.

It is possible to determine the level of dangerous concentration of waste for the environment by determining the distance of distribution of the ambient air from the sanitary protection zone of the location of production waste in the northern direction with the most wind.

Several environmental factors affect the distribution of harmful substances in the atmosphere:

a) temperature stratification of the source of pollution - coefficient A, which affects the horizontal and vertical distribution of harmful substances from the source of pollution due to the climatic features of the local area (the coefficient of temperature stratification for Kazakhstan is a dimensionless value of 200);

b) atmospheric air temperature;

c) wind speed and direction.

The speed and direction of the wind in many cases determine adverse meteorological phenomena that affect the distribution of harmful substances and thus pollute the atmospheric air. In this regard, it should be noted that, from an ecological point of view, each source of pollution and direction of harmful substances is characterized by a particularly dangerous wind speed.

Table 1 shows the wind parameters of the Shymkent city along the eight main wind directions.

Table 1. Wind parameters in eight directions of the city of Shymkent

	Wind directions							
	N	NE	E	SE	S	SW	W	NW
January								
Repeatability	4	8	32	24	6	11	8	7
Average speed	1,6	2,7	2,6	2,8	5,4	5,1	2,9	2,2
July								
Repeatability	9	22	25	12	3	6	8	15
Average speed	3,6	5,6	2,8	2,7	3,8	4,2	3,3	3,2

The “SouthPolimetall” JSC is located in the densely populated southwestern part of the city. Unfavorable wind directions are the south and south-east areas. They blow in these directions in 26 % of cases, that is, harmful emissions from pollution sources are transported over settlements in every third case.

The main pollution of the central, north-western and south-eastern regions of the city by lead aerosol is explained by the prevailing level of the wind direction in these directions (21 and 26 %, respectively). The lowest level of lead contamination of environmental objects in the north-eastern region of the city is explained by the significant distance from the lead plant in this region and the lowest level of wind speed in this direction (10 %) (Solomentsova, 2002).

According to the monitoring data, the assessment of the level of atmospheric air pollution carried out in the research works in accordance with the environmental document 03.3.0.4.01–96 describes the level of atmospheric air pollution as permissible concentrations for the industrial site of the plant and for the slag heap at the border of the sanitary protection zone and in the area of the plant. However, the harmful effects of aerosol particles of heavy metals rising from waste collectors on windy days have not been identified in the monitoring documents.

Even after the extraction of non-ferrous metals, slags can be used in the production of cement and building materials, since lead production slags contain up to 75-85% iron, calcium and silicon oxides (Bagova et al., 2021).

According to the laboratory data of the Sanitary epidemiological control (SEC) of Turkestan region, in 2014, at a distance of 500 m from the enterprise, there was a 62-fold exceedance of the norms of the SEC for sulfur dioxide, 32-fold for inorganic dust, 43-fold for lead, and 3-fold for hydrogen sulfide. According to the data of the hydrometeorological center of RMC "Kazgidromet" of Turkestan region, in 2013, there was a 12-fold increase in the norms MPC of inorganic dust, a 68-fold increase in carbon monoxide and a 12-fold increase in nitrogen dioxide. According to the results of control instrumental measurements, abnormally high emissions of pollutants into the atmosphere were determined: sulfur dioxide - 1.04 times and nitrogen dioxide - 1.6 times.

There are methods of assessing atmospheric air quality from the point of view of environmental hazards (Muzalevsky et al., 1988). However, determining the ecological condition of the environment through pollution indicators and indices is considered to be the most suitable method in practice. Oxidation of sulphide minerals, which are the polluted components of the natural environment, leads to the release of chemical elements dangerous to the environment from ore raw materials and mine tailings, pits and infiltration waters that form sulfuric acid (Bagova et al., 2021).

Quality indicators of the atmosphere are the environmental safety coefficient (EQ) and the Air Pollution Index (API). These indicators make it possible to determine the degree of pollution of the environment with harmful substances for the purpose of environmental safety which can be determined by the following formula:

$$\alpha = \frac{1}{\beta_i} = \frac{MPC_{da}}{MPC_{mot} - Cb} \qquad (1)$$

where: βi-environmental safety coefficient;

MPC_{da} – results of average daily maximal permissible concentrations of harmful substances;

MPC_{mot} – the maximum-one-time concentrations of harmful substances;

C_b - the background results of the concentration of harmful substances in the atmosphere.

In order to assess the pollution of the environment of the area where the slag wastes mixed with lead are located in Shymkent's slag plant, it is necessary to determine the amount of slag dust, as well as the amount of lead aerosols and inorganic dust (SiO_2) contained in them, rising into the atmosphere on windy days. As a result of our research, at an average annual wind speed of 2.8 m/s, lead-mixed slag and SiO_2 dust measured in g/s are emitted from the surface of granulated slag heaps into the atmosphere. Inorganic slag dust emissions spread in the direction of the wind towards the Kazygurt settlement bordering the edge of the warehouse where it is stored.

Research was carried out to analyze the lead content in the blood of children living in the zone of influence of the former lead plant. It was found that the lead content in the blood of children is on average 20.1 mcg/dL, and the average value in the contamination zone is 28.07 mcg/dL (Salybekova et al., 2015).

According to the regulatory documents, the environmental hazard of granulated slag dust is at the 3rd class level, and the lead contained in slag dust is at the 1st level of danger, and its MPC = 0.0003 mg/m^3, and silicon dioxide (SiO_2) is at the 2nd level of ecological danger and its MPC = 0.02 mg/m3. If root crops are very susceptible to macrosporiosis, the content of carotene and sugar in root crops is reduced by 20–40 (Isaev et al., 2022). Therefore, to improve the ecological condition of this locality, it is necessary to determine the environmental safety factor. That is, the ecological safety coefficient allows to evaluate the results of the activities carried out to improve the ecology of the local area.

If $n_i = MPC_{mot} / MPC_{da}$ in the ratio, then the environmental safety coefficient is determined by the following formula:

$$\alpha = \frac{n_i - 1}{n_i} \cdot \frac{MPC_{da}}{C_{fact}} \qquad (2)$$

Based on the results of ecological indicator analysis, the formula is reduced to the following form:

$$\frac{1}{\beta_i} = \frac{S^n}{i=1}\frac{1}{\beta_i} \qquad (3)$$

The ecological safety coefficient of Kazygurt settlement determined by this method of calculation is shown in Table 2 below.

Table 2. Results of calculation of atmospheric air quality indicators

Indicators	Concentration of harmful substances in the air, mg / m^3
Quantitative results	
MPC_{da}	0,0003
MPC_{mot}	0,15
Hazard Class	1
Relative number N MPC	
β_i – environmental safety coefficient	
Kazygurt settlement	
Environmental indicator based on analysis results	0,535

The environmental safety indicators determined in this way are compared with the environmental analysis indicator shown in Table 3, which evaluates the degree of atmospheric air pollution.

Table 3. Environmental indicator based on the results of the analysis

Талдау нәтижелері негізіндегі экологиялық индикатор	Qualitative description of the degree of ecological danger
0,01-0,1	An accident
0,1-0,2	Test
0,2-0,4	Dangerous
0,4-0,8	Transient boundary of environmental danger
0,8-1,0	Limited
1-2	Acceptable
2-4	Satisfying
4-7	Good
Above 8	Background

The result of comparing the environmental hazard coefficient and the environmental indicator of the analysis presented in this table shows that the territory of the village of Kazygurt, located 930 m from the border of this slag storage, is located at the transitional boundary of the environmental hazard of the influence of slag dust rising from the territory where lead slag waste is stored.

In addition, as a result of the study it has been found that teachers who seek to control behavior tend to be obsessive (Zhongzhong et al., 2022).

However, the ecological indicator does not provide a complete ecological description of settlements located near industrial sites and cannot indicate the distribution area of environmental hazards caused by wind. Therefore, in order to assess the distribution of slag dust from pollution sources into the environment, it is necessary to create an ecological map-scheme, and determine the distribution diagrams of slag dust.

Lead smelting slags (LSS) are hazardous waste containing heavy metals (Cr, Ni, Cu, Zn, As and Pb improper disposal can cause irreparable damage to the ecosystem (Biswas et al., 2020).

In the ecological map-scheme of the territory where the sources of pollution are located, the amount of air pollutant depletion to the level of MPC is determined. The environmental hazard of wind should be taken into account before making a schedule of distribution of harmful substances up to the level of MPC in the map-scheme. Environmentally dangerous winds, instead of reducing the concentration of harmful substances rising into the atmosphere, on the contrary, contribute to their subsidence and increase the concentration of harmful substances in the surface layer of the atmosphere.

Interestingly, the ratio of cadmium concentration in the root to the soil (bioaccumulation coefficient) More than 1, centella Asiatica may be a potential source of cadmium bioaccumulation (Kunting et al., 2022).

The speed of the environmentally dangerous wind, which increases the concentration of harmful substances in the surface layer of the atmosphere, depends on the speed of lead aerosols rising from the surface of waste collectors, i.e. vm. If vm >2, then $u_m = 2.2 \bullet v_m$. The highest concentration of harmful substances in the surface layer of the atmosphere during an ecologically dangerous wind is determined by the following formula:

$$C_{mu} = r \cdot C_m , \qquad (4)$$

here R is a dimensionless quantity characterized by the ratio $r = U_m / v_m$.

If Um/ vm = 3/1406 = 0.00235, then r is determined by the following formula:

$$r = 0{,}67 \cdot (U / \upsilon_m) + 1{,}67 \cdot (u / \upsilon_m)^2 - 1{,}34 (U / \upsilon_m)^3 = 0{,}0022 \quad (5)$$

Since the highest concentration of lead aerosols in the atmosphere during ecologically dangerous winds is Sfgmi = 0.0016 mg/m3, its distribution in dangerous winds is not considered. Therefore, when determining the dispersion of harmful substances in the surface layer of the atmosphere up to the level of SRK and during the determination of the boundaries of the distribution of slag dust depending on the wind speed, the maximum distance of their spread in the air is determined due to the fact that the highest concentration of slag dusts is $C_m = 0.21$ mg/m^3 during the ecologically dangerous wind.

Therefore, it is imperative to assess the bioavailability of PHEs in the soil of mining/smelting sites in order to determine soil standards for mining and metallurgy with regional characteristics (Kunting et al., 2022).

Since the outer border of the Kazygurt settlement is 930 m away from the waste collectors, in order to determine the distance of the slag waste rising from the waste storage warehouses to the air level of MPC, in addition to the maximum distance where the maximum concentrations of slag particles are known, the vertical scattering coefficient (S_2) of the slag dust in the direction of the lead aerosols (Y) rising into the atmosphere determined by the following formula:

$$S_2 = \frac{1}{\left[1 + 8{,}4 \cdot U\left(\frac{y}{x}\right)^2\right]\left[1 + 28{,}2 \cdot U^2\left(\frac{y}{x}\right)^4\right]} \qquad (6)$$

Calculations made using the results of the conducted research and the formulas given above, allow to determine the concentration of dispersion of harmful substances at the calculated points from the waste collectors to the settlement of Kazygurt, located 930 m away, and by connecting them with a line, a scattering diagram of lead aerosols is drawn up to the level of MPC. Such calculations made sure that the distribution of lead aerosols in the atmospheric air in the southeast direction of the wind up to the level of MPC covers the territory of Kazygurt settlement close to the warehouse.

Figure 1 shows the diagram of the distribution of slag dust in the atmosphere determined as a result of these calculations.

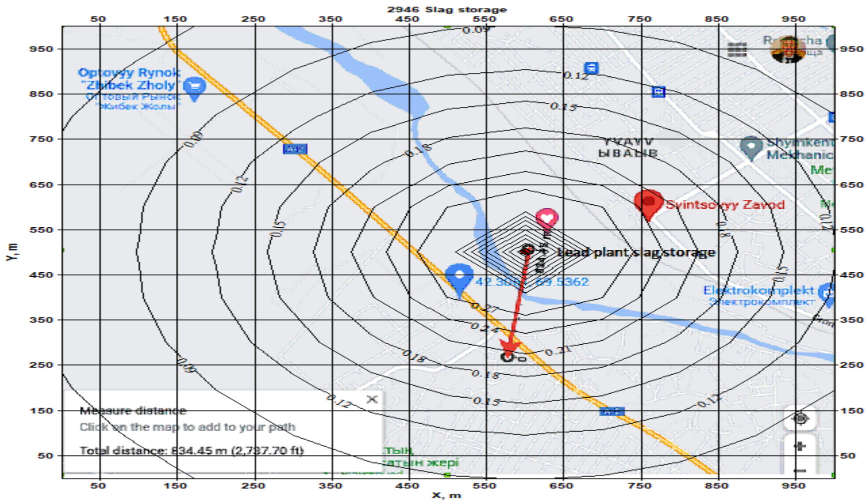

Figure 1. Map-scheme of slag dust dispersion in the air

If we consider the accumulation of production waste as a source of environmental pollution, the sanitary break distance, which is determined by the distribution distance of its sanitary protection zone from the wind speed divided into chambers to the level of MP, is determined by the following formula:

$$l = L_0 \frac{P}{P_0} \qquad (7)$$

where: L_0 is the distance of distribution of harmful substances to the level of MPC and is determined by the X/X_m ratio, m;
P-wind speed;
Rumbas of P_0-wind.

If we take the scattering concentration of harmful substances in the form of c, mg/m^3 up to the level of MPC, then the formula $C = S_1 \cdot Cm$ can be reduced to the following form:

$$S_1 = ПДК / C_m \qquad (8)$$

In this regard, the distribution distance of harmful substances from the accumulations of granular slag to the level of MPC is the same, therefore, as shown in the figure, the distribution boundary of lead aerosols is determined depending on all 8 directions of the wind as follows:

$L_N = 2456 \frac{19}{12{,}5} = 3733$ m $\qquad L_S = 2456 \frac{18}{12{,}5} = 3537$ m

$L_{NE} = 2456\,\frac{19}{12,5} = 1768$ m $L_{SW} = 2456\,\frac{4}{12,5} = 786$ m

$L_{E} = 2456\,\frac{2}{12,5} = 393$ m $L_{W} = 2456\,\frac{6}{12,5} = 1179$ m

$L_{SE} = 2456\,\frac{24}{12,5} = 4715$ m $L_{NW} = 2456\,\frac{18}{12,5} = 3537$ m

According to the results of these calculations, it was known that the concentration table of the boundaries of the distribution of slag dust, depending on the 8 directions of the wind, is reduced to the level of SRK, and covers the territory of the south, north, south-west and north-east directions of the wind. Among the wind directions, the south-west direction is the most frequent compared to other winds, so it was determined that Kazygurt settlement, located in this direction, is in an ecologically dangerous area..

Conclusion

It was found that the slag dust rising into the atmosphere on windy days from the storage of slag residues of the lead factory of JSC "YUPM OK" pollutes the settlement of Kazygurt, which is adjacent to the storage, to an ecologically dangerous level. The map-scheme showing the dispersion of slag dust flying into the air from the surface of the warehouse storing lead slag showed that the slag dust pollution of Kazygurt district, located 930 m from the enterprise, exceeds the standards of the MPC by 1.8 times.

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