Technoeconomics. 2024, Vol. 3, No. 1 (8). Pp. 71–80.
Техноэкономика. 2024, Том 3, № 1 (8). С. 71–80.

Scientific article
UDC 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.7

MANAGEMENT OF ATMOSPHERIC AIR QUALITY AT MINING FIELDS BASED ON ESG PRINCIPLES

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Abstract. Mining plays one of the most significant roles in modern economy, which, on the one hand, provides an opportunity for a region to provide additional jobs, develop infrastructure and, as a result, improve the quality of life. However, on the other hand, it poses a threat to the environment. Research in this area is relevant for the development and implementation of effective air quality management strategies. With their help, it becomes possible to create and implement innovative and environmentally sustainable technologies, reduce environmental impact and take measures to improve air quality in mining fields. This article is devoted to the analysis of pollution sources and climatic conditions of the lead-zinc mine area, assessment of the air quality management system in the study area, as well as the role of ESG principles in the air quality management system of "Shalkiya ZincLtd".

Keywords: air quality management, mining, ESG principles, lead-zinc mines, sustainable technologies

Citation: Salnikov V., Kozhagulov S., Rysmagambetova A. Management of atmospheric air quality at mining fields based on ESG principles. Technoeconomics. 2024. 3. 1 (8). 71−80. DOI: https://doi.org/10.57809/2024.3.1.8.7

Научная статья
УДК 330.15
DOI: https://doi.org/10.57809/2024.3.1.8.7

УПРАВЛЕНИЕ КАЧЕСТВОМ АТМОСФЕРНОГО ВОЗДУХА ГОРНОРУДНЫХ МЕСТОРОЖДЕНИЙ НА ОСНОВЕ ПРИНЦИПОВ ESG

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Аннотация. В современном мире невозможно обойтись без добычи полезных ископаемых, с одной стороны дающей возможность какому-либо региону получить дополнительные рабочие места, развить инфраструктуру и в итоге повысить качество жизни, а с другой, представляющей значительную опасность для окружающей среды (ОС). Исследования в этой области являются актуальными для разработки и реализации эффективных стратегий управления качеством атмосферного воздуха. С их помощью становится возможным создать и внедрить инновационные и экологически устойчивые технологии, снизить воздействие на окружающую среду и принять меры к улучшению качества воздуха в горнорудных месторождениях. Данная статья посвящена анализу источников загрязнения и климатических условий района свинцово-цинкового рудника, оценке системы управления качеством атмосферного воздуха в районе исследования, а также роли принципов ESG в системе управления качеством атмосферного воздуха АО «Шалкия ЦинкЛТД».

Ключевые слова: управление качеством воздуха, горнорудные месторождения, ESG принцыпы, свинцово-цинковые рудники, устойчивые технологии

Для цитирования: Сальников В., Кожугалов С., Рысмагамбетова А. Управление качеством атмосферного воздуха горнорудных месторождений на основе принципов ESG // Техноэкономика. 2023. Т. 3, № 1 (8). С. 71–80. DOI: https://doi.org/10.57809/2024.3.1.8.7

Introduction

Ore deposits, including mines and quarries, are a significant source of emissions and air pollution. Ore extraction and processing, including the use of heavy machinery and chemicals, often results in the release of hazardous substances and dust into the atmosphere. This can have a negative impact on the environment, the health of local residents and ecosystems. Therefore, the integration of mining air quality management is required.

Thus, Pb-Zn is widely used in the construction and automotive industries of the world. However, the global assessment of Pb-Zn mineral resources, which has been conducted, clearly reflects the environmental challenges, especially those related to air pollution, facing the lead-zinc (Pb-Zn) ore mining sector. According to operational data from the mining industry, the volume of tailings generated is estimated to be approximately 0.26-2.5 tons for every ton of Pb-Zn ore processed. It is estimated that more than 8100 tailings ponds with a discharge volume of 10 billion m3 are generated worldwide (Chen, 2023).

ESG principles are oriented to a balanced consideration of the environment, social aspects and management. The implementation of these principles in the air quality management of mining deposits can lead to the reduction of harmful emissions, improvement of technologies

used in ore mining, and reduction of negative impact on health and the environment.

Materials and Methods

The problem of air pollution in general is now unprecedentedly urgent due to natural causes, as well as the increasing impact of anthropogenic factors, in particular, the continuing increase in the concentration of carbon dioxide and other greenhouse gases (GHG) in the Earth's atmosphere, which has a direct and indirect impact on humans, the food chain and the environment. Compared to other components of the geosphere, the atmosphere has a number of inherent features: unlimited capacity, high mobility, variability of its constituent components, peculiarity of physical and chemical processes and transformations. Specific features of these transformations are associated with both natural (activity of the Sun, geographical location, climate, seasons and day) and anthropogenic factors (Morozov, 2020).

Atmospheric concentrations of GHGs reflect the balance between emissions from human activities, sources and sinks. The increase in atmospheric GHG levels due to human activities is a major driver of climate change. The ongoing climate change caused by the accumulation of GHGs in the atmosphere lasts from decades to centuries and causes changes in the OS around the world. According to all data collected by WMO, the last eight years could be the warmest on record, fueled by ever-increasing GHG concentrations and accumulated heat. The global average temperature in 2022 was about 1.15 [1.02-1.27] °C above pre-industrial (1850-1900) levels. 2022 was the eighth consecutive year (2015-2022) when annual global temperatures were at least 1 °C above pre-industrial levels (WMO Bulletin on Air Quality and Climate No. 1).

In today's world, global environmental policy has a clear goal to ensure the realization of the Sustainable Development Goals (SDGs), one of the main objectives of which is to preserve, restore and effectively use the components of the natural environment. The study of these problems and the search for ways to solve them within the framework of achieving carbon neutrality, commitments in the Paris Climate Agreement is an urgent task to ensure sustainable development for each country, including Kazakhstan ("adilet").

According to the World Bank experts, air pollution in Kazakhstan is the cause of 10 thousand premature deaths and economic damage of more than 10.5 billion dollars per year. In the rating of countries on combating climate change in 2022, Kazakhstan ranked last among 64 countries as the country with the worst air pollution index (API) (Liter.kz network).

The scientific concept of sustainable development has now been realized in the form of more specific ESG standards (ESG The Report) based on the principles of Environmental Impact Assessment (EIA) (WECOOP). The ESG agenda for the mining sector includes the following issues:

– Environment (Environment): biodiversity, ecosystem services, water management, mine waste/tailings, air, noise, energy, climate change (carbon footprint, greenhouse gases), hazardous substances, mine closure;

– Social: human rights, land use, resettlement, vulnerable people, labor practices, worker/community health and safety, security, miners, mine closure/after-use;

– Governance: legal compliance, ethics, transparency.

In doing so, mining companies need to consider whether there are environmental, social or governance risks that may affect their ability to: raise capital; obtain permits; work with communities, regulators and NGOs; and/or protect their assets from impairment. And then there may be opportunities to: reduce energy and water bills or carbon emissions; improve operational performance; and improve community and regulatory relations (Ruan, 2019).

An important part of implementing an ESG strategy is green mining, which involves using environmentally friendly mining technologies, building environmentally friendly mines, and

shifting from extensive mining to a green, zero-waste mining regime. One of the first countries to put forward the concept of "green mining" is China. At present, China defines a green mine (Shuai, 2022) as a mine that carries out scientific and planned mining in the whole mining process, controls the disturbance of the ecological environment in the mining area and adjacent areas within a controlled range, and realizes an ecological environment, scientific mining methods, efficient resource utilization, digitized management information and a harmonious mining community (Chaulya, 2003; Zaitsev, 2022).

Globally recognized ESG principles presuppose consideration of technical, environmental, social and economic indicators of the designed economic object in interrelation; proposal of several variants of economic activity implementation ensuring fulfillment of environmental requirements; consideration of regional peculiarities of the natural environment condition; consideration of prospects of socio-ecological development of the region and social interests of its population. ESG standards management recommendations are organized in accordance with five key principles:

ESGP 1 – Environmental and Social Governance: create effective leadership and governance on ESG issues.

ESGP 2 – Impact and Risk Management: assess and manage impacts and risks.

ESGP 3 – Permits: obtain and maintain compliance with approvals and permits.

ESGP 4 – Environmental planning: minimizing environmental impacts and long-term liabilities.

ESGP 5 – Social Planning: protecting people and benefiting communities.

In order to improve ESG rating and attract sustainable finance, mining companies create and publish non-financial reporting on sustainable development, corporate social responsibility and GHG regulation.

ShalkiyaZinc LTD JSC plans to implement the project for construction of the processing plant at the Shalkiya lead-zinc mine in compliance with ESG standards based on reduction of environmental impact and implementation of the principles of closed-loop economy. One of the main types of environmental impacts associated with the Shalkiya mine expansion project is the impact of mining operations on air quality.

JSC "ShalkiyaZinc LTD" is an enterprise for mining and processing of lead-zinc ore at the Shalkiya deposit, which is located in the south-east of Kyzylorda, in the north-east 17 km from the town of Zhanakorgan, at 67°25'00 "E east longitude and 44°01'20 "N north latitude (Figure1). According to research company BrookHunt (2006) total zinc reserves of Shalkiya deposit make more than 30% of all reserves of Kazakhstan and is the 5th largest deposit in the world with proven and probable reserves of 6.5 million tons of zinc.

On the territory of JSC "ShalkiyaZinc LTD" there are no pollution monitoring stations of RGP "KKG".

of the natural environment of RGP "Kazgidromet". The nearest settlement, which also bears the name Shalkiya, is located 4 km south of the mine and was built in Soviet times to provide housing for miners' families. Currently, the population of the settlement is approximately 5 thousand people, since the population of the settlement is less than 10 thousand people, according to RD 52.04.186-89, when the population is less than 10 thousand people, background concentrations are assumed to be equal to zero for all pollutants.

Results and Discussion

In industrialized countries, the optimal combination of the amount of atmospheric pollution and the degree of protection from it is the system of atmospheric air quality management in accordance with the EIA principles. The system of atmospheric air quality management is based

on consideration of environmental and economic priorities (Stehlнk, 2018; Represa, 2020). The purpose of atmospheric air quality management is to ensure the fulfillment of norms and requirements limiting the harmful impact of production processes on the environment, ensuring the rational use of natural resources, their recovery and reproduction (Tsyplakova, 2012). The state of atmospheric air in the area of mining operations, affecting the components of the OS, is determined by two factors:

– climatic features of the territory, determining the conditions of dispersion of polluting components;

– ingredient composition, volumes of pollutant emissions and characteristics of sources of harmful emissions.

At the first stage of the study we analyzed the sources of pollution and climatic conditions of the area of the lead-zinc mine, characterized the object as a source of atmospheric air pollution (Kozhagulov, 2023).

The geographical location of the mine determines the magnitude and character of zonal climatic processes. The deposit is located in the southwestern part of the Karatau Range. The relief is weakly hilly with a slope to the southwest with a difference in altitude from 260 to 230 meters.

The Shalkiya mine is located 18 km north of the Zhanakorgan station, Kzylorda region, Republic of Kazakhstan.

region, Republic of Kazakhstan. The mine site is flat with a slight gradient to the west towards the Syrdarya River.

towards the Syr Darya River. The vegetation is mainly steppe grass and low shrubs. Economic use of lands - pastures. Climate of the district is sharply continental. It is characterized by aridity and significant fluctuations of daily and annual temperatures.

– Climatic sub-area IV - G.

– Road-climatic zone - V.

– Region by weight of snow cover - I

– Area by ice wall thickness - II

– District by wind pressure - III.

– The average monthly temperature of the warmest month (July) is 27.8 degrees, the coldest month (February) - 6.1 degrees.

– The prevailing wind direction is NE. Average wind speed in winter is -2.7m/s in July -1.8m/s.

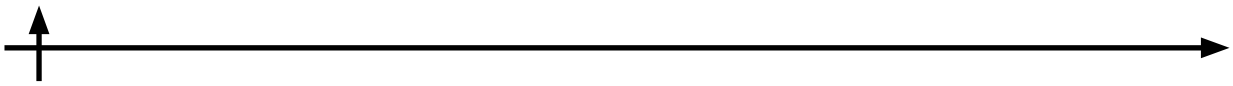
– Average precipitation (total) for April-October - 71mm.

– Average precipitation (total) for November-March-86 mm.

– The thickness of snow cover is 20cm.

The climate of the district is sharply continental with hot, dry, long summer and cold, snowy winter. Continentality of the climate is manifested in large fluctuations of meteorological elements, in their daily and annual course, aridity. Natural-climatic conditions of the territory under consideration, characterized by a significant predominance of evaporation over precipitation, have formed naturally saline lands (Geldyeva, 2004).

The abundance of heat, sunny days, low precipitation, and large amplitudes of air temperature are characteristic. Increased temperatures together with significant reduction and mineralization of precipitation, aeolian processes contribute to aridization, which leads to the process of salinization and desertification of the territory. Due to prevalence of easily dispersed soil, which on desert, semi-desert lands poor in vegetation cover, in the presence of dry and hot weather in most part of the year, favorable conditions are created for formation of increased background of natural atmospheric pollution by dust. The abundance of sunny days and high intensity of



solar radiation create favorable conditions for the formation (in the presence of pollutants) of secondary harmful substances, even more toxic than the initial products, as a result of photochemical reactions - the formation of so-called photochemical smog (Salnikov, 2006).

It is established that in the presence of dry and hot weather in most part of the year, favorable conditions for the formation of an increased background of natural atmospheric pollution by dust are created.

It is established that in the process of the enterprise activity 15 pollutants are emitted into the atmosphere at the present position. Emissions of harmful substances are emitted during mining operations, movement of vehicles and from fuel combustion products. The results of air emissions monitoring for 2021 and 2022 showed the following: air pollutant emissions from stationary sources at the main industrial site of the mine do not exceed the established limits, concentrations of pollutants in the air at the boundary of the sanitary protection zone and in settlements comply with applicable standards. The content of Pb, Zn, Cd in air samples also did not exceed the permissible limits. In the future, during the construction of the enrichment plant their amount will increase to 64 pollutants, the priority ones being suspended solids, sulfur dioxide, carbon monoxide and nitrogen oxides (Unified environmental portal).

It is shown that the totality of climate-forming factors of the mine area, located in the zone with high potential of atmospheric pollution, can create unfavorable conditions for the dispersion of harmful substances. In this regard, it is necessary to conduct system measurements of background atmospheric air concentrations in different seasons of the year for operational forecasting of impurity concentrations.

At the second stage we analyzed the system of atmospheric air quality management, which is an integral part of the environmental policy of the company.

The position of the company JSC "Shalkiya ZincLtd" in relation to its role and obligations in preservation of favorable environment in the territories of facilities location and adjacent territories is formed as its own vision of environmental policy of development and transition of the company to ESG standards, contains necessary elements such as principles, intentions and obligations of the organization in relation to the protection of the environment (Yadav, 2020).

The company sees its mission in the creation of production that intelligently combines primary and secondary material resources, based on advanced technological solutions, adaptive, fair, safe and inclusive model of interaction of all participants of the value chain.

First of all, the enterprise is focused on meeting the requirements set by the legislation of the Republic of Kazakhstan in the field of atmospheric air protection (Ecological Code of the Republic of Kazakhstan).

The requirements imposed by modern environmental legislation of the Republic of Kazakhstan include the organization and maintenance of primary accounting, which is based on the inventory of sources of harmful emissions, development and approval of such important for the enterprise regulatory documents in terms of air protection, such as "Draft standards of maximum permissible emissions (MPE) of pollutants into the atmospheric air". The permit for emission of harmful (polluting) substances into the atmospheric air establishes maximum permissible emissions and other conditions that ensure atmospheric air protection (Chaulya, 2006; Pezzella and Pliushch, 2022). The most important element of the atmospheric air quality management system is regular industrial environmental control. The atmospheric air quality management system at the Shalkiya lead-zinc mine affects a number of important technological and organizational aspects of production activities, including the energy resources and energy efficiency management system and emission treatment methods.

The Environmental Policy of JSC "ShalkiyaZinc LTD" contains necessary elements such as principles, intentions and obligations of the organization in relation to the environment. This

policy declares ensuring compliance of the company's activities with the legislation of the Republic of Kazakhstan, allocation of necessary resources, openness and dialogue with the public, minimization of risks and impacts on the environment, monitoring, etc. The framework for revision of the policy is set. It should be noted the unconditional importance of adopting an environmental policy as the first key step towards the creation of an Environmental Management System.

Conclusion

In accordance with the basic principles of ESG JSC "Shalkiya ZincLtd" has undertaken the following obligations:

– implementation of measures to ensure environmental safety and protection of the environment;

– carrying out preventive measures to prevent pollution and environmental damage;

– elaboration of management decisions based on multi-variant development scenarios and taking into account environmental priorities;

– ensuring minimization of risks of negative environmental impacts at all stages of production activities;

– conducting industrial environmental monitoring;

– ensuring the availability of the Company's environmental information in the field of environmental protection and decisions taken;

– periodic updating of the environmental policy taking into account changing environmental requirements and scientific and technical development.

The main mechanisms of air quality management at the Shalkiya mine include: application of air quality norms and standards; control and regulation of pollutant emissions, through licensing and permitting procedures for the company; application of the best available technologies and production processes; development and implementation of programs to limit the use of fossil fuel-based transportation, in the future it is envisaged to transition to a "digital mine - concentrator", application of the "digital mine - concentrator".

The analysis has shown that the totality of climate-forming factors of the mine area, located in the zone with a high potential of atmospheric pollution, can create unfavorable conditions for the dispersion of harmful substances. In this regard, it is necessary to conduct systematic measurements of background atmospheric air concentrations in different seasons of the year for operational forecasting of impurity concentrations.

The atmospheric air quality management system at the Shalkiya lead-zinc mine affects a number of important technological and organizational aspects of production activities, including the energy resources and energy efficiency management system and emission treatment methods.

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Статья поступила в редакцию 01.03.2024; одобрена после рецензирования 07.03.2024; принята к публикации 07.03.2024.
The article was submitted 01.03.2024; approved after reviewing 05.03.2024; accepted for publication 07.03.2024.