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Satbayev University

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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**DUST SUPPRESSION ON THE SURFACES OF STORAGE
DEVICE OF TECHNOGENIC MINERAL FORMATIONS**

Abstract. The work is devoted to the search and substantiation of the dust suppression method on the beaches of the waste dump at Zhezkazgan concentrating factory 1,2. This work involves the search and substantiation of the optimal methods to reduce the industrial impact of the mining and processing industry on the environment by ensuring dust suppression on the beaches of the tailings dams of the concentration factories. The selected dust reducing reagents were experimentally studied in 400 m² areas with a single coating. Monitoring of the resulting coverage state showed that the most resistant to mechanical stress, the coating with the maximum thickness on the waste storage surface is formed when using the Nalco Dustbind reagent. To assess the current state of dusting at the waste dump under consideration and the effectiveness of dust suppression, studies were carried out on the content of pollutants in atmospheric air. The concentration in the air of such pollutants as suspended matter, sulfur dioxide, hydrogen sulfide, inorganic dust with a content of 70-20% silicon dioxide, dust PM 2.5 and PM 10 was analyzed. The main type of emissions from the surface of waste is dust (suspended matter); fine-dispersed dust PM 2.5 and less prevails in granulometric composition. The measurements were carried out at 11 points with the maximum coverage of the entire territory of the waste dump and the sanitary protection zone. As a result of measurements, no excess was revealed for any of the analyzed substances. The atomic emission method with inductively coupled plasma, the element composition of the waste dump dust showed the content of 23 chemical elements with it. The obtained research results have

practical importance for providing the dust suppression on the waste dumps of concentrating factories.

Key words: mining enterprise, concentrating factory, waste dump, dust suppression.

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ТЕХНОГЕНДІК МИНЕРАЛДЫҚ ТҮЗІЛІМДЕР ЖИНАҚТАҒЫШТАРЫНЫҢ БЕТТЕРІНДЕГІ ШАҢДЫ БАСУ

Аннотация. Жұмыс Жезқазған байыту фабрикаларының 1,2 қалдық қоймасының жағажайларында шаңды басу әдісін іздеуге және негіздеуге арналған. Бұл жұмыс байыту фабрикаларының қалдық қоймалары жағажайларының шаң басуын қамтамасыз ету арқылы тау-кен байыту саласы кәсіпорындарының қоршаған ортаға техногендік жүктемесін төмендетудің неғұрлым оңтайлы әдістерін іздестіруден және негіздеуден тұрады. 400 м² көлеміндегі учаскелерде алдын ала іріктеп алынған шаң басатын реагенттер эксперименттік зерттеулерге ұшырады. Эксперименттік зерттеулердің әрбір қатысушысы үшін өлшемі 400 м² бірдей учаске бөлінді. Әрбір реагент шаң басатын жабынды бір мезгілде, бір рет жағуды жүзеге асырды. Алынған жабынның жай-күйін бақылау Nalco Dustbind реагентін пайдалану кезінде ең жоғары қалыңдығы бар қойма бетіндегі пленка механикалық кернеуге төзімді екенін көрсетті. Қарастырылып отырған қалдық қоймасындағы шаңның ағымдағы жай-күйін және шаң басудың тиімділігін бағалау үшін атмосфералық ауадағы ластаушы заттардың құрамы бойынша зерттеулер жүргізілді. Ауада қалқыма заттар, күкірт диоксиді, күкіртті сутек, құрамында 70-20% кремний диоксиді бар бейорганикалық шаң, РМ 2,5 және РМ 10 шаң сияқты ластаушы заттардың концентрациясына талдау жүргізілді. Қалдық сақтау қоймаларының бетіндегі эмиссиялардың негізгі түрі – шаң (қалқыма заттар); гранулометриялық құрамы бойынша РМ 2,5 және одан аз ұсақ дисперсті шаң басым болады. Өлшеулер қалдық қоймасының және санитарлық-қорғау аймағының барлық аумағын барынша қамти отырып, 11 нүктеде жүргізілді. Өлшеу нәтижесінде талданатын заттардың бірде-біреуінен асып кету анықталған жоқ. Индуктивті-байланысқан плазмамен атомдық эмиссия әдісімен жүргізілген қалдық қоймасының шаңының

элементтік құрамы онымен бірге 23 химиялық элементтердің құрамын көрсетті.

Түйін сөздер: тау-кен байыту кәсіпорны, байыту фабрикасы, қалдық қоймасы, шанды басу.

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ПЫЛЕПОДАВЛЕНИЕ НА ПОВЕРХНОСТЯХ НАКОПИТЕЛЕЙ ТЕХНОГЕННЫХ МИНЕРАЛЬНЫХ ОБРАЗОВАНИЙ

Аннотация. Работа посвящена поиску и обоснованию метода пылеподавления на пляжах хвостохранилища Жезгазганских обогатительных фабрик 1,2. Данная работа заключается в поиске и обосновании наиболее оптимальных методов снижения техногенной нагрузки предприятий горно-обогатительной отрасли на окружающую среду путем обеспечения пылеподавления пляжей хвостохранилищ обогатительных фабрик. Экспериментальным исследованием подвергнуты предварительно отобранные пылеподавляющие реагенты на участках размером 400 м² при однократном покрытии. Мониторинг состояния полученного покрытия показал, что наиболее устойчивая к механическим воздействиям, с максимальной толщиной пленка на поверхности хвостохранилища образуется при использовании реагента Nalco Dustbind. Для оценки текущего состояния пыления на рассматриваемом хвостохранилище и эффективности пылеподавления проведены исследования по содержанию загрязняющих веществ в атмосферном воздухе. Проводился анализ концентрации в воздухе таких загрязняющих веществ, как: взвешенные вещества, диоксид серы, сероводород, пыль неорганическая с содержанием 70-20% диоксида кремния, пыль РМ 2,5 и РМ 10. Основной вид эмиссий с поверхности хвостохранилищ – пыль (взвешенные вещества); по гранулометрическому составу преобладает пыль мелкодисперсная РМ 2,5 и менее. Замеры проводились в 11 точках с максимальным охватом всей территории хвостохранилища и санитарно-защитной зоны. В результате измерений не выявлено превышения ни по одному из анализируемых веществ. Проведенный атомно-эмиссионный методом с индуктивно-связанной плазмой элементный состав пыли хвостохранилища показал содержание

в ней 23 химических элементов. Полученные результаты исследований имеют практическое значение для обеспечения пылеподавления пляжей хвостохранилищ обогатительных фабрик.

Ключевые слова: горно-перерабатывающее предприятие, обогатительная фабрика, хвостохранилище, пылеподавление.

Introduction. The aim of this work is to find and substantiate the optimal methods to reduce the technogenic impact of mining and processing industry enterprises on the environment by ensuring dust suppression on the beaches of the tailing dumps of the concentrating factory of «Kazakhmys Corporation» LLP.

Objectives of the work are substantiation and study of the most effective method for reducing and gradually emissions eliminating into the environment from tailing dumps of Zhezkazgan concentrating factory No. 1,2 (ZhCF-1,2) of «Kazakhmys Corporation» LLP. Assessment of the impact of mining facilities on the environment is the subject of research in a number of works. For example, in (Bosak P. et.al, 2020), the toxicological properties of mine waste dumps and their impact on the environment are considered; in (Bosak P. et.al, 2020), the peculiarity of the seasonal dynamics of the content of hazardous components in wastewater from dumps of coal mines in a coal-mining region is considered; work(Yermekov M.T. et.al, 2020) is devoted to the storage of industrial waste from the mining and metallurgical industry of Kazakhstan, the arrangement of landfills, efficiency and operational features.

The problem of the tailing dumps dusting of the concentrating factories is also relevant. Dust drift from opencast mines and dumps, dry beaches, tailings and ash dumps causes significant damage to the environment. In addition to the constant excess of the dust content in atmospheric air, there is also an indirect impact on the environment. This factor should be attributed to a permanent one, because atmospheric dust, settling on the adjacent territories, pollutes the earth's surface, and upon subsequent dissolution, toxic compounds migrate into the soil and, ultimately, into groundwater. Thus, the problem of dust suppression of the existing tailing dumps of the mining and processing industry is very urgent.

There are various methods of dust suppression of tailing dumps beaches, which can be divided into the following main groups: hydraulic engineering, technological, chemical and biological. As the analysis of the available literary sources show (Hickel T. et.al, 2012; Idczak R. et.al, 2012), the most widely applicable are chemical methods, which provide the treating the surface of a site at the tailings damp with chemicals. The method of using phenol-formaldehyde resins, as well as compositions including polyacrylamide and technical lignosulfonates is also used. However, it is advisable to use them only for fixing the surface of dispersed materials for a short-term period from

1 to 2 months (Ilyina T.N et.al, 1999). A method of dust suppression at tailing dumps of iron ore processing enterprises has been proposed (Lychagin Ye.V. 2007). It involves the applying a chalk suspension to a dusty surface and further processing it with a dilute solution of sulfuric acid. As a result, the surface is covered with a protective layer similar in composition to natural gypsum. The disadvantage of this method is the time duration (7-8 days under the condition of dry and hot weather) of the protective layer formation and dependence on meteorological conditions, and there are also no studies of the effect of sulfuric acid on environmental components with this method of dust suppression. For dust suppression at the tailing dump of Zyryanovsk mining processing complex JSC «Kazzinc» uses an innovative technology with reagents from «Stockhausen-Eurasia» company. At the dusty beaches of the tailing dumps of the mining and processing complexes of the Kursk magnetic anomaly, fixing compounds have been created based on aqueous acrylic dispersions, a copolymer of vinyl acetate with vinyl esters of higher carboxylic acids, carboxymethyl cellulose, polyethylene oligomer and alkyl sulfates (Yastrebinsky R.N 2009). The authors of (Lobanov F.I. et.al, 2007) proposed a dedusting composition for the treatment of dusty surfaces, containing polyelectrolyte and water, characterized in that it contains aqueous solutions of an alkali metal polyacrylate and a copolymer of acrylamide with acrylic acid derivatives; solution of an alkali metal polyacrylate is 0.1-1.0 wt %, and the concentration of a solution of a copolymer of acrylamide with acrylic acid derivatives is 0.05-0.5 wt %. In (Kassymkhanova Kh.M. et.al, 2012), a method is described for strengthening dusty surfaces through the use of waste from concentrating factories and the production of rubber (divinyl styrene latex), cement and water. The preventive composition to avoid blowing out of fine materials, containing urea-formaldehyde resin, hardener, calcium chloride and water is also known (SU Certificate of authorship). The disadvantage of the composition is its reduced water resistance as a result of the destruction of the water-soluble polymer by atmospheric precipitation, as well as the low mechanical strength of the resulting polymer film during vibration, which occurs during the transportation of fine cargo and negative temperatures below minus 20°C.

Thus, chemical stabilization consists of directed change in the properties of the surface layer of the washed-in material by creating an anti-erosion coating from the dump material treated with chemical binders. The choice of binders, in each case, is determined by the granulometric, chemical and mineral composition of the tailings and the required frequency of work. The created coating should ensure normal operation of the alluvial structure, not adversely affect its water regime and ensure the structural safety of the fixed tailings under load.

As can be seen from the above, chemical methods are very diverse in terms of the compositions used, which are selected mainly as a result of experiments for

each specific dust suppression object. However, in the published sources there is no information on solving the problem of dusting the beaches of the tailing dumps of Zhezkazgan concentrating factories.

Materials and methods. The aim of the research is to identify optimal reagent to reduce dusting on the tailing dump beaches. Preselected reagents were subjected to experimental studies, i.e. Sedifloc @ RH-4810 (section 1); AZ 550 (section 2); Nalco Dustbind (section 3).

The same area of 400 m² was allocated for each participant in the experimental studies. Each was subjected to a simultaneous, one-time dust suppression coating.

Section 1 was treated with Sedifloc @ RH-4810 reagent at a concentration of 5%. Solution consumption 300 l, specific solution consumption - 0.75 l / m². Section 2 was treated with AZ 550 polymer dust-suppressing reagent at a concentration of 7%. Solution consumption 260 l, specific solution consumption - 0.65 l / m². Section 3 was treated with NalcoDustbind reagent at a concentration of 5%. Solution consumption 400 l, specific solution consumption - 1 l / m².

To determine the concentration of suspended solids, sulfur dioxide, hydrogen sulphide, inorganic dust with a content of 70-20% silicon dioxide in the air, the gas analyzer GANK-4 was used; the Atmos dust analyzer was used to express measurements of PM 2.5 and PM 10 dust, microclimate parameters were determined by the Meteoscope device. All equipment is included in the register of measurement instruments of the Republic of Kazakhstan and has passed the planned metrological certification (verification). All studies were carried out in accordance with the requirements of regulatory documents.

Results and discussion. The structure of the tailings storage system ZhCF-1,2 includes two fields of the tailings storage facility. The hydraulic structures of the first field of the tailing's management were operated in the period from 1964 to 2008 with the construction of a dump up to 67 meters high. The first field of the tailing dump is located at a distance of 0.2 km from the Zhezkazgan-Karaganda highway and at a distance of 4.2 km from Zhezkazgan railway station. The second field of the tailing's storage facility (new tailing dump) of the slope type is located to the east of the first field, being its continuation to the east for a distance of 3.5 km. In accordance with ZhCF - 1,2 «Kazakhmys Corporation» LLP belongs to the enterprises of the 1st hazard class - mining and processing industries, dumps, tailing dumps and sludge ponds for the extraction of non-ferrous metals, with the size of the sanitary protection zone (SPZ) not less than 1000 m. The dusting of the beaches of the ZcCF-1,2 tailing dump occurs on an area of 399 hectares. In 2019, the dusting of the surface (beaches) amounted to 1557.51 tons/year, the volume of stored tailings of copper ore dressing in 2020 amounted to 22,994382.16 tons.

The first observations of the treated areas were made the day after coating.

The inspection results are:

- section 1 - thickness 1–1.5 mm, the crust is plastic, flexible, does not collapse;
- section 2 - 3–4 mm thick, the crust is not destroyed;
- section 3 - 5–7 mm thick, the crust is not destroyed.

Secondary monitoring of the test sections state was carried out 24, 46, 70 days after the application of dust suppression coatings. The observation showed the following results:

- section 1 - the most flexible, film-like layer, not damaged, partially visible by dust, the crust is smooth, even, well-set. The average value of the crust thickness is 3.3 mm.
- section 2 - the layer is thin, loose, fragile, quickly broke under the weight of a person, not noticeable by dust. The average value of the crust thickness is 3.9 mm.
- section 3 - thick, not flexible, did not break with hands, not damaged, partially visible by dust. Visually, the crust is uneven, with differences in height. The crust is irregular: in some places layered, the thickness of which is 9–13.5 mm (average value 11.4 mm), in some places homogeneous, the thickness of which reaches 6–8 mm (average value 6.4 mm). This comparative analysis shows that it is preferable to use the reagent applied to area 3.

To assess the current state of dusting at the tailing dumps under consideration and the effectiveness of dust suppression, studies were carried out on the content of pollutants in the air. The research was carried out on tailings dumps in Zhezkazgan. Figure 1 shows the sampling points of the ZhCF - 1, 2 tailing dams.

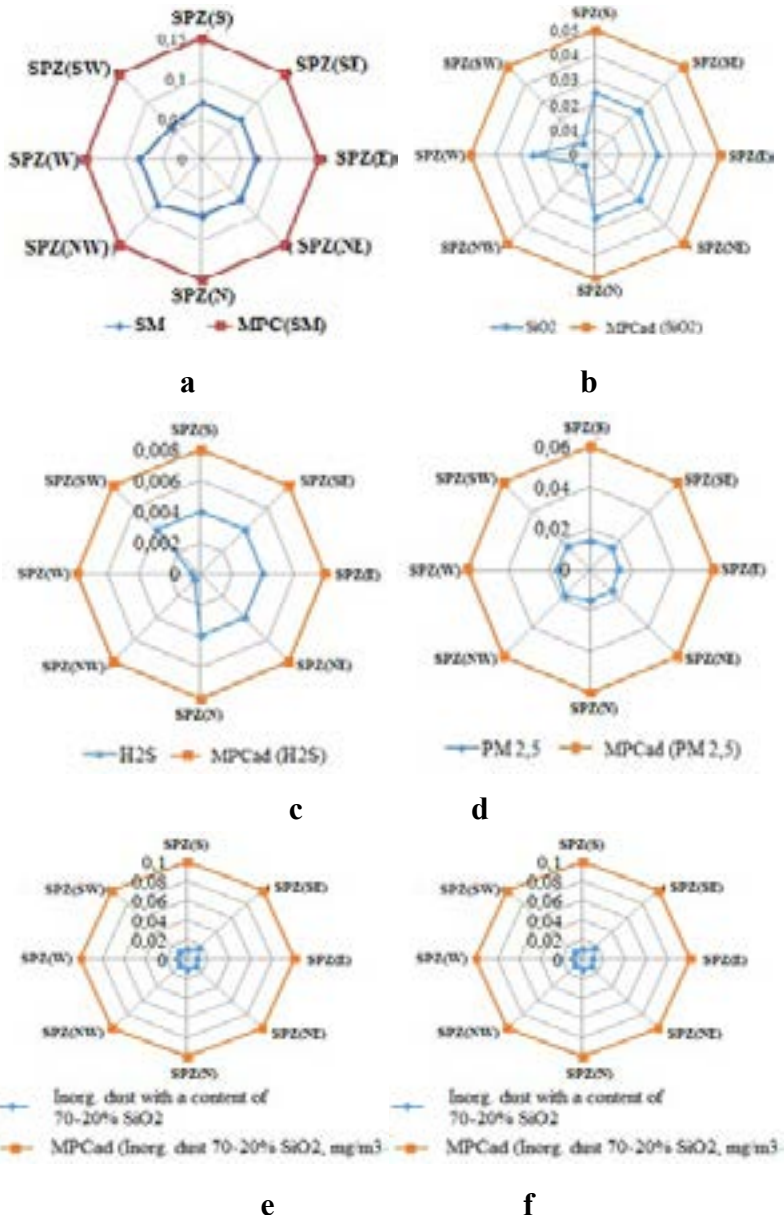
The concentration of such pollutants as suspended matter, sulfur dioxide, hydrogen sulfide, inorganic dust with a content of 70-20% silicon dioxide, dust PM 2.5 and PM 10 in the air was analyzed

It should be noted that the main type of emissions from the surface of tailings is dust (suspended matter); fine dust PM 2.5 and less prevails in granulometric composition.



Figure 1 - Sampling points at the ZhOF -1, 2 tailing dump of

Figure 2 shows the concentrations of suspended solids, silicon dioxide, hydrogen sulfide, PM 2.5, PM 10 particles, inorganic dust (70-20% silicon dioxide), built according to 8 points at the boundary of the SPZ.



a - suspended solids; b - silicon dioxide;
 c - hydrogen sulfide; d - PM 2.5;
 e - PM 10; f - inorganic dust (70-20% silicon dioxide).

Figure 2 - Concentrations of pollutants at the ZhCF - 1,2 tailing dump

The data analysis shows that no excess was found for any of the analyzed substances at the time of measurements. Considering the meteorological conditions during measurements (temperature + 11-13°C, wind 3-4 m / s), the obtained results on the concentrations of pollutants can be taken as the initial ones when carrying out further studies on dust suppression at the ZhCF-1,2 tailing dump.

The elemental composition of dust in the studied areas of the tailing dump was analyzed. The studies were carried out by the atomic emission method with inductively coupled plasma. The analysis results are presented in Table 1.

Table 1 - Results of dust samples research

Defined element	Content, mg/kg	Defined element	Content, mg/kg	Defined element	Content, mg/kg
Silver	0.9	Gallium	8.7	Strontium	235.0
Arsenic	5.6	Lanthanum	35.71	Titanium	1662
Barium	1236	Manganese	191.4	Vanadium	49.8
Cadmium	<0.05	Molybdenum	6.9	Wolfram	1.7
Cobalt	14.9	Nickel	11.0	Ittrium	9.0
Chromium	21.2	Lead	822.0	Zinc	39
Copper	8411	Antimony	<0.1	Zirconium	70.5
Iron	14160	Stannum	5.5		

According to data in the table the dust composition of the ZhCF-1,2 tailing dump is rather complex and varied; the content of copper, barium, iron, titanium, lead prevails; contains less cadmium, silver and antimony.

Conclusion. The mining industry has a wide variety of environmental impacts (Tseshkovskaya Ye. et.al.2021). One of the urgent problems for the mining and processing industry is the dusting of the beaches of the tailing dumps of the concentrating factories. In this work, studies have been carried out on the selection and justification of the most effective dust suppression reagent using for the tailing dump of the Zhezkazgan concentrating factories -1,2 (ZhCF-1,2).

Analysis of the current situation at the tailing dump ZhCF-1,2, showed that a significant amount of stored waste and the available dusting area of the beach surface require dust suppression measures.

A chemical method of dust suppression with the use of reagents form a coating on the surface of the waste, preventing the spread of dust into the atmospheric air, is considered.

Studies have shown that Nalco Dustbind reagent proved to be the most effective among three pre-selected reagents (considering the manufacturer's recommended concentration, specific reagent consumption, thickness of the resulting coating and its mechanical properties).

The monitoring of the concentration of six pollutants in atmospheric air on

the territory of the tailing dump (suspended matter, sulfur dioxide, hydrogen sulfide, inorganic dust with a content of 70-20% silicon dioxide, PM 2.5 and PM 10 dust) did not reveal an excess for any of the analyzed substances.

The elemental composition of the tailing dump dust also showed the content of 23 chemical elements in it.

The obtained research results face practical importance for the dust suppression ensuring on the surface of the tailing dumps beaches of concentrating factories.

The work was carried out within the framework of the research topic «Substantiation and study of the most effective method for reducing and gradually eliminating emissions into the environment from the tailing dumps of the 1, 2, 3 Zhezkazgan concentrating factories».

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