ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный исследовательский
технический университет им. К. И. Сатпаева

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Kazakh national research technical university
named after K. I. Satpayev

SERIES
OF GEOLOGY AND TECHNICAL SCIENCES

4 (436)

JULY – AUGUST 2019

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

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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. Webof 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.

«ҚР ҰҒА Хабарлары. Геология мен техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген **№10892-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
http://www.geolog-technical.kz/index.php/en/

Редакцияның мекенжайы: Қазақстан, 050010, Алматы қ., Қабанбай батыра көш., 69а.
Қ. И. Сәтбаев атындағы геология ғылымдар институты, 334 бөлме. Тел.: 291-59-38.

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№10892-Ж,** выданное 30.04.2010 г.

Периодичность: 6 раз в год
Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18,
http://nauka-nanrk.kz /geology-technical.kz

Адрес редакции: Казахстан, 050010, г. Алматы, ул. Кабанбай батыра, 69а.
Институт геологических наук им. К. И. Сатпаева, комната 334. Тел.: 291-59-38.

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 10892-Ж, issued 30.04.2010

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz/geology-technical.kz

Editorial address: Institute of Geological Sciences named after K.I. Satpayev
69a, Kabanbai batyr str., of. 334, Almaty, 050010, Kazakhstan, tel.: 291-59-38.

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 4, Number 436 (2019), 230 – 237 **https://doi.org/10.32014/2019.2518-170X.118**

UDC 614.76

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FEATURES OF TEMPERATURE AND HUMIDITY CONDITIONS OF EXTINGUISHING WASTE HEAPS OF COAL MINES IN SPRING

Abstract. Burning of waste heaps of coal mines causes pollution of the environment with toxic gases, increases the temperature of the environment thereby changing the microclimate of the mining area. The purpose of the work is to investigate the temperature and humidity conditions of extinguishing heaps in the spring period in Novovolynsk mining area of Ukraine. The waste heap №1 of mine №9 "Novovolynska" mine were chosen for the research because the combustion processes were observed there in spring.

The following actions are foreseen to implement this goal: to determine the temperature on the surface of the heap and in the places of combustion; to determine relative humidity indicators of the rock at a depth of 5 cm, 30 cm, and 50 cm; to measure the radiation background at the extinguishing heap. The temperature of the surface of the extinguishing heap was determined by the contactless pyrometer NR-1300. Humidity of the rock was measured with a moisture tester MG-44. The radiation background was measured by dosimeter by SOEKS USA, LLC. The software is a package of applications Surfer, MS Excel, MS Visio. Statistical data processing was performed using correlation analysis.

It was found out that: the highest temperature regimes (+ 33-39 °C) was typical for the sites in combustion areas that are located on the middle tier of the southern slope exposure; at a depth of 5 cm the highest humidity was at the foot of the western side of the heap (44.8%); at a depth of 30 cm the highest humidity was at the foot of the western side of the heap (47%); at a depth of 50 cm, the highest humidity was at the foot of the northern side of the heap (55.1%); the highest rates of equivalent radiation dose were observed near the combustion sites of the rock and reached up to 0.18 μSv / h; the temperature on the surface of the extinguishing heap correlates with a humidity at a depth of 5 cm (K = -0.58542), 30 cm (K = -0.75665), 50 cm (K = -0.78303) and does not depend on the radiation background at all (K = 0.368116). With an increase in the rock temperature its moisture decreases and vice versa - at high humidity the temperature of the rock reduces.

Extinguishing heaps are environmentally hazardous as they cause emissions of toxic substances to the environment that do not decrease over the years. Extinguishing heaps due to combustion processes cause the burning of the root system of plants, that leads to the complications of recultivation.

Keywords: waste heap, burning, temperature, environmental safety.

Introduction. Combustion of mines waste heaps causes pollution of the environment with toxic gases, increases the temperature of the environment thereby changing the microclimate of the region [1, 2]. There are numerous scientific works on combustion of waste heaps in the summer and their ecological safety. However, this phenomenon at the initial stage is insufficiently studied.

In the Lviv-Volyn coal basin, which includes the Novovolynsk mining area, rock combustion takes place on operating heaps, heapsof the ChervonogradCentral Mining Enrichment Factory and extinguishing ones [3]. From the point of view of environmental safety, the most dangerous are extinguishing heaps, since combustion processes in them lastfor an average of 20 years and are accompanied by shifts of rock andsubsidences. [4-6]. On the extinguishing heaps vegetation, formed with the participation of zonal vegetation performing aesthetic and buffer functions between combustion products and the environment, develops [7, 8]. Extinguishing heaps are a medium for the development of fungi, invertebrates and some species of animals, which is a positive phenomenon of adaptation of man-made objects to environmental conditions [9].

Investigation of combustion processes on the heaps, where forest vegetation is forming due to natural overgrowing in the spring period, is an up-to-date issue.

Purpose, tasks and methods of research. The purpose of the work is to investigate the temperature and humidity conditions of extinguishing heaps in the spring period in Novovolynsky mining area of Ukraine. The waste heap # 1 of mine №9 "Novovolynska" mine was chosen for the research because the combustion processes were observed there in spring.

The following actions are foreseen to implement this goal:

– to determine the temperature on the surface of the heap and in the places of combustion;

– to determine relative humidity indicators of the rock at a depth of 5 cm, 30 cm and 50 cm;

– to measure the radiation background at the extinguishing heap.

In order to study the temperature and humidity conditions of the heap, 8 study areas were chosen: 1 - at the foot of the northern side of the heap; 2 - on the top of the heap at 59 m; 3 - at the foot of the eastern side of the heap; 4 - at the foot of the western side of the heap; 5, 6, 7 - in the burning places on the southern slope exposition; 8 - at the foot of the south side of the heap. The research was conducted according to approved methods [10-12]. The period of research is April 2017. The average temperature of the environment was +8.1 °C.

The temperature of the surface of the extinguishing heap was determined by the contactless pyrometer NR-1300. Humidity of the rock was measured with a moisture tester MG-44. The radiation background was measured by dosimeter by SOEKS USA, LLC. The software is a package of applications Surfer, MS Excel, MS Visio. Statistical data processing was performed using correlation analysis.

Results and their discussion. Waste heap №1 of the mine №9 "Novovolynska" of the state enterprise "Volynvuhillya" began to operate in 1961, and was completed in 1982.

After the end of waste heap operation, the processes of combustion of the rock refuse are taking place. Intensification of combustion is observed immediately after the snow melting in spring and at the beginning of a fire hazard period. The peak periods of combustion occur in the summer months of July and August. Extremely important is the investigation of temperature and humidity regimes of the waste heap №1 of mine №9 "Novovolynska" in spring, as these regimes directly affect the natural forest-forming processes observed on the surface of the heap and the area of forest re-cultivation in the initial period of plant development. The geometrics of the heap is given in table 1.

Table 1 – Geometric parameters of the waste heap №1 of the mine №9 "Novovolynska"

Parameter	Project	Real situation
Volume, thous. m^3	1430	1050
Height, m	70	59.8
Base area, thous. m^2	61.5	47.1
Pitchangle, degrees	50	40

The control of the thermal condition of the waste heaps is carried out in order to: timely identify the area of self-heating on operating heaps and take measures to prevent self-firing of rocks; evaluation of the effectiveness of measures to reduce the burning rate of waste heaps; obtaining of initial data for the development of projects for the extinguishing or dismantling of waste heaps; determination of the amount of harmful substances released into the atmosphere by the waste heap [12-14].

The average temperature on the surface of the extinct heap at the time of the research was + 18.8 °C. The lowest rates were at the top and at the foot from the south side + 6-8 °C. The highest temperature regimes (+ 33-39 °C) were typical for sections 5, 6, 7 - in combustion areas on the southern slope exposition (figure 1).

In high temperatureareas emissions of combustion products from the rock mass were observed. Combustion products of the waste heaps are characterized by high toxicity and the content of hazardous substances and compounds of various origin [15-19].

It should be noted that according to the normative documents of Ukraine, a waste heap is considered to be burning if it has at least one combustion source (regardless of its area) with a rock temperature more than + 80 °C at depths up to 2.5 m. If the heap was non-burning but during the temperature survey at a

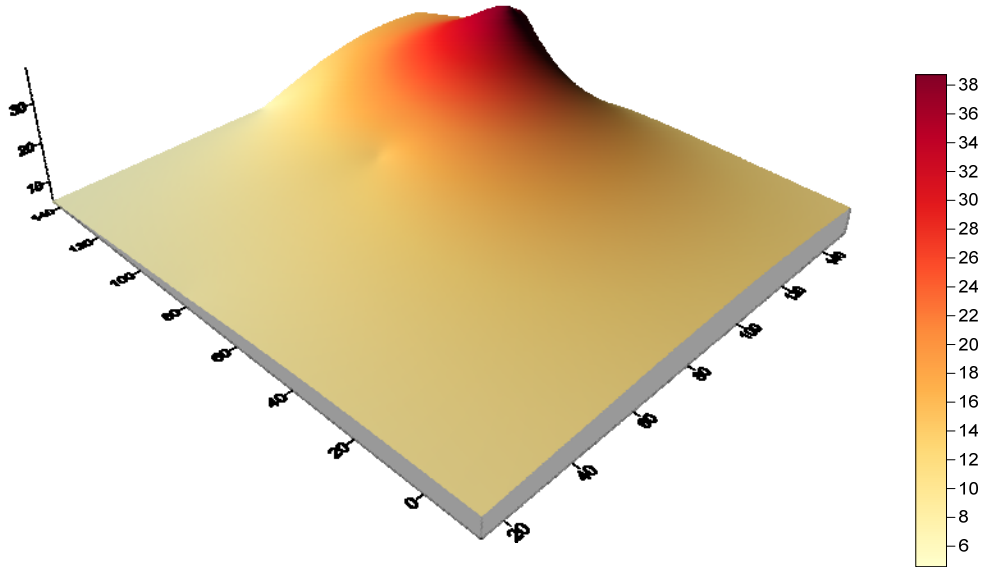

Figure 1 – Temperature profile of the surface of waste heap (°C)

depth of up to 2.5 m a temperature would be more than + 80 °C, and during the next survey it would be the same, then the waste heap is identified as burning, according to the corresponding act [12].Thus, if in accordance with the regulatory documents the heap is considered to be not burning, the measures for temperature reduce and decommissioning are supposed to beinappropriate (in accordance with the regulatory documents). However, the environmental hazards of such heaps are not less than those with a surface temperature of more than + 80 °C, since emissions of toxic substances to the environment do not decrease over the years. Due to combustion processes extinguishingheaps cause the burnt out of the root system of plants and result in inefficient remediation works.

The humidity measurement of the waste heap was carried out on the same sites at a depth of 5 cm, 30 cm and 50 cm from the surface. It was established that at a depth of 5 cm the highest humidity was at the foot of the western side of the heap (44.8%). The lowest humidity was observed on site 7 where combustion processes were present (16%) (figure 2).

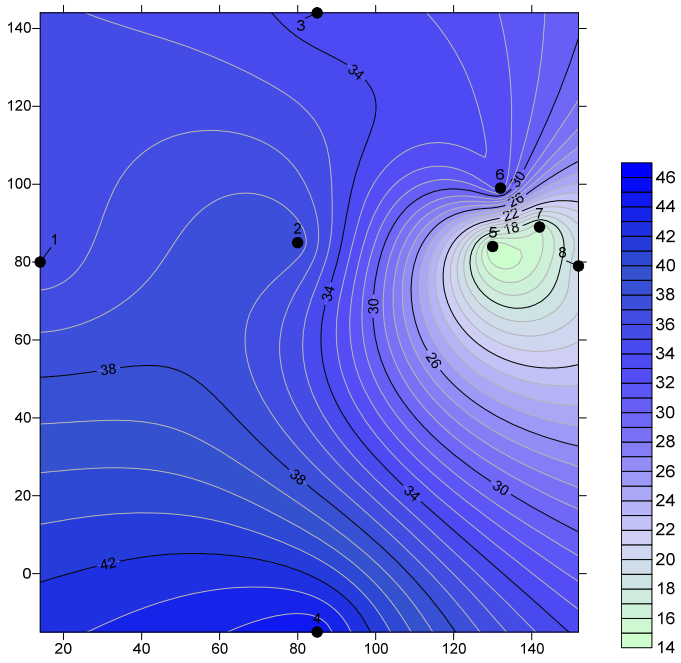

Figure 2 – Humidity of waste heap in the depth of 5 cm from the surface (%)

The same situation with humidity was observed at a depth of 30 cm. The highest humidity was at the foot of the western side of the heap (47%). The lowest humidity was observed at site 7 where combustion processes were present (11.2%) (figure 3).

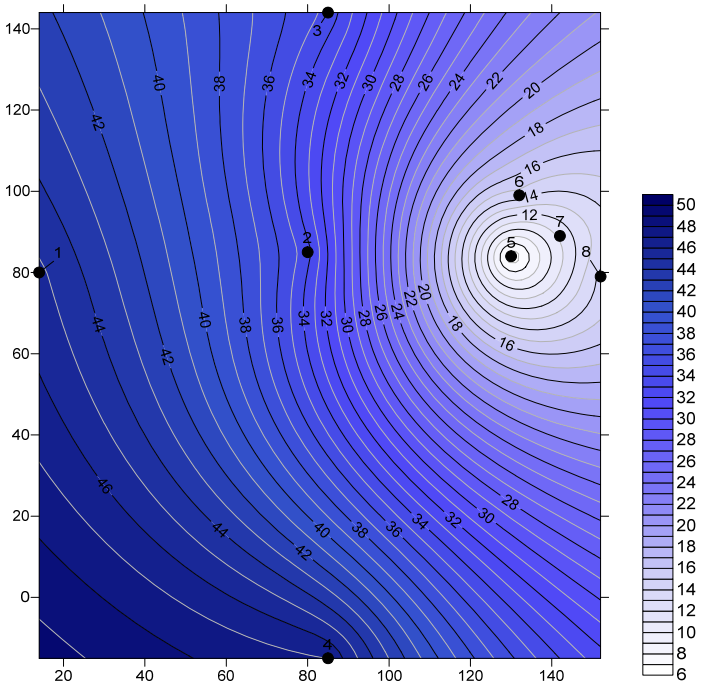

Figure 3 – Humidity of waste heap in the depth of 30 cm from the surface (%)

At a depth of 50 cm, the highest humidity was at the foot of the northern side of the heap (55.1%). In general, high humidity rates on the north side of the waste heaps are caused by low weathering, the lowest influence of solar radiation and initial soil forming processes that cause spontaneous vegetation overgrown. The lowest humidity was observed at site 5 where combustion processes were present (5%) (figure 4).

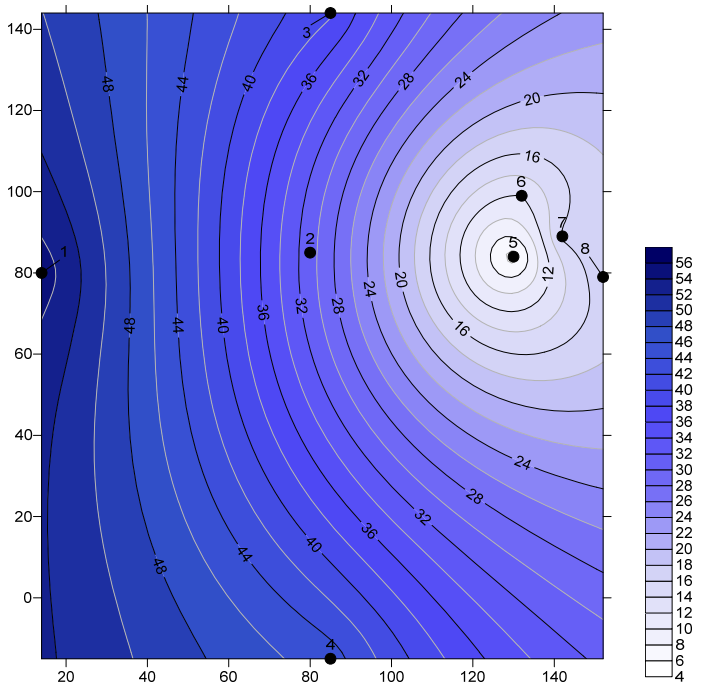

Figure 4 – Humidity of waste heap in the depth of 50 cm from the surface (%)

Some researchers [20, 21] confirm that combustion of the rock refuse causes an increase in the radiation background. Some aspects of the radiation background on coal mine waste heaps were considered in the monograph [22]. It was found that at a level of 15 m from the foot of the heap, the radiation power is much larger than in other areas. The conducted investigation of the radiation background of the heap №1 of mine №9 "Novovolynska" showed that the averaged indicators of the exposure dose rate on the surface of the extinguishing heapare 0.15 μSv/h. Indicators of the background radiation do not exceed the permissible norms, which are 0.3 μSv / h [23], but exceed the background values for Novovolynsk (0.11 μSv/h).Itshould be noted that the highest levels of exposure dose rate were observed near the combustion sites of the heap and were equal to 0.18 μSv/h. The lowest rates were stated at the foot of the heap at all sides (0.14 μSv/h). A detailed map of the radiation background of the waste heap is shown in figure 5.

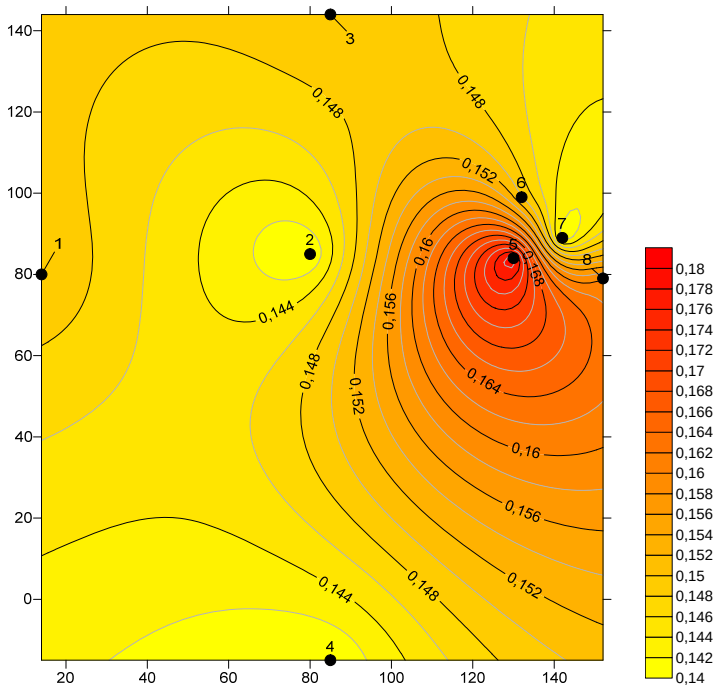

Figure5 – Exposuredoserate on the surface of waste heap (μSv/h)

Basing on the correlation analysis, we have established the correlation coefficients (K) used for evaluation of the mutual influence of the investigated indicators. It was established that the temperature on the surface of the extinguishing heap is correlates with a humidity at a depth of 5 cm (K = -0.58542), 30 cm (K = -0.75665), 50 cm (K = -0.78303) and does not depend from the radiation background (K = 0.368116). With the increase of temperature in the rock, its humidity decreases and vice versa - at high humidity, the temperature of the rock reduces. High positive correlation coefficients are registered for the humidity content at different depths (K = 0.754308-0.9652). More correlation coefficients are given in table. 2.

Table 2 – Correlation index of the investigated parameters

Indicator	Tempe-rature, °C	Humidity in the depth 5 cm, %	Humidity in the depth 30 cm, %	Humidity in the depth 50 cm, %	Radiation background, μSv/h
Temperature, °C	1				
Humidity in the depth 5 cm, %	-0.58542	1			
Humidity in the depth 30cm, %	-0.75665	0.879313	1		
Humidity in the depth 50cm, %	-0.78303	0.754308	0.9652	1	
Radiation background, μSv/h	0.368116	-0.62318	-0.55868	-0.52439	1

Thus, the correlation analysis gave an opportunity to clarify the peculiarities of the mutual influence of the investigated physical indicators on the surface of the extinguishing waste heap.

In order to prevent the dangerous devastation processes on waste heaps, it is necessary to use natural resources rationally, to carry out reclamation, phytomelioration of disturbed lands, to filter out dangerous emissions into the atmosphere, and to waterproof the underground and ground waters [24, 25]. At the same time, measures for soil protection from erosion should be carried out - phased land development, construction of water retaining and catchwater drain facilities, terracing, regrassingand afforestation, and the application of soil protection technologies for the cultivation of crops [26-29].

Conclusions. The investigation of the temperature and humidity conditions of extinguishing heaps in the spring period in Novovolynsk mining area of Ukraine was presented.As an example, the waste heap № 1 of mine №9 "Novovolynska" was chosen.

It was found out that:

– the highest temperature regimes (+ 33-39 °C) was typical for the sites in combustion areas that are located on the middle tier of the southern slope exposure;

– at a depth of 5 cm, the highest humidity was at the foot of the western side of the heap (44.8%). The lowest humidity was observed on the site where combustion processes were present (16%); at a depth of 30 cm the highest humidity was at the foot of the western side of the heap (47%), the lowest humiditywas observed on the site where combustion processes were present (11.2%); at a depth of 50 cm, the highest humidity was at the foot of the northern side of the heap (55.1%), the lowest humiditywas observed on the site where combustion processes were present (5%);

– the highest rates of equivalent radiation dose were observed near the combustion sites of the rock and reached up to 0.18 μSv/h. The lowest rates were stated at the foot of the heap at all sides (0.14 μSv/h); the averaged indicators of the exposure dose rate on the surface of the extinguishing heapwere 0.15 μSv/h.

– the temperature on the surface of the extinguishing heap correlates with a humidity at a depth of 5 cm (K = -0.58542), 30 cm (K = -0.75665), 50 cm (K = -0.78303) and does not depend on the radiation background (K = 0.368116). With an increase in the rock temperature its moisture decreases and vice versa - at high humidity the temperature of the rock reduces.High positive correlation coefficients are registered for the humidity content at different depths (K = 0.754308-0.9652).

Extinguishing heaps are environmentally hazardous as they cause emissions of toxic substances to the environment that do not decrease over the years. Extinguishing heaps due to combustion processes cause the burning of the root system of plants, that leads to the complications of recultivation.

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КӨКТЕМ КЕЗЕҢІ КӨМІР ШАХТАЛАРЫНЫҢ ӨШІП ҚАЛҒАН ТЕРРИКОНЛАРЫНДА ТЕМПЕРАТУРА МЕН ЫЛҒАЛДЫЛЫҚ ЖАҒДАЙЛАРЫ ЕРЕКШЕЛІКТЕРІ

Аннотация. Көмір шахталарының қалдықтарды қоқыстыру улы түтіндер мен газдармен қоршаған ортаның ластануына алып келеді, қоршаған орта температурасын көтереді, сондықтан осылайша тау-кен облысының микроклиматты өзгерту. Жұмыстың мақсаты - краинадағы Нововолинская тау-кен өнеркәсібі аймағында көктемгі кезеңде өшіп қалғанterриконларда температуралық және ылғалдылық режимдерін зерттеу. Зерттеу үшін Нововолинская № 9 шахтасының №1 терконы шоғырланған, өйткені көктемде оның үстінде күйдірілген процестер байқалды.

Осы мақсатқа жету үшін мұндай өлшемдерді жасау керек еді: терриконын бетінде және тұқымды жану орындарында температураны орнату; 5 см, 30 см және 50 см тереңдіктегі салыстырмалы жыныстық ылғалдылық көрсеткіштерін белгілеу; қалдықтарды массасінің сөну кезінде фон радиациясын өлшеу. Өшіп қалған терриконның тақтасы бетінің температурасы HP-1300 контактісіз пирометрімен орнатылады. Тау жыныстарының қалыптасуы ылғалдылығы MG-44 ылғал өлшеуішімен өлшенді. Радиацияның фоны Soaks экологиялық сынауышымен өлшенді. Бағдарламалық жасақтама - Surfer, MS Excel, MS Visio қосымшалар пакеті. Статистикалық деректерді өңдеу корреляциялық талдау арқылы жүзеге асырылады.

Зерттеу барысында табылды: ең үлкен температура режимдері (+ 33-39 ° C) оңтүстік беткі қабаттың ортаңғы қабатында орналасқан күйдіру орындарындағы аудандармен сипатталды; 5 см тереңдікте, ең жоғарғы ылғалдылық (44,8%) қалдықтардың батыс бөлігінің аяғында болған; 30 см тереңдікте, ең жоғарғы ылғалдылық (47%) қалдықтардың батыс бөлігінің аяғында болған; 50 см тереңдікте, ең жоғарғы ылғалдылық (55,1) қалдықтардың батыс бөлігінің аяғында болған; жоғары қуат фотонды иондаушы сәулеленудің балама дозасы тау жыныстарының жану орындарында байқалды және 0,18 мкЗв / сағ құрады. Әлсіреді теркон бетінің температурасы 5 см (K = -0,58542), 30 см (K = -0,75665), 50 см (K = -0,78303) тереңдікте ылғалды-

лыққа өзара әсер етеді және радиациялық фонға толығымен тәуелсіз (К = 0.368116). Тау жыныстарының температурасы артуымен, оның ылғалдылығы азаяды және керісінше - жоғары ылғалдылық кезінде таудың температурасы төмендейді.

Өшіп қалған терриконлар экологиялық қауіпті болып табылады, өйткені қоршаған ортаға улы шығарындылар, ол жылдар бойы азайған жоқ. Өшіп қалған үйіндіжану процестеріне байланысты өсімдіктердің тамыр жүйесі күйіп кетуіне, бұл мелиорациялау асқынулардың туғызады.

Түйін сөздер: терриконы, жану күю өртену, температура, экологиялық қауіп.

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ОСОБЕННОСТИ ТЕМПЕРАТУРНЫХ И ВЛАЖНОСТНЫХ РЕЖИМОВ ЗАТУХАЮЩИХ ТЕРРИКОНОВ УГОЛЬНЫХ ШАХТ ВО ВРЕМЯ ВЕСЕННЕГО ПЕРИОДА

Аннотация. Горение породных отвалов угольных шахт приводит к загрязнению окружающей среды токсичными испарениями и газами, повышает температуру окружающей среды тем самым изменяя микроклимат горнодобывающего региона. Цель работы - исследовать температурные и влажностные режимы затухающих терриконов в весенний период в пределах Нововолынского горнопромышленного района Украины. Для исследований выбран террикон №1 шахты №9 «Нововолынская», поскольку на нем наблюдали процессы горения в весенний период.

Для достижения поставленной цели предполагалось: установить температуру на поверхности террикона и в местах горения породы; установить относительные показатели влажности породы на глубине 5 см, 30 см и 50 см; измерить радиационный фон на затухающем терриконе. Температура поверхности угасающего террикона установлена с помощью бесконтактного пирометра НР-1300. Влажность породы измерялась с помощью влагомера МГ-44. Радиационный фон измерялся с помощью экотестера окружающей среды «Soeks». Программное обеспечение - пакет прикладных программ Surfer, MSExcel, MSVisio. Статистическую обработку данных осуществлено с помощью корреляционного анализа.

Установлено, что: повышенными температурными режимами (+33-39°С) характеризовались участки, которые находятся на среднем ярусе южной экспозиции склона; на глубине 5 см самой высокой влажность была у подножия с западной стороны террикона (44,8%); на глубине 30 см самой высокой влажность была у подножия с западной стороны террикона (47%); на глубине 50 см самой высокой влажность была у подножия с северной стороны террикона (55,1%); высокие показатели мощности эквивалентной дозы фотонного ионизирующего излучения наблюдались у мест горения породы и составили 0,18 мкЗв / ч; температура на поверхности затухающего террикона имеет взаимосвязь с влажностью на глубине 5 см (К = -0,58542), 30 см (К = -0,75665), 50 см (К = -0,78303) и совершенно не зависит от радиационного фона (К = 0,368116). При повышении температуры породы, ее влажность снижается и наоборот - при высокой влажности температура породы снижается.

Затухающие терриконы являются экологически опасными, поскольку вызывают выбросы токсичных веществ в окружающую среду,которые не снижаются с годами. Затухающие отвалы, вследствие процессов горения, вызывают выгорание корневой системы растений, что вызывает осложнения при проведении рекультивационных работ.

Ключевые слова: террикон, горение, температура, экологическая опасность.

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Верстка *Д. Н. Калкабековой*

Подписано в печать 22.07.2019.
Формат 70x881/8. Бумага офсетная. Печать – ризограф.
15,7 п.л. Тираж 300. Заказ 4.

Национальная академия наук РК
050010, Алматы, ул. Шевченко 28, т. 272-13-19, 272-13-18