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Д.В. Сокольский атындағы «Жанармай,
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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
АО «Институт топлива, катализа и
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Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Химия және технология 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. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

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K. Zhantassov[1], Z. Bagova[1], G. Turebekova[1], B. Sapargaliyeva[2], G. Pusurmanova[1]

[1]M. Auezov South-Kazakh University, Shymkent, Kazakhstan;
[2]Abai Kazakh National Pedagogical University, Almaty, Kazakhstan.
E-mail: cornerstone_z@mail.ru

DEVELOPMENT OF TECHNOLOGY FOR THE EXTRACTION OF LEAD AND ZINC OXIDES FROM DUST AND SLAGS DURING THE UTILIZATION OF LEAD PLANT WASTE

Abstract. The object of the study is lead-containing slag dumps from a lead plant. The slags of the lead plant contain a large number of toxic compounds: lead, zinc, osmium, cadmium, which are dangerous sources of environmental pollution. Due to the open storage of slags, it was found that the maximum permissible concentrations of lead were exceeded. Utilization of lead production slags allows to obtain non-ferrous metals and to reduce the technogenic load on the environment as a result of processing of slags. At the same time, slags are valuable raw materials containing compounds of non-ferrous and rare-earth metals.

The article proposes methods for the extraction of lead and zinc from slag waste and selects the optimal method for the selective extraction of zinc and lead oxides from dust and slags of lead production. The proposed technology of continuous carbon-free selective extraction of zinc and lead from the dust of electric steelmaking production allows the use of lead production slag, which is fed into a rotating drum furnace in two oppositely directed streams. During the movement of lead slag in the furnace drum and the burning of the torch, lead and zinc are more completely extracted from the dust-like material, where the transporting object is compressed air, and the purified flue gas after the gas is further purified by means of a smoke pump is released into the atmosphere.

When using the proposed selective method for extracting non-ferrous metals, the ecological state of the environment will be improved, and it will also reduce the negative impact on human health due to the disposal of toxic slags from lead production.

Keywords: waste, lead waste, toxic compounds, lead and zinc compounds, environmental pollution, toxic waste processing, waste disposal.

Introduction. Industrial enterprises generate dangerous and toxic chemicals, which are one of the most significant factors of environmental pollution.

The bulk of the waste is sent to dumps, landfills, sludge and tailings dumps, landfills and other storage facilities, of which there are a lot. For these accumulators, large areas of land are alienated, as well as for most of them, reliable isolation of the environment from pollution is not provided [1-4].

The object of the study is lead-containing slag dumps from a lead plant, which are production costs. To determine the methods of utilization and processing of lead slags and for the extraction of lead and zinc oxides, the following methods are proposed. There is a known method for separating zinc and lead oxides from dust formed in steelmaking and foundry industries, which consists in making briquettes from dust and a carbon-containing binder, further hardening them at a temperature of 315°C, extracting zinc and lead at a temperature of 1370°C with further oxidation of metals to oxides and their capture [5-8]. The disadvantages of this method are: the joint extraction of non-ferrous metal oxides from dust, the high energy and resource intensity of the process due to the need to introduce a reducing agent and fluxes.

The closest in technical essence and the achieved result to the proposed author's work is the production of lead and zinc oxides from the dust of metallurgical production (mainly electric steelmaking) and zinc production waste of a similar composition without the additional introduction of a reducing agent. The extraction of lead oxide proceeds by using fuel in a drum rotary kiln, and zinc oxide by using a plasma or arc energy source. The method of selective extraction of zinc and lead oxides from dust is provided by monitoring the pressure and temperature of the process in each reaction zone. The device for implementing the method under consideration consists of a drum rotating furnace, a chamber equipped with a jet plasma torch, gas cleaning systems with bag filters for collecting condensate of lead and zinc oxides [9-12]. The disadvantage of this method is: high labor intensity and complexity of technological design and control of the process temperature in the first reaction zone, high environmental risks and emissions of harmful compounds into the atmosphere.

The task of the proposed method for the disposal of slag waste from lead production is to more fully extract lead and zinc compounds, as well as to improve the environmental situation of the environment and reduce the harmful effects on human health. The technical result is the production of lead and zinc oxides. This is achieved by the fact that in the proposed technology of continuous carbon-free selective extraction of zinc and lead from the dust of electric steelmaking production, lead production slag is additionally used, fed into a rotating drum furnace by two oppositely directed flows, the dispersion of the composition containing the slag: 1–10 mm, a trifle coke and internal overburden of coal in the ratio of 1:0,2(3.8 to 4.5): from the cold end of the drum of the rotary kiln and pulverized part of the dispersion to 1 mm together with carbonaceous material dispersion up to 1 mm from the hot end of a rotary kiln, in the ratio of dust – bulk material 1: (9–9.5) and in accordance with the following scheme of the rotating drum furnace and flow chart of the method of extraction of oxides of lead and zinc are given below in figures 1 and 2 [13-16].

Problem statement. The slag of lead-zinc production is a sintered material with a granular shape from 2 to 6 mm, containing a small amount of class up to 10 mm with a bulk density of about 2 t/m^3 and an angle of repose of 35 degrees.

Table 1 shows the chemical composition of the used carbon-containing materials.

Table 1 – Chemical composition of carbon-containing materials

Content of components (%,%)						
Material	Cfree	SiO_2	Al_2O_3	Fe_2O_3	$S_{gen.}$	Moisture
Screenings of coal mining	35-65	27-32	2.5-6.5	2.6-2.9	up to 0.6	up to 3
Fines of coke	85	2-4	2-3	1-2	up to 4.0	up to 3

The proposed technology is implemented as follows (figure 1): from the slag hopper of the mixture with the charge 4 through the feeder with the drive 6 and the chute 10, the rotary drum furnace 1 is loaded with the charge material of class 1–10 mm from the cold end of the furnace equipped with the combustion chamber 2. The required temperature in the zone of high melting temperatures of the material is maintained within the range of 1000-1150°C ± 20°C, due to the combustion of natural gas through the gas burner device 3, where the nozzle is arranged above the burner for supplying the mixture of the dusty material 7, from fines of coke and slag of class 0–1 mm, fed from the hopper of the mixture of the dusty carbon-containing materials 8, using the feeder with the drive 9, and the pneumatic chamber pump for feeding the dusty material 5, in the presence of the torch from the fuel combustion in the burner from the hot (unloading) end of the rotary drum furnace 1.

During the lead-zinc slag movement in the furnace drum and the torch combustion, lead and zinc are extracted both from the dusty material, where the transporting object is compressed air, and from the charge material due to the formation of zinc and lead oxides according to the reactions:

first stage $PbO+CO=Pb+CO_2$

$Zn+CO=Zn+CO_2$

second stage $Pb+O_2=PbO$

$Zn+O_2=ZnO$

At the second stage of the process, the reducing agent of lead and zinc is an excess of oxygen injected by the nozzle together with the dusty fraction from the hot end into the furnace.

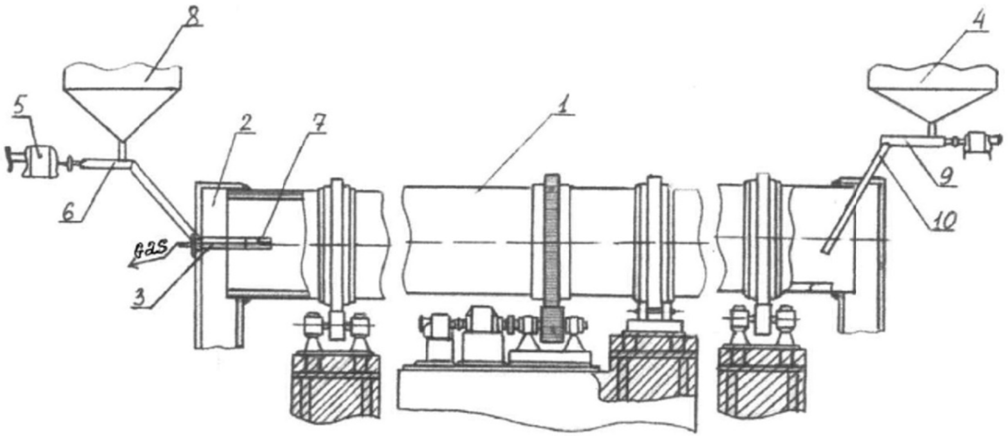

Figure 1 – Diagram of the rotary drum furnace:
1 – rotary drum furnace; 2 – combustion chamber (hot head);
3 – gas burner device (burner); 4 – slag hopper of the mixture with the charge;
5 – pneumatic chamber pump for feeding the dusty material; 6 – feeder with the drive;
7 – nozzle for feeding the mixture of the dusty material; 8 – hopper of the mixture
of the dusty carbon-containing materials; 9 – feeder with the drive; 10 – chute

The dust-gas mixture obtained in the rotary drum furnace (Figure 2) enters the flame-resistant chamber, and then into the cooling chamber. From the cooling chamber, the cooled material enters the duster with the bag filter. The dusty fraction of lead oxide and zinc oxide material precipitated in the duster with the bag filter is sent to the bunker of the filling device, and the filtered flue gas after additional filtration of gases using the smoke exhauster is released into the atmosphere.

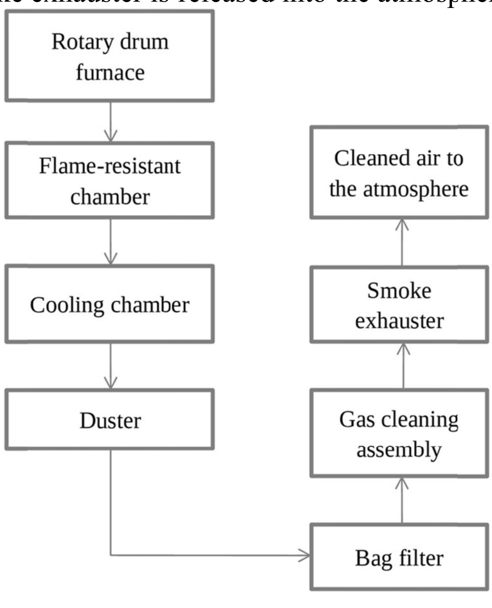

Figure 2 – Process diagram of the method for extracting lead and zinc oxides

Conclusion. Based on the results of processing and analysis of experimental data, we came to the conclusion that the presented technology allows to selectively obtain powders of zinc and lead oxides without introducing an additional reducing agent. Thus, in the proposed technology of continuous carbon-free selective extraction of zinc and lead from electric steelmaking dust, containing slag of lead production is additionally used, fed into the rotary drum furnace by two oppositely directed flows, material of class 1–10 mm containing slag, fines of coke and internal overburden of coal mining in a ratio of 1:0.2(3.8-4.5): from the cold end of the rotary drum furnace and the dusty part of class 0 – 1 mm together with carbon-containing material of class 0 – 1 mm from the hot end of the rotary furnace, in the ratio of dust to lump material 1:(9-9.5).

Analyzing the results of preliminary tests, we came to the conclusion that the proposed technology showed a more complete and selective extraction of lead and zinc oxides from slag wastes of lead production in comparison with other methods.

When using the proposed selective method for extracting non-ferrous metals, the ecological state of the environment will be improved and the negative impact on human health will be reduced due to the disposal of toxic slags from lead production. At the same time, a significant contribution is made to the development of a system for the rational use of natural resources.

Қ. Жантасов[1], З. Багова[1], Г. Туребекова[1], Б. Сапаргалиева[2], Г. Пусурманова [1]

[1]М.Әуезов атындағы Оңтүстік Қазақстан университеті, Шымкент, Қазақстан;
[2]Абай атындағы Қазақ Ұлттық педагогикалық университеті, Алматы, Қазақстан

ҚОРҒАСЫН ӨНДІРІСІНІҢ ҚҰРАМЫНДА ҚОРҒАСЫН БАР ҚАЛДЫҚТАРЫН ТАЛДАУ ЖӘНЕ АДАМНЫҢ ТІРШІЛІК ӘРЕКЕТІНЕ ЖӘНЕ ҚОРШАҒАН ОРТАҒА ӘСЕРІ

Аннотация. Зерттеу объектісі қорғасын зауытынан қорғасын бар қож үйінділері. Қорғасын зауытының шлактарында көптеген улы қосылыстар бар: қорғасын, мырыш, осмий, кадмий, олар экологиялық ластанудың қауіпті көзі болып табылады. Қождарды ашық сақтауға байланысты қорғасынның шекті рұқсат етілген концентрациясының асып кетуі анықталды. Қорғасын өндірісінің қождарын пайдалану түсті металдарды алуға және қождарды қайта өңдеу нәтижесінде қоршаған ортаға техногендік жүктемені азайтуға мүмкіндік береді. Сонымен қатар, шлактар түсті және сирек кездесетін металдардың қосылыстары бар құнды шикізат болып табылады.

Мақалада қож қалдықтарынан қорғасын мен мырышты алу әдістері ұсынылған және мырыш пен қорғасын оксидтерін шаң мен қорғасын өндірісінің шлактарынан іріктеп алудың оңтайлы әдісі таңдалған. Электрод болат балқыту өндірісінің шаңынан мырыш пен қорғасынды үздіксіз көміртексіз іріктеп алудың ұсынылып отырған технологиясы айналмалы барабанды пешке қарама-қарсы бағытталған екі ағынмен берілетін қорғасын өндірісінің қожын пайдалануға мүмкіндік береді. Пештің барабанындағы қорғасын қожының қозғалуы және алаудың жануы кезінде шаң тәрізді материалдан қорғасын мен мырыштың толық алынуы орын алады, онда тасымалдау объектісі сығылған ауа болып табылады, ал тазартылған түтін газы газдарды түтін сорғыштың көмегімен толық тазартқаннан кейін атмосфераға шығарылады.

Түсті металдарды алудың ұсынылып отырған селективті тәсілін қолдану кезінде қоршаған ортаның экологиялық жай-күйі жақсартылады, сондай-ақ қорғасын өндірісінің улы шлактарын кәдеге жарату есебінен адамдардың денсаулығына теріс әсерін азайтуға мүмкіндік береді.

Түйін сөздер: Өндірістік қалдықтар, улы қалдықтар, экологиялық ластану, қорғасын қалдықтары, қалдықтарды кәдеге жарату, мырыш оксиді, қорғасын оксиді, көміртексіз селективті алу.

К. Жантасов[1], З. Багова[1], Г. Туребекова[1], Б. Сапаргалиева[2], Г. Пусурманова[1]

[1] Южно-Казахстанский университет имени М.Ауэзова, Шымкент, Казахстан;
[2] Казахский национальный педагогический университет имени Абая, Алматы, Казахстан

РАЗРАБОТКА ТЕХНОЛОГИИ ИЗВЛЕЧЕНИЯ ОКСИДОВ СВИНЦА И ЦИНКА ИЗ ПЫЛИ И ШЛАКОВ В ПРОЦЕССЕ УТИЛИЗАЦИИ ОТХОДОВ СВИНЦОВОГО ПРОИЗВОДСТВА

Аннотация. Объект исследования – свинецсодержащие шлаковые отвалы от свинцового завода. Шлаки свинцового завода содержат большое количество токсичных соединений: свинец, цинк, осмий, кадмий, которые являются опасными источниками экологического загрязнения. Из-за открытого хранения шлаков было выявлено превышение предельно допустимых концентраций свинца. Утилизация шлаков свинцового производства позволяет получить цветные металлы и снизить техногенную нагрузку на окружающую среду в результате переработки шлаков. В то же время шлаки являются ценным сырьем, содержащим соединения цветных и редкоземельных металлов.

В статье предложены способы извлечения свинца и цинка из шлаковых отходов и выбран оптимальный способ селективного извлечения оксидов цинка и свинца из пыли и шлаков свинцового производства. Предлагаемая технология непрерывного безуглеродного селективного извлечения цинка и свинца из пыли электросталеплавильного производства позволяет использовать шлак свинцового производства, который подают во вращающуюся барабанную печь двумя противоположно направленными потоками. В процессе движения свинцового шлака в барабане печи и горения факела происходит более полное извлечение свинца и цинка из пылевидного материала, где транспортирующим объектом является сжатый воздух, а очищенный дымовой газ после доочистки газов при помощи дымососа выбрасывается в атмосферу.

При применении предлагаемого селективного способа извлечения цветных металлов будет улучшено экологическое состояние окружающей среды, а также снизится отрицательное влияние на здоровье людей за счет утилизации токсичных шлаков свинцового производства.

Ключевые слова: производственные отходы, токсичные отходы, экологическое загрязнение, свинцовые отходы, утилизация отходов, оксид цинка, оксид свинца, безуглеродное селективное извлечение.

Information about authors:

Kurmanbek Zhantassov, Doctor in technical science, Professor, M. Auezov South-Kazakh University, Shymkent, Kazakhstan, https://orcid.org/0000-0001-6867-1204;

Zarina Bagova, PhD in Life Safety and Environment Protection, M. Auezov South-Kazakh University, Shymkent, Kazakhstan, e-mail: cornerstone_z@mail.ru, https://orcid.org/0000-0002-9290-0772;

Gaukhar Turebekova, Candidate in technical science, Associate Professor, M. Auezov South-Kazakh University, Shymkent, Kazakhstan, https://orcid.org/0000-0003-3251-1449;

Bayan Sapargaliyeva, PhD in Life Safety and Environment Protection, Postdoctoral Researcher, Abai Kazakh National Pedagogical University, Almaty, Kazakhstan, https://orcid.org/0000-0001-7119-2466;

Gulzhamal Pusurmanova, Candidate in technical science, Professor, M. Auezov South-Kazakh University, Shymkent, Kazakhstan, https://orcid.org/0000-0002-1872-8599

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