

## Abstract

**Current state assessment of solved scientific problem.** Today, one of the main issues in ensuring the safety of life safety and environmental protection is the introduction of waste-free technologies and technologies for the integrated use of secondary raw materials, which ensures maximum extraction of the main and related elements and disposal of industrial waste without harming the environment and the safety of human life, flora and fauna. Scientists in this field are updating scientific paradigms leading to the search for solutions to the main issues of reducing man-made impacts and improving the ecological balance of the environment. Pyrometallurgical methods and technologies for the production of lead and its alloys from secondary raw materials and man-made waste are mainly used abroad. These raw materials contain lead in the form of oxides, sulfates, sulfides and other compounds. Processing of lead-containing raw materials to obtain the target product involves significant material costs, requiring the disposal of dust and gas emissions into the atmosphere containing toxic compounds of lead and other heavy metals. An important task in this direction is the need to introduce improved innovative methods of processing slag waste and the integrated use of secondary raw materials.

**General description of the work.** The dissertation work is devoted to improving the level of life support and protecting the environment during the construction of a new production facility for the processing of dump technogenic slags of lead production with the production of lead and zinc oxides.

**The relevance of the work.** Global systems of production and consumption have significant implications for the environment and human health. Most of the natural resources used are returned to the environment in the form of solid, liquid, gaseous wastes, which in most cases are toxic.

As a result of more than 70 years of operation of Chimkent Lead Plant, about 2 million tons of wastes have been accumulated in the form of lead production slags, which contain a significant amount of toxic elements such as lead, zinc, osmium, cadmium and others, which are dangerous sources of environmental pollution: air, groundwater and soil. Due to the open storage of slags, an excess of the maximum permissible concentrations (MPC) of lead was revealed. Currently, in the soil near the plant, the MPC of lead is more than 3000 mg/kg, while according to regulatory documents it should be 3.2 mg/kg. Lead is a heavy metal and a toxic substance that pollutes the environment in the course of human activities. The influence of lead ions on biochemical processes is due to the direct connection with enzymes, and on physiological processes due to changes in the properties of biomembranes and ion channels of living organisms. The ability to accumulate lead in the tissues of living organisms leads to serious pathologies and poisoning, due to the excess of its concentration in the atmosphere, biosphere and lithosphere.

Non-ferrous metals obtained from the processing of secondary raw materials have a significant impact on the overall balance of their production and consumption both in the Republic of Kazakhstan and abroad.

Lead has a high economic value, which allows its anti-corrosion properties to be widely used in the manufacture of storage facilities for caustic solutions, protection against radioactive substances and X-rays, production of paints and pigments, as well as in the IT sector.

Zinc is widely used for galvanizing metal products, technology for imparting anti-corrosion properties to them, as well as in the production of brass, cupronickel, printing materials, pigments for paints, the production of rubber, glass and glaze, as well as in the composition of neutralizing cosmetic pastes and pharmaceuticals. After the extraction of non-ferrous metals, the slag can be used in the production of cement, building materials and fertilizers.

A review of literary sources and an analysis of the level of technology development testify to the urgent task of the present day of the chosen subject of dissertation research aimed at developing a technology for processing and utilizing toxic lead production slags. This will improve the ecological state of the environment. In addition, the disposal of lead production slag will reduce the negative impact on human health, and will also make a significant contribution to the rational use of natural and secondary resources.

**The research objective.** Increasing the level of life support and improving the ecological balance of the environment, due to the utilization of technogenic and toxic slags from lead production.

In accordance with the objective, the following **problems** were solved:

- analysis and study of slags for the content of heavy and toxic chemical compounds;
- determination of the potential threat of lead production slag storage for human life and the environment;
- improvement of the technology for utilization of lead production slags through the use of modern technological foundations for their processing;
- implementation of an environmental and economic assessment and calculation of the effectiveness of the construction of a new production facility for the processing of lead slags;
- study of the main elements of lead production slags and their extraction into target semi-products based on mathematical and computer modeling;
- verification of the obtained results in experimental conditions and implementation in industrial production.

**The research object and subject.** The research object is the slags of Shymkent Lead Plant. The research subject is the improvement of the technology for the utilization of lead production slags to increase the level of life support and improve the ecological condition of residential and crop areas adjacent to the dump.

**The scientific novelty of the work** lies in the fact that on the basis of theoretical and experimental studies of lead production slags in Shymkent, an improved method for extracting lead and zinc oxides from lead production slags was scientifically substantiated;

- an improved technology for the utilization of lead production slags was developed and the technological features of the processing of slags and charge

materials fed into a rotating drum furnace by two oppositely directed flows were determined;

- the physicochemical regularities of the technical foundations of slag waste disposal were established by blowing a dusty mixture of lead slag and carbon-containing material with a fraction less than 1 mm from the hot end while supplying the main mass of the initial charge components of a class less than 10 mm from the cold feed end of a rotating drum furnace;

- the optimal parameters of the technological regime were revealed, at a ratio of 1:0,2:3,8, a pulverized part of the slag with a dispersion of about 1 mm was supplied from the cold end of the drum rotary kiln, and from the hot end of the drum kiln, a dust-like part of the slag with a dispersion of about 1 mm was supplied together with a carbon-containing material with a dispersion of 0,5-1 mm, in a ratio of 1:9,5 in a mixture with compressed air supplied by blowing from the hot end at a temperature in the melting zone of the furnace 1100-1150 °C, allowing to increase the extraction rate of lead and zinc oxides;

- the degree of correlation of calculated and experimental values was determined during the processing of lead production slags to extract lead and zinc into target products, due to oppositely directed materials in a rotating drum furnace, which allowed to reduce the dust content of the working room and the environment to 10% or more.

#### **The practical significance of the work:**

Based on the research results, “Method for the disposal of technogenic slags from lead production with the production of target products: lead oxide and zinc oxide” was developed on 24 November 2020, deposited in all countries participating of Berne Convention for the Protection of Literary and Artistic Works (Bern, Switzerland).

- a safe and improved technology was developed for the disposal of toxic lead production slags with the production of target semi-products – lead and zinc oxides, which allows to increase the level of life support and reduce their harmful effects on the environment;

- an environmental and economic calculation of the expected efficiency from the implementation of a new production facility and an improved technology for the disposal of lead production slags was carried out;

- the optimal technological and heat engineering parameters for the processing of lead production slags were identified;

- technological solutions and recommendations were developed to improve the level of life support and environmental protection by utilizing lead production slags.

#### **The main provisions for the defense:**

- improved technology for the processing of lead production slags;
- increasing the level of life support by reducing the harmful effects of toxic lead production slags;

- a computer-mathematical model for planning the process of extracting the main elements of lead production slags into target products;

- environmental and economic calculations of the effectiveness of the construction of a new production facility for the processing of lead slags.

**Relation to the plan of the main scientific works.**

The work was carried out in accordance with the state budget themes of M. Auezov SKU: SB SRW-21-07-04 “Development and creation of an environmentally safe technology for processing technogenic wastes of phosphorus and lead-zinc industries to obtain target products”.

**Compliance of the dissertation work with the passport of the scientific specialty.** The dissertation corresponds to the specialty 6D073100 – "Life safety and environmental protection".

**Approval of the results of work, publications.** The main scientific results and recommendations of the scientific hypothesis were published in 15 printed publications, including international scientific journals included in Scopus and Web of Science databases – 1, in scientific publications recommended by the Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan – 3, articles in proceedings of international conferences – 4, articles in proceedings of conferences of the Republic of Kazakhstan – 6, European patent No. EC-01-003041 dated 24.11.2020, deposited in 167 member countries of Berne Convention for the Protection of Literary and Artistic Works (Bern, Switzerland).

The author's **personal contribution** consists in:

- conducting theoretical research on the analysis of literary and patent materials on the topic of the dissertation;
- determining the chemical composition and physicochemical properties of the initial components and finished products using modern instruments and equipment;
- conducting scientific research of lead production slags for the content of harmful substances;
- experimental tests of the extraction technology of lead and zinc oxides from slag waste of lead production;
- ecological and economic calculation of the efficiency from the implementation of a new production facility was carried out using the developed improved technology for the utilization of lead production slags;
- technological solutions were developed to ensure compliance with the requirements in the field of industrial safety.