

ABSTRACT

Of thesis on the theme:

“STUDY OF ELECTROLEACHING OF NON-FERROUS METALS FROM MULTICOMPONENT RAW MATERIALS USING A SULFUR-GRAPHITE ELECTRODE”,

submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D070900

– “Metallurgy”

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The purpose of the thesis work. Study of conditions for the use of the reagent generation process on the sulfur-graphite electrode to increase the efficiency of copper and zinc extraction from multicomponent raw materials in aqueous solution.

Research Objectives:

- information-patent search for the extraction method of electrochemical leaching of non-ferrous metals from complex multicomponent raw materials;
- study of patterns of electroleaching of metal-containing raw materials during electrolysis with alkaline solutions;
- Determination of peculiarities of electroleaching of metal-containing raw materials for zinc and copper ores;
- Determination of the influence of current density, temperature and pH on metal extraction during leaching;

Each problem to be solved is logically related to the others and is aimed at achieving the overall goal to which the thesis is devoted.

Research Methods:

During the performance of the dissertation research were used physico-chemical methods of investigation of solutions, solid products of experiments and the following types of instruments, equipment and analyzers:

- X-ray analysis of condensed systems was performed on a D8 Advance analyzer (Bruker), α -Cu, 40 kV tube voltage, 40 mA current;
- IR spectroscopic method of investigation of initial solid samples, solutions before and after leaching were carried out on FTIR spectrometers "BRUKER Alpha" and "Avatar 370";
- X-ray fluorescence analysis of metal-containing samples was performed on an Alpha InnovX Systems portable analyzer;
- The analysis of metals was performed on an atomic absorption spectrometer "ContrAA 300" "Analytic Jena";
- Anton Paar Multiwave 3000 multifunctional modular system was used for sample preparation;
- The pH and electrical conductivity of solutions after electroleaching were determined on a Metrohm 856 combined module.
- the oxygen concentration in the solution was determined on a SensIon 156 multiparameter meter.

The main provisions (proven scientific hypotheses and other conclusions that are new knowledge) defended:

- The use of SGE electrolysis products for transferring metals into soluble states during electrochemical leaching of metals from raw concentrates.
- The results of studies on the influence of conditions of electrochemical generation of sulfur-containing leaching components on the kinetics of the leaching process of metals from various metal-bearing ores;
- Determination of optimal conditions for copper and zinc extraction from raw concentrate from the Ridder-Sokolny deposit.

Description of the main results of the research:

- it was established for the first time that the leaching efficiency of different materials is determined by the polarization sign of the sulfur-graphite electrode.
- It was established that the main product of the transformation of SGE providing leaching of metals are sodium thiosulfate, which forms soluble complexes with them.
- thiosulfate formation during cathodic polarization of SGE is due to the formation of sulfides and polysulfides in the cathodic process as intermediate compounds. They subsequently enter the anode, where they are oxidized to thiosulfate.
- The scheme of sulfide ore leaching processes through the stage of its oxidation with oxygen generated at the anode and transfer to a soluble state of metals in the form of thiosulfate complex is presented.

The justification of the novelty and importance of the results obtained:

The novelty of the results of the proposed work lies in the development of a new scheme of electrochemical generation of leaching agent and the establishment of regularities of flow of electrochemical leaching of complex raw materials, non-ferrous metals by electrolysis with sulfur-graphite electrode in a heterogeneous system.

The technological side of research consists in the development of technology for extraction of non-ferrous metals from complex metal-containing raw materials using combined electrochemical reactions in a single unit and reduction of technological operations in the chain "raw material - commodity product" in hydrometallurgical processes.

To perform the main volume of experimental work and to achieve the set goals, a set of modern scientific installations and methods was used, which is provided by the availability of the necessary instrumentation, technological park and analytical equipment.

The complex of modern research methods and new analysis devices (X-ray phase and X-ray fluorescence analysis, infrared spectroscopy and atomic absorption spectroscopy, etc.) used in the work shows the high confidence of the obtained results.

It has been determined that the combined electrochemical reactions can be used for the extraction of metals from various types of raw materials (including metal compounds, alloys and secondary metal sources) in hydrometallurgy. This

technological technique is based on the use of original fundamental results, which serve as the basis for the creation of fundamentally new knowledge-intensive technologies, in particular, electrochemical hydrometallurgy.

The basic initial data for the development of innovative technologies of extraction of copper, zinc from complex raw materials with the use of combined electrochemical reactions used to obtain leaching reagent and extraction of metals in the volume of one reactor are justified. The developed technical method makes it possible to involve in production the substandard wastes of chemical and metallurgical production.

Compliance with the direction of science or state programs. Dissertation work is executed in testing laboratory "Perspective materials and technologies" now scientific-educational center of material science and corrosion problems at the Kazakhstani-British Technical University within the framework of the state grant of the Committee of Science of the MES RK on the theme: "Development of fundamental preconditions for hydrometallurgical processes of extraction of nonferrous metals from metal-bearing raw materials with the purpose of creating the basis for innovative technologies", 2012-2014., and "Development of fundamental foundations of hydrometallurgical processes to improve the efficiency of metal extraction from complex and low-grade raw materials" (R&D № 0269 / GF4 from 12.02.2015 for 2015-2017), funded by the Ministry of Education and Science of Kazakhstan under the subprogram "Grant financing of scientific research" on the priority "Rational use of natural resources, processing of raw materials and products" for 2015-2017.

Description of the doctoral student's contribution to each publication. The author's personal contribution consists in setting the goal and objectives of the work, conducting research, processing and analyzing the results, formulating conclusions, writing articles and abstracts.

On the materials of the dissertation work 7 scientific papers were published, which reflect the main content of the dissertation:

1. Yessengaziyev A.M., Kenzhaliyev B.K., Berkinbayeva A.N., Sharipov R.H., Suleimenov E.N. Electrochemical extraction of Pb and Zn from a collective concentrate using a sulfur-graphite electrode as a cathode // Journal of Chemical Technology and Metallurgy, - Vol.52. -No.5, -2017, - P. 975-980. Scopus (IF:0.331), **Percentile Scopus 42 (Industrial and Manufacturing Engineering)**.

2. Kenzhaliev B.K., Berkinbaeva A.N., Dosymbaeva Z.D., Sharipov R.H., Suleimenov E.N. "Change of parameters of water solutions in the process of electrochemical leaching of secondary raw materials using sulfate electrode" // Journal "Complex use of mineral raw materials" - №1. - 2016. - P. 66-70.

3. Sharipov R.H., Berkinbaeva A.N., Kenzhaliev B.K., Dosymbaeva Z.D., Suleimenov E.N. "The influence of the leaching agent formation dynamics on the parameters of aqueous alkaline solutions when using combined electrochemical reactions for brass leaching" // Journal "Complex use of mineral raw materials" - №2. - 2016. - P. 83-87.

4. Berkinbayeva A.N., Dosymbayeva Z.D., Sharipov R.H., Zheksembiyeva B.T. Electrochemical leaching of refractory sulfide ore with an application of the

sulphur-graphite electrode // Complex use of mineral Resources, - No.2. - 2017. - P. 53-57.

5. Kenzhaliyev B.K., Berkinbayeva A.N., Dosymbayeva Z.D., Sharipov R.H., Chukmanova M.T., Suleimenov E.N. "Using the composite electrode for the organization of aligned electrochemical reactions during the extraction of metals from raw materials". "48th International October Conference on Mining and Metallurgy, September 28 to October 01, 2016, at Hotel Albo, Bor Serbia. P. 33-36.

6. Kenzhaliev B. K., Berkinbaeva A. N., Dosymbaeva Z. D., Sharipov R. H., Kolesnikov A. V., Suleimenov E. N. The possibility of processing of metal wastes by electrochemical method. Proceedings of the Congress with international participation and the Conference of young scientists "Fundamental research and applied development of recycling and utilization of technogenic formations", V Forum "Urals market of scrap, industrial and municipal waste", - Yekaterinburg: UrO RAS, 2017. TECHNOGEN 2017. P. 403-406.

7. Sharipov R.H. Application of combined electrochemical reactions for extraction of metals from various raw materials // International Conference on Recent Advances in Metallurgy for Sustainable Development (IC-RAMSD 2018) 2018 February 1st - 3rd.