PROCESS of ZINC SULFATE SOLUTION PURIFICATION from COPPER and CADMIUM

Abstract: This paper is aimed to the solution of the actual problem on the involving into processing of low-grade zinc sulfide concentrate of Nikolayevsk deposit of Kazakhstan and the development of technology of its processing with produce the intermediate product – copper-cadmium solid precipitate – cake. The article presents the results of experimental studies of the process of purification from a copper and cadmium the zinc sulfate solution obtained after hydrolytic purification from iron, arsenium, antimony, lead and silicon of the solution after the autoclave leaching of low grade zinc sulfide concentrate of Nikolayevsk fields of Kazakhstan. It was determined that the determined conditions of the process of cadmium and copper cementation provide high degree of the purification of the test productive solution from copper and cadmium. In the purified solution copper and cadmium content is less than 2,98 g/dm$^3$, zinc – 221,4g/dm$^3$. The resulting intermediate product - copper-cadmium solid precipitate – cake is suitable for the production of copper and cadmium.

Keywords: X-ray analysis, atomic absorption analysis, process time, zinc dust, one-stage purification, cementation, copper-cadmium solid precipitate, cake, sulfide concentrate.

Introduction. In world practice feedstock used for production of zinc sulphide concentrates rich or conditioning zinc content (over 50 %) [1]. In this regard, the current challenge of zinc metallurgy in the Republic of Kazakhstan and abroad is the widespread involvement in the processing of low grade sulphide zinc concentrates as the primary type of raw material and the development of highly efficient technologies for their processing.

We carry out studies on the involvement in the processing of low-grade sulphide zinc concentrate Nikolayev fields of Kazakhstan, in particular, the way it was designed autoclaved leaching [2].

Average zinc sulfate solution of 10 experiments on the pressure leaching of low grade sulphide zinc concentrate Nikolayev fields of Kazakhstan contains significant quantities of impurities. Table 1 shows the chemical composition of the solution.

<table>
<thead>
<tr>
<th>Sample of solution after pressure leaching of the concentrate solution</th>
<th>Element content, g/dm$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Zn</td>
</tr>
<tr>
<td>1,1</td>
<td>134,0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample of solution after pressure leaching of the concentrate solution</th>
<th>Element content, g/dm$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_{diss}$</td>
<td>SiO$_2$</td>
</tr>
<tr>
<td>34,57</td>
<td>3,21</td>
</tr>
</tbody>
</table>

As seen from Table 1, the solutions are representative of the content and recovery of zinc from them. However, the impurity content of the resulting zinc sulfate solution does not meet the requirements of Air Conditioning zinc-containing commercial product (metallic zinc or zinc oxide).
Based on literature data [5,6] we had selected and executed from a group of cleaning hydrolytic impurities: iron, arsenic, antimony, lead, silicon and the purified solution was obtained, which contains the following elements (Table 2).

Table 2 - Chemical composition of the zinc sulfate solution purification after the hydrolytic impurities from the iron group, arsenic, antimony, lead and silicon

<table>
<thead>
<tr>
<th>Sample of solution</th>
<th>Element content, g/dm³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zn</td>
</tr>
<tr>
<td>after hydrolytic removal of impurities solution</td>
<td>186.05</td>
</tr>
</tbody>
</table>

Table 2 shows that the solution contained significant amounts of copper and cadmium. The objective of these studies is the removal of copper and cadmium zinc sulfate solution obtained after hydrolytic cleaning solution from the autoclave leaching of low grade zinc sulfide concentrate Nikolayev fields of Kazakhstan from iron, arsenic, antimony, lead and silicon.

This process is based on the reduction of copper and cadmium in copper-cadmium solid precipitates and dissolution of zinc from zinc dust. For example, the chemistry of the process of cementation of copper and cadmium from zinc sulfate solutions is described by the following reactions (1-2):

\[
Zn + Cu^{2+} = Zn^{2+} + Cu, \quad (1)
\]

\[
Zn + Cd^{2+} = Zn^{2+} + Cd. \quad (2)
\]

At the simultaneous presence in solution of copper and cadmium copper will be cemented first. This is due to the fact that the number of elements in the copper has a more positive potential than cadmium, therefore cadmium is precipitated from solution is added to cement copper. Consequently, to ensure complete cleaning solutions of cadmium and copper in the experiments using excess zinc dust was provided by the theoretically required amount of [7,8].

**Experimental part. The methodology of the experiments.**

Experiments were performed in heat-resistant glass beakers. The solution was heated on an electric plate, maintaining the selected temperature and duration of the process. The solution temperature was controlled laboratory glass thermometer TLC-2; stirred solution of BP-8000 laboratory mixer with variable speed for n = 300 rev/min.

The chemical composition of the solution and solid precipitates was determined by chemical and atomic absorption methods of analysis, phase composition - the method of semi-quantitative XRD diffract meter X’Pert MPD PRO (Panalytical).

**Terms of the cementation process.** For experiments on single-step purification of copper and cadmium were taken 0.5 dm³ solution purified from iron, arsenic, antimony, lead and silicon with a content of metals: Zn - 93.02 g, Cu - 3.99 g, Cd - 0.51 g; process temperature - 60 °C, cementation process duration - 30 min. In experiments using zinc dust Ridder metallurgical complex “Kazzinc” (99 % Zn), granule metric dimensions of which are class “-0,074 mm.” Consumption of zinc powder was 1: 2 with respect to the stoichiometric total amount of copper and cadmium in solution.

**Results and Discussion.** Research on one-step purification of the solution from the copper and cadmium cementation with zinc dust. After experimentation by one-stage solution purification of copper and cadmium were obtained 0.44 dm³ purified solution and 4.05 g copper-cadmium solid precipitate.

The results of determining the chemical composition of the purified solution and copper, cadmium and zinc, copper and cadmium in the solid precipitate are shown in Table 3. Extractions of copper and cadmium in the solution and the solid precipitate after a single stage of cementation with zinc dust are presented in Table 4.

In the one-stage zinc dust cementation copper recovery (65,14 %) and cadmium (52,77 %) in the copper-cadmium solid precipitate is sufficiently high. Copper and cadmium in copper-cadmium solid precipitate: copper – 2.59 g (63,95 %), cadmium – 0.27 g (6,67 %).

**Experimental part. The methodology of the experiments.**

Experiments were performed in heat-resistant glass beakers. The solution was heated on an electric plate, maintaining the selected temperature and duration of the process. The solution temperature was controlled laboratory glass thermometer TLC-2; stirred solution of BP-8000 laboratory mixer with variable speed for n = 300 rev/min.
Cadmium content of copper and cadmium solid precipitate small because of its low content in the initial solution. In fact, 94.7% of the zinc consumed from stoichiometry. The excess of zinc in the initial solution. In fact, 94.7% of the zinc consumed from stoichiometry. The excess of zinc was stoichiometrically required amount is provided to prevent the inverse transition of copper and cadmium from solution in the precipitate.

Figure shows a flow diagram of a one-step purification method of cementation with zinc dust solution of hydrolytic treatment.

Conclusions. Carrying out a one-step purification of cementing in a zinc sulfate solution from the autoclave leaching of low grade zinc concentrate of Nicholayev deposit yielded copper-cadmium solid precipitate, which can be sent to the production of copper and cadmium. The zinc sulfate solution after the single-step purification method of cementation with zinc dust solution of hydrolytic treatment.

REFERENCES

DEVELOPMENT OF TECHNOLOGY and EQUIPMENT for DIRECT SMELTING of REFRACTORY LEDGE GOLD ORES of TERISKKEY Ltd ORE MINING COMPANY

Abstract: This article presents the results of the works on improvement of the process parameters and development of the basic design elements of an electric furnace for processing of ledge gold ores from a number of deposits of Terisky Ltd Ore Mining Company in order to create a pilot project for testing and implementation of a contractile pyrometallurgical selection process (CPS-process) for refractory gold-bearing materials in this enterprise. The design compositions were prepared based on previously completed studies on direct melt processes of the ledge gold ores from Terisky Ltd deposits, i.e. three-, four- and five-component charges for the CPS-process. The ratio of individual components and their calculated compositions were determined. Constructional calculations of basic dimensions, design and technological parameters of individual components and systems of the pilot project were carried out. Thus, the basic parameters of a two-electrode electric furnace with the capacity of 200 – 300 kVA, the main equipment for the gas cleaning system, systems of feeding and preparation of the raw charge materials with the determination of the structure of load devices were found. Based on the initial data and production schedules of Institute of Metallurgy and Ore Beneficiation JSC, the project of above-mentioned pilot plant of CPS-process approved by the management of OMC Terisky Ltd has been performed.

Keywords: matte, slag, gold, contractile pyrometallurgical selection, CPS - process, blending.