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DEVELOPMENT AND IMPROVEMENT OF LEAD-COPPER CONCENTRATE SEPARATION TECHNOLOGY USING A LOCAL REAGENT

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Abstract

Improvement of the technology of enrichment of polymetallic ores and methods of separation of collective concentrates can increase the share of production of copper, lead, zinc, rare and noble metals without excessive costs.

In practice, separating the lead-copper collective concentrate from each other is one of the most difficult tasks facing enrichment technologists. In recent years, as a result of scientific research conducted by researchers on the extraction of lead-copper concentrates, it has been possible to reduce the copper content in the lead concentrate at many processing plants and increase the quality and extraction percentage of the lead concentrate.

Keywords: Bichromate method, activating reagents, suppressing reagent, cyanide technology, contact time, collective concentrate, ammophos solution, butyl xanthate solution, foaming reagent, cyanide-free technology

Introduction

Due to the differences in the chemical, mineralogical composition, and other properties of ores in different deposits, this issue has not yet found its fundamental solution.

Currently, more than thirty methods of separating lead-copper flotation concentrate are known, and two methods of selective flotation are widely used.

One of them is the chromium method, which involves the enrichment of copper by pressing galena with chromium, and the second is the enrichment of lead by pressing chalcopyrite with cyanide.

The following methods for improving the technology for separating lead-copper concentrates are of particular importance. [1, 2, 4].

Bichromate Method

Potassium dichromate or sodium dichromate salts are effective inhibitors of inactive galena, ensuring good flotation of sulfide minerals such as chalcopyrite and tetrahedrite.

The dichromate method differs from other methods in its simplicity and low operating costs due to the low consumption of chromium and the fact that it is a strong reducing agent of galena. Another advantage is that it prevents gold and silver from being disposed of. Selective pressing of the galena mineral with chromium is carried out by covering the lead surface with a hydrophilic chromium film.

The bixromate method is used at the Sumsarsk and Konsoy processing plants, as well as in factories in Sweden, Finland, and other countries. The dichromate method is used only for the separation of lead-copper concentrates obtained from ores containing low-oxide and secondary copper minerals (7-10%). [3]

In some processing plants, the separation of lead-copper concentrates is easily carried out when sodium chromate salt is in contact for 15 minutes; in other plants, this process is difficult, and the duration of contact with chromite is prolonged, i.e., up to 4-6 hours.

The disadvantage of this method is the penetration of sphalerite from the collective concentrate into the foam product.

Activation of galena with copper ions leads to a deterioration in the extraction process, and therefore, in the 1950s, processing plants that used the chromium method began to use the cyanide method.

Cyanide Method

At one of the enrichment plants, M.M. Polyakov used cyanoplav instead of chromium to compress galena. The process of separating lead-copper concentrates has been significantly improved.

In this method, copper minerals are suppressed with cyanide, but cyanide does not suppress galena at all, and at the same time, not only copper minerals but also the mineral sphalerite is well suppressed. Due to this, the lead recovery rate is high, and the copper and zinc content in the concentrate is relatively low.

As a result of the research conducted by A.S. Konev and L.V. Debrivnoy to determine the degree of suppression of cyanide and chromium, it was established that cyanide salts are stronger suppressants than chromium.

Another advantage of using the cyanide method is that the content of not only copper but also zinc in the lead concentrate decreases.

The disadvantage of the cyanide method is that it partially dissolves gold and silver in the concentrate and is considered a toxic reagent.

Sodium sulfite when used together with cyanide, it enhances the compression of chalcopyrite without weakening the flotation properties of galena.

The replacement of toxic suppressant reagents with other reagents began much earlier. As a result, several methods of cyanide-free technology were proposed. However, in most cases, their use did not yield better results than the cyanide method.

In recent years, a number of studies have been conducted on the flotation separation of polymetallic concentrates by the cyanide-free method.

Among them, the sulfoxide method is more effective than other methods and is distinguished by the fact that it does not dissolve noble metals during the process.

In particular, the method of obtaining a copper concentrate by separating lead-zinc concentrates using sulfite technology, proposed by K.G. Bakinov at the "Mekhanobr" Institute, was included in the project of the Almalyk Lead Processing Plant, but was not used in industry due to the

shortage of Na_2SO_3. In addition, this reagent gives good results in the presence of activated carbon and iron sulfate. Another advantage of sodium sulfite is that it is not a toxic reagent.
An aqueous solution of ammophos, produced at the Almalyk Chemical Plant, was prepared for research using ammophos technology. 1 liter of ammophos solution was prepared in a heat-resistant beaker at a temperature $^{of\ 600C}$ for 10-15 minutes.
The shelf life of this solution is quite long, since the solution does not decompose.
The experimental work was carried out on a 1.3-liter flotation machine.
A solution of ammophos was added to the lead-zinc concentrate in the flotation chamber.
In addition to ammophos, the following reagents are used for the separation of lead-zinc concentrate:
a) 10% ammophos solution;
b) 8% sodium sulfide solution;
c) 1% solution of butyl xanthate;
g) 99.5% - T-80 foaming agent;
d) 4% NaCl solution.
To analyze the results of experimental work with minerals, experiments were conducted using ammophos as a reagent suppressing galena with a conditioned lead concentrate containing 2.89% copper.
Preliminary experiments have confirmed that positive results are obtained when ammophos is used to suppress galena. Therefore, experiments were conducted to determine the optimal parameters of enrichment in the selection of lead-copper concentrates using ammophos.
When selecting the lead-copper concentrate at the consumption of ammophos (0-10 kg/t) without desorption, the results of the experiments were not positive. The main reason for this is the transfer of galena minerals to the foam product, and with an increase in the amount of ammophos, copper minerals also begin to decrease. In addition, the mineral particles are coated with flotation reagents (xanthate, foaming reagent), and as a result, ammophos cannot interact with the surface of mineral particles.
Desorption of the collective concentrate was carried out in the following order: a certain part of the collective concentrate was mixed with a sodium sulfide solution for 15-20 minutes and water was added at a L:S ratio of 1:20, mixed, precipitated, and the water part was separated until the precipitate was 50%.
In the process of separating the lead-copper concentrate, the contact time of the pulp with sodium sulfide and the washing time of the collective concentrate with water were studied. In subsequent experiments, the desorption process was carried out with sodium sulfide.
The results of experimental tests showed that to remove the flotation reagent from the surface of mineral particles, the concentrate should be mixed with sodium sulfide for 15 minutes (6-8 kg/t). The collective concentrate, purified from the flotation reagent, was separated by flotation.
In the selection of copper and lead, the dependence of ammophos consumption, contact duration, and pH on the medium was studied. The results of the experiments showed that the selection of copper and lead is fully carried out at a consumption of ammophos of 2.5-3 kg/t. (Table 1).

The agitation time was 15-60 minutes, the consumption of ammophos was 2.5 kg/t.
When the agitation time was 15-30 minutes, the compression of the galena mineral was incomplete, and the flotation of chalcopyrite deteriorated. Satisfactory results were obtained when the agitation period lasted 45 minutes.

Table 1 Dependence of the degree of extraction of copper and lead concentrate on the consumption of ammophos.

Product name	Output, %	Amount, %		Extraction percentage, %		Amofos consumption. kg/t
		copper	lead-shin	copper	lead-shin	
Basic copper concentrate	56.4	4.6	54.75	77.4	60.20	0
Primary copper flotation waste	43.6	1.74	46.83	22.6	39.80	
Initial Pb-Cu concentrate	100.0	3.35	51.30	100.00	100.00	
Basic copper flotation concentrate	23.7	11.4	23.5	80.9	10.86	0.5
Copper flotation waste	76.3	0.84	59.90	19.1	89.14	
Initial Pb-Cu concentrate.	100.0	3.35	51.30	100.00	100.00	
Basic copper flotation concentrate	22.0	12.6	19.6	82.73	8.40	1.0
Copper flotation waste	78.0	0.74	60.24	17.27	91.60	
Initial Pb-Cu concentrate.	100.0	3.35	51.30	100.00	100.00	
Basic copper flotation concentrate	21.30	15.30	17.60	84.60	7.30	2.5
Copper flotation waste	78.70	0.65	60.40	15.40	92.70	
Initial Pb-Cu concentrate.	100.0	3.35	51.30	100.00	100.00	
Basic copper flotation concentrate	23.00	12.30	20.40	84.40	9.15	5.0
Copper flotation waste	77.00	0.69	60.50	15.60	90.85	
Initial Pb-Cu concentrate.	100.0	3.35	57.30	100.00	100.00	
Basic copper flotation concentrate	28.90	10.80	33.50	93.00	18.87	10.0
Copper flotation waste	71.10	0.33	58.50	7.00	81.13	
Initial Pb-Cu concentrate.	100.0	3.35	51.30	100.00	100.00	

When the agitation time exceeded 45 minutes, the copper minerals were partially compressed, and the copper content in the copper concentrate began to decrease.
To determine the influence of pH in the experiment, ammophos (amount of ammophos 2.5 kg/t, agitation time 45 minutes) was added as a suppressing reagent, and calcined soda solution as a medium-regulating reagent.

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The results of the experiments showed that an alkaline environment with a pH of 8.9 and higher has a negative effect. If the pH value was from 6.4 to 8.2, the lead content in the copper concentrate was 25.7% - 28.9%, then at pH=8.9, this indicator increased by 38.1%.
The compression of lead minerals is fully realized when the xanthate on its surface is displaced by phosphorus ions.
In order to reduce the lead content in the copper concentrate, an additional process of lead removal of the copper concentrate can be introduced into the technological scheme.
To determine the final version of the technological scheme for the selection of lead-copper concentrates, two identical experiments were conducted in open and closed cycles: desorption with sodium sulfide for 15 minutes, ammophos consumption for 2.5 kg/t at pH=8.5, agitation time for 45 minutes, four purification processes, and lead removal of the copper concentrate. The obtained results showed good results when conducting the experiment in a closed cycle.
The technology for separating the lead-copper concentrate using ammophos consists of the following processes: the pulp is mixed with sodium sulfide for 15 minutes (sodium sulfide consumption is 6-8 kg/t), then water is added at a S:L ratio of 1:3, after settling the precipitate is 50%.
Galenite depression lasts 45 minutes, ammophos consumption is 2.5 kg/t. The main copper flotation and four copper refining processes are carried out in an open cycle. Several experiments were conducted according to the proposed technology, and an 18-30% copper concentrate was obtained (the extraction percentage was 50-81%). Lead content in the copper concentrate was 2.3-3.4% (percentage of recovery 0.2-0.7%).
The results of thermodynamic and chemical analyses showed that ammophos - (NH4) 2HPO4, depending on the pH of the medium, dissociates into $_{H3PO4-,}$ HPO4-2, PO4-3 ^{ions,} forming refractory compounds with the lead cation.
If the pH is 6 - 7, the compound RbHPO4 is formed, and if the pH is 9 - 10, the equilibrium shifts and the compound Pb3 (PO4) 2 is formed; i.e.:

$$PbS + (NH_4)_2HPO_4 = PbHPO_4 + (NH_4)_2S$$

$$3PbS + 2(NH_4)_2HPO_4 + 4H_2O\ Pb_3(PO_4)_2 + 3H_2S + 4\ NH_4OH$$

$$Pb_3(PO_4)_2\ 3Pb^{2+} + 2PO_4^{3-}\ \ Na_2S\ 2Na^+ + S^{2-}$$

$$(NH_4)_2NRO_4 2\ NH_4^- + NRO_4^{2-}\ S^{2-} + HOH\ SH^- + OH^-$$

$$N_3RO_4\ N^+ + H_2RO_4^-\ HPO_4^{2-} + HOH = H_2PO_4 + OH^-$$

$$rK_1 = 2.15;\ pK_2 = 7.2;\ rK_3 = 12.$$

It has been proven that the depressant properties of ammophos are due to the formation of hydrophilization of the galena surface ions $^{HRbO-2,\ PO4-3}$ and OH $^-$. In addition, the compression of galena is due to the displacement of xanthate ions from its surface by phosphate ions.
In conclusion, an effective and environmentally safe technology for the extraction of lead-copper concentrate has been developed.
1. Method for improving the technology of lead-copper concentrate separation for obtaining additional copper concentrate.

2. A method for obtaining a 22-26% copper concentrate using the proposed effective and environmentally safe lead-copper concentrate separation technology.
3. A method for achieving optimal results using four purification processes in open and closed cycles and lead removal of copper concentrate.

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