Cooperative Processing of Ores and Flotation Concentrate

Nadezhda Nikolaevna Neizvestnykh

National Research Irkutsk State Technical University, 83 Lermontov St., Irkutsk, 664074, Russian Federation
JSC «Omolon Gold Mining Company» Transport St., Magadan, 685007, Russian Federation

ABSTRACT

The article presents the results of research of cooperative processing of ores and flotation concentrate. The dependence of the PM content in the finished product and the total extraction of the factory on the content of PM in the incoming raw materials to the factory are regarded. The corresponding dependence charts are presented. The optimal ratio of the charge of flotation concentrate/ore is presented. There was founded and proven the form of lead finding in the flotation concentrate - mineral galena. Studies on the flotation concentrate leaching were made; in this case there is dissolution of lead and its transition into the ionic form. There was firstly proposed the scientific hypothesis of chemistry surface modification of zinc dust by lead, contained in the flotation concentrate.

INTRODUCTION

In the field of mineral processing one of the modern trends of research is the cooperative processing of ores of several fields, which implies the processing of ores of different fields in the charge on one concentrator. Currently, in addition to various ore deposits in the gold extraction plants flotation concentrate is processed as well. This improves the quality of the finished products, delivered to the refinery from 20 kg/t silver in the flotation concentrate to 80% of silver in zinc cementite and reduces the cost of transporting of large volumes of products. Cooperative processing of ores and flotation concentrate is practiced in many plants, including, one of the gold mining companies JSC "Polymetal" – gold-extraction factory of mining and processing enterprise "Kubaka".

Main part:

Cooperative processing of ores and flotation concentrate was introduced to optimize the work of GEF due to the constant composition of raw materials entering the factory, increase the through extraction in the factory and improve the quality of the finished product.

The scheme, including leaching, cementation by zinc dust, the CCD and the sorption of DM on the activated carbon is effective within the processing of ores with high silver content – Merrill-Crowe’s process is most often used for the enrichment of the rich silver-bearing ores. In the GEF Kubaka within this scheme ores of Sopka Kvarcevaya are processed, Dalnaya (gold – 5-15 g/t silver – 150-300 g/t), flotation concentrate (FC) concentrator MCC "Ducat" (Gold 35-40 g/t, silver more than 20 kg/t). In this paper we offer the introduction of cooperative processing of ores of Sopka and Dalnaya and the flotation concentrate at a certain ratio of the charge.

With an increase of the precious metal content in the incoming raw materials to the factory the content of precious metals in a productive solution increased as well. And the content of precious metals in the productive solution, in their turn, is directly proportional affects the deposition process of precious metals (PM) on zinc, and accordingly, the quality of the finished product (the zinc cementite). That is to say, when flotation concentrate is charged to the processed ores the precious metal content in a productive solution is increased (at average of 60 mg/l AU+AG to 93 mg/l AU+AG), and there by increasing the quality of the finished product (65% AU+AG 85% AU+AG).
The dependence of the charge flotation concentrate / ore and silver content in the finished product (FP) during studies are shown in Picture 1.

**Picture. 1:** The dependence of the charge FC/ore and silver content in the finished product during studies

To determine the optimal ratio of the charge were also conducted laboratory studies consisting in cyanidation, washing and pulp sorption cyanidation with different ratios in the experimental mixture of ores and flotation concentrate.

Dependence of the ratio of the charge flotation concentrate / ore and the resulting extract is shown for precious metals in Picture 2.

**Picture. 2:** The dependence of the charge FC/ore and extraction ratio of PM

During the study, it was found that the optimal ratio of FC/ore to area Merrill Crowe processing plant Kubaka on the amount of metal – 1/70. With such a ratio of ore and concentrate the removal of finished products – zinc cementite – from press- filters is conducted in a day.

During the study, it has been hypothesized that the deposition of precious metals on the zinc dust is influenced by the presence of leadin the flotation concentrate in, the content of which varies from 3 to 7%.
Studies have been conducted to determine the form of lead finding in the flotation concentrate. In the flotation concentrate lead sulfide PbS (mineral galena) is present – this is confirmed by the data of elemental analysis of the flotation concentrate sample surface in the laboratory of X-ray analysis methods Geochemistry Institute by name of A.P. Vinogradov SB RAS. Picture 3 shows galena PbS presence in the sample, which is determined by X-ray wavelength.

Picture 3: The presence of lead sulfide (galena) in flotation concentrate

To confirm the scientific assumptions about the impact of lead, which is in the form of galena in flotation concentrate on the process of deposition of precious metals on zinc dust, laboratory experiment was conducted. During 72 hours spent flotation concentrate leaching with sodium cyanide was conducted by the addition of lime milk to maintain pH = 11.5. The resulting mixture was filtered, and a chemical analysis of the liquid phase was made to find in the presence of lead. The presence of lead in the liquid phase of the slurry after leaching (2.5 mg/l) in solution confirms the presence of lead ions.

As in the solution contains lead ions after leaching, it is not necessary to add to the process the lead nitrate or is required in a smaller amount, which leads to expensive reagent saving.

According to the chemical and X-ray phase analysis data, the chemistry process of surface modification of zinc dust by lead, contained in the flotation concentrate is offered.

It is known that lead sulphate in a weak alkaline medium creates an insoluble hydroxide Pb(OH)$_2$, which precipitates:

$$\text{PbS} + 2\text{NaOH} = \text{Pb(OH)}_2 \downarrow + \text{Na}_2\text{S} \quad (1)$$

In the factory technological process the lime milk is added Ca(OH)$_2$, which at the gradual dissolution provides the presence of ions OH$^-$. In this case calcium hydroxide is weekly dissociating substance, the dissociation constant $K_d<1$, which dissolves to a certain content of OH$^-$ ions in solution. When ions are removed from the solution at OH$^-$ their interaction with other substances, dissolution is resumed.

Also in the process hydrolysis of sodium cyanide:

$$\text{NaCN} + \text{H}_2\text{O} = \text{NaOH} + \text{HCN} \quad (2)$$

In this case NaOH dissociates into ions Na$^+$ and OH$^-$. Within the excessive ions’ content OH$^-$ reaction, which is described by the formula 1 may proceed as follows:
The complex salt of tetrahydroxoplubate – Na$_2$[Pb(OH)$_4$] dissolves in water and under the cyanide influence the reaction of replacement of hydroxy 1 group into cyanide group happens and cyanide lead salt appears according to the reaction 4:

$$\text{Na}_2\text{[Pb(OH)$_4$]} + 4\text{HCN} = \text{Na}_2\text{[Pb(CN)$_4$]} + 4\text{H}_2\text{O}$$ 

(4)

Compound Na$_2$[Pb(CN)$_4$] in water dissociates into ions, including the ion of lead Pb$^+$ according to the reaction 5:

$$\text{Na}_2\text{[Pb(CN)$_4$]} \rightarrow 2\text{Na}^+ + \text{Pb}^+ + 4\text{CN}^-$$ 

(5)

Conclusions:

Taking into account the above data, it is safe to say that the cooperative processing of the flotation concentrate and ordinary ores leads to an increase of the extraction of precious metals in the factory, increase the nobility of the finished product, resulting in savings of commercial reagent.

The main scientific and practical conclusions, which are drawn from the research are as follows:

1. The increase of precious metal content in the initial raw material and, consequently, in a productive solution Merrill-Crowe, increases the quality of the finished product.
2. Increase of the precious metals’ content of the initial raw material and the presence of lead in the flotation concentrate leads to an increase of through extraction in the factory.
3. The optimum ratio of the charge of FC/ore – 1/70.
4. The form of lead in the flotation concentrate it is mineral galena.
5. The flotation concentrate leaching leads ions to go into solution, which leads to lead nitrate saving.
6. The scientific hypothesis was proposed – complex cyanide salt of lead Na$_2$[Pb(CN)$_4$] in water dissociates into ions, including lead ion Pb$^+$, which explains the presence of lead ions during the flotation concentrate leaching.

REFERENCES