Extraction Of Non-Ferrous And Noble Metals From Mill Tailing By Solutions In The Presence Of Oxidizing Agents

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***Abstract*— Optimal parameters of leaching of non-ferrous and noble metals from mill tailing by solutions in the presence of oxidizing agents (paramagnetic catalyst) are investigated.The optimum concentration of sulfuric acid and sodium cyanide was determined in the leaching of gold-containing mill tailings.It is shown that the presence of oxidizing agents in solutions leads to an increase in the extraction of metals into the solution. It was found that the extraction of gold, copper, zinc, lead and manganese during the process of conventional sulfuric acid leaching is significantly lower than during the presence of an oxidizing agent.Dissolution of copper, depending on the different concentration of sulfuric acid (g / dm3: 5.0, 10.0, 15.0, 20.0) showed that the degree of metal extraction by using oxidizing agents increases, respectively, 35.2%, 64.0%, 65.0%, 65.9%.**

***Index Terms*— Paramagnetic catalyst, sodium cyanide, non-ferrous metals, gold**

I. INTRODUCTION

In the scientific and technical literature, various data are given on increasing the extraction of metals from low-grade and resistant raw materials. For example, [1] is proposed to use rhodanate solutions instead of cyanide as leaching agent in the technological scheme of gold and uranium extraction. Rhodanate solutions are less toxic and allow sequential extraction of uranium and gold without intermediate stage of ore washing from one of the reagents. This technological method allows to ensure a closed water circulation in the leaching stage, sequential extraction and sorption of uranium, and then gold, and organize the regeneration of sorbents. Also, the methods of chlorination are among the promising directions of gold-copper processing of arsenic-containing ores. Currently, this method is considered as one of the most progressive methods of opening a mineral raw material to produce a base metal of high purity. In [2], the results of a study of the chloridation process with reference to a copper gold-containing flotation concentrate are presented. Optimal process conditions are set up. A principal technological scheme for the processing of concentrate is proposed, including the cyanidation of cinders ofchloridation. In [3] several factors affecting the process of dissolution of Au and its complexation with thiourea ions have been studied. The optimal technological parameters of the leaching process are determined for the thiourea environment: S: L = 1: 0.8-4; class content - 0.071 mm> 95%; the concentration of thiourea in the range of 10 g / l, the concentration of the oxidant-ion of Fe3 +, of the order of 3 g / l, the pH of the solution was in the range from 1.5 to 2. The process was conducted in agitational mode. The maximum degree of gold extraction into the solution for the conditions described above was 52%. However, the main technological method in hydrometallurgy is sulfuric acid leaching. To optimize the processes of metal extraction into the solution by this method, for example, the peculiarities of the changes in sulfides during the storage of mill tailings of copper-nickel ores and the influence of these processes on the technological properties of raw materials are determined. There is no doubt that the processing of the mill tailing of the current mining is beneficial and can be more efficient than the processing of stale mill tailings. In [4], the processes of sulfuric acid leaching of the sand fraction of mill tailing of copper-nickel ores were simulated with the tank leaching and heap leaching. After studying the different leaching regimes, it was shown that copper recovery can reach 80% at a redox potential of 410 mV, 85 ° C, 15 g / dm3 of the initial concentration of H2SO4 and an initial Fe concentration of 5 g / dm3. At a higher concentration of sulfuric acid, the leaching process can be inhibited by the release of Fe, S and jarosite [5]. Analysis of literature data shows that the solution of the problem of extraction of gold and non-ferrous metals from complex and low-grade raw materials should be based on a set of measures to reduce the number of chemical operations of technologies to improve the efficiency of metals recovery into solution. The creation of effective technologies in hydrometallurgy for extraction of precious and non-ferrous from complex and low-grade mineral raw materials remains a vital and very current problem.

II. EXPERIMENTAL PART

To determine the optimum parameters of leaching of nonferrous and noble metals by solutions in the presence of oxidizing agents, the mill tailing of the gold recovery factory with the chemical composition were chosen,%: Au - 1.43 g / t, Ag - 0.7 g / t, Cu - 0.07, Zn - 0.02, Fe - 9.5, Pb - 0.06, Mn - 0.05, Ti -5.7, Sn-0.06, Cr-0.05, Co-0.10, As-1.1, Ba-0.4.

When studying the effect of an oxidizing agent on the process of dissolving metals, a solution of sulfuric acid and sodium cyanide was used.

When leaching gold-containing tailings with sulfuric acid in the presence of a paramagnetic catalyst, gold was practically not extracted into the solution (below 0.1%).

Figures 1-4 show the kinetic curves of the process of interaction of tailings as a function of the different concentration of sulfuric acid (5.0-20.0 g / dm3). It can be seen from the experimental results that the concentration of dissolved metals increases with the concentration of sulfuric acid in the presence and without the addition of an oxidizing agent.

According to Figures 1-4, it is clear that the extraction of copper, zinc, lead and manganese in conventional sulfuric acid leaching is significantly lower than in the presence of an oxidizing agent. The dissolution of copper depending on the different concentration of sulfuric acid (g / dm3: 5.0, 10.0, 15.0, 20.0) indicates that the degree of copper extraction increases from 14.5% to 35.2%, from 21.4% to 64.0%, from 25.8 to 65.0%, from 29.1% to 65.9%.

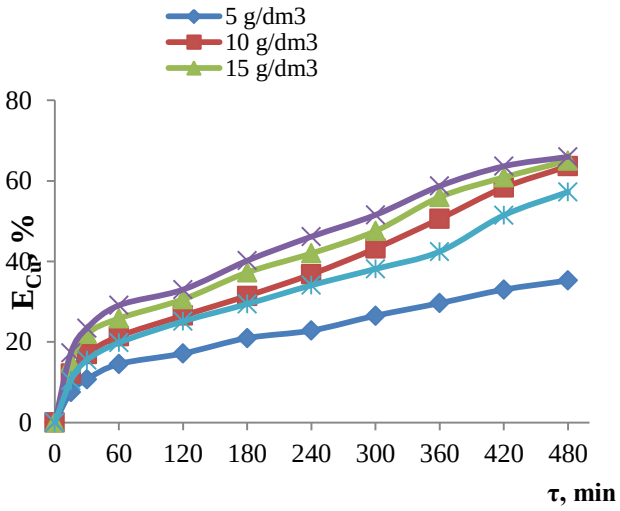

Figure 1 - Extraction degree of copper during leaching of mill tailing depending on the concentration of sulfuric acid in the presence of a paramagnetic catalyst

As can be seen from Figure 2, the degree of extraction of zinc with an increase in the concentration of sulfuric acid, g / dm3: 5.0; 10.0; 15.0; 20.0 in the presence of the catalyst increases, respectively: from 2.1% to 41.8%, from 10.2% to 73.5%, from 11.5 to 71.7%, from 14.2% to 72.2%.

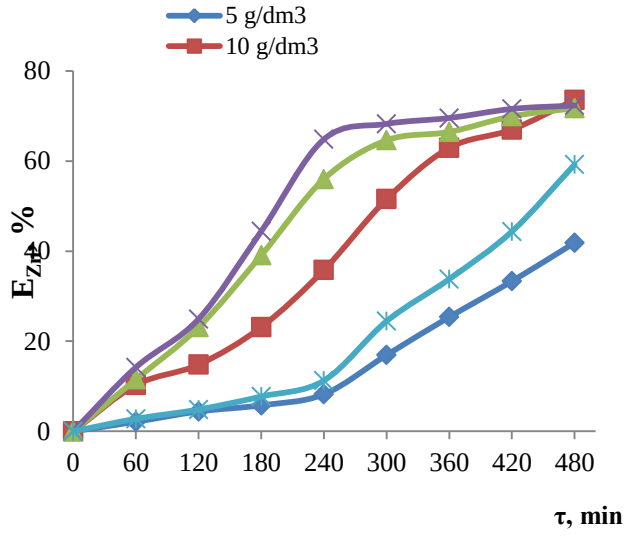

Figure 2 - Extraction of zinc in the leaching of mill tailing depending on the concentration of sulfuric acid in the presence of a paramagnetic catalyst

For lead, these figures are respectively from 1.1% to 3.1%, from 2.2% to 19.8%, from 3.5 to 22.4%, from 4.3% to 23.2% (Figure 3).

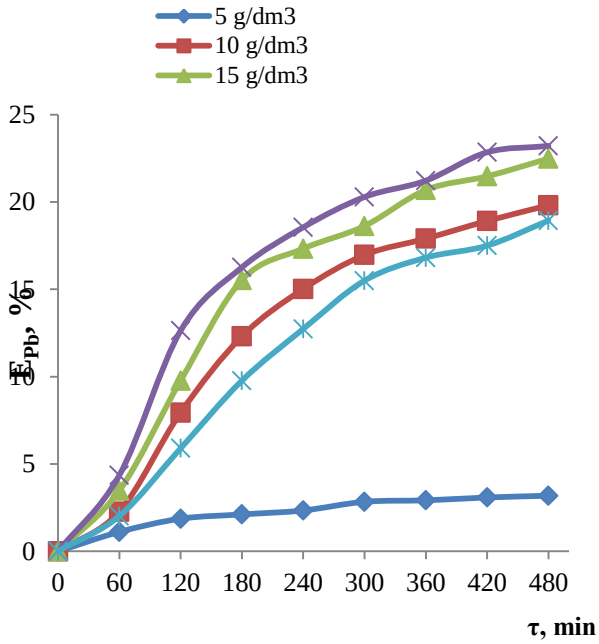

Figure 3 - Degree of extraction of lead during leaching of mill tailing depending on the concentration of sulfuric acid in the presence of a paramagnetic catalyst

The degree of extraction of manganese with an increase in the concentration of sulfuric acid, g / dm3: 5.0; 10.0; 15.0; 20.0 - increases from 2.3% to 13.4%, from 3.7% to 17.5%, from 4.5 to 19.1%, from 5.7% to 20.7% (Figure 4).

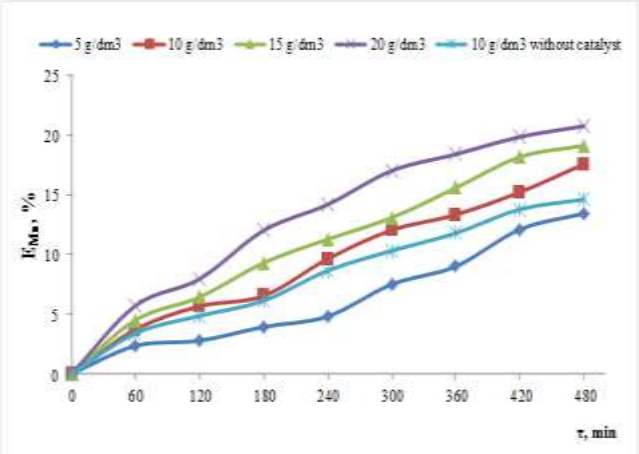

Figure 4- Degree of manganese extraction during leaching of mill tailings depending on the concentration of sulfuric acid in the presence of a paramagnetic catalyst

The optimum concentration of sulfuric acid is 10.0 g / dm3. If we compare the results of Figures 1 through 4, the sulfuric acid leaching of mill tailings without and in the presence of a paramagnetic catalyst under identical conditions, then at an optimum sulfuric acid concentration of 10.0 g / dm3, the presence of an oxidizing agent increases the metal extraction by 1.2 times.

The results of studies on cyanide leaching of mill tailings without and in the presence of a paramagnetic catalyst are presented in Figures 5-7.

As can be seen from Figures 5-7, an increase in the

concentration of sodium cyanide from 0.1 g / dm3 to 1.0 g / dm3 during leaching for 6 hours contributes to an increase in the extraction of metals in all the cases studied.

The presented results of the process of gold dissolution by cyanide solutions depending on different concentrations, g / dm3: 0.1; 0.3; 0.5; and 1.0 in the presence of an oxidizing agent showed that, with an increase in the concentration of sodium cyanide, gold extraction increases, respectively, from 2.3 to 91.1% (Figure 5).

Dissolution of copper depending on the different concentration of sodium cyanide, g / dm3: 0.1; 0.3; 0.5; 1.0 showed (figure 6) that the extraction rate increases, respectively, from 20.0% to 38.9%, from 23.6% to 50.8%, from 32.1 to 58.7%, from 36.7% to 61.2%. For zinc, these figures are, respectively: from 9.4% to 35.7%, from 16.1% to 41.5%, from 19.4 to 55.1%, from 20.5% to 61.5% (Figure 7).

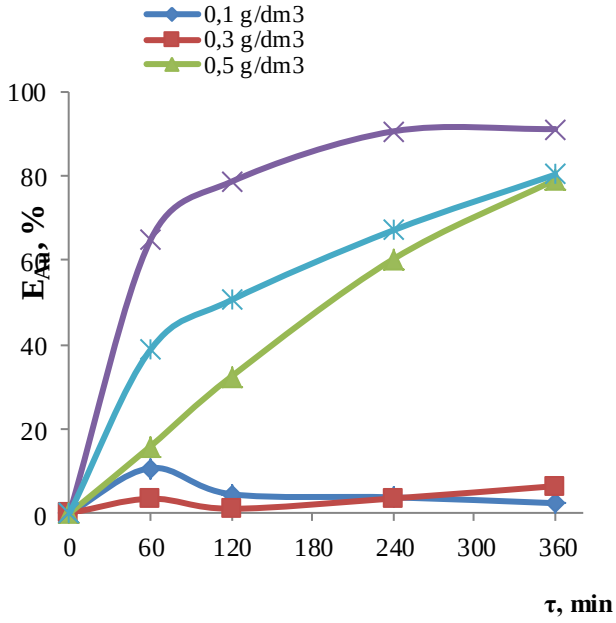

Figure 5 - The degree of gold extraction from mill tailings at different concentrations of sodium cyanide in the presence of a paramagnetic catalyst

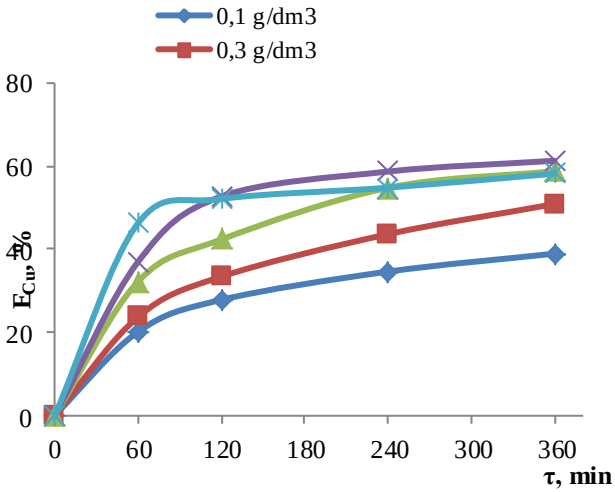

Figure 6 - Extraction degree of copper from mill tailings at various concentrations of sodium cyanide in the presence of a paramagnetic catalyst

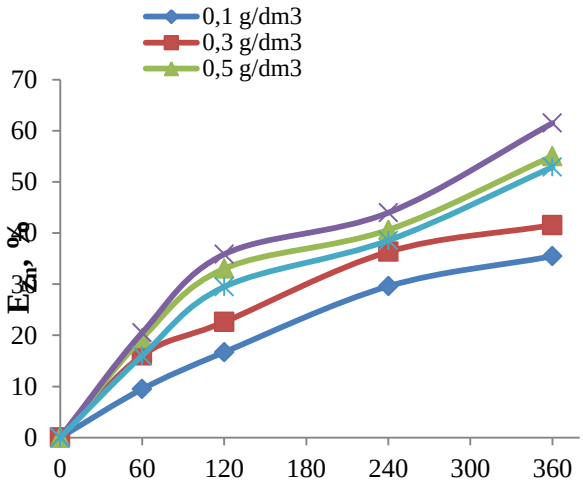

Figure 7 - Extraction of zinc from mill tailings at various concentrations of sodium cyanide in the presence of a paramagnetic catalyst

By comparing the results of the processes of cyanide leaching of the mill tailings in the presence of a paramagnetic catalyst and without a catalyst under the same conditions, then, in cyanide solutions in the presence of a paramagnetic catalyst, the extraction of metals into the solution is 1.2 times higher.

III. CONCLUSION

It is shown that the addition of a paramagnetic catalyst leads to an increase in the dissolution of metals from the mill tailings. In all the investigated cases, using an oxidizing agent, an increase in the extraction of metals from the mill tailings was observed and the possibility of practically maximizing the extraction with increasing leaching time was observed.

It is established that extraction of non-ferrous and noble metals from low-grade raw materials (tailings of enrichment) by leaching in the presence of an oxidizing agent increases by 1.2 times.

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