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COPPER SOLVENT EXTRACTION FROM ACID SOLUTIONS OBTAINED BY ORES SOLUBILIZATION

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ABSTRACT. Solvent extraction is the separation technique used, in this case, for purification and concentration of acid solutions obtained by low-grade copper ores leaching. The acid solution contents, beside copper, considerable amounts of zinc, lead and iron, which are undesirable components. To separate the copper from this unwished elements, copper was extracted by chelatable extractant (α-benzoin oxime, named cupron). To increased the extraction efficiency, two contacting methods, between aqueous and organic phase, were investigated. When one organic phase was contacted successionally with three loaded aqueous phases, it was obtained an increase of copper concentration in organic phase, relate to the case in which one aqueous phase was contacted sequential with three unloaded organic phase.

INTRODUCTION

The solutions obtained by acid solubilization of low-grade complexes ores contents, beside copper, considerable amounts of zinc, lead and iron. In the most hydrometallurgical processes of copper winning, the final step is electrowinning (electrolysis). The presence of zinc, lead and iron in leaching solution disturbs the electrowinning process. Therefore, is necessary to separate copper from undesirable components and, in the same time, to concentrate copper in the solution, by solvent extraction.

The purpose of this paper is to test two method of contact between aqueous and organic phase, with a view to obtain a higher copper concentration in organic phase. Therefore, the aqueous and organic phase were submitted to a three-stapes extraction succession, either using only one aqueous phase and three unloaded organic phases, or using only one organic phase and three loaded aqueous phases.

EXPERIMENTAL

The extraction solvent

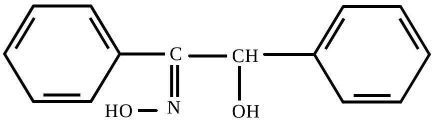
As extraction solvent, α-benzoin oxime in benzol was used. The extracting agent (structure I), named cuprous [1], forms a chelate compound (structure II) by azote (N) and hydroxylic oxygen (OH) atoms with cupric ion [2-3].

The aqueous phase

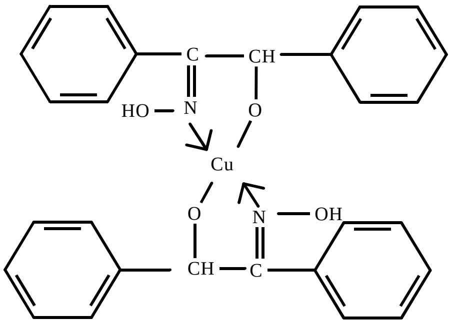
The aqueous phase subjected to solvent extraction, was obtained at Cavnic Mine ore solubilization [4-7], under following experimental conditions:

- ratio solid/liquid: 1/7.5
- solubilization agent: H_2SO_4 8 N;

- oxidizing agents: $Fe_2(SO_4)_3$ 30 g/l and air bubbling at 200 l/hour in a volume of 210 ml leaching agent;
- solubilization temperature: 60°C;
- solubilization time: 24 hours;
- fraction of ore: -160+100 μm.



(I)



(II)

The chemical and mineralogical composition of the low-grade chalcocite-covellite-chalcopyrite ore is given in table 1.

Table 1.

The chemical and mineralogical composition of low-grade ore.

Element	%	Element	Compounds	%
Cu	0.37	Cu	sulphates	0.003
Pb	1.50		carbonates and oxides	0.013
Zn	2.00		chalcocite and covellite	0.144
Au	0.38*		chalcopyrite	0.212
Ag	45.7*	Pb	sulphates	0.140
Fe	7.52		carbonates	0.110
As	0.00		sulphides	1.010
S	7.92		oxidic compounds	0.240
SiO_2	53.4	Zn	sulphates	0.005
	* g/t		carbonates and oxides	0.065
			silicates	0.080
			sulphides	1.855

The copper and iron content of aqueous phase obtained by acid solubilization, in presence of oxidizing agents, is presented in table 2.

Table 2.

The copper and iron content of aqueous phase.

$c_{Cu^{2+}}$ (g/l)	$c_{Fe_{total}}$ (g/l)	$c_{Fe^{2+}}$ (g/l)
0.26	6.85	5.10

The solvent extraction experimental conditions

The copper extraction from aqueous phase was carried out by a three-stapes extraction succession, which is showed schematically in figure 1.

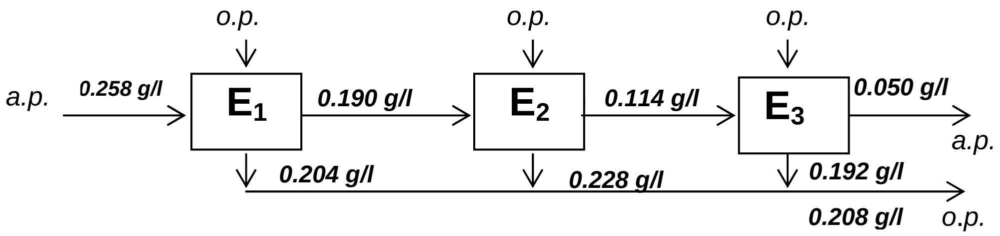


Figure 1. The diagram of modifications in aqueous (a.p.) and organic phases (o.p.) copper content.

In this case, the experimental conditions were the following:

- aqueous phase volume: 15 ml;
- organic phase volume: 5 ml;
- α-benzoin oxime concentration in benzol: 0.5 moles/l;
- phases contact time: 20 minutes/step.

The phases separation was made with separating funnel and the copper concentration in solution was analysed by spectrophotometrical method, using cuprizon (oxalic acid bis(cyclohexylidenhidrazide)) as complexing agent.

In the second method of aqueous and organic phase contact, schematically showed in figure 2, the copper extraction was realized by a three steps extraction succession, using only one organic phase, under the following conditions:

- aqueous phase volume: 15 ml;
- organic phase volume: 15 ml;
- α-benzoin oxime concentration in benzol: 0.5 moles/l;
- phases contact time: 20 minutes/step.

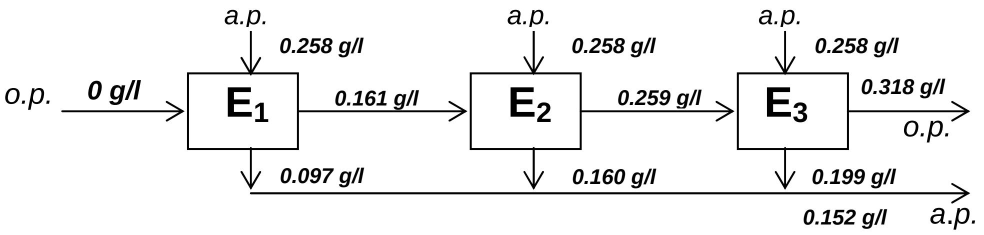


Figure 2. The diagram of modifications in organic (o.p.) and aqueous phases (a.p.) copper content.

RESULTS AND DISCUSSIONS

The values of extracted by first method copper percent, for each step of extraction (E_1, E_2 and E_3), for first and second steps of extraction (E_{1-2}) and for all three steps of extraction (E_{1-3}) are presented in figure 3.

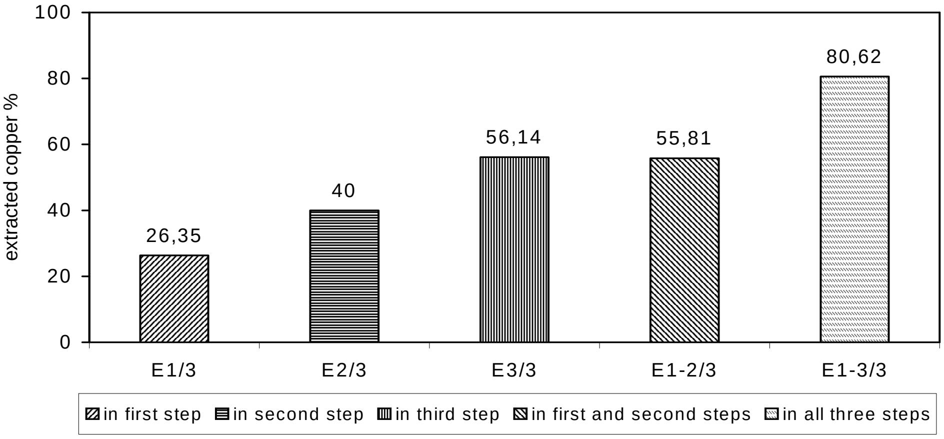


Figure 3. The extracted by first method copper percents in: first, second, third, first and second, and all three steps.

In figure 4 are presented the values of extracted by second method copper percent, for each step of extraction (E_1, E_2 and E_3), for first and second steps of extraction (E_{1-2}) and for all three steps of extraction (E_{1-3}).

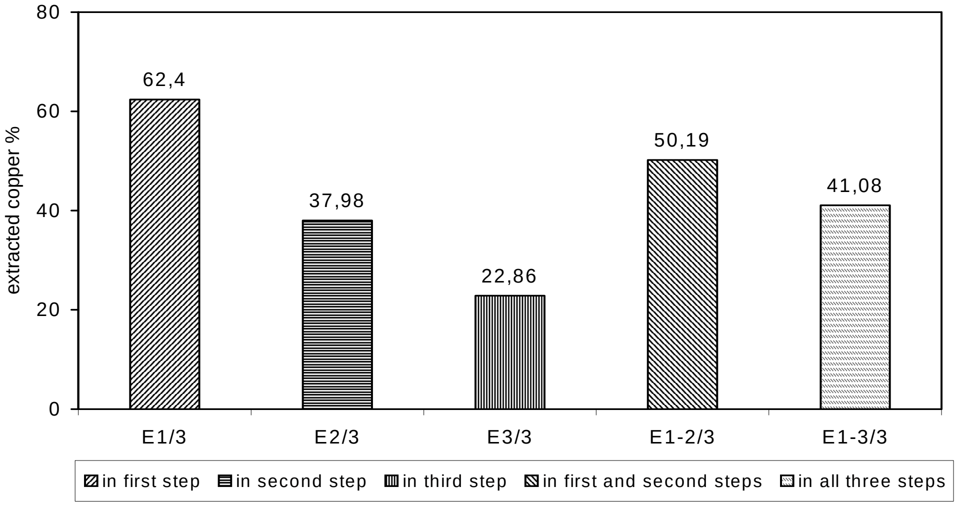


Figure 4. The extracted by second method copper percents in: first, second, third, first and second, and all three steps.

To increase moreover the extracted copper percent and the copper concentration in organic phase, the partial unloaded aqueous phase obtained by second extraction method was submitted, in the same experimental conditions, to another three-stage extraction succession.

In this case, the diagram of modification in aqueous and organic phases copper content is presented in figure 5.

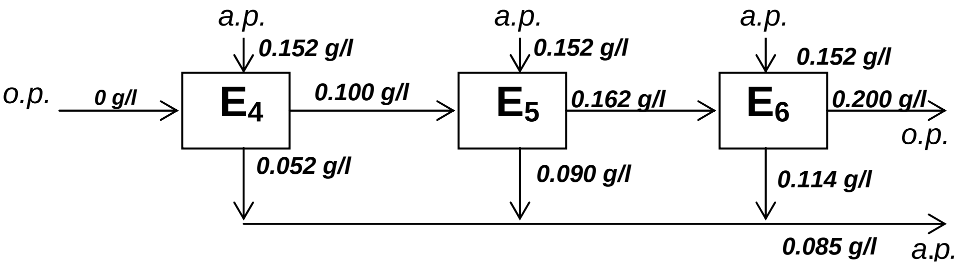


Figure 5. The diagram of modifications in organic (o.p.) and aqueous phases (a.p.) copper content.

The values of extracted copper percent, in this case, are presented in figure 6.

In table 3 are contained the initial and final copper concentrations of aqueous and organic phases for each of steps, the extracted copper percents according to steps and the total extracted copper percent after six steps of extractions.

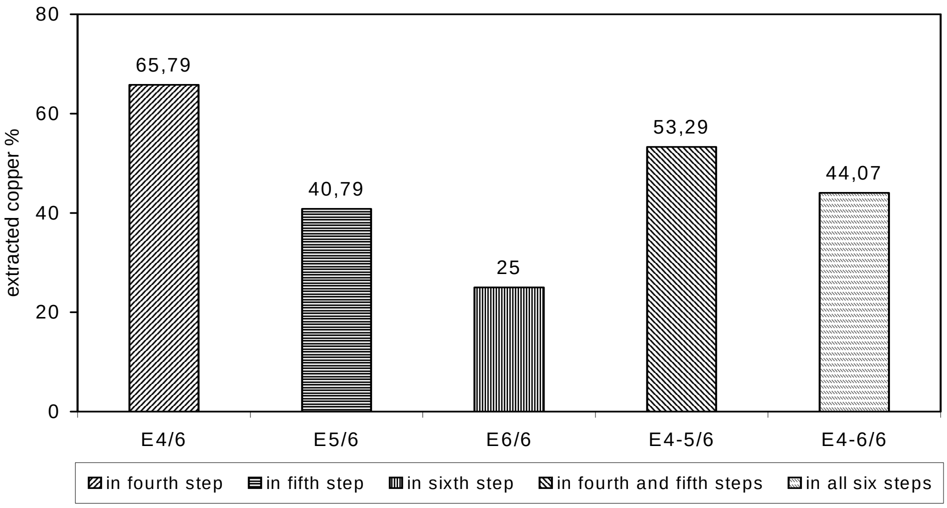


Figure 6. The extracted by second method copper percents in: fourth, fifth, sixth, fourth and fifth, and all six steps.

Table 3.

The initial and final copper concentrations of aqueous and organic phases, and the extracted copper percents.

Step	Aquouse phase		Organic phase		Extracted copper %			
	$c_{initial}$ (g/l)	c_{final} (g/l)	$c_{initial}$ (g/l)	c_{final} (g/l)				
E_1	0.258	0.097	0.000	0.161	62.40	50.19	41.08	67.05
E_2	0.258	0.160	0.161	0.259	37.98			
E_3	0.258	0.199	0.259	0.318	22.86			
E_4	0.152	0.052	0.000	0.100	65.79	53.29	44.07	
E_5	0.152	0.090	0.100	0.162	40.79			
E_6	0.152	0.114	0.162	0.200	25.00			

CONCLUSIONS

The examination of the extracted copper percent obtained values leads to the following conclusions:

(a) the extracted by first method (when is used only one aqueous phase and three unloaded organic phases) copper percent amounts to 80.62% after three-stages extraction succession; although the extracted copper percent is raised enough, the copper concentration in organic phase is mealy 0.208 g/l;

(b) when the second extraction method is used (three loaded aqueous phases and only one organic phase) the extracted copper percent amounts to 41.08% after three-stages extraction succession; in this case, the copper content in organic phase is higher (0.318 g/l) than the copper concentration in organic phase (0.208 g/l) obtained by first method, though the extracted copper percent after all three extraction steps (41.08%) is lower than the extracted by first method copper percent (80.62%);

(c) the increase of extraction steps number until six, leads to an extracted copper percent of 67.05%.

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