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Technological Research of Multicomponent Middlings Processing I. Nitric Acid Leaching

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Abstract

Technological research carried out of sulfide multicomponent middlings leaching in nitric acid, followed by stepwise selective isolation of components from the resulting productive solution to verify and confirm the results of laboratory tests. The scheme of two-stage countercurrent leaching of sulfide multicomponent middlings was offered.

Keywords: Technological research, multicomponent middlings, nitric acid, two-stage countercurrent leaching

1 Introduction

The aim of this work is to carry out technological research of sulfide multicomponent middlings leaching in nitric acid to verify and confirm the results of laboratory tests [1-4].

In our previous studies a middlings nitric acid leaching of «Maykain B» were conducted [5, 6].

2 Experimental

Analyzed middlings are an intractable division of the selective flotation multicomponent sulphurous materials of deposits «Maykain B», Kazakhstan. The chemical composition of middling is presented in Table 1.

Table 1. The chemical composition of sulfide multicomponent middlings «Maykain B», % mass

Ag, g/t	**Au, g/t**	**Al**	**As**	**Ba**	**Ca**	**Cd**	**Co**	**Cr**	**Cu**
81,3	11,5	0,1	0,21	0,06	1,72	0,03	0,016	0,006	6,37
Fe	**Mg**	**Mn**	**Ni**	**P**	**Pb**	**S**	**Sb**	**Si**	**Se**
33,57	0,24	0,01	0,009	0,005	1,18	46,3	0,0063	<0,05	0,005
Sn	**Sr**	**Te**	**Ti**	**V**	**Zn**	**K**	**Na**	**Tl**	
0,005	0,013	<0,005	0,001	<0,001	9,21	0,09	1,66	<0,001	

Technological research plan consists of a sequence of operations:

1. Nitric acid leaching of middlings receiving copper and zinc-containing solution and insoluble precipitate containing sulfur, lead and precious metals.
2. Nitrous gases capture which are released during leaching and regeneration of nitric acid.
3. Precipitation of iron from the leaching solution with NTP-acid and separation of the residue from the solution.
4. Electroextraction of copper to produce cathode deposit.
5. Sorption of residual copper by ion exchange resin Lewatit Monoplus TP-220.

Technological research of leaching were conducted in a round-bottomed glass reactor with a volume of 1 dm^3 having 3 holes: first for supplying the estimated amount of 71 percent nitric acid with the Biohit prospenser metering device (L:S=5:1); second for air from the compressor for the oxidation of nitrous gases to higher oxides of nitrogen at air flow 1,1 dm^3/min; third for removal of nitrous gases which pass through a water-cooled reflux absorption column for nitric acid regeneration. System is sealed. The process proceeded with continuous stirring with a magnetic stirrer at a speed of 500 rpm. Sample weight was 100 g.

After leaching, the pulp goes to vacuum filtration step to receive a solution and the precipitate which contains elemental sulfur, and precious metals [7-9]. After separation of the insoluble sulfur and the lead residue can be processed by traditional methods for gold and silver recovery [10].

Next, the precipitate was washed, dried and weighed. Flushing water was directed on to the nitrous gases capture stage. All intermediates were analyzed.

3 Results and discussion

In first cycle of leaching the following parameters were used: the volume of water – 200 cm^3, the volume of 71 percent nitric acid – 330 cm^3, HNO_3 concentration was 10,65 mol/dm^3, process time 3:00. Completion of the process was determined by reduction of pulp agitation intensity due to reaction gases released.

At the initial stage of the process part of sulfide sulfur is oxidized to elemental state, as evidenced by analysis results. However, it’s yield does not exceed 10% of the total and has no significant effect on the performance in metal extraction to leaching solution.

Thus, it was possible to achieve following extraction of elements to solution: copper – 99,0%, zinc – 99,0%, iron – 99,3%, sulphur – 90,1%. In the insoluble residue content of gold increased to 92,74 g/t, silver - to 638,6 g/t.

After leaching, using I-160 M laboratory ionomer and ALICE-121NO_3 ion-selective electrode solution was analyzed for the content of nitrate ions – 164,3 g/dm^3.

Such an amount of NO^-_3 is excessive and impedes the further stages of the proposed flowsheet.

The results of the leaching cycle 1 are shown in Table 2.

Table 2. Removing elements in the intermediates of cycle 1 leaching

Products	Amount	Cu		Zn		Fe	
		g/dm³	**%**	**g/dm³**	**%**	**g/dm³**	**%**
Leaching solution, cm³	420	13,9	91,5	19,9	90,9	74,4	93,1
Flushing water, cm³	300	1,6	7,5	2,5	8,1	6,9	6,2
Cake (dry), g	12,4	**g/t**	**%**	**g/t**	**%**	**g/t**	**%**
		51,4	1,0	74,3	1,0	189,5	0,7
Products	Amount	Ag		Au		S	
		g/dm³	**g/dm³**	**%**	**g/dm³**	**%**	**%**
Leaching solution, cm³	420	2,1* *10^{-4}	2,6	0	0	90,33	81,9
Flushing water, cm³	300	0	0	0	0	12,57	8,2
Cake (dry), g	12,4	**g/t**	**%**	**g/t**	**%**	**kg/t**	**%**
		638,6	97,4	92,74	100	369,6	9,9

Therefore we decided to carry out a two-stage countercurrent leaching of polymetallic sulphide middlings to reduce the concentration of nitrate ions in the leaching solution, enhance the recovery of nitric acid and increase the concentration of copper and zinc in the leaching solution.

4 Conclusions

Use of a two-stage countercurrent leach allowed to increase the concentration of valuable components in the solution to following: copper to 20,3 g/dm^3, zinc to 29,9 g/dm^3. Residual concentration of NO^-_3 leaching solution decreased to 10,5 g/dm^3. Furthermore, it is possible to reduce the consumption of fresh nitric acid to 25% from the original amount. Gold and silver content in the pellet compared to the starting material has increased by more than 10 times and was, g/t: 136,9 Au, 951,4 Ag.

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