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Extraction of copper from pregnant leaching solutions of lead dusts by liquid extraction

*¹ Altaibayev B. T., ² Khabiyev A.T., ² Baigenzhenov O.S., ³ Bulenbayev M. Zh., ⁴ Turan M.D.

¹ LLP "Space of Implementation Research Testing", Nur-Sultan, Republic of Kazakhstan

² Satbayev University, Almaty, Kazakhstan

³ LLP "Joint Venture "Southern Mining and Chemical Company", Shymkent, Republic of Kazakhstan

⁴ Firat University, Engineering Faculty, Metallurgical and Materials Eng, 23119, Elazig, Turkey

* Corresponding author email: alibek1324@mail.ru

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Abstract. This paper presents the results of studies of intermediate processing for liquid extraction and re-extraction of copper from sulfate solutions obtained during agitation sulfuric acid leaching of lead dusts, which are technogenic wastes of the Zhezkazgan copper smelter and contain valuable components: more than 38 % lead, 2.4 % iron, 3 % zinc, 3.5% copper, 0.7 % arsenic, etc. The utilization of them can provide additional commercial products and improve the ecological environment of the area where they are located. The article also presents the results of the material balance of the processes of liquid extraction and copper re-extraction.

Keywords: metal impurities, extraction, re-extraction, lead dust, Acorga M5640.

Information about authors:

Altaibayev B. Tolbasuly - Doctor Ph.D., LLP "Space of Implementation Research Testing", Nur-Sultan, Republic of Kazakhstan. ORCID ID: 0000-0002-7405-6854. Email: bagdat777_87@mail.ru

Khabiyev Alibek Talgatbekovich - Doctor Ph.D., Assoc. Professor. Non-commercial joint-stock company "Satbayev University", the department "Metallurgical processes, heat engineering and technology of special materials", Almaty, the Republic of Kazakhstan. ORCID ID: 0000-0001-9397-2367. Email: a.khabiyev@satbayev.university

Baigenzhenov Omirserik Sabyrzhanovich - Doctor Ph.D., Assoc. Professor. Doctor Ph.D., Assoc. Professor. Non-commercial joint-stock company "Satbayev University", the department "Metallurgical processes, heat engineering and technology of special materials", Almaty, the Republic of Kazakhstan. ORCID ID: 0000-0001-5803-7680. E-mail: o.baigenzhenov@satbayev.university

Bulenbayev Maxat Zhumabayevich - LLP "Joint Venture "Southern Mining and Chemical Company", Shymkent, Republic Of Kazakhstan, Doctor Ph.D., mbulenbaev@mail.ru

Turan Mehmet Deniz - Firat University, Engineering Faculty, Metallurgical and Materials Engineering, Elazig, Turkey, Assoc. Professor Doctor Ph.D., mdturan@firat.edu.tr

Introduction

At present, a large amount of lead dust has accumulated on the territory of the Zhezkazgan copper smelting plant, which pollutes the environment and at the same time is a source of valuable components such as a lead, copper, cadmium, zinc and others. Utilization of this waste

can contribute to the improvement of the environment of the territories of their burial and the receipt of additional expensive products [1].

When developing extraction technology for complex processing of lead dust, the following processes are carried out: agitational leaching of lead dust with an oxidizer - H_2SO_4 , extraction of copper from a product solution with an extractant grade - "ACORGA M5640", re-extraction with

sulfuric acid electrolyte, and then, in order to obtain pure commercial copper, the copper electrolyte is subjected to electrolysis, and the raffinate obtained after copper extraction is sent to obtain the remaining valuable components using traditional technology [2-5].

The use of a selective extractant allows only copper ions to be isolated from the solution. When analyzing the literature data, it was found that chelate extractants (ACORGA M5640) are most selective for liquid extraction of copper from sulfuric acid solutions [6,7].

The objective of this study is to determine the possibility of obtaining copper in the electrolyte from copper solutions of agitational leaching of lead dust and adapting the process to the conditions of copper extraction existing at the Production Association "Zhezkazgantsvetmet".

Composition of the solution after the leaching of lead dust

The initial product for carrying out the processes of extraction and stripping is a solution obtained after agitational leaching of lead dust with an average content of the components shown in Table 1.

Table 1 - Quantitative composition of the copper-containing solution of agitational acid leaching of lead dust

Component name	Fe _{total}	Cu	Zn	As _{total}
Substance, g/dm ³	2,6	15	16	12

Reagents for copper extraction and stripping include: extractant - ACORGA M5640, density $\rho = 0.95-0.97$ g / dm³, flash point ~ 62 °C; diluent - kerosene (purified sulfonated or lighting), $\rho = 0.811-0.815$ g / dm³, viscosity $0.780-0.784$ N·s/m² (20-21 °C), flash point > 40 °C; sulfuric acid (reagent grade, $\rho = 1.83-1.84$ g / dm³); cationized water (cation exchanger CU-1).

Methodology for the extraction and stripping process

For the extraction, a clarified extractant, ACORGA M5640, was preliminarily prepared by diluting it with kerosene (purified sulfided or clarified) in a ratio of 1: 4. The kerosene was preliminarily purified 2 times with concentrated sulfuric acid in a ratio of 3: 1, then washed with cationized water in a ratio of 1: 1.

To carry out the experiments of extraction and stripping, it was necessary to carry out the

maximum loading of the selected extractants with copper.

Extraction of copper. For copper extraction from solutions after leaching of lead dusts, the optimal copper content in the solution should be no more than 9 g / l. With such a content, the end-to-end extraction of copper will be at least 95% with the production of cathode copper grade M00K. Therefore, the original copper solution was diluted with technical water 1: 1. With such a copper content, to obtain these parameters, the extraction should be carried out in two stages.

For this, 0.5 dm³ of organic extractant ACORGA M5640 (20%, diluent-kerosene) with a ratio of aqueous and organic phases during extraction 1: 1 was placed in a separating funnel, then 0.5 dm³ of a copper-containing solution was added, after which the phases were subjected to active stirring in within 3 minutes. Further, the aqueous phase (A) separated from the organic phase (O) was sent to copper extraction (stage 2) with a fresh portion of the finished extractant with a volume of 0.5 dm³. After the 2nd stage of extraction, a sample was taken from the raffinate (aqueous phase), which was sent for chemical analysis to determine the content of copper, total iron, zinc, total arsenic and residual acidity.

ACORGA M5640 is a mixture of C₉ aldoximes modified with ether: 5-nonyl salicylaldoxime. A key molecule in the production of copper by liquid extraction is aldoxime - 5-nonylsalicylaldoxime or 5-dodecylsalicylaldoxime [2], the structure of which is shown below in Figure 1.

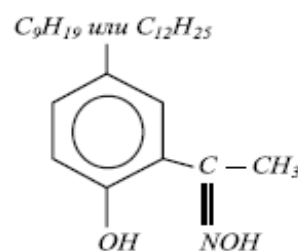


Figure 1 - General structure of aldoximes

When copper is extracted from stock solutions, molecules of the ACORGA extractant form chelate compounds with the copper cation inside (Figure 2).

The extractant selectively binds copper cations into a complex, without reacting to the presence of other metal cations. In this case, a reaction occurs between the copper cation and the ACORGA hydroxyoximes [8,9].

Copper re-extraction. After the extraction, the obtained extract was subjected to back-extraction in separating funnels with a capacity of 1 dm³. In this case, manual stirring was used for 2 minutes. A

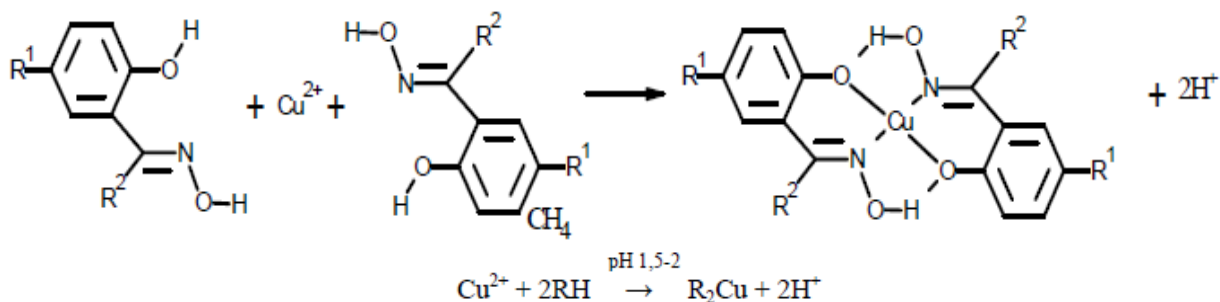


Figure 2 - Chemical equation of the process of copper extraction with ACORGA extractant

Table 2 - Reagents and process parameters

Process names	Reagents	Technological parameters
Copper extraction	Extractant: ACORGA M5640 (20%), kerosene (80%)	O: A ratio = 1: 1, mixing time 3 min, room temperature 20-25°C
Re-extraction of copper	acid H ₂ SO ₄ , conc.: 240 g / l	O: A ratio = 1: 1, duration 6-8 min, temperature 20-25°C
Organic washing	Washing liquid: cationized water 0,994 dm ³ + 0,06 dm ³ H ₂ SO ₄ (ρ=1,83 g/dm ³)	O: A ratio = 1:10, mixing time 2-3 minutes

Table 3 - Results of studies of extraction and re-extraction of copper (copper concentration in the initial solution Cu = 7.5 g/l)

Technological parameters of extraction processes	Cu content in ref. solution, g / dm ³	Extraction of Cu into extract, %	Cu content in extract, g/dm ³	Extraction of Cu into re-extract, %	Cu content in extract, g / dm ³
Extraction: O: A=1:1, τ _{mixing} = 3min., τ _{sed.} = 15 min.	7,5	96,8	7,26		
Re-extraction: H ₂ SO ₄ (conc. 240 g / l), O: A = 1: 1, τ _{mixing} = 2 min., τ _{sed.} = 12 min.				98,0	7,1148

solution of sulfuric acid with a concentration of 240 g / dm³ at a ratio of "O: A = 1: 1" was used as a stripping agent. Then the suspension was defended on a vertical stand. Reextraction was carried out in one stage. The time for complete separation of the spent extract and re-extract was 12-15 minutes. After separate draining of the extract and the productive solution (re-extract-electrolyte), they were analyzed for copper content. The spent extract was sent for regeneration, and the copper solution was sent for further processing in order to extract copper from it by one of the methods of copper extraction, which includes electrolysis.

Results and discussion

The test results showed a high selectivity of the "ACORGA M5640" extractant in the presence of relatively high concentrations of other elements in solutions, such as arsenic, zinc and iron. The extraction of copper from solutions after two stages of extraction amounted to 97%, with an insignificant transfer of other elements to the electrolyte. The

content of copper in the rich electrolyte after stripping was 45-65 g / l.

Table 2 shows the technological conditions for the extraction and stripping of copper. Table 3 shows the results of extraction, washing and re-extraction of copper from a productive agitational leaching solution.

The results of the conducted studies of the extraction method for separating copper from the solution showed the enrichment of the re-extract copper by 15-25 times when using the extractant ACORGA M5640. The bulk of the impurities of elements remains in the raffinate (Zn, Fe, Cd, etc.), for the extraction of which cementation and carbonization methods are used.

As can be seen from Table 4, the best re-extraction results were obtained using sulfuric acid with a concentration of 240 g / dm³. In this case, the extraction of copper in the re-extract reaches 98.03 %. A further increase in the concentration of sulfuric acid 300 g / dm³ does not give a significant effect. As a result of the research carried out, a

Table 4 - Results of balance tests of extraction and re-extraction of copper

Processes	Refined products, volume (mass), extraction (%), content (g), (g / dm ³)		Name and content of components, g; g / dm ³				
			Cu	Fe	Zn	As	
			52,5	9,1	56	42	
			7,5	1,3	8	6	
Extraction, V _{solution} = 7 dm ³ , O: A = 1: 1 V _{org} = 0.5 dm ³	Extract: 0,485 dm ³	Extraction		96,8	5,4	4,7	6,8
		Content	g	50,82	0,4914	2,632	2,856
	g / dm ³		7,26	0,0702	0,376	0,408	
	Raffinate: 6,95 dm ³	Extraction		2,2	93	94	90
		Content	g	1,155	8,463	52,64	37,8
	g / dm ³		0,165	1,209	7,52	5,4	
Re-extraction, O: A = 1: 1 V _{electrolyte} = 0.8 dm ³	Reextract (electrolyte): 0,8 dm ³	Extraction		98	98,2	99	95
		Content	g	49,8036	0,4825	2,6057	2,7132
	g / dm ³		7,1148	0,0689	0,3422	0,3876	
	Extractant, 0,465 dm ³	Extraction		1,2	0,8	0,5	2
		Content	g	0,60984	0,0039	0,0132	0,0571
	g / dm ³		0,08712	0,0005	0,0019	0,0082	
Discrepancy, Losses			%	1	1,6	1,3	3,2
			g	0,525	0,1456	0,728	1,344

solution enriched with copper (copper electrolyte) with a copper content of 62.25 g / dm³ was obtained.

Balance tests of copper extraction from a solution of agitational acid leaching of lead dust. Balance tests were carried out according to the method described above, the test results are shown in Table 4.

The results of balance tests showed the end-to-end recovery of copper from the clarified agitational leaching solution to a copper-containing re-extract is 94.86%. A significant part of zinc (94%), iron (93%), arsenic (90%) remains in the raffinate of the copper extraction process. To purify the raffinate from iron and zinc, the following processes are carried out: hydrolytic purification from iron and carbonization to obtain a rich zinc cake. The best re-extraction results were obtained using sulfuric acid with a concentration of 240 g / dm³.

Conclusions

As a result of the study, it was possible to establish the optimal parameters and efficiency of the "ACORGA M5640" extractant for copper extraction. Balance tests showed 94.86% copper throughput. In the process of extraction and re-extraction, a significant part of the impurity components in the solution after leaching of lead dust - zinc, iron and arsenic (over 93%) remains in the raffinate.

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Қорғасын тозаңдарын агитациялық ерітінділеу процесінде алынған ерітінділерден сұйық экстракция әдісімен мыс алу

Алтайбаев Б.Т., Хабиев А.Т., Байгенженов О.С., Буленбаев М.Ж., Туран М.Д.

Түйіндеме. Жұмыста сульфатты ерітінділерден мысты сұйықтықтық экстракция және реэкстракциялау бойынша зерттеу нәтижелері келтірілген. Құрамында қорғасынның 38 % - дан астамы, темірдің 2,4% - ы, мырыштың 3 % - ы, мыстың 3,5 % - ы, 0,7 % мышьяк және тағы басқалар бар бұл ерітінділер Жезқазған мыс балқыту зауытының техногендік қалдықтары болып табылады және құрамында бағалы компоненттері бар қорғасын шаңдарын күкірт қышқылымен агитациялық ерітінділеу кезінде алынды. Қорғасын шаңдарын кәдеге

жарату арқылы қосымша тауарлық өнім алынады және зауыттың орналасқан ауданының экологиялық ортасы жақсарады. Сондай-ақ, мақалада мысты сұйықтықтық экстракция және реэкстракциялау процестерінің материалдық балансының нәтижелері келтірілген.

Түйінді сөздер: металл қоспалары, экстракция, реэкстракция, қорғасын шаңы, Acorga M5640.

Извлечение меди из растворов агитационного выщелачивания свинцовых пылей методом жидкостной экстракции

Алтайбаев Б.Т., Хабиев А.Т., Байгенженов О.С., Буленбаев М.Ж., Туран М.Д.

Аннотация. В данной работе представлены результаты исследований промежуточного передела по жидкостной экстракции и реэкстракции меди из сульфатных растворов. Данные растворы были получены при агитационном сернокислотном выщелачивании свинцовых пылей, которые являются техногенными отходами Жезказганского медеплавильного завода и содержат ценные компоненты: более 38 % свинца, 2,4 % железа, 3 % цинка, 3,5 % меди, 0,7 мышьяка, и др. Утилизация свинцовых пылей может обеспечить получение дополнительной товарной продукции и оздоровить экологическую среду района их расположения. Также в статье представлены результаты материального баланса процессов жидкостной экстракции и реэкстракции меди.

Ключевые слова: примеси металлов, экстракция, реэкстракция, свинцовая пыль, Acorga M5640.

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