

Flotation Results of Oxidized Copper Ores of the Kalmakyr Deposit

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ABSTRACT

According to preliminary calculations, oxidized copper ores in the dumps of the Kalmakyr deposit are about 107.6 million tons (01.01.2020) of which:

- Balance ores 12.1 million tons with a Cu content of 0.8%; Au-1.2 g/t; Ag-3.9 g/t.
- Off-balance ores 95.5 million tons with content: Cu-0.3%; Au-0.4 g/t; Ag-2 g/t.

Total metals: copper - 373 thousand tons, gold - 56.6 tons, silver - 246.5 tons.

The total reserves of metals in the accumulated dumps are estimated at 373 thousand tons of copper, 56.6 tons of gold and 246.5 tons of silver, which is of interest primarily for non-ferrous metallurgy. As a result of a set of studies carried out on samples of oxidized copper ore dumps from the Kalmakyr deposit, the following conclusions can be drawn:

- Three methods (hydrometallurgical, flotation and combined) of processing oxidized copper ores of the Kalmakyr deposit have been shown experimentally and cathode copper with a content of 99.6%, a gold-bearing concentrate with a gold content of 36.5 g/t and silver content of 47.1 g/t. Optimal modes and indicators of concentration efficiency are determined.
- On the basis of laboratory studies, a technology for processing oxidized copper ores of the Kalmakyr deposit has been proposed.

Technological schemes for processing dumps of oxidized copper ores from the Kalmakyr deposit have been developed and recommended for implementation, the implementation of which will make it possible to obtain an estimated 6,183 tons of copper, 425 kg of gold and 707 kg of silver per year.

KEYWORDS: oxidized copper, extraction, electro winning, leaching

INTRODUCTION

Over the past 30 years, the cost of raw materials has been steadily increasing by 5-10% per year. The current high price level and constantly growing demand have already made it profitable to extract metals from man-made accumulations of mineral raw materials. Interest in them grows as the reserves of large deposits are depleted, the needs of the industry increase, and innovative technologies for processing industrial waste are applied. According to experts, the practical implementation of the already developed technical solutions for the development of technogenic deposits will reduce the volume of extraction of mineral raw materials by 20-30%.

The problem of expanding the mineral resource base of non-ferrous and noble metals in the Republic of Uzbekistan can also be solved by studying and involving in the development of balance and off-balance dumps of the Kalmakyr deposit.

The emerging need is primarily associated with the extensive development of mining production. With the expansion of ore mining, the volumes of stocks of conventionally substandard mineral raw materials stored in

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dumps are increasing. Poor in content and complex in mineral composition, oxidized and mixed ores of non-ferrous metals, primarily copper, are not profitable for enrichment using one of the traditional methods, and the reserves of the technological schemes used are close to exhaustion [1].

The purpose of this work is to study flotation methods with new reagents for the extraction of metals into rough concentrate from oxidized copper ores of the Kalmakyr deposit.

Many researchers believe that froth flotation of oxidized copper ores is a complex process, and it first needs a sulfidization step.

The object of research oxidized copper ores in the dumps of the Kalmakyr deposit.

Results and their discussion flotation studies were carried out with the aim of extracting copper, molybdenum, gold and silver from oxidized copper ores of the Kalmakyr deposit.

The content of metals in the original sample according to the data of chemical analysis is shown in Table 1.

Table 1 Contents of copper (Cu), molybdenum (Mo), gold (Au) and silver (Ag) in the original sample according to the data of chemical analysis

Sample	Cu,%	Mo,%	Au,g/t	Ag,g/t
Dump 9	1,142	0,01	2,18	3,29

Butyl xanthate (BCC), spindle oil, terephthalic acids (flotilla 1,2) from Wintech (China), hydrosamic acids (flotilla 3) from Hellochem (China) were used as a collector in the flotation process. To create a stable foam, a T-92 foaming agent was used. Lime was used to create a silky environment.

Flotation was carried out in laboratory flotation machines 240-FML with a chamber capacity of 3 liters. The sample was crushed to a size of -0.074 mm, class 85%.

The flotation scheme is shown in Fig. 1. The results of flotation of dumps of oxidized copper ores of the Kalmakyr deposit at different reagent modes are given in table. 2

FLOTATION SCHEME OF OXIDIZED COPPER ORE DUMPS

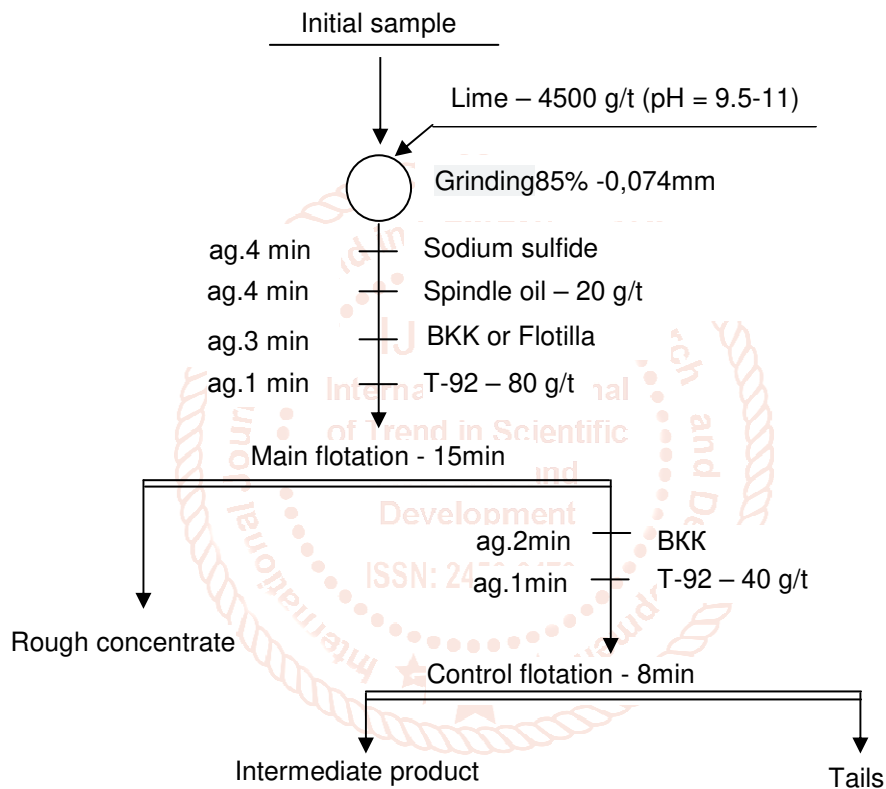


Fig. 1

Table 2 Results of flotation of dumps of oxidized copper ores from the Kalmakyr deposit under different reagent modes

Products	Exit, %	Content, %				Retrieving, %				Reagent consumption, g/t
		Cu	Mo	Au, g/t	Ag, g/t	Cu	Mo	Au	Ag	
Rough concentrate	5,1	2,64	0,02	22,46	21,10	13,85	6,71	59,20	38,24	Main flotation: Na ₂ S - 1000 BKK - 100 Cont flotation: BKK - 50
Intermediate product	2,2	2,71	0,01	3,47	7,01	6,20	2,05	3,99	5,54	
Tails	92,7	0,84	0,02	0,77	1,71	79,95	91,25	36,81	56,22	
Outgoing sample	100	0,97	0,02	1,94	2,82	100	100	100	100	Main flotation: Na ₂ S - 800 BKK - 100 Cont flotation: BKK - 50
Rough concentrate	5,5	5,22	0,03	21,79	22,78	29,50	10,10	55,09	42,98	
Intermediate product	2,8	8,11	0,03	5,40	9,56	23,38	5,67	6,96	9,20	
Tails	91,7	0,50	0,02	0,90	1,52	47,12	84,23	37,95	47,82	
Outgoing sample	100	0,97	0,02	2,17	2,91	100	100	100	100	Main flotation: Na ₂ S - 600 BKK - 100 Cont flotation: BKK - 50
Rough concentrate	4,2	5,35	0,04	23,51	22,88	23,27	11,58	55,46	34,75	
Intermediate product	4,6	6,06	0,02	4,41	7,82	28,69	6,93	11,32	12,93	
Tails	91,2	0,51	0,01	0,65	1,59	48,05	81,49	33,22	52,32	
Outgoing sample	100	0,97	0,01	1,78	2,77	100	100	100	100	Main flotation: Na ₂ S - 600 BKK - 100 Cont flotation: BKK - 50

Rough concentrate	5,7	1,44	0,02	15,88	12,27	8,90	10,26	47,01	24,56	Main flotation: Флот1 – 50 Cont flotation: Флот1 – 25
Intermediate product	4,9	1,36	0,03	3,01	4,57	7,32	12,42	7,75	7,96	
Tails	89,4	0,86	0,01	0,97	2,14	83,78	77,32	45,24	67,48	
Outgoing sample	100	0,92	0,01	1,92	2,83	100	100	100	100	
Rough concentrate	4,1	1,65	0,02	15,33	13,76	6,93	5,90	32,94	20,89	Main flotation: Флот2 – 50 Cont flotation: Флот2 – 25
Intermediate product	3,2	1,20	0,02	6,27	5,57	3,98	4,40	10,66	6,69	
Tails	92,7	0,93	0,01	1,15	2,09	89,09	89,70	56,40	72,42	
Outgoing sample	100	0,97	0,01	1,89	2,68	100	100	100	100	
Rough concentrate	12,3	1,53	0,02	7,75	6,59	20,05	9,55	54,22	27,59	Main flotation: Флот3 – 50 Cont flotation: Флот3 – 25
Intermediate product	2,9	1,21	0,02	4,24	5,23	3,76	2,26	7,03	5,19	
Tails	84,8	0,84	0,02	0,80	2,32	76,19	88,18	38,74	67,22	
Outgoing sample	100	0,94	0,02	1,75	2,93	100	100	100	100	

As follows from the table. 3, that when flotation of dumps with different consumption of sodium sulfide, the output of rough concentrate was 4.6-5.1%. In this case, the recovery of gold and silver in the rough concentrate from the original ores is in the range of 53-59% and 36-41%, respectively. The gold and silver content in the rough concentrate is 21-23 g/t and 21-22 g/t, respectively. The extraction of copper and molybdenum is low, 27.9 and 9.4%, respectively. The copper content is 5.2% and molybdenum 0.03%.

Flotation experiments with new reagents (Flotilla 1, 2, 3), which were obtained from China (Hellochem company), did not yield positive results. The rough concentrate yield was 4.1-12.3%. The extraction of metals (copper, molybdenum, gold and silver) into the rough concentrate from the original ores was in the range of 7-20%, 6-10%, 32-54% and 20-27%, respectively. The content of metals in the rough concentrate is Cu = 1.4-1.6%; Mo = 0.2%; Au = 7-15g/t and Ag = 6-13g/t.

On the basis of the results obtained from earlier studies, the flotation of oxidized copper ores of the Kalmakyr deposit was carried out at a rate of 2000 and 4000 g/t of sodium sulfide. The research results are shown in table. 3

Table 3 Results of flotation of dumps of oxidized copper ores of the Kalmakyr deposit at different flow rates of reagent regimes

Products	Exit,%	Content, %				Retrieving, %				Reagent consumption, g/t
		Cu	Mo	Au, g/t	Ag, g/t	Cu	Mo	Au	Ag	
Rough concentrate	5,3	3,27	0,01	23,44	16,96	18,25	12,48	70,92	38,60	Main flotation: Na ₂ S – 2000 BKK – 100, T-92 – 80 Cont flotation: BKK – 50, T-92 – 40
Intermediate product	2,4	3,61	0,02	4,10	7,51	9,26	7,83	5,71	7,86	
Tails	92,3	0,74	0,00	0,44	1,34	72,49	79,69	23,37	53,54	
Outgoing sample	100	0,94	0,005	1,74	2,31	100	100	100	100	
Rough concentrate	4,9	3,79	0,02	28,28	20,15	17,72	12,91	69,17	41,89	Main flotation: Na ₂ S – 4000 BKK – 100, T-92 – 80 Cont flotation: BKK – 50, T-92 – 40
Intermediate product	1,7	4,03	0,02	6,53	9,47	6,42	5,87	5,44	6,71	
Tails	93,4	0,86	0,01	0,55	1,31	75,86	81,22	25,39	51,40	
Outgoing sample	100	1,06	0,006	2,02	2,38	100	100	100	100	

As you can see from the table. 4, with flotation with sodium sulfide (2000 and 4000 g/t), the crude concentrate yield was 4.9-5.3%. The extraction of metals (copper, molybdenum, gold and silver) into the rough concentrate from the original ores was in the range of 17-18%, 12%, 69-71% and 38-41%, respectively. The content of metals in the rough concentrate is Cu = 3.2-3.7%; Mo = 0.1-0.2%; Au = 23-28g/t and Ag = 16-20g/t.

EXTRACTION OF Au and Ag INTO CONCENTRATE AT DIFFERENT CONSUMPTIONS OF SODIUM SULFURIDE

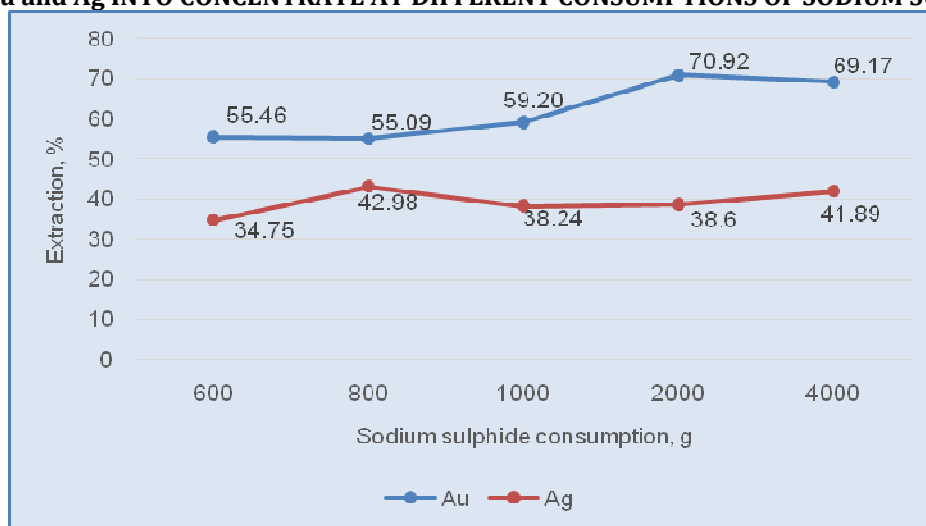


Fig. 2

Main conclusions

The studies carried out in general showed that during the flotation of oxidized copper ores of the Kalmakyr deposit, it is possible to extract 70% gold and 38% silver with a content of 23-28 g/t and 16-20 g/t in the rough concentrate, respectively. The recovery of copper and molybdenum by the flotation method is impractical.

Based on the results of laboratory studies, the optimal parameters of the reagents for flotation of dumps of oxidized copper ores of the Kalmakyr deposit were determined.

Main flotation: Na₂S - 2000 g/t, Spindle oil - 20 g/t, BPC - 100 g/t, T-92 - 80 g/t;

Control flotation: BPC - 50 g/t, T-92 - 40 g/t.

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