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APPLICATION OF MODIFIED SULFIDIZING REAGENT (MSR) IN PROCESSING FLOWSHEET OF OXIDIZED COPPER ORE

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This paper demonstrates the research results on flotation of the oxidized copper ore with the preliminary sulfidization by a modified reagent. The planning method of an experiment investigated the influence of various factors on flotation process of the oxidized copper ore with a preliminary sulfidization by the modified reagent. Dependence of copper extraction in a flotation concentrate was received from consumptions of sulfidizer and collector, pulp agitation time with a sulfidizing reagent. A mathematical model of process was received.The optimal conditions of flotation providing the copper extraction in flotation concentrate at a level of 85,12 % were determined with this model.

Key words: oxidized copper ore, ore processing, sulfidization, flotation, mathematical model

INTRODUCTION

Development of the copper industry requires involvement of the oxidized and mixed ores in the processing. In order to extractthe copper from such raw materials the traditional methods of flotation enrichment for the processing of sulfide raw materials is ineffective by means of the natural hydrophilicity of the oxidized copper minerals [1-4].

The literary data analysis demonstrates that one of the perspective directions to solve this problem is a chemical modification of minerals by sulfidization as a result the oxidized minerals transform a sulfide form with a hydrophobic surface. In order make such transformation the sulfur-containing reagents such as element sulfur, inorganic sulfides and polysulfides can be used [5-8].

In this connection our research on sulfidization of the oxidized copper ores with the modified sulfidizing reagent is perspective [9].

As a result this process is without heating and the individual equipment for sulfidization.

EXPERIMENTAL PART AND DISCUSSION OF RESULTS

In order to choose the device for sulfidization of the oxidized copper ore with the modified reagent, the experiments were performed in a laboratory ball mill (variant I) and flotation chamber (variant II).

Researches were performed on a sample of the oxidized copper ore containing mass/%: $Cu_{gener.}$ – 2,7 and $Cu_{oxid.}$ – 1,8.

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The modified sulfidizing reagent (MSR) consisted the water solution of sodium sulfide with ammonium sulfate in ratio of $Na_2S:(NH_4)_2SO_4 = 1:1$.

For each experiment (variant I) was prepared a ore charge which loaded into the laboratory mill together with water at a ratio of S:L (1:1) with addition of estimated quantity of MSR. The pulp with ore reduction (71 %) – 0,071 mm was floated in the laboratory flotation machine with chamber volume of 0,5 lunder an open scheme: L:S (liquid/solid) = 3:1. Butyl potassium xanthate was used as a collector, and foaming reagent – T - 92.

All experiments showed the identical flotation mode. Copper extraction in flotation products was defined with using the data of the chemical analysis. Results of experiments are presented in Table 1. The similar experiments with using of sodium sulfide as sulfidizer were performed for comparison. Results are given in Table 2.

Figure 1 demonstrates the dependence of copper extraction in a concentrate on a type of sulfidizer (variant

Table 1 **Parameters of flotation of ore, sulfurized with MSR in mill**

Consumption of MSR/%	Product	Yield/%	Content of Cu/%	Extraction of Cu/%
20	concentrate	7,32	16,95	45,79
	intermediate product	2,62	6,91	6,68
	tails	90,06	1,43	47,53
30	concentrate	9,01	15,93	54,04
	intermediate product	2,32	8,29	7,24
	tails	88,67	1,16	38,72
50	concentrate	12,3	15,2	70,16
	intermediate product	2,36	5,12	4,54
	tails	85,34	0,79	25,30

Table 2 Parameters of flotation of ore, sulfurized with sodium sulfide in a mill

Consumption of Na_2S/%	Product	Yield/%	Content of Cu/%	Extraction of Cu/%
20	concentrate	3,82	22,45	31,14
	intermediate product	1,73	16,8	10,55
	tails	94,45	1,7	58,31
30	concentrate	5,24	22,58	43,91
	intermediate product	2,15	15,16	12,10
	tails	92,61	1,28	43,99
50	concentrate	8,02	18,85	56,92
	intermediate product	3,86	8,87	12,89
	tails	88,12	0,91	30,19

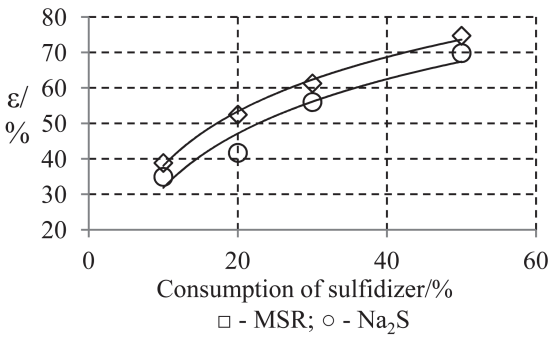

Figure 1 Dependence of copper extraction in concentrate on consumption of sulfidizer (variant I)

I). Data shows that the copper extraction increases in process of the rising consumption of the sulfidizing reagents, however sodium sulfide exceeds in efficiency than MSR is.

Experiments (variant II) were performed on ore charges crushed to 71 % of a yield (0,071 mm). MSR gave to a pulp in the flotation chamber. In other cases flotation conditions are identical to variant I. Results of experiments are demonstrated in Table 3. In order to

Table 3 **Parameters of flotation of ore, sulfurized with MSR in flotation chamber**

Consumption of MSR/%	Product	Yield/%	Content of Cu/%	Extraction of Cu/%
20	concentrate	18,88	9,04	64,33
	intermediatep roduct	8,56	3,51	11,33
	tails	72,56	0,89	24,34
	ore	100,00	2,65	100,00
30	concentrate	18,65	9,71	68,17
	intermediate product	11,02	3,78	15,68
	tails	70,33	0,61	16,15
	ore	100,00	2,66	100,00
50	concentrate	22,82	8,91	76,15
	intermediate product	9,86	2,43	8,97
	tails	67,32	0,59	14,88
	ore	100,00	2,67	100,00

Table 4 **Parameters of flotation of ore, sulfurized with sodium sulfide in flotation chamber**

Consumption of Na_2S/%	Product	Yield/%	Content of Cu/%	Extraction of Cu/%
20	concentrate	17,01	6,45	40,11
	intermediate product	13,54	7,07	35,00
	tails	69,45	0,98	24,89
	ore	100,00	2,74	100,00
30	concentrate	19,82	5,84	43,31
	intermediate product	9,91	8,20	30,40
	tails	70,27	1,00	26,29
	ore	100,00	2,67	100,00
50	concentrate	15,44	8,23	47,72
	intermediate product	9,71	7,32	26,70
	tails	74,85	0,91	25,58
	ore	100,00	2,66	100,00

compare the similar experiments were made with using of sodium sulfide as sulfidizer.

Results are given in Table 4. Figure 2 illustrates the dependence of copper extraction on a type of sulfidizer (variant II). The direct dependence of copper extraction on reagent consumption is characteristic for MSR.

Sodium sulfide from 10 % consumption has an inverse relation. The modified sulfidizing reagent (MSR) exceeds in efficiency than sodium sulfide at more 20 % consumptions.

Comparing results of the experiments (I and II variants) it could be concluded on application efficiency of MSR for a preliminary sulfidization of the oxidized copper ore in the flotation chamber, i.e. by variant II.

This procedure of sulfidization of the oxidized copper minerals with using of MSR was tested on a sample of the oxidized copper ore from the Balkhash region containing mass/%: $Cu_{gener.}$ – 2,7 and $Cu_{oxid.}$ – 1,8.

The mathematical model of process reflecting the influence of the relevant factors on copper extraction in flotation concentrate was received with using of the probabilistic determined planning of experiment [10-11].

Consumption of sulfidizer (P/%) in relation to the oxidized copper containing the consumption of butyl potassium xanthate (kxt/g/t) and agitation time of pulp (τ/min) in base ore were studied as factors.

Figure 3 shows the dependence of copper extraction on I and II variants for MSR.

For each experience a crushed ore charge was prepared which mixed with water to S:L ratio (1:4). Sulfidization was performed in flotation chamber with addition of a set amount of a sulfiding reagent and agitation for a set time. Then collector and T - 92 foaming agent were added in pulp. Flotation of product was made in an open cycle for 10 and 15 min as the basic and control flotation time.

Products of flotation were analyzed with a chemical method on content of a general copper. Considering the research function of the copper extraction in flotation

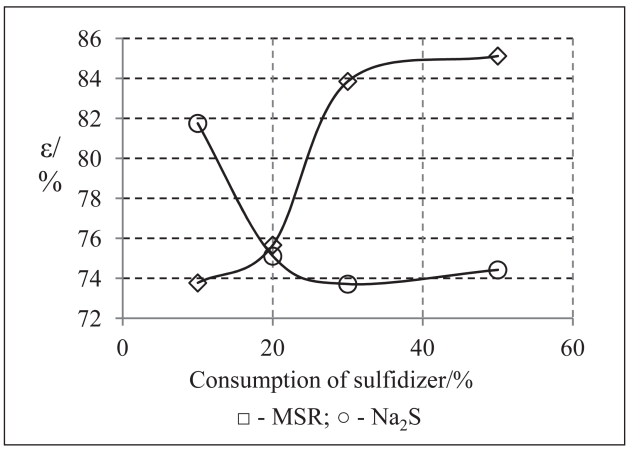

Figure 2 Dependence of copper extraction in concentrate on consumption of sulfidizer (variant II)

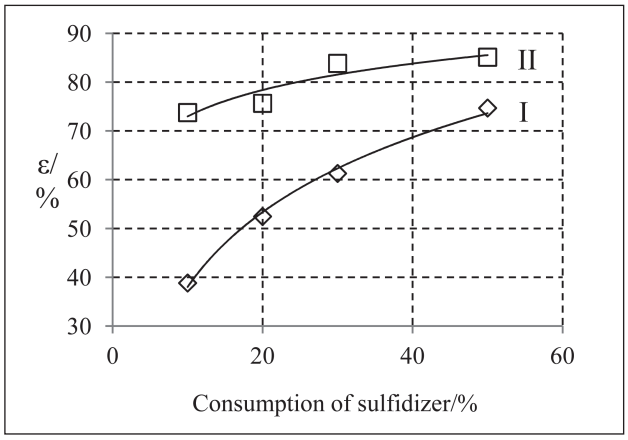

Figure 3 Dependence of copper extraction in concentrate on device at using of MSR

concentrate, some experimental data were sampled on levels of factors, and the graphs of particular dependences of copper extraction in a concentrate from the studied factors were constructed (Figure 4). The analysis of particular dependences showed that at 50 % consumption of MSR in relation to the oxidized copper containing in base ore and agitation of pulp with MSR for 4 min is reached the maximum copper extraction in flotation concentrate.

The particular dependence of copper extraction on consumption of flotation agent shows that after saturation of a mineral surface with ions and molecules of the collector, the copper extraction stops growing. The optimum consumption makes 200 g/t.

The generalized multiple-factor equation for ore flotation based on significant particular dependences as follows:

$$\alpha = (4{,}840\ln(P) + 65{,}65)(2{,}309\ln(\tau) + 72{,}64)(0{,}782\ln(kxt) + 70{,}39)/74{,}9^2$$

This equation represents a mathematical model of flotation process of the oxidized copper ore the preliminary sulfidization by a modified sulfidizing reagent. Referring to this model it is possible to recommend the optimal conditions for flotation: 50 % of MSR in relation to the oxidized copper containing in floated ore, 4 min of agitation of pulp with MSR and 200 g/t of a collecting agent. Under these conditions the copper extraction was 85,12 %, and a calculating extraction was 85,23 %.

CONCLUSION

The flotation researches of the oxidized copper ore from the Balkhash region with a preliminary sulfidization by the modified reagent in various devices such as the mill and flotation chamber were performed. It was found that an effective device for sulfidization of the oxidized ore was the flotation chamber; at 50 % consumption of reagent the copper extraction was higher by 10,42 % in comparison with the mill. It was also established that the modified reagent at 50 % consumption exceeded sodium sulfide in flotation efficiency by 10,7 %. The experiment planning method investigated the flotation process of oxidized copper ore from the Balkhash region with preliminary sulfidization of the ore with the modified reagent. Under the particular dependences the mathematical model of the process was obtained as a generalized multifactor equation. The optimal flotation conditions were determined: 50 % sulfidizer to a copper content in a base ore, 4 min of agitation of the pulp with sulfidizing reagent and 200 g/t of the collector provided the copper extraction in the flotation concentrate by 85,12 %.

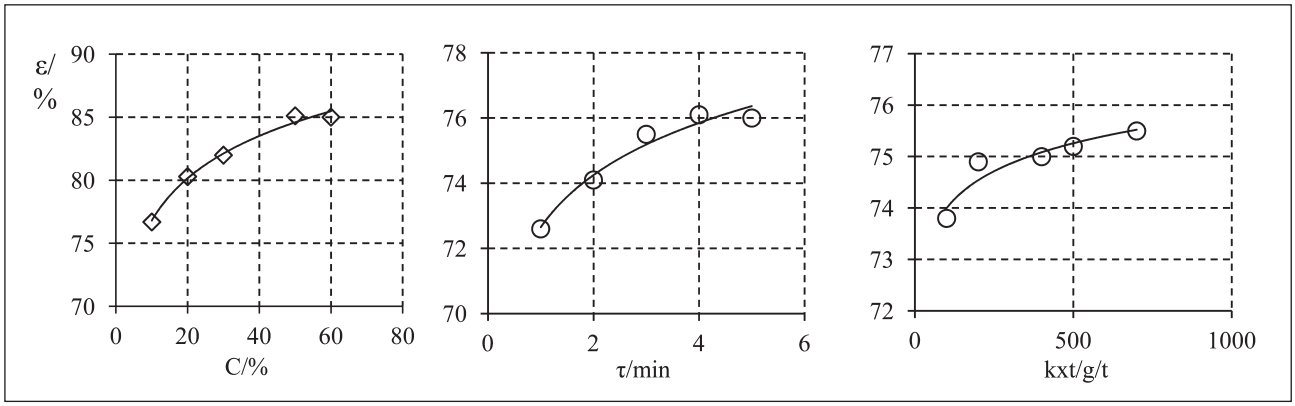

Figure 4 Dependence of copper extraction in concentrate on studied factors

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Note: The responsible translator for English languages is Folmer Yelena Pavlovna, Karaganda, Kazakhstan.