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DEVELOPMENT OF ENRICHMENT REAGENT REGIME OF POLYMETALLIC ORES WITH OXYGEN-CONTAINING AND SULFUR-CONTAINING FLOTATION REAGENTS

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Introduction

The separation of polymetallic ores at this stage of the processing industry development is associated with the peculiarities of ore formation, fine inclusions, and mutual germination among themselves. Therefore, scientific research is focused on finding effective flotation reagents that provide the necessary enrichment indicators.

Methodology

Copper-lead ore and titanium ore was used in the work. The collectively selective flotation of Cu-Pb ore, sodium oleate, sodium dibutyldithiophosphate was carried out as collectors. The collectors for titanium ore were sodium oleate and sodium benzenesulfonate. Variable parameters change of the hydrodynamic (impeller rotation frequency, air flow rate) and reagent regimes (medium regulator's consumption, collector consumption) at the flotation: air flow rate of 20-60 l/h, impeller rotation frequency of 30-40 Hz, lime consumption of 1000-3000 g/t, collector consumption of 50-150 g/t. Ore enrichment was carried out on a laboratory chamber-type flotation machine with mechanical mixing of the FML brand according to method [1]. Elemental analysis was performed on the ore grade instrument (Spektrolab).

Results and discussion

Based on the modified scheme of collectively selective flotation of Cu-Pb ore using sodium oleate in the main flotation, a schematic diagram was drawn up (Figure 1) and calculations of purification operations of enrichment were carried out (Tables 1, 2) [2].

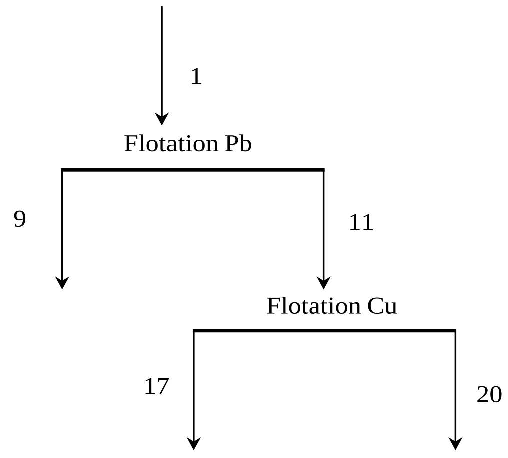

Figure 1 - Schematic diagram of flotation of Cu-Pb ore

Table 2 - Balance for final products of flotation

Product Number	Name of products	Yield, %	Content, %		Extraction,%	
			Pb	*Cu*	*Pb*	*Cu*
9	*Pb* concentrate	13.79	0.25	0.01	68.95	0.14
17	*Cu* concentrate	1.60	0.07	39.46	2.24	63.78
20	Tailings	84.61	0.02	0.42	28.81	36.08
1	Initial ore	100.00	0.99	0.05	100.00	100.00

Table 3 - Balance of enrichment products of Cu-Pb ore

Stage №	Name of operations and products	*Q*, g/h	*γ*, %	*β*, %	*ε*, %
I	Basic lead flotation				
	Entrance:				
1	Classifier drain	375	100	0.05	100
12	Combined industrial product	146.57	39.09	0.02	14.95
2	*Total:*	521.57	139.09	0.04	114.95
	Egress:				
3	Concentrate of main flotation	197.86	52.76	0.08	83.02
4	Tailings of main flotation	323.71	86.32	0.02	31.93
	Total:	521.57	139.09	0.04	114.95
II	The first cleanup flotation				
	Entrance:				
3	Concentrate of main flotation	197.86	52.76	0.08	83.02
8	The second cleanup tailings	37.16	9.91	0.03	5.63
5	*Total:*	235.03	62.67	0.07	88.65
	Egress:				
6	Concentrate of the first cleanup	88.88	23.70	0.16	74.58
7	Tailings of the first cleanup	146.15	38.97	0.02	14.07
	Total:	235.03	62.67	0.07	88.65
III	The second cleanup flotation				
	Entrance:				
6	Concentrate of the first cleanup	88.88	23.70	0.16	74.58
	Total:	88.88	23.70	0.16	74.58
	Egress:				
9	Concentrate	51.71	13.79	0.25	68.95
8	Tailings of the second cleanup	37.16	9.91	0.03	5.63
	Total:	88.88	23.70	0.16	74.58
IV	Control flotation				
	Entrance:				
4	Tailings of main flotation	323.71	86.32	0.02	31.93
	Total:	323.71	86.32	0.02	31.93
	Egress:				
10	Froth product of control	0.42	0.11	0.39	0.88
11	Tailings of control	323.29	86.21	0.02	31.05
	Total:	323.71	86.32	0.02	31.93

Calculation of the lead flotation cycle. The calculation of the first flotation cycle was carried out according to the following scheme (Figure 2) with previously identified products.

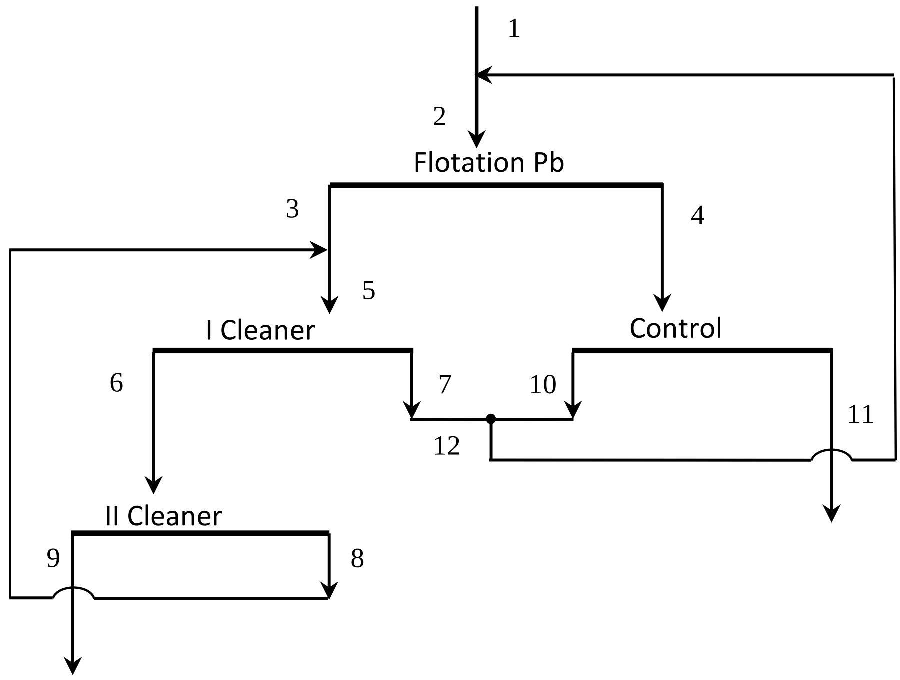

Figure 2 - Lead Flotation Cycle

The material balance calculation of lead flotation was carried out using the Solver Excel software package. The calculation results of qualitative-quantitative scheme of lead flotation cycle are given in Table 1.

Calculations were carried out for the copper flotation cycle (Figure 3).

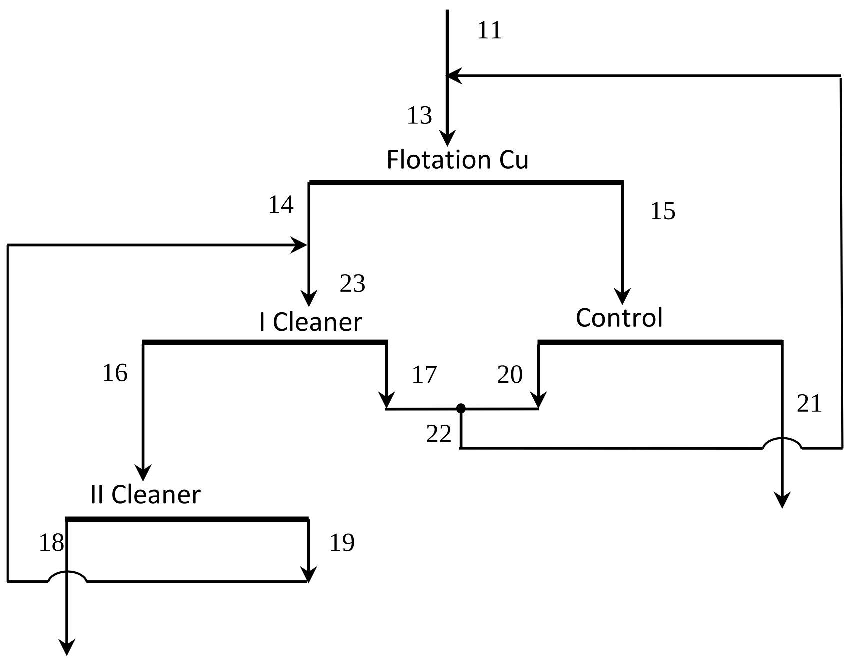

Figure 3 – Copper flotation cycle

Thus, to calculate the copper flotation cycle, the initial indicators are:

a) two indicators relating to the source data (Q_1 and α^{Cu});

b) four indicators of copper recovery in flotation products;

c) four indicators of copper content in concentrates of operations.

The number of initial indicators is 4, number of stages is 4. The results are given in Table 3.

Table 3 - Balance of copper enrichment products

Stage №	Name of operations and products	*Q*, g/h	*γ*, %	*β*, %	*ε*, %
I	Main copper flotation				
	Entrance:				
11	Tailings of lead flotation	323.29	86.21	1.15	99.86
22	Combined industrial product	36.54	9.74	4.00	33.96
13	*Total:*	359.83	95.95	1.60	133.82
	Egress:				
14	Concentrate of main flotation	30.71	8.19	9.51	78.65
15	Tailings of main flotation	329.12	87.76	0.72	55.18
	Total:	359.83	95.95	1.60	133.82
II	The first cleanup flotation				
	Entrance:				
14	Concentrate of main flotation	30.71	8.19	9.51	78.65
19	The second cleanup tailings	7.34	1.96	2.67	4.56
23	*Total:*	38.06	10.15	9.40	83.21
	Egress:				
16	Concentrate of the first cleanup	13.34	3.56	19.01	68.34
17	Tailings of the first cleanup	24.71	6.59	2.59	14.87
	Total:	38.06	10.15	9.40	83.21
III	The second cleanup flotation				
	Entrance:				
16	Concentrate of the first cleanup	13.34	3.56	19.01	68.34
	Total:	13.34	3.56	19.01	68.34
	Egress:				
18	Concentrate	6.00	1.60	39.46	63.78
19	Tailings of the second cleanup	7.34	1.96	2.67	4.56
	Total:	13.34	3.56	19.01	68.34
IV	Control flotation				
	Entrance:				
15	Tailings of main flotation	329.12	87.76	0.72	55.18
	Total:	329.12	87.76	0.72	55.18
	Egress:				
20	Froth product of control flotation	11.83	3.15	5.99	19.10
21	Tailings of control flotation	317.29	84.61	0.42	36.08
	Total:	329.12	87.76	0.72	55.18

Results of circuit experiments confirm that the following concentrates can be obtained on the developed technological scheme and reagent mode: lead concentrate with lead content of 0.25% and extraction 68.95% in the inter-cycle flotation, copper concentrate with lead content of 39.46% and extraction of 63.78% in copper flotation cycle; the use of cleanup operations makes it possible to increase the valuable component content of β_{Pb} from 0.08 to 0.25%, β_{Cu} from 9.51 to 39.46%. However, in both cases, the metal extraction and concentrate amount are reduced.

The introduction to the cycle circuit for a combined industrial product in lead and copper flotations is caused by the need to reduce metal losses with tailings.

Thus it is shown that the use of sodium oleate as a primary flotoreagent in lead flotation cycle and sodium dibutyldithiophosphate in the copper flotation cycle allows to develop the selective and circuit modes.

Conclusion

Calculation of the qualitative-quantitative scheme of flotation of Cu-Pb ore with the use of sodium oleate as the main reagent was carried out. It is shown that the scheme should include two clean-up operations at the Pb flotation stage, one control operation, at the copper flotation stage, two clean-ups of selective concentrate and closed-loop control flotation are also envisaged. An increase in the content of Cu and Pb in the concentrates of the same name was established using the use of β_{Pb} purge operations from 0.08 to 0.25%, β_{Cu} from 9.51 to 39.46%. However, in both cases, the extraction of metal and the amount of concentrate are reduced.

References

1. Vasyunina, N. V., Belousov, S. V., Dubova, I. V., Morenko, A. V., & Druzhinin, K. E. Recovery of Silicon and Iron Oxides from Alumina-Containing Sweepings of Aluminum Production, Russian Journal of Non-Ferrous Metals, **59** (3), 230–236 (2017) https://doi.org/10.3103/s1067821218030148.

2 Komlev S.G. Technological calculations in the enrichment of minerals (in Russian). Choice of equipment. Ekaterinburg, USTU.-2007.-57 p.