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ПРЕЛИМИНАРНИ ИСТРАЖУВАЊА НА КОЛЕКТИВНА ХАЛКОПИРИТНА-ПИРИТНА ФЛОТАЦИЈА НА ДОМАШНА БАКАРНА РУДА

THE PRELIMINARY INVESTIGATIONS OF THE BULK CHALCOPYRITE - PYRITE FLOTATION BY DOMESTIC COPPER ORE

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Introduction

The Bucim copper mine and the flotation concentrator are situated on the Southwest slopes of the Plackovica mountain in the southern part of Macedonia. The Bucim deposit consists three ore bodies, relatively shallow low grade, mined by open pit mining method. Mineralization, a porphiritic type consists of primary chalcopyrite, pyrite, hematite and rarely molibdenite. Gold and silver occur together in the forms of tellurides and tetrahedrites. Secondary mineralization consists of secondary chalcocite and covelite and in small quantities of Cu-carbonates. The ore dressing and concentration is covered by primary, secondary and tertiary crushing, screening and storing, grinding and classification, selective flotation, regrinding, thickening and filtering for the capacity of 3,7 million tons.

The technological parameters of the average (1982-1994) production of 3.486.036 t/y are followed:

Q	mined ore, t/y	3.486.036
H_2O	(%)	2
Q	treated dry ore, t/y	3.416.315
Cu	Cu content, %	0,27
K/Cu	concentrate, t/y	43.878
k/Cu	quality, %	18-20
R/Cu	recovery, %	88
T	tailing, t/y	3.372.438
t/Cu	Cu in tailing, %	0,03
Tp	available time, h/y	8.760
Tef	effective time, h/y	7.270
Tb	effective time, %	83

The generally concept of the new investigated technological scheme of the flotation concentration process in the Bucim-mine is based on the demands of the possible complex recovery from the useful present minerals or mineral components: $CuFeS_2$; FeS_2; Fe_2O_3; Fe_3O_4; Na-feldspar and K-feldspar; SiO_2 etc. The coceptual technological scheme of the complex recovery is shown on the Fig.1.

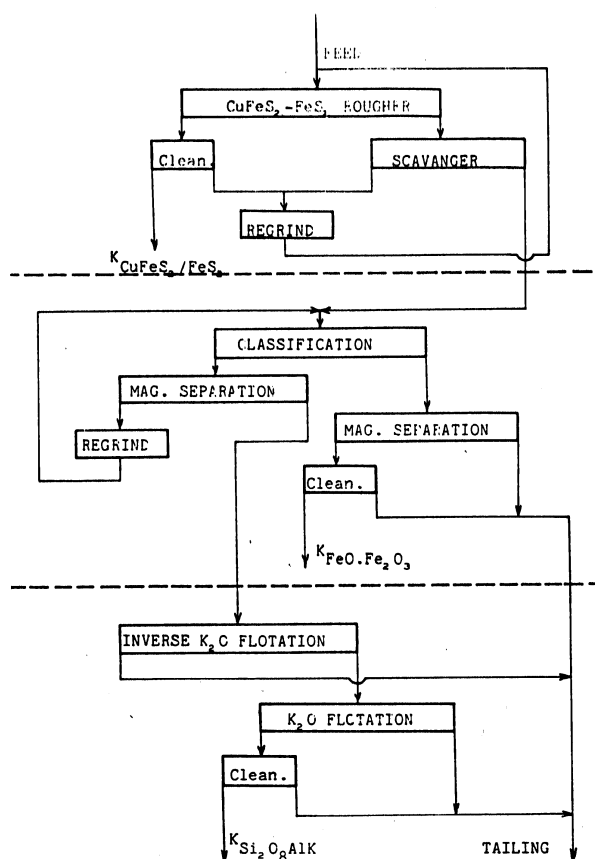[*] Faculty of Mining & Geology , Stip, Macedonia

Fig. 1. Scheme of the complex minearal recovery

The investigation should be to serve as a basis of the invention by possibilities for the increased both Cu-recovery and Cu-grade in the concentrate, and to decrease gross consumption of the lime Cao, also.

The optimization of the technological process in these techno - laboratory investigations has understood that bulk (collective) flotation of the $CuFeS_2$-FeS_2 have to operate by lower values of the pH, at the same time making possibilities of the increased recovery of the copper, gold, silver and pyrite, decreasing the lime consumption, decreasing of the incrustations appearing, and protecting environment. Also, these laboratory tests have enabled to prove the optimum conditions of the process of bulk flotation on the lower pH-values.

The Behavior of the Copper Minerals and Pyrite in Flotation Process

The representative samples from the Bucim-mine were with the average Cu-content from 0,168-0,23%. The bench-scale tests from the bulk flotation were made of the copper minerals and pyrite, depending on values of pH; the pulp densities and the reagents consumption using tha same conditions to determine the optimal conditions for extraction of rougher bulk concentrates (RC) and scavanger bulk concentrates (SC).
The following experimental operating conditions were used (Table 1.):

Table 1. Experimental operating conditions

Test N^o	(a) Ore/Water (g)	(b) (min^{-1})	(c) (ml)	(d) (ml)	(e) (min)	(f) drops	pH values
1	300/1700	700	4	2	2	3	8.25
2	560/1680	1000	4	2	2	3	8.25
3	300/1700	700	8	6	2	3	8.70
4	560/1680	700	8	2	4	3	8.70
5	300/1700	1000	8	2	4	3	7.00
6	560/1680	700	4	6	4	3	7.00
7	300/1700	1000	4	6	4	3	7.50
8	560/1680	1000	8	6	2	3	7.50

The laboratory investigations have to enable knowledge for the influence of the following factors:

a) Pulp density, the solids content (%), the elementary level from 20+5 %;

b) Aeration (rpm), the elementary level 850+150 rpm; c) Consumption of the combine xanthate collectors (KAX:KEX:KBX=2:1:1), the elementary level 6+2 ml 1%;

d) Consumption of the combine frother (Pine Oil:MIBK=1:1), the elementary level 6+2 ml 1%;

e) Conditioning time, the elementary level 3+1 min.;

f) Conditioning with presence of polyacrilamide, drops;

g) After conditioning : 75% collectors and flotation time 8 minutes - rougher flotation, and after that 25% collectors with 15 minutes - scavenger flotation.

The laboratory investigations about the effects of the various factors, shown on the Table 2. were carried out on the ore samples from the Bucim-mine, particle sizes 100%-0,200 mm using the various values of pH. Obtained results are shown on the following table:

Table 2. Results from laboratory investigations on the operating conditions

Product	Mass (%)	Assay (%)		Recovery (%)	
		Cu (%)	S (%)	R$_{Cu}$	
RC$_1$	2.53	6.00	29.18	67.26	
SC$_1$	2.53	1.72	12.88	19.27	86.53
T$_1$	94.94	0.03	0.36	13.47	
RC$_2$	3.56	4.50	23.96	70.14	
SC$_2$	3.90	0.80	11.41	13.66	83.80
T$_2$	92.54	0.04	0.40	16.20	
RC$_3$	3.00	4.68	20.76	60.94	
SC$_3$	2.80	2.24	13.28	27.21	88.15
T$_3$	94.20	0.02	0.56	11.85	
RC$_4$	3.27	4.40	28.28	79.28	
SC$_4$	1.78	0.72	12.77	7.10	86.38
T$_4$	94.95	0.03	0.20	13.62	
RC$_5$	2.53	5.50	22.09	66.20	
SC$_5$	2.90	1.47	16.95	20.27	86.47
T$_5$	94.57	0.03	0.20	13.53	
RC$_6$	3.93	3.60	22.33	74.99	
SC$_6$	4.17	0.56	12.28	12.35	87.34
T$_6$	91.90	0.03	0.20	12.66	
RC$_7$	2.80	3.60	25.32	59.93	
SC$_7$	5.06	0.84	7.09	25.27	85.20
T$_7$	92.14	0.03	0.20	14.80	

RC$_8$	2.98	3.90	22.74	58.10	
SC$_8$	4.17	1.23	10.92	25.65	83.75
T$_8$	92.85	0.04	0.32	16.25	

Note: RC - Rougher concentrate; SC - Scavanger concentrate; T - Tailing

Bench-Scale Flotation Tests - the Flotation Kinetics

Concerning the previous laboratory investigations from the effects of the various factors on the technological indicators of the bulk flotation, the bulk flotation of the copper minerals and pyrite were carried out using the diferent pH-values effecting on the flotation kinetic. The following experimental operating conditions were used:
◊ Pulp density ORE:WATER = 560:1680
◊ Pulp aeration 1000 rpm
◊ pH-values 7 & 8
◊ Particle size 65% -0,074 mm
◊ Reagent regime: collector (KAX:KEX:KBX=2:1:1) - 6 ml 1% r-r
　　　　　　　　　frother (Pine Oil:MIBK=1:1)　　 - 6 ml 1% r-r
　　　　　　　　　conditioning time　　　　　　　 - 4 min
　　　　　　　　　total flotation time　　　　　　 - 30 min

The obtained results of the collective flotation are worked out by means of Agar equation for flotation kinetic using computer programm.

Table 3. Cumulative valuation of the flotation optained data on pH = 7
　　　　E - concentration efficiency

T (sec.)	R - Met. (%)	Met. (%)	R - Tailing (%)	E (%)
10.00	10.30	6.40	0.31	9.98
30.00	30.01	5.85	1.02	28.99
90.00	55.37	4.66	2.45	52.91
180.00	65.74	3.68	3.80	61.93
360.00	73.53	2.88	5.57	67.96
480.00	78.54	2.47	7.03	71.51
720.00	81.86	2.23	8.20	73.65
960.00	84.80	2.03	9.39	75.41
1170.00	87.32	1.69	11.68	75.63
1380.00	89.16	1.40	14.60	74.56
1560.00	90.67	1.15	18.19	72.48
1800.00	91.50	0.96	22.14	69.36

KINETIC flotation data:

MINERAL:
Kinetic constant = 0.0038793 per sec
Maksimum possible recovery = 86.10 %
Correction time = 116.36 sec

Table 3. Cumulative valuation of the flotation optained data on pH = 8
E - concentration efficiency

T (sec.)	R - Met. (%)	Met. (%)	R - Tailing (%)	E (%)
10.00	5.95	6.60	0.17	5.78
30.00	27.93	6.20	0.86	27.07
90.00	45.72	5.35	1.68	44.04
180.00	60.74	4.78	2.55	58.18
360.00	69.34	4.17	3.40	65.94
480.00	74.37	3.63	4.27	70.10
720.00	79.94	3.13	5.41	74.53
960.00	83.48	2.65	6.76	76.72
1170.00	85.71	2.44	7.61	78.10
1380.00	87.71	2.10	9.15	78.56
1560.00	89.55	1.66	11.99	77.56
1800.00	90.99	1.26	16.17	74.82

KINETIC flotation data:

MINERAL:
Kinetic constant = 0.0035344 za sec
Maksimum possible recovery = 85.50 %
Correction time = 93.88 sec

Conclusion

The conducted investigation has had aim to ensure bulk colective flotation by chalcopyrite-pyrite from Bucim copper mine ensuring the possibilities of the increased Cu-recovery contemporary decreasing both the lime consumption and incrustation appearing, and protecting environment, as well as.

The worked out equation about the kinetic of the flotation process (Agar equation) provides the following form equations (for different values by pH=7 and pH=8):

◊ pH = 7 $R_{(t)} = 0.861 \cdot (1 - e^{-0.00388 \cdot (t + 116.36)})$
◊ pH = 8 $R_{(t)} = 0.855 \cdot (1 - e^{-0.0035 \cdot (t + 93.9)})$

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