НАУЧНО-ТЕХНИЧЕСКИ СЪЮЗ ПО МИННО ДЕЛО, ГЕОЛОГИЯ И МЕТАЛУРГИЯ
SCIENTIFIC AND TECHNICAL UNION OF MINING, GEOLOGY AND METALLURGY
НАУЧНО-ТЕХНИЧЕСКИЙ СОЮЗ ПО ГОРНОМУ ДЕЛУ, ГЕОЛОГИИ И МЕТАЛЛУРГИИ

PROCEEDINGS

OF THE XI-TH NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION OF THE OPEN AND UNDERWATER MINING OF MINERALS

June 19-23, 2011
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Proceedings of the XI-th NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION
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THE DESCRIPTIVE STATISTICS FOR THE INPUT AND OUTPUT PARAMETERS IN THE NEW SELECTIVE GALENA AND SPHALERITE FLOTATION IN SASA MINE, MACEDONIA

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ABSTRACT

In this paper the descriptive statistics of the obtained results in the selective galena and sphalerite flotation from the Sasa mine, Macedonia will be shown. The consumption of the flotation reagents, balls and rods grinding media in the flotation flowsheet, lead and zinc feed contents, lead and zinc concentrate contents, the appropriate recoveries of the mentioned minerals with estimation of the correlation for reagents regime, recoveries, contents in the lead and zinc feeds and concentrates, based on the descriptive statistics or Excel-solver computer presentation.

Introduction

Flotation separation and recovery of lead and zinc concentrates from ores containing galena (PbS) and sphalerite (ZnS) is well established and generally achieved quite effectively. Silver often provides highly significant economic value, if not the greatest value, with the silver most often associated with the galena mineralization which is fortuitous since smelters pay more for silver in lead vs. zinc concentrates. The non-values include iron sulphides such as pyrite and pyrrhotite that, while are often floatable, can be controlled. Siderite, an iron carbonate mineral, is often also associated in at least some minor quantity.

Marmatite ((Zn,Fe)S) is an iron-rich sphalerite which consequently results in lower zinc concentrate grades. Marmatite concentrates have a lower zinc level due to dilution from the iron minerals. Separations are made possible by galena's inherent natural hydrophobicity and due to the fact that sphalerite as a mineral is not easily collected by flotation reagents. The well established two stage sequential flotation process is employed. An important first step entails ensuring the sphalerite surface is not activated with dissolved metal ions, which then makes the sphalerite non-floatable. The established lead-zinc ore flotation processing scheme is to add zinc sulphate (ZnSO4) to the grind to control metal ion activation (sphalerite depression).

Lead flotation collectors and frother are conditioned before lead flotation which is conducted typically at near neutral to slightly elevated pH which can be increased in the cleaner circuit to ensure iron sulphide rejection. Sometimes cyanide, if can be used, is added to help depress iron sulphides. Because silver typically is mineralogically associated with galena, most of the silver values are carried with and report to the galena concentrate. Sphalerite that is rejected into the lead flotation tails is then floated in a second flotation step after activation with copper sulphate. The copper ions replace zinc atoms on the sphalerite surface creating a pseudocopper mineral surface coverage on the sphalerite which is then collected using copper flotation type collectors.

Because most of the iron sulphides also report to the lead flotation tails and so feeds the zinc flotation circuit, typically lime is used to raise pH for iron sulphide depression. The flotation collectors used in sphalerite flotation tend to be less powerful because sphalerite at this stage typically readily floats and using a more aggressive collector can float more non-sphalerite minerals.

Optimum lead concentrate metallurgy and recoveries are usually achieved using a combination of a xanthate and dithiophosphates. If the galena surfaces are slightly oxidized ("tarnished"), including mercaptobenzothiazole (MBT) is often made part of the collector suite to maximize galena recoveries. Frothers used in galena flotation tend to be of the weaker type, such as MIBC, because galena is readily floatable and have high flotation kinetics. However, because of the high float kinetics and high galena mineral density, the mineral froth carrying capacity may necessitate use of a slightly stronger frother or a combination with a stronger frother component for achieving optimum metallurgical results. Normal sphalerite flotation practice is to raise flotation pH to 10-12 for enhancing the rejection of iron sulphide minerals to the sphalerite flotation tails. Many operators prefer to use an alcohol type frother in sphalerite flotation to maximize sphalerite flotation selectivity. A lower molecular weight xanthate such as NaIPX is used in combination with a less powerful dithiophosphate flotation collector, and in rare cases, a thionocarbamate flotation reagent.

In rare circumstances, mineralogy and metallurgical response considerations necessitate an initial bulk lead-zinc concentrate with the lead and zinc minerals subsequently separated in a selective flotation step. Under this scheme, a bulk galena and sphalerite flotation concentrate is produced at pH 6.5 (modified with H_2SO_4) with some copper sulphate addition to ensure full sphalerite activation. The bulk concentrate is subsequently conditioned with sodium hydroxide to achieve an approximate 11.5 pH and collector addition from which a lead concentrate is floated. The zinc concentrate is actually the tails from this bulk separation step. The flotation tailing is the zinc concentrate.

If the silver is associated with the galena, the silver reports to the lead concentrate.

Lead and zinc concentrates and result from flotation in Sasa mine

Lead-zinc ores in the Republic of Macedonia is processed in three flotation plants and mines: Zletovo mine, Sasa mine and Toranica mine. Former Sasa concentrator flowsheet gave the following technological results: Pb+Zn collective concentrate with average 32-34% Pb and 21-23% Zn with appropriate recoveries of 92-94% Pb and 77-80%Zn.

The recent Sasa concentrator has changed flowsheet from collective to selective flotation of galena concentrate and sphalerite concentrate with following contents in concentrate from average 73-75%Pb (2,5-3,0%Zn) and average 49,5-51%Zn (1-1,5%Pb), with appropriate recoveries from cca 89-91%Pb and 89-91%Zn.

Table 1.

Reagents and Materials (kg/t)	January		February		March		April	
	Plan	Fact	Plan	Fact	Plan	Fact	Plan	Fact
CaO	5,100	3,644	3,700	3,954	3,700	3,790	3,600	2,801
KEX	0,100	0,095	0,095	0,118	0,095	0,095	0,095	0,076
KAX	0,030	0,022	0,027	0,025	0,027	0,026	0,027	0,017
DOW 250	0,060	0,049	0,055	0,046	0,055	0,049	0,055	0,052
NaCN	0,060	0,057	0,060	0,050	0,060	0,043	0,060	0,032
$CuSO_4$	0,530	0,453	0,490	0,458	0,490	0,400	0,420	0,349
$NaSO_3$	0,190	0,179	0,180	0,173	0,180	0,142	0,170	0,064
$ZnSO_4$	0,160	0,145	0,160	0,155	0,160	0,110	0,160	0,081
RODS φ100	0,400	0,479	0,400	0,411	0,400	0,461	0,400	0,309
BALLS φ60	0,300	0,224	0,300	0,310	0,300	0,250	0,300	0,276
BALLS φ20	0,030	0,000	0,027	0,031	0,027	0,013	0,027	0,015

Table 2.

Reagents and Materials (kg/t)	May		Jun		July		August	
	Plan	Fact	Plan	Fact	Plan	Fact	Plan	Fact
CaO	3,600	2,985	4,000	2,219	3,400	1,806	3,400	1,822
KEX	0,095	0,088	0,095	0,104	0,105	0,101	0,105	0,093
KAX	0,027	0,022	0,027	0,021	0,033	0,026	0,033	0,023
DOW 250	0,055	0,031	0,040	0,037	0,040	0,035	0,040	0,038
NaCN	0,060	0,057	0,060	0,050	0,060	0,043	0,060	0,032
$CuSO_4$	0,420	0,350	0,480	0,340	0,400	0,270	0,400	0,280
$NaSO_3$	0,170	0,005	0,060	0,125	0,140	0,101	0,140	0,111
$ZnSO_4$	0,160	0,066	0,100	0,097	0,110	0,094	0,110	0,087
RODS φ100	0,400	0,369	0,400	0,313	0,400	0,345	0,400	0,400
BALLS φ60	0,300	0,246	0,300	0,252	0,300	0,267	0,300	0,299
BALLS φ20	0,027	0,041	0,027	0,017	0,027	0,031	0,027	0,029

Table 3.

Reagents and Materials (kg/t)	September		October		November		December	
	Plan	Fact	Plan	Fact	Plan	Fact	Plan	Fact
CaO	2,200	1,807	2,400	2,076	2,400	2,090	2,400	2,401
KEX	0,105	0,089	0,100	0,102	0,095	0,095	0,095	0,076
KAX	0,033	0,024	0,030	0,024	0,027	0,026	0,027	0,017
DOW 250	0,067	0,056	0,060	0,048	0,055	0,049	0,055	0,055
NaCN	0,040	0,033	0,045	0,035	0,045	0,043	0,045	0,032
$CuSO_4$	0,340	0,296	0,380	0,324	0,380	0,340	0,380	0,349
$NaSO_3$	0,125	0,107	0,130	0,090	0,130	0,100	0,130	0,065
$ZnSO_4$	0,100	0,077	0,110	0,078	0,100	0,085	0,100	0,085
RODS φ100	0,400	0,480	0,400	0,433	0,400	0,420	0,400	0,365
BALLS φ60	0,300	0,474	0,300	0,315	0,300	0,250	0,300	0,300
BALLS φ20	0,027	0,015	0,027	0,015	0,027	0,013	0,027	0,015

Table 4

Months 2010	GALENA KONCENTRATE		SPHALERITE CONCENTRATE	
	Pb%	Zn%	Pb%	Zn%
January	76,2	2,7	1,3	50,1
February	77,5	2,8	1,5	51,2
March	76,5	3,0	1,3	50,8
April	76,5	3,2	1,0	50,0
May	74,5	3,0	1,1	49,5
Jun	72,5	2,8	0,8	51,0
July	74,0	2,6	0,8	50,8
August	73,5	2,8	1,0	51,0
September	74,5	3,0	1,1	51,5
October	75,5	2,9	1,3	51,2
November	75,0	2,6	1,1	50,7
December	75,5	2,3	1,0	51,0

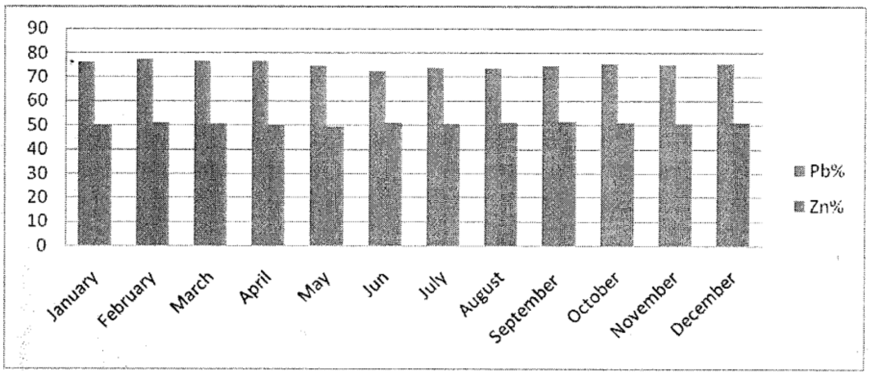

Fig 1. The histrogram from Pb&Zn contents in concentrates

Table 5.

Months 2010	FEED 1		FEED 2	
	Pb%	Zn%	Pb%	Zn%
January	4,8	4,5	5,0	4,8
February	3,8	3,8	4,5	3,8
March	4,6	5,0	4,5	4,5
April	4,5	4,5	4,3	4,5
May	3,9	3,1	3,6	3,0
Jun	4,3	4,3	4,1	4,2
July	4,3	3,5	4,0	3,9
August	4,6	4,8	3,6	3,5
September	3,7	3,6	3,7	3,3
October	4,3	4,1	4,3	4,1
November	4,0	3,8	3,7	3,2
December	4,2	4,1	4,3	3,9

Table 6.

Months 2010	PHASE Ball/Rod -200≠		CLASIFIERS -200≠	
	1	2	3	4
January	22,4	30,0	74,0	68,0
February	23,5	24,0	68,5	68,0
March	28,3	32,0	68,2	72,0
April	23,5	28,2	67,0	67,2
May	27,3	27,5	68,5	68,5
Jun	36,3	37,2	72,5	75,0
July	24,5	34,3	870,3	70,1
August	24,5	30,3	70,5	68,3
September	22,0	28,5	69,1	70,3
October	23,0	30,3	68,5	68,5
November	25,2	26,7	65,6	66,0
December	25,8	26,2	67,.3	68,5

Table 7.

Months 2010	CaO (kg/t)		DOW 250 (kg/t)	
	PLAN	FACT	PLAN	FACT
January	5,100	3,644	0,060	0,049
February	3,700	3,954	0,055	0,046
March	3,700	3,790	0,055	0,049
April	3,600	2,801	0,055	0,052
May	3,600	2,985	0,055	0,053
Jun	4,000	2,219	O,o65	0,073
July	3,400	1,806	0,067	0,060
August	3,400	1,822	0,067	0,063
September	2,200	1,807	0,067	0,056
October	2,400	2,076	0,060	0,048
November	2,400	2,090	0,055	0,049
December	2,400	2,041	0,055	0,055

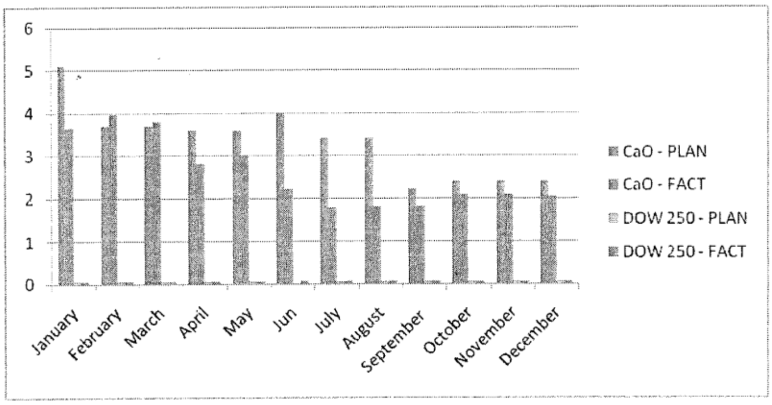

Fig 2. Histograms for CaO and DOW 250 consumption in Sasa concentrator

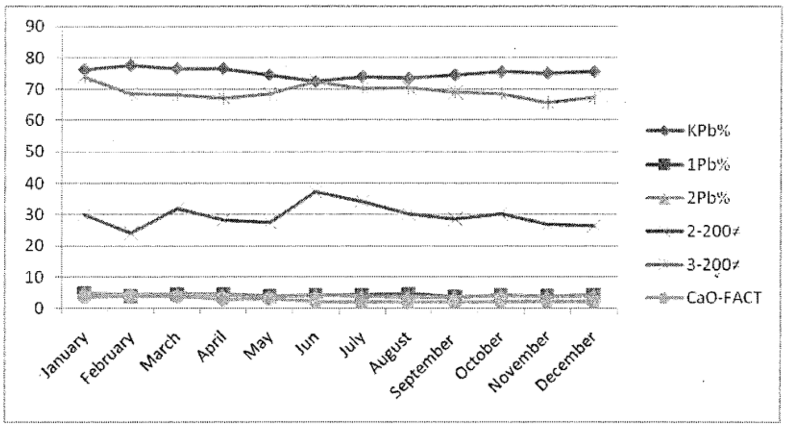

Fig 3. Graphic for Pb&Zn contents, size particles, feeds and Cao consumption

Table 8.

Months 2010	KEX (kg/t)		KAX (kg/t)	
	PLAN	FACT	PLAN	FACT
January	0,100	0,095	0,030	0,022
February	0,095	0,118	0,027	0,025
March	0,095	0,095	0,027	0,026
April	-0,095	0,076	0,027	0,017
May	0,095	0,088	0,027	0,022
Jun	0,095	0,104	0,027	0,021
July	0,105	0,101	0,033	0,025
August	0,105	0,093	0,033	0,023
September	0,105	0,089	0,033	0,024
October	0,100	0,102	0,030	0,024
November	0,095	0,095	0,027	0,026
December	0,095	0,076	0,027	0,017

Table 9.

Months 2010	$CuSO_4$ (kg/t)		$ZnSO_4$ (kg/t)	
	PLAN	FACT	PLAN	FACT
January	0,530	0,453	0,160	0,145
February	0,490	0,458	0,160	0,155
March	0,490	0,400	0,160	0,110
April	0,420	0,349	0,160	0,081
May	0,420	0,350	0,160	0,066
Jun	0,480	0,340	0,100	0,097
July	0,400	0,270	0,110	0,094
August	0,400	0,280	0,110	0,087
September	0,340	0,296	0,100	0,077
October	0,380	0,324	0,110	0,078
November	0,380	0,340	0,110	0,085
December	0,380	0,340	0,110	0,085

Table 10.

Months 2010	NaCN (kg/t)		$NaSO_3$(kg/t)	
	PLAN	FACT	PLAN	FACT
January	0,060	0,057	0,190	0,179
February	0,060	0,050	0,180	0,173
March	0,060	0,043	0,180	0,142
April	0,060	0,032	0,170	0,064
May	0,060	0,031	0,170	0,005
Jun	0,040	0,037	0,060	0,125
July	0,040	0,035	0,140	0,101
August	0,040	0,038	0,140	0,111
September	0,040	0,033	0,125	0,107
October	0,045	0,035	0,130	0,090
November	0,045	0,035	0,130	0,100
December	0,045	0,035	0,130	0,065

Table 11.

Months 2010	BALL (kg/t)		ROD (kg/t)	
	PLAN	FACT	PLAN	FACT
January	0,300	0,244	0,400	0,479
February	0,300	0,310	0,400	0,411
March	0,300	0,250	0,400	0,461
April	0,300	0,276	0,400	0,309
May	0,300	0,246	0,400	0,369
Jun	0,300	0,252	0,400	0,313
July	0,300	0,267	0,400	0,345
August	0,300	0,299	0,400	0,400
September	0,300	0,474	0,400	0,487
October	0,300	0,315	0,400	0,433
November	0,300	0,250	0,400	0,420
December	0,300	0,300	0,400	0,365

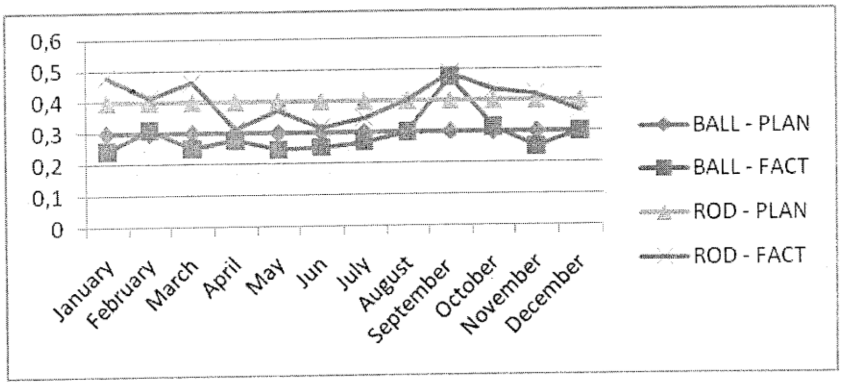

Fig 4. The consumption of balls and rods in Sasa selective concentrator

Conclusion

It's evidently that recent technological flowsheet gave results with satisfactory characteristics which are needed for the metallurgical demands in the lead and zinc smelter outside from the Republic of Macedonia. The reagents regime clearly is seen from tables shown above of the paper. As a matter of fact, the results are expected after changes of flowsheets, new performance and equipment ensured from new owner of the Sasa mine with from average 73-75%Pb (2,5-3,0%Zn) and average 49,5-51%Zn (1-1,5%Pb), with appropriate recoveries from cca 89-91%Pb and 89-91%Zn.

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