OPTIMIZING OF SOME PARAMETERS IN THE PHAZE OF COARSE FLOTATION IN "SASA" - MINE R. MACEDONIA

Blagoj GOLOMEOV[1], Boris KRSTEV[1], Mirjana GOLOMEOVA[1] ,

Abstract

Optimizing of some parameters during the phase of coarse Pb - Zn flotation in "Sasa" mine, R. Macedonia is shown in this work supported by the modern investigations and the accomplishment of the mineral flotation.

Introduction

The succes in the selective flotation concentration process as the most important, and in industrial conditions the most common step in the flotation concentration of typical lead - zinc ores, is first of all seen, in obtaining qualitative selective lead and zinc concentrations adequate for further metallurgical treatment with high metal recovery in the concentrations.

In order to achieve this, it is necessary to make maximum separation of lead minerals and zinc minerals during the phase of coarse lead flotation. If this is not reached, there will be an increase of zinc content in the lead concentration lowers its value down, and secondly the presence of zinc in lead concentration at the same time means its loss, because zinc from such concentration can not be efficiently recovered.

Having all this in mind, it is clear that the process of coarse flotation of lead minerals is the most significant segment in the whole process of selective flotation of lead - zinc minerals.

The most important factors which influence the effeciency of separation of lead minerals and zinc minerals during the phase of coarse flotation of lead among others are: the degree of opening of mineral raw material, pH and pulp density, the collector expenditure for lead minerals, the depressant expenditure for zinc minerals and flotation time.

All this factors are more or less well examined for all deposits which are in the process of explotation.

The aim of this work is optimizing the reagent regime and the pulp density during the phase of coarse Pb - Zn flotation in "Sasa" - mine - R. Macedonia.

In doing this we had in mind that it was not possible to optimize these factors in a classical way, in other words, by change of one factor along the constant change of another because of their mutual influence.

It is clear that in conditions where we have easily flotable sphalerite, and the high collector concentration, collecting of sphalerite will be increased. On the other hand it means that a greater depressant expenditure will be necessary that itself may have a negative influence on collecting of galenite surfaces.

For this reason we made the optimizing of these parameters by the use of full factor plan, gradient of Box and Uilson method and we took the separation efficiency for the target function because the treated parameters mutually influence it.

[1] Faculty of Mining and Geology, Goce Delcev 87, Stip, R. Macedonia

Full Factor Plan of Experiments for The Four Factors

Changeable factors:

x_1 - Collector expenditure KIBX
x_2 - Depressant expenditure $ZnSO_4$
x_3 - Depressant expenditure NaCN
x_4 - Pulp density

The target process parameter (parameter that follows the influence of the given factors for the process) will represent the efficiency in the separation of lead minerals and zinc minerals, digitly shown as the difference between lead recovery and the distribution of zinc in the coarse lead concentration (I(%) Pb - R(%) Zn).

The zero regime (initial values for x_1, x_2, x_3 and x_4)

x_1 - 25 g/t KIBX
x_2 - 125 g/t $ZnSO_4$
x_3 - 20 g/t NaCN
x_4 - 27,5% solid

These values were taken on the basis of the average expenditure of the mentioned factors in the last two years in "Sasa" flotation.

We accept the following variation intervals of changeable factors:

$\Delta x_1 = 3$ g/t;
$\Delta x_2 = 13$ g/t;
$\Delta x_3 = 2$ g/t;
$\Delta x_4 = 2.5\%$

According to this, +1 and -1 are adequate to the following values of factors:

+1	−1
$x_{1\ max.} = 28$ g/t	$x_{1\ min.} = 22$ g/t
$x_{2\ max.} = 138$ g/t	$x_{2\ min.} = 112$ g/t
$x_{3\ max.} = 22$ g/t	$x_{3\ min.} = 18$ g/t
$x_{4\ max.} = 30$ %	$x_{4\ min.} = 25$ %

Our experimental plan is shown in the following table:

Table 1

Number of assay	x_1	x_2	x_3	x_4
1	+ (28 g/t)	+ (138 g/t)	+(22 g/t)	+(30 %)
2	– (22 g/t)	+ (138 g/t)	+(22 g/t)	+(30 %)
3	+ (28 g/t)	– (112 g/t)	+(22 g/t)	+(30 %)
4	– (22 g/t)	– (112 g/t)	+(22 g/t)	+(30 %)
5	+ (28 g/t)	+ (138 g/t)	–(18 g/t)	+(30 %)
6	– (22 g/t)	+ (138 g/t)	–(18 g/t)	+(30 %)
7	+ (28 g/t)	– (112 g/t)	–(18 g/t)	+(30 %)
8	– (22 g/t)	– (112 g/t)	–(18 g/t)	+(30 %)
9	+ (28 g/t)	+ (138 g/t)	+(22 g/t)	–(25 %)
10	– (22 g/t)	+ (138 g/t)	+(22 g/t)	–(25 %)
11	+ (28 g/t)	– (112 g/t)	+(22 g/t)	–(25 %)
12	– (22 g/t)	– (112 g/t)	+(22 g/t)	–(25 %)
13	+ (28 g/t)	+ (138 g/t)	–(18 g/t)	–(25 %)
14	– (22 g/t)	+ (138 g/t)	–(18 g/t)	–(25 %)
15	+ (28 g/t)	– (112 g/t)	–(18 g/t)	–(25 %)
16	– (22 g/t)	– (112 g/t)	–(18 g/t)	–(25 %)

Collector KIBX was added during the phase of conditioning whereas, depressants $ZnSO_4$ and NaCN were added during the phase of grinding.

Other constant conditions during separation of assay:

- fineness of opening in mineral raw material 65% -0.074 mm;
- pH ≅ 10;
- conditioning time = 3 min.;
- flotation time = 10 min.

In the mentioned conditions experimental plan from Table 1 was repeated twice, in other words, two parallel series of 16 assays each were made in coarse lead mineral flotation and gave the following results:

Table 2

Assay number	x_0	x_1	x_2	x_3	x_4	E_1	E_2	$E_{av.}$	$E_{est.}$	ΔE
1	+	+	+	+	+	26.00	26.20	26.10	25.42	0.69
2	+	–	+	+	+	34.06	32.54	33.30	32.12	1.18
3	+	+	–	+	+	4.59	5.50	5.05	5.30	–0.25
4	+	–	–	+	+	50.04	45.39	47.72	46.15	1.57
5	+	+	+	–	+	17.40	14.02	15.71	14.99	0.72
6	+	–	+	–	+	31.57	27.81	29.69	30.55	–0.86
7	+	+	–	–	+	3.08	4.71	3.90	4.17	–0.27
8	+	–	–	–	+	18.50	14.50	16.50	16.94	–0.44
9	+	+	+	+	–	25.92	23.55	24.74	25.42	–0.68
10	+	–	+	+	–	32.47	29.39	30.93	32.12	–1.19
11	+	+	–	+	–	4.27	6.83	5.55	5.30	0.25
12	+	–	–	+	–	44.11	45.05	44.58	46.15	–1.57
13	+	+	+	–	–	15.05	13.49	14.27	14.99	–0.72
14	+	–	+	–	–	32.73	30.08	31.41	30.55	0.86
15	+	+	–	–	–	4.74	4.16	4.45	4.17	0.28
16	+	–	–	–	–	15.36	19.38	17.37	16.94	0.43

E - represents the efficiency of Pb separation in relation to Zn
E = I(%) Pb – I(%) Zn;

Bearing all this in mind, in the following pages we will make modelling of $E=f(x_1, x_2, x_3, x_4)$ dependence in the form of linear model in order to see the intensity of influence by changeable factors on the target function and to determine the gradient that we will follow in order to obtain its optimum values.

The results of the separation efficiency of Pb in relation to Zn minerals are shown in columns E_1 and E_2. The model was estimated for medium values of $E_{av.}$.

According to this, the mathematical model of the process of coarse lead flotation expressed through the separation efficiency of Pb and Zn minerals and depending upon the factors x_1 (collector expenditure KIBX), x_2 (depressant expenditure $ZnSO_4$), x_3 (depressant expenditure NaCN) and x_4 (pulp density), in conditional units is the following (polynome of first degree):

$$E=21.95-9.48x_1+3.81x_2+5.29x_3+0.29x_4+3.92x_1x_2-2.4x_1x_3-0.07x_1x_4-2.29x_2x_3+0.14x_2x_4+0.50x_3x_4+4.62x_1x_2x_3+0.34x_1x_2x_4-0.51x_1x_3x_4-0.003x_2x_3x_4-0.013x_1x_2x_3x_4$$

According to Kohren's, Student's and Fisher's criterion we made analysis of model and found as follows:

- coefficients related to factor x_4 are considered as unimportant and because of this the final form of mathematical model is as follows:

$$E = 21.95-9.48x_1+3.81x_2+5.29x_3+3.92x_1x_2-2.4x_1x_3-2.29x_2x_3+4.62x_1x_2x_3$$

- the model is appropriate

This means that observed process is described correctly by the polynome of first degree and the difference which appears between the experimental and mathematical results is fortuitous.

According to obtined results it is clear that, in order to achieve optimum efficiency in Pb and Zn minerals during the coarse lead flotation a further decrease of collector expenditure is needed, and at the same time a further increase of depressant expenditure.

Determination of optimum collector expenditure (KIBX) and depressant ($ZnSO_4$, NaCN)

On the basis of the analysed mathematical model we made another series of four assays. Besides the constant conditions that were equal to those from the first and second series, in this assay the collector expenditure was decreased from assay to assay and the depressants expenditure were increased.

Collector expenditure KIBX and the depressants $ZnSO_4$ and NaCN in individual assay was the following:

Table 3

Assay number	Expenditure KIBX	Expenditure $ZnSO_4$	Expenditure NaCN
1	22 g/t	130 g/t	21 g/t
2	19 g/t	135 g/t	22 g/t
3	16 g/t	140 g/t	23 g/t
4	13 g/t	145 g/t	24 g/t

It is clear that the rate of expenditure decrease KIBX is in relation to the speed of expenditure increase $ZnSO_4$ and NaCN.

Third series of four assays gave the following results:

Table 4

Assay number	I(%)Pb	I(%)Zn	E
1	80.76	22.75	58.01
2	80.45	20.66	59.79
3	79.78	19.78	60.00
4	78.44	19.1	59.34

Analising the results from the third series of assays it is clear that in the second and third assays we have increase of separation efficiency of Pb and Zn minerals in coarse lead flotation, while in the fourth assay it decreases.

This means that in the third assay we obtain maximum value in the separation efficiency of Pb and Zn minerals. After that, during the fourth assay, there is decline because of the decrease in lead recovery in coarse Pb concentration, although zinc recovery in the same product remain closely equal to the third. This shows that collector concentration in the pulp in the fourth assay was below the minimum necessary in order to achieve collecting of all mineral grains of lead bearers.

Bearing this in mind we may come to the conclusion that the optimum KIBX collector expenditure in the coarse Pb flotation is 16 g/t, optimum expenditure of $ZnSO_4$ depressant is 140 g/t and optimum expenditure of NaCN depressant is 23 g/t.

CONCLUSION

Considering the completed laboratory examinations and the obtained mathematical model for coarse lead mineral flotation expressed by the efficiency of Pb and Zn mineral separation it follows that:

- Collector expenditure (KIBX) has almost twice as great an influence on the efficiency of lead and zinc mineral separation than the depressant expenditure for zinc minerals ($ZnSO_4$, NaCN). This leads to the fact that even a small increase in collector expenditure in the pulp above the optimum causses collecting of zinc mineral surfaces (sphalerite). This is supported by the modern investigations according to which for the mineral flotation, in this case it is galenite, small or "practical" xanthate concentration is necessary because its surplus remains in the pulp and may cause undesirable effect during the selective flotation process;
- Optimum collector expenditure (KIBX) in the coarse lead mineral flotation of Pb - Zn ore from "Sasa" mine is about 16 g/t;
- Optimum depressant expenditure ($ZnSO_4$) of zinc minerals (sphalerite) during the process of coarse lead mineral flotation from the same raw material is about 140 g/t;
- Optimum depressant expenditure (NaCN) of zinc minerals (sphalerite) during the process of coarse lead mineral flotation is about 23 g/t

References

1. B. A. WILLS - Mineral Processing Technology, Pergamon Press, Oxford 1989
2. T. GEORGIEV, K. KOVATCHEV - Determination The Parameters of Analitico - Experimental Correlation Describing The Flotation Kinetics, Annual of the Higher Institute of Mining and Geology (1988-1989), Sofia, 1989
3. T. IMAIZUMI, T. INOUE - Kinetic Considerations of Froth Flotation, Proceeding of the 6th IMPC, Cannes, France, 1963
4. D. N. SUTHERLAND - A Study on The Optimization of The Arrangment of Flotation Circuits, International Jurnal of Mineral Processing vol 7, 1981
5. M. BOX - A New Method of Constrained Optimisation and a Comparision With Other Methods, Computer Jurnal, vol 8, N° 1, 1965
6. R. KLIMPEL - Some Engineering Guidelines on Flotation Reagent Use, Chemical Engineering, vol 91, N° 18, 1984
7. B. GOLOMEOV, B. KRSTEV - Optimizing The Flotation Time in The Phase of Rougher Pb-Zn Flotation, Turkiye Medencilik Kongresi Yurutme Kurulu, Istanbul Turkey, 1993
8. B. GOLOMEOV, B. KRSTEV - Optimizing The Reagent Regime During The Phaze of Coarse Pb-Zn Flotation in "Zletovo" mine Macedonia, Geologica Macedonica, vol 5, N° 1, 1990-1991