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NEW DEVELOPMENTS IN MINERAL PROCESSING

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NEW DEVELOPMENTS IN MINERAL PROCESSING

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Güven Önal, Suna Atak, Ali Güney, Mehmet S. Çelik, A.E.Yüce
Department of Mining Engineering, Mineral and Coal Processing Section, Istanbul Technical University, Turkiye

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MATHEMATICAL INTERPRETATION ON KINETICS OF Pb - Zn ROUGHER FLOTATION IN THE ZLETOVO MINE

B. Golomeov, B. Krstev and M.Golomeova
Faculty of Mining and Geology, Stip, Macedonia

ABSTRACT: Several equations that describe the kinetics of the flotation process can be found in the literature. One of the most appropriate, with no doubt, is Agar's equation. This paper makes an attempt to describe the kinetics of rougher Pb - Zn flotation process in the Zletovo mine using the Agar's equation.

INTRODUCTION

As we know, Agar describes the kinetics of flotation process as follows:

$$R = R_{max.} \cdot \left(1 - e^{[-k \cdot (t+b)]}\right)$$

where:

R - recovery of useful component;

R_{max} - maximum possible recovery

k - kinetics constant of flotation;

t - time of flotation;

b - corrective time of flotation;

Iterative procedure was used to determine unknown constants of particular equation. That means that all unknowns were changed in certain limits, defined based on explorer's knowledge and experience. Through this procedure, medium quadrant deviation between experimental and estimation results can be calculated. In the end, we accepted those values of unknowns, which gave minimal values of standard deviation. These complex cal ululations were carried out with computer program. This computer program was written in high program language "PASCAL". The Results obtained were checked with appropriate software "EUREKA" and proved identical.

EXPERIMENTAL

Table 1 shows experimental results obtained by mathematical modeling using Agar's equation. Since it is related to rougher lead flotation, instead of the word "recovery" (R) the word "distribution" (D) will be used as more appropriate for zinc and other of minerals.

Table 1. Experimental results.

Time [s]	R-Pb [%]	Pb [%]	D-Zn [%]	Zn [%]	D-RM [%]
30,00	37,55	57,76	4,34	2,20	1,39
60,00	64,02	54,06	9,68	2,69	2,86
90,00	78,61	51,35	13,86	2,98	4,00
120,00	85,80	49,23	17,05	3,22	4,83
240,00	92,84	44,94	23,34	3,73	6,38

Table 2 shows a review of both experimental and calculated results, obtained after mathematical modeling of the first, using Agar's equation for describing the kinetics of process. Below Table 2 are shown the values obtained for kinetics constant (k), maximum possibly recovery (R_{max}), and corrective time of flotation (b) individually. Based of these results, recovery of lead, distribution of zinc and distribution of zinc along with other minerals in rough lead concentrate are calculated.

Table 2. Review of experimental and calculated results.

Time [s]	R - Pb [%] experimental	R - Pb [%] calculated	D - Zn [%] experimental	D - Zn [%] calculated	D - Zn+RM [%] experimental	D -Zn+RM [%] calculated
30,00	37,55	37,57	4,34	4,21	1,39	1,45
60,00	64,02	64,53	9,68	9,77	2,86	2,90
90,00	78,61	78,47	13,86	13,92	4,00	3,98
120,00	85,80	85,68	17,05	17,02	4,83	4,78
240,00	92,84	92,85	23,34	23,33	6,38	6,39

Pb :

$k = 0.0219795$

$R_{max.} = 93.40$

$b = -6.59$

Zn :

$k = 0.0097035$

$D_{max.} = 26.20$

$b = -11.94$

Zn + RM :

$k = 0.0098886$

$D_{max.} = 7.10$

$b = -6.94$

Medium quadrant deviation (standard deviation - σ) between experimental and calculated results for lead, zinc and zinc and the rest of minerals individually are shown in Table 3. As it can be seen, according to the calculated standard deviation, the best results are obtained for zinc and rest of minerals, then for zinc and then for lead. Generally, these results are very acceptable because they interpret experimental results quite well.

Table 3. Calculated results.

	Standard deviation		
	Lead	Zinc	Zinc+RM
	$(R_{exp.}-R_{calc.})^2$	$(D_{exp.}-D_{calc.})^2$	$(D_{exp.}-D_{calc.})^2$
	0,0003159	0,016482	0,003329
	0,2553143	0,007236	0,001494
	0,020482	0,003127	0,000522
	0,0151164	0,000997	0,002623
	0,0000566	0,000032	0,000131
SUM:	0,2912852	0,027874	0,008099
σ	0,2698542	0,083477	0,044997

Where is:

$$\sigma = \sqrt{\frac{\sum_{1}^{5}(R_{eksp.} - R_{presm.})^2}{4}}$$ and

$$\sigma = \sqrt{\frac{\sum_{1}^{5}(D_{eksp.} - D_{presm.})^2}{4}}$$

In figures 1, 2 and 3 graphic dependences between experimental and calculated obtained recovery and distribution of lead, zinc and zinc and rest of minerals together in function of time "t" are shown. It is evident that experimental and calculated curves overlap. This means that Agar's equation for interpretation of kinetics of flotation process explains the process very well and can be taken as one of most appropriate equations regarding this issue.

Lead

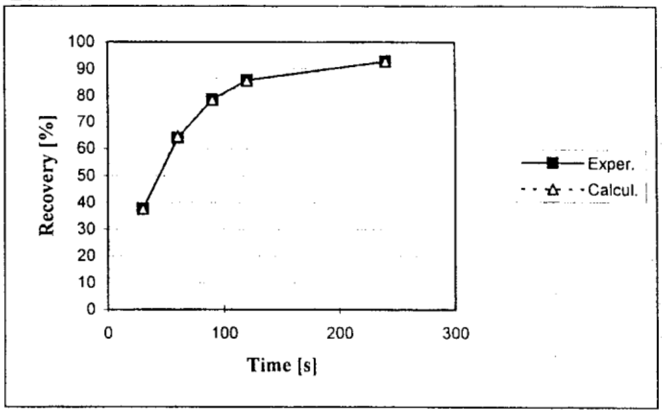

Figure 1

Zinc

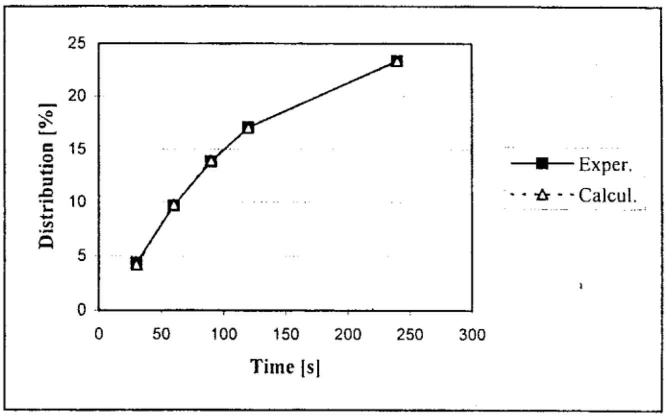

Figure 2

Zinc + rest of minerals

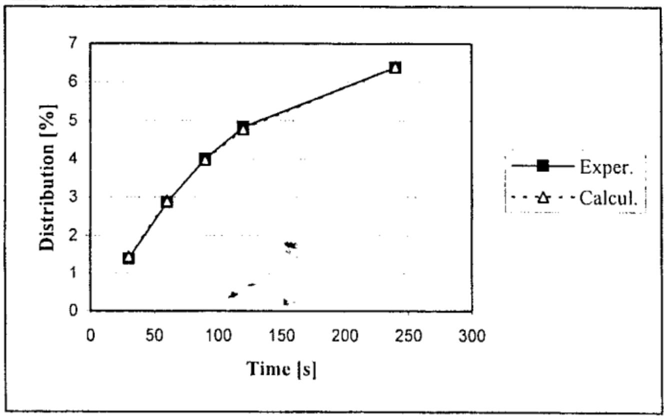

Figure 3

CONCLUSION

It can be said in brief that these investigations show that Agar's equation for describing of kinetics of flotation process is very appropriate and acceptable and can be used with great level of confidence.

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