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Study of the Flotation Process by Simulation

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ABSTRACT: This paper presents some results of flotation modelling and simulation. The modernisation of technology is very slow in this field and the only way of contributing to the increment of extraction performances is to know the technological parameters and capacity reserves as precisely as possible. Some of the representative dependencies characterising the flotation process were simulated using MATLAB SIMULINK programs. Analysis and comparison of the results of simulations carried out enabled the determination and formulation of some of the flotation process characteristics.

1 THE STUDY OF A FLOTATION TWO-PHASE MODEL

The model considers the froth and pulp as two distinct phases dynamically equilibrated as given in Figure 1.

The notation in Figure 1 is as follows:

M - floated material mass;

V - pulp volume, excepting air;

r, s - the ratio of the pulp volume (including air) to the airless volume, respectively and of the froth volume (including air) and the airless volume respectively;

Q - volumetric flow rate, excluding air;

C* - concentration (ratio of the mass to volume unit, including the air in the pulp);

a - speed constant, regarding the concentrate transfer from the pulp to the froth;

b - speed constant, regarding the concentrate transfer from the froth to the pulp;

p, s, e, t - indexes, referring to the pulp, froth, concentrate and waste.

The differential equation reflecting the pulp composition change for ideal mixing cells is:

$$\frac{dM_p}{dt}=QC^*-rQC_p-arV_pC_p+bsV_sC_s=\frac{dC_p}{dt}V_pr \qquad 0)$$

The differential equation reflecting the change in the froth composition for the same cells is:

$$\frac{dM_s}{dt}=-sQ_cC_s-bsV_sC_s+arV_pC_p=\frac{dC_s}{dt}V_ss \qquad (2)$$

The transfer functions determined are given as follows:

$$H_1(s)=\frac{M_p(s)}{Q(s)}=\frac{k_1}{T_ps+1} \qquad (3)$$

$$H_2(s)=\frac{M_p(s)}{C(s)}=\frac{k_2}{T_ps+1} \qquad (4)$$

$$H_3(s)=\frac{M_s(s)}{Q(s)}=\frac{k_3}{T_ss+1} \qquad (5)$$

$$H_4(s)=\frac{M_x(s)}{Q(s)}=\frac{k_4}{T_ss+1} \qquad (6)$$

Where T_p, and T_s are time constants; ki, k2, k3, and k, proportionality constants depending on V_p, V_s, Q_L Qc Q* following the same notation as in Figure 1.

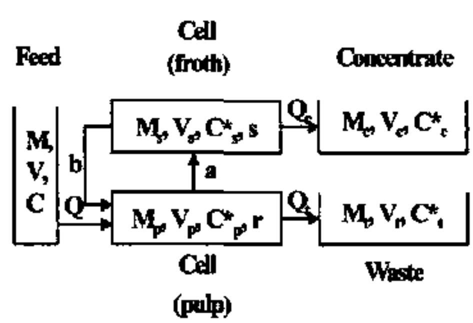

Figure 1. Flotation cell block diagram

2 FLOTATION SIMULATION USING MATLAB

Mineral flotation of the raw material exploited in the Baia-Mare area, processed in the mineral processing plant from this town was studied. A primary flotation cell was considered, for which we evaluated the characteristic values of die constants m the transfer functions were evaluated (Table 1).

Table 1. Values for time and proportionality constants in the transfer functions.

Constant	*Relation*	*Value*
T_p	V_p/Q_i	0,004808
T_s	V_s/Q_c	0.025749
k_1	$T_p C^*$	0,003468
k_2	$T_p Q$	1,153920
k_3	$T_s C^*$	0,013572
k_4	$T_s Q$	6,179760

The response of the considered system was investigated, for the unit input signal of the feeding flow rate Q and the concentration C*, as well as for the "white noise" signal, in the case of C*.

The results of the simulation are presented in Figure 2, Figure 3 and Figure 4.

Analysing the system response, it can be concluded that:

- the stabilising time for the pulp composition is 1.5-2 min., a sudden variation of the feeding flow rate or the feeding concentration being reflected in the system for about 2 min.; the concentration influence is more significant:

- the froth composition stabilisation time is about 6 min;

- the "white noise" stochastic variation of the flow rate influences the froth composition more.

Using die transfer functions which allow us to study the mechanism of the mineral particle transfer from the pulp to the from and the reverse, the optimum time of the flotation in a cell can be determined, using me stabilisation time of the process.

Considering the estimating relations for the time and proportionality constants, it can be stated that these depend on the pulp flow rate, processed mineral composition, useful elements content in the raw material, weight extraction, aeration and dilution.

Our conclusion from the study performed is that; jV a certain material and a given flotation technological htie the optimisation parameters are the aeration and the feedme dilution

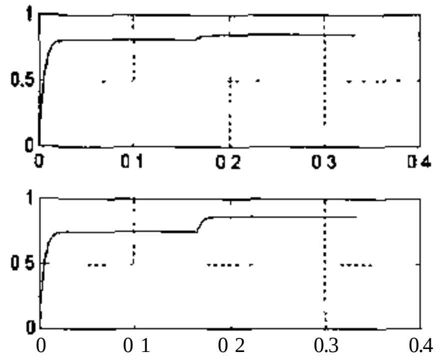

Figure 2. System response concerning the pulp composition variation when the unit input is the feeding flow rate (a) and the feeding concentration (b)

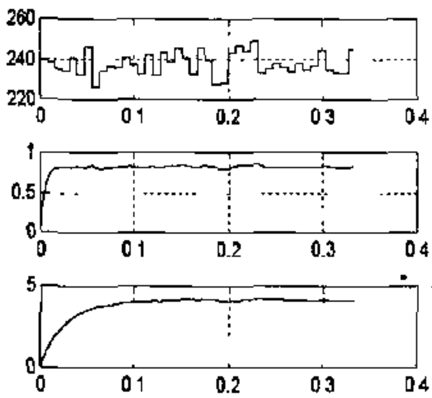

Figure 3 System response to the stochastic variation of the feeding flow rate (a) concerning the pulp (b) and the froth (c) composition.

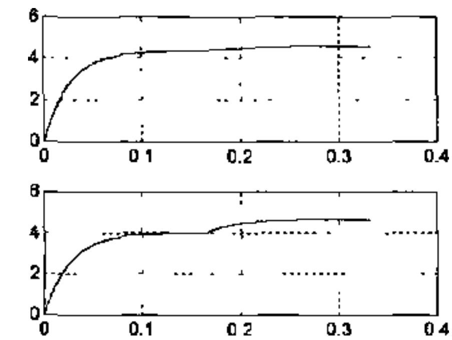

Figure 4. System response concerning the froth composition variation when the unit input is the feeding flow rate (a) and the feeding concentration (b)

3 CONCLUSIONS

Flotation can be considered as physical and chemical separation process of solid products, by establishing a contact in three phases: the floating mineral, the liquid phase and air.

The great number of parameters involved in flotation, due to the high complexity of the process, require a new kind of approach to this process study.

The development of computer hardware and, most importantly, software, allows a new method of experimental research by simulation.

In order to simulate a primary flotation cell, a two-phase model can be adopted, considering the pulp and the froth as two distinct phases.

Use of MATLAB SIMULINK software enabled obtaining the process response when the feed flow rate and composition exhibited a sudden step or stochastic variation.

Using the transfer functions which allow study of the mechanism of the mineral particle transfer from the pulp to the froth and reverse, the optimum time of flotation in a cell can be determined, using the stabilisation time of the process.

Considering the estimating relations for the time and proportionality constants, it can be stated that these depend on: the pulp flow rate, processed mineral composition, useful elements content in the raw material, weight extraction, aeration and dilution.

The main conclusion of this study can be stated as; for a certain material and a given flotation technological line, the optimisation parameters are the aeration and the feeding dilution.

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