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# PROBABLE MECHANISM OF THE OPERATION OF THE FLOTATION PULP DENSITY ON THE SELECTIVE FLOTATION OF THE SULPHIDE MINERALS

## 1. Introduction

The research works of the influence of the flotation pulp density on the rheology and hydrodynamics of the processes running within the flotation machines take main place in the literature. It is proved that the stroke power needed for the forming of the flotation aggregate depends on the pulp density. However, the usage of higher degree of density at the time of the flotation process of the mineral raw-materials within the flotation machines confines of the pulp aeration and the decrease in the common case of the selectivity of the flotation process. Till now, the most authors had treated, mainly, the selectivity of the useful component separation from the rock mass. There are scarcely piece of information about the separation of the particular sulfide minerals. It is not well-known whether the variations of the flotation ability of the sulfide minerals at the flotation process within the dense pulp decrease or increase. The decrease of the common water expense in the conditions of the flotation at increased degree of density leads to lessening the water sources pollution, or otherwise, the problem of the pulp density is strictly connected with the preservation the environment clean. Namely, that is the main purpose of the present research: studying of the possibilities, by the way of flotation at high degree of the flotation pulp density, to be realized the selection of sulfide minerals at lower degree of common expense of flotation reagents-collectors, depressors and activators. Thus, part of the flotation defects at high density of the flotation pulp, known by the literature, would change into its advantages in the process of the sulfide minerals selection.

## 2. Methods of carrying out of the investigation

To gain the inquired purpose were made flotation experiments, using the real ore in laboratory conditions with varying solid phase content in the flotation pulp. The operations of

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smashing and grinding were going before the flotation experiments. The smashing ore process was made by a laboratory jaw breaker with massiveness of 3 mm, and after that it was used a rolling one with massiveness of 1.5 mm. As for the grinding, it was made in the laboratory balling mill, where were running 500 g ore and 340 ml water for each of the grinding. Having been well-prepared for the flotation experiments making, the ore goes into the laboratory mechanical flotation machine "Denver". The volume of the used flotation cell is $V$ = 1.2l. (When the air is out). In the flotation process, as a collector is used potassium isobutylene xanthate (made as 1% water solution), and as frother is used "Minfrot 2002". The couple "collector-frother" is sorted accordingly the structure of the carbon-hydrogen radicals of the reagents. The flotation products have been dried and analyzed chemically, and after that it has estimated the metal balance and the selectivity indices. To be estimated the selectivity indices it is used the formula of Beloglazov [3]

$$\eta = \frac{\lg \dfrac{1}{1-\varepsilon^{\mathrm{Cu}}_{concentrate}}}{\lg \dfrac{1}{1-\varepsilon^{\mathrm{Mo}}_{concentrate}}} \tag{1}$$

By definition, the flotation pulp density is estimated by the formula of Fomenko [4]

$$\delta_n = \frac{G}{V} = \Delta + \frac{(\delta - \Delta)\rho}{1000\delta}, \text{ g/cm}^3 \tag{2}$$

where:

$\delta_n$ — the density of the pulp, g/l;
$G$ — the mass of the pulp, g;
$V$ — the volume of the pulp, cm$^3$;
$\Delta$ — the density of the water, g/cm$^3$;
$\delta$ — the real density of the solid, g/cm$^3$;
$\rho$ — the content of solid in the pulp, g/l.

The change of the pulp density through change of the liquid phase has issued in [5, 6]. In the present research, the pulp density has been changed through the change of the solid content ($\rho$).

## 3. Reseived results and discussion

The flotation experiments are carried out with sulfide cupric-molybdenum ore from the ore deposit "Elatsite". The cupric content in the ore estimates 0.45%, the granodiorites content is 93.08% and the schist content is 6.92%. The main cupric-ore minerals are chalcopyrite, chalcosine, covelline, cuprite and chrisocolla. There are also both minerals-pyrite and molybdenite. The content of gold is under 0.1 g/t ore. The flow-sheet of flotation is exposed in Figure 1.

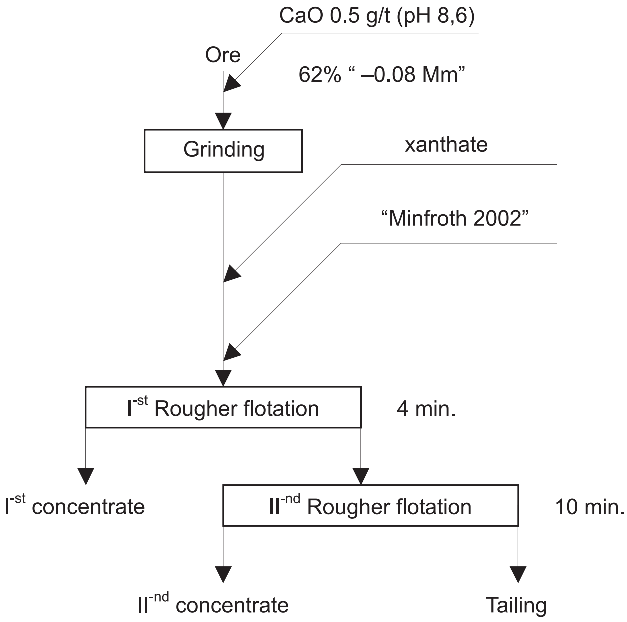


**Fig. 1.** Flow-sheet of flotation

On the ground of the flotation experiments made by using different pulp density, it has studied its influence of the flotation process selectivity. For that purpose, on the ground of the experiments results it has estimated the metal balance and selectivity's indices — Tables 1 and 2. Each of the experiments is carried out three times and the results got its medium indicies.

TABLE 1

**Change of selectivity's index accordingly the change of the solid phase in percentage, when there's variable collector expense and frother expense of 20 g/t**

| Expense of xanthate, g/t | Products | Index of selectivity, η | | |
|---|---|---|---|---|
| | | 30% solid | 50% solid | 60% solid |
| 20 | I concentrate | 1.65 | 2.94 | 2.47 |
| | II concentrate | 1.98 | 1.00 | 0.33 |
| 40 | I concentrate | 2.25 | 3.26 | 2.69 |
| | II concentrate | 1.56 | 0.92 | 0.36 |
| 60 | I concentrate | 2.44 | 2.61 | 3.50 |
| | II concentrate | 0.79 | 0.88 | 0.24 |

TABLE 2
**Change of selectivity's index accordingly the change of the solid phase in percentage, when there's variable frother expense and collector expense of 40 g/t**

| Expense of "Minfroth 2002", g/t | Products | Index of selectivity, η | | |
|---|---|---|---|---|
| | | 30% solid | 50% solid | 60% solid |
| 10 | I concentrate | 2.17 | 4.41 | 2.24 |
| | II concentrate | 1.01 | 0.08 | 0.62 |
| 20 | I concentrate | 2.49 | 2.90 | 2.37 |
| | II concentrate | 0.58 | 0.63 | 0.68 |
| 30 | I concentrate | 2.93 | 3.11 | 2.60 |
| | II concentrate | 0.50 | 0.48 | 0.61 |

Generally received results from the first table show that increasing the solid phase content within the pulp (%) lead to change of the probability for flotation aggregate formation, which probably, on one hand, is determined by increasing the hydrofobity of the mineral surface and decreasing the air bubbles number towards the mineral parts number. However, in the same time, the increasing density leads to decrease the probability of tearing the flotation aggregates to pieces. That is the reason to search for the optimum within the flotation pulp density, depending as well of the sort of the mineral raw material and the reagent dispense, as of the type of the flotation machine.

In all occasions, however, the increasing of the flotation pulp density leads, at other identical conditions, to increasing the index of selectivity.

The second table shows clearly that the index of selectivity is in its highest state when it is in the first rougher flotation at 50% solid phase and 10 g/t dispense of "Minfroth 2002". By increasing the solid phase concentration in the flotation pulp, the flotationable mineral mass increases, and the area of between-phased surface liquid-gas decreases. That leads to increasing the index of selectivity in a more notable way, in the first rougher flotation and in a less notable way in the second one, as there the high flotationable clear mineral grains of the copper sulfides have already flotated and there remained only copper sulfide's and molybdenite's accretes with the rock forming minerals and free molybdenite grains. Therefore, the increasing of the pulp density to the fixed limit improves the selectivity of the process, and it gets worse only having passed that limit. It is an important conclusion, as the generally shared view in the literature is that the increasing density (the content of solid in the flotation pulp) always leads to decrease of the selectivity of the process.

The results from the experiments issued in the first and second table proves the presence of a limit, which changes the influence direction of the pulp density on the selectivity of the process. It is most likely for this limit to be different for the particular technological cases but obviously, it is always available.

## 4. Final conclusions

On the ground of the reseived results done by the research, it can be making the next conclusions:

The probable mechanism of the fixed possibilities for the mineral selection at lesser reagents regulator expense could be presented in this way: when there is gas phase lack in the flotation pulp, the mineral parts within the pulp that have possibility of three-phased perimeter forming and flotation fall into competitive conditions to place the area limited for three-phased perimeter forming at the bubble surface. Under these competitive conditions, the mineral fragments with higher hydrophobic surfaces and higher relative density (bigger moment of the hit with the air bubble at the same grain size), succeed in forming of the three-phased perimeter in the competitive conditions, as they fill in the probable surface of air bubbles and there doesn't remain any area over the air bubbles for the fragments with less probability of realization.

In the three-phased froth it runs as well, additional processes of increasing the flotation selectivity in the dense pulp of the sulfide minerals. As the lamellas getting thinner within the three-phased froth, the more hydrophobic fragments take the common lamella place, which is proved in the literature. It forms three-phased perimeter with the both neighboring bubbles, as the more hydrophobic drops of the three-phased froth out. It is realized additional purifying of the concentrate. As a whole, the process of selection goes at a lower reagent-depressor expense, as in the direct selection of sulfide minerals, as at the selection of the collective concentrates of the sulfides of the coloured metals with increased content of solid phase.

REFERENCES

[1] *Верман Н.А., Глембицкий В.В., Сидоров А.Ф., Строганов Д.Н.*: Определение массовых долей меди, железа, молибдена и твердого в пульповых продуктах переработки ОП "Елаците" на аналитическом комплексе СРМ-13/УВК М-6000, *Обогащение руд*-1988, №4, с. 22–25

[2] *Десятов А.М. и др.*: Совершенствование технологии селекции колективного концентрата на Жирекенской обогатительной фабрике, *Цветная металлургия* –1995, № 1–2, с. 9–12

[3] *Классен В.И.*: Вопросы теории аэрации и флотации, *Госхимиздат*, 1949

[4] *Фоменко Т.Г., Бутовецкий В.С., Погарцева Е.М.*: Исследование углей на обогатимость, *Недра*, Москва 1978

[5] *Boteva A., Hr. Petrova*: Research work on selectivity of flotation process depending on the change of pulp density, *34-th IOC on Mining and Metallurgy*, University of Belgrade, Technical Faculty Bor, Yugoslavia, 2002, p. 247–252

[6] *Boteva A., Hr. Petrova*: Selective flotation in dense ore pulp, *Proceedings of the X-th Balkan Mineral Processing Congress*, Varna, Bulgaria, 2003, p. 188–191