D.R. MAGOMEDOV, A.K. KOIZHANOVA, G. TOKTAR,
N.A. ABDYLDAYEV, A.N. BAKRAYEVA

ISSN 0543-5846
METABK 62(2) 262-264 (2023)
UDC – UDK 661.185:669.083:669.052:669.21=111

DETERMINATION OF OPTIMAL PRESSURE PARAMETERS FOR THE SYSTEM OF PULP MICROAERATION DISPERSANTS IN COLUMN FLOTATION

Received – Primljeno: 2022-10-23
Accepted – Prihvaćeno: 2022-12-20
Preliminary Note – Prethodno priopćenje

The article presents the results of experiments intended to beneficiate gold-bearing mineral raw materials by column flotation with the use of micro aeration of pulp through a dispersant system. The influence of the pressure level in the pressure system of dispersants within the range from 202,65 to 1013,25 KPa was studied during the experiments. It was found that the parameter of 607,95 KPa enables to achieve the optimal balance of the precious metal mass yield and the content in the concentrate, with a final gold recovery of 87 %.

Keywords: column flotation, pressure, ore beneficiation, gold, microaeration

INTRODUCTION

To date, the column flotation method is widely used in gold mining operations. Particle-bubble-liquid flows widely exist in industrial processes, such as fluidized beds, flotation cells, and bubble column reactors, but the high-fidelity simulation of these flows is a great challenge [1]. The column flotation method is used in the production of graphite [2], sodium bicarbonate [3], and for removal of natural organic substances [4] besides metal mining.

Column flotation machines widespread in beneficiation practice, along with traditional mechanical and pneumomechanical machines, allow to increase controllability of the process radically due to preservation of a flowing principle for all sub-processes requiring essentially different hydrodynamic conditions, in a single volume of the unit [5-7]. Studies of reagent mode and flotation process regularities in the reactor-separator-type column machine are considered by domestic and foreign authors in a number of works [8-10]. Thus, the actual task of these studies is to find the most effective methods intended to beneficiate and process gold-containing raw materials by development of a highly efficient technology to recover metals from fine and refractory minerals using dispersion systems on column flotation machines with calculations of parameters and design features.

D.R. Magomedov (davidmag16@mail.ru)
Satbayev University, JSC "Institute of Metallurgy and Ore Beneficiation", Almaty, Republic of Kazakhstan
A.K. Koizhanova, G. Toktar, N.A. Abdyldayev, A.N. Bakrayeva Satbayev University, JSC "Institute of Metallurgy and Ore Beneficiation", Almaty, Republic of Kazakhstan.

MATERIALS AND METHODS

The column flotation machine shown in Figure 1 was used for the studies. The design and operating principle of this column flotation machine are characterized with a possibility to product fine bubbles simultaneously and use them at an increased rate of the downward flow of pulp that provides a higher specific capacity of the pulsation layer in the column compared with the currently used pneumatic flotation machines.

Preliminary studies of the material composition for the initial ore were performed. X-ray phase, X-ray fluo-

Figure 1 Column flotation unit.

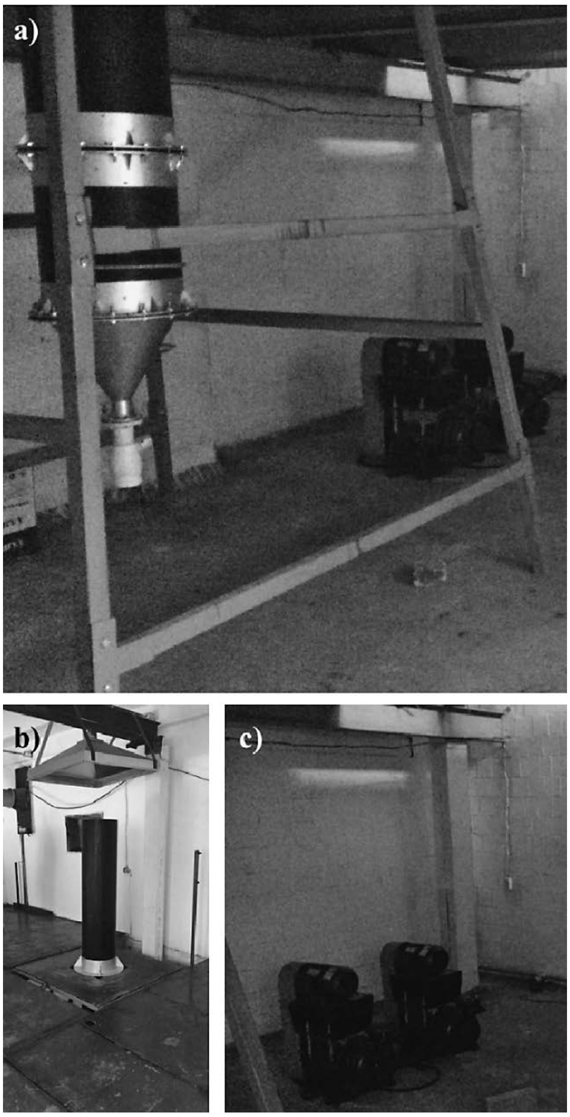
Table 1 **Chemical composition of the initial technological sample**

Elements	Mass fraction / %
Zn	5,61
Pb	0,29
Cu	0,3
Fe	1,7
Ag	4,71 g/t
Au	0,86 g/t

rescence and chemical analyses were made. The results of chemical analysis are specified in Table 1.

EXPERIMENTAL PART

When each experiment was performed in a flotation column it was required to use not less than 90 kg of the initial ore crushed to a class of minus 0,071 mm 80 % - taking into account working volume of the column of 360 L and content of solid in a pulp at the rate of 25 % (Figure 2a).



a) - 1st floor, lower part of the column; b) - 2nd floor, upper part of the column with the hood; c) - slurry pumps.

Figure 2 Scientific and production room for installation of the unit, the IMOB JSC base.

The obtained ore pulp was loaded by means of slurry pumps into the open upper part of the column. The column itself was fixed on the two-storey platform in the production premises of of IMOB JSC (Figure 2b, c).

The reagent mode of flotation beneficiation included feeding of butyl xanthate at the concentration of 120 g/t and foaming agent T92 - 60 g/t. The pulp was loaded in the ratio of 25 % solids - 270 liters of water were used for 90 kg of crushed ore. Flotation was performed only in the main mode, for 20 minutes. A total of 5 variants of pressure generator modes were worked out with different air pressure applied to the dispersant system. The results of the experiments are presented in Table 2.

Table 2 **The results of the experiments on flotation beneficiation in the column unit at different pressure modes.**

Parame-ters of the pressure / KPa	Product name	mass / %	Au content / g/t	Au recovery / %
202,65	Concentrate	7,0	8,0	66,7
	Tailings	93,0	0,3	33,2
	Total	100,0	0,84	100,0
405,3	Concentrate	8,6	7,22	73,9
	Tailings	91,4	0,24	26,1
	Total	100,0	0,84	100,0
607,95	Concentrate	9,0	8,12	87,0
	Tailings	91,0	0,12	13,0
	Total	100,0	0,84	100,0
810,6	Concentrate	12,1	5,42	78,1
	Tailings	87,9	0,21	22,0
	Total	100,0	0,84	100,0
1013,25	Concentrate	14,65	4,28	74,6
	Tailings	85,35	0,25	25,4
	Total	100,0	0,84	100,0

The results of the experiments showed that 607,95 KPa is the most optimal parameter of the pressure generator in terms of pressure applied into the dispersion system. A further increase in pressure contributes to intensive transfer of waste rock to the concentrates which significantly increases the mass yield but reduces the gold content therein at the same time. A value of 607,95

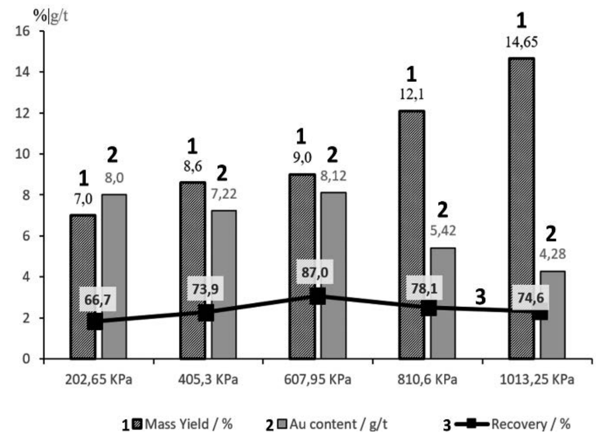


Figure 3 Dependence of concentrate recovery and quality on air pressure in the dispersion system.

KPa achieves an optimal balance of mass yield and noble metal content in the concentrate. Comparison of qualitative and quantitative parameters of the column flotation process is presented in the diagram in Figure 3.

CONCLUSION

The concentrate yield was 7,0 % with a gold content of 8,0 g/t resulted in the recovery of 66,7 % during the experiment with 202,65 KPa pressure in the pressure generator. Increase in the pressure up to 4,0 atm increased the concentrate yield up to 8,6 %, with a gold grade of 7,22 g/t and a 73,9 % recovery in the concentrate. The mass yield of the concentrate reached 9,0 % and with a gold content of 8,12 g/t, the recovery increased up to 87,0 % at a pressure of 6,0 atm in the pressure generator dispersion system. Subsequent variants with higher pressures of 810,6 and 1013,25 KPa, resulted an increase in the mass yield of concentrates up to 12,1-14,65 %, while the gold content decreased to 5,42 and 4,28 g/t, respectively. It also led to a decrease in the recovery to 78,1 % at 810,6 KPa and 74,6 % at 1013,25 KPa. Thus, the parameter at 607,95 KPa enables us to achieve an optimum balance in terms of mass yield and noble metal content in the concentrate.

Acknowledgment

This research was supported by a grant project of the Science Committee of the Ministry of Education and Science of Republic of Kazakhstan, project No. AP08051925.

REFERENCES

[1] Xia H., Zhang Z., Liu J., Ao X., Lin S., Yang Y. Modeling and numerical study of particle-bubble-liquid flows using a front-tracking and discrete-element method. Applied Mathematical Modelling, 114 (2023), 525-543 DOI: 10.1016/j.apm.2022.10.022

[2] Dong L., Wang L. Cooperative effect of electrolyte and oscillatory air supply on recovering graphite in column flotation. (2022) Separation and Purification Technology, 301, art. no. 121970. DOI: 10.1016/j.seppur.2022.121970

[3] 3. Sudibyo S., Suharto S., Rarasati S.A.A., Wulandari Y.R., Shintawati S., Rohman F.S. Optimization of Sodium Bicarbonate Production from Ammonium Hydroxide Using a Froth Flotation Column. Chemical Engineering and Technology, 45 (2022) 11, 1952 – 1959. DOI: 10.1002/ceat.202200060

[4] Le T.V., Dang L.T.T., Yasui H., Imai T., Microbubbles improve removal of oil-in-water emulsions stabilized by humic acids. Desalination and Water Treatment, 272 (2022) 183 - 191, DOI: 10.5004/dwt.2022.28819

[5] Kenzhaliyev B.K., Innovative technologies providing enhancement of nonferrous, precious, rare and rare earth metals recovery. Kompleksnoe Ispolʹzovanie Mineralʹnogo syrʹâ/Complex Use of Mineral Resources/Mineraldik Shikisattardy Keshendi Paidalanu (2019) 3, 64–75. https://doi.org/10.31643/2019/6445.30.

[6] Toktar G, Koizhanova A.K., Magomedov D.R., Abdyldaev N.N., Bakraeva A.N. Increased recovery of free fine gold in the leaching process. Kompleksnoe Ispol’zovanie Mineral’nogo Syr’a = Complex Use of Mineral Resources 322 (2022) 3, 51-58. https://doi.org/10.31643/2022/6445.28.

[7] Putra R.S., Arrunillah D., Fitria F., Ripki N. 2021. Measurement of Gas Bubbles Distribution on Electroflotation Process Using Titanium and Stainless Steel Electrode with Dino Capture 2.0 InHeNce 2021 - 2021 IEEE International Conference on Health, Instrumentation and Measurement, and Natural Sciences DOI: 10.1109/InHeNce52833.2021.9537227

[8] Kvyatkovskiy, S.A., Kozhakhmetov, S.M., Ospanov, Ye.A., Semenova, A.S. Pyrometallurgical opening of refractory carbonaceous and arsenic gold ledge ores with noble metal recovery to matte // Tsvetnye Metally (2017) 9, 53–58. https://doi.org/10.17580/tsm.2017.09.08

[9] Mukhanova A., Tussupbayev N., Turysbekov D., Yessengaziyev A. Improvement of the selection technology of copper-molybdenum concentrate with the use of modified flotoragents. Metalurgija 61 (2022) 1, 221-224

[10] Koizhanova A.K., Kenzhaliev B.K., Magomedov D.R., Abdyldaev N.N.. Development of a combined processing technology for low-sulfide gold-bearing ores (2021) Obogashchenie Rud (2020) 2, 3 – 8. DOI: 10.17580/or.2021.02.01

Note: The responsible translator for English language is Nastya Kurash, Translation agency “ART Translations”, Almaty