MINING AND METALLURGY INSTITUTE BOR ISSN: 2334-8836 (Štampano izdanje)
UDK: 622 ISSN: 2406-1395 (Online)

UDK: 622.765.061(045)=111 doi:10.5937/MMEB1602025J

Ivana Jovanović[*], Milenko Ljubojev[*], Vladan Milošević[**], Dejan Todorović[**]

THE EFFECT OF DIFFERENT COLLECTORS ON THE QUALITY OF BASIC COPPER CONCENTRATE OF THE ORE BODY TENKA[***]

Abstract

This paper presents the results of a part of technological tests, whose aim was to determine the optimum techno-economic conditions for the flotation concentration of ore from the deposit Tenka-3 - North Mining District, Copper Mine Majdanpek. The given view refers to testing the effects of collectors NaIPX, 3418 A and 5500 AP, as well as the pulp pH value on the quality of concentrate from the primary flotation process. It was found that the majority of copper, gold and silver in the primary concentrate is obtained using the collector AP 5500. In addition, a better quality of primary concentrate was obtained at higher pH values of pulp in the tested pH range (10.0 – 11.5).

***Keywords:** flotation, quality of concentrate, copper, gold, silver*

1 INTRODUCTION

The polymetallic-goldbearing deposit "Tenka" is located in the far northern part of the North Mining District of the porphyry copper deposit "Majdanpek". The deposit has an irregular trapezoid shape and direction of north-south. Length of deposit is 650 m, while the width ranges from 150 to 250 m. Polymetallic sulphide mineralization is spatially restricted to the western part of mineralization zone [1,2].

The Tenka deposit consists of several ore bodies of complex morphology, among which the mining wires, pillars, lenses and pockety ore bodies dominate. Its position is determined by tectonic zones at the contact of volcanic rocks of the Upper Cretaceous and Jurassic age structure. In zones with more prominent tectonics (breccias), along which the movement of mineralized fluids was easier, there are smaller ore bodies of irregular shape, stock work-impregnation type of mineralization. Polymetallic as well as the copper-pyritic mineralization were deposited in scarns, tectonic breccias and partly in andesites. The area around the massive-sulphide mineralization is filled with the stockwork-impregnation and wire type of mineralization with occurrences of limestone inclusions.

The massive sulphide type of mineralization is regularly present in limestones with a sharp border to the surrounding rock mass and in tectonic breccias in the form of combination with smaller ore veins and interveins. The interveins are most often frequent in andesites, while the ore veins

[*] *Mining and Metallurgy Institute Bor, e-mail: ivana.jovanovic@irmbor.co.rs*
[**] *ITNMS, Belgrade*
[***] *This work is the result of the Project Projekta TR 33007: Implementation the Modern technical-technological and Ecological Solutions in the Existing Production Systems of RBB and RBM, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.*

are less frequent. Mineralization is deposited in breccia limestones in the existing cavities and cracks where cementation of limestone fragments is developed [1].

From an economic point of view, three ore bodies are of particular importance - Tenka-1 (located to the north); Tenka-2 (located in the south); and Tenka-3 (the ore body located in the eastern part of productive zone). These ore bodies vary according to the morphological characteristics, and partly to the mineralogical composition and content of useful components [1].

The ore body Tenka-3 is formed in fault zones at the contact of limestone of Starica and volcanic rocks of the Upper Cretaceous, and partly in limestone, or hydrothermally altered andesites. In terms of mineralogical composition, the ore body Tenka-3 is an agglomerate composed of massive pyrite body (pyrite content is 60 - 90%), magnetite the ore bodies of magnetite in scarns as well as vein-impregnation copper mineralization in andesites [1,2].

The issue of this scientific-research work essentially represents testing the possibilities for valorization the useful compo nents (copper and precious metals) from a complex polymetallic raw materials of the ore body Tenka-3. In this aspect, defining the optimal conditions of its processing and obtaining a commercial product with satisfactory technological effects, presents a difficult task and requires a serious research approach to the technological testing. An important factor for the concept of laboratory testing is the use of the existing technological solutions and parameters from current production in the flotation plant of RBM [2,3].

2 CHARACTERIZATION OF STARTING SAMPLES

Ore sampling for laboratory tests was performed at 3 locations of a boundary part of the deposit Tenka-3. After crushing and homogenization of each sample from the above mentioned locations, a composite sample is formed (in mass ratio 1:1:1). Thus prepared sample was used as a raw material for the flotation concentration experiments. Chemical composition of individual samples, as well as a composite sample is shown in Table 1.

Table 1 *Chemical composition of samples from the ore body Tenka-3*

Component	***Location 1***	***Location 2***	***Location 3***	***Composite***
Pb, %	0.06	0.10	0.06	0.073
Zn, %	0.0075	0.0160	0.0240	0.016
Cu, %	0.63	0.30	0.49	0.473
Cu_{sulf}, %	0.608	0.288	0.462	0.453
Cu_{ox}, %	0.0175	0.0120	0.0320	0.021
S,%	17.86	41.59	6.11	21.853
Au, g/t	<0.03	1.50	<0.03	0.520
Ag, g/t	1.65	4.65	10.4	5.567

Qualitative mineralogical analysis was carried out under the polarizing microscope for reflected light in the air, with identification of ore and non-ore minerals. In samples taken from all three locations, the presence of mineral pyrite, chalcopyrite, limonite, quartz, silicates and carbonates was found out. A sample from the location 1 contains tetrahedrite, while samples from the location 3, besides specified minerals, also contain bornite, galena and sphalerite (Figure 1).

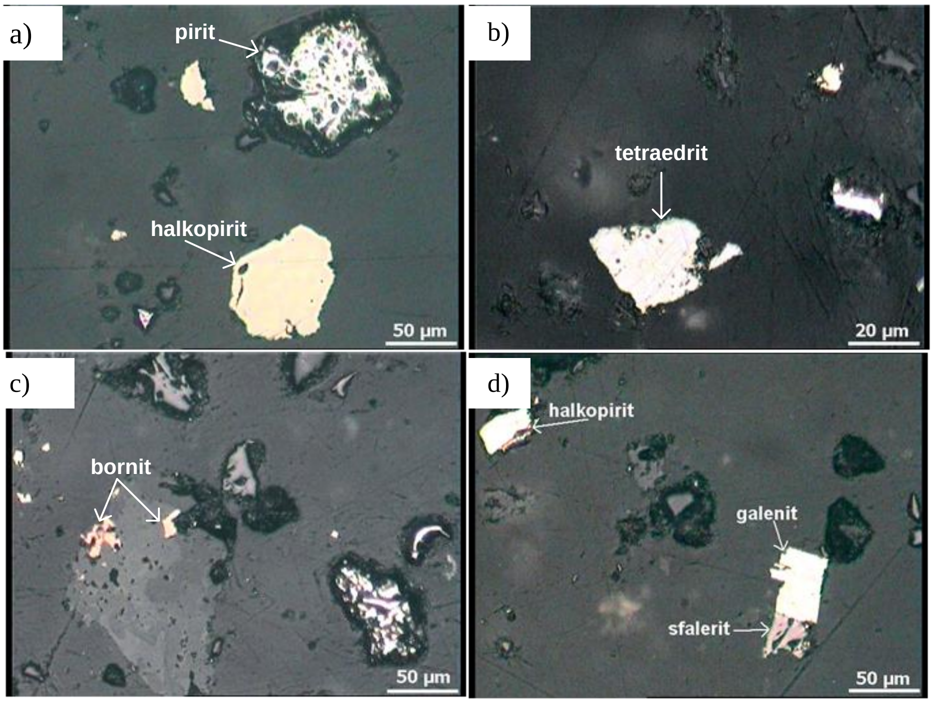

Figure 1 *Results of microscopic tests of samples: a) mineral grains of chalcopyrite and pyrite - location 1; b) grain of tetrahedrite - location 1; c) aggregate of carbonate with bornite inclusions – location 3; d) polymetallic ore – location 3*

Moisture content in a composite sample was 6.6%, and the natural pH value of pulp with mass participation of solid phase of 32% was 7.43.

Composite sample, with the upper size limit of 2 mm, was further reduced by grounding to a fineness of 60% -0.074 mm, thus achieving the optimum size class of mineral grains (according to the mineralogical analysis) for the needs of flotation concentration experiment. Testing the particle size distribution of ground mineral resources was carried out by the method of screening on sieves, and the result is shown in Table 2.

Table 2 *Grain size distribution of ground ore (composite)*

Size class, mm	*M, %*	*ΣM↓, %*	*ΣM↑, %*
+0.589	0.36	100.00	0.36
–0.589+0.295	8.18	99.64	8.54
–0.295+0.104	25.29	91.46	33.83
–0.104+0.074	7.56	66.17	41.39
–0.074+0.052	13.77	58.61	55.16
–0.052+0.037	5.12	44.84	60.28
–0.037+0.000	39.72	39.72	100

3 TECHNOLOGICAL CONDITIONS OF TESTING

Laboratory technological tests the conditions of flotation concentration have comprised a change of relevant technological parameters in the scope of existing values, applicable in the Flotation Plant Majdanpek, as follows:

- Tests were carried out through six test series of the primary flotation experiment.
- Each series consisted of four experiments, wherein the pulp pH value by the experiments was 10.0, 10.5, 11.0 and 11.5.
- Pulp density in grinding in all experiments was 70% of solid phase.
- Pulp density in flotation in all experiments was 32% of solid phase.
- Grinding fineness in all experiments was 60% -0.074 mm (size class in which the optimum release of useful minerals is achieved).
- AEROFROTH 76A was used as a frother in all experiments with the recommended consumption by the manufacturer.
- The following reagents were used as collectors as well as their combinations:
  - ➢ NaIPX (sodium isopropyl xanthate) as a good collector of sulphide minerals,
  - ➢ 3418 A (ditiophosphinate), characterized by good results in terms of gold and silver recovery, and
  - ➢ AP 5500 (ethoxycarbonyl thiou-rea), reagent that is in theory and practice well known as a good collector of sulphide copper minerals and highly selective relative to iron sulphides and at lower pH values of pulp.
- Consumption of collectors, either individually or in combination, was 40 g/t of ore in all experiments of the primary flotation. This dose of collector was determined on the basis on content of sulphide minerals, because it should be borne in mind that, apart from copper mineral, the content of pyrite in the ore is very high (about 30%). Consumption of individual collector by the series of experiments is shown in Table 3.
- In the all experiments, the conditioning time was 7 minutes, and the primary flotation time was 18 minutes. The collectors were added in three equal doses, that is one dose in the conditioning and in two in the primary flotation.

Table 3 *Consumption of collectors in the flotation experiments by series of experiments*

Consumption of collectors, g/t dry ore	***Series of experiments***					
	I	***II***	***III***	***IV***	***V***	***VI***
NaIPX	/	/	40	24	/	24
3418 A	40	/	/	16	20	/
AP 5500	/	40	/	/	20	16

4 RESULTS AND DISCUSSION

Copper content in the basic concentrate by series of experiments is shown in Figure 2.

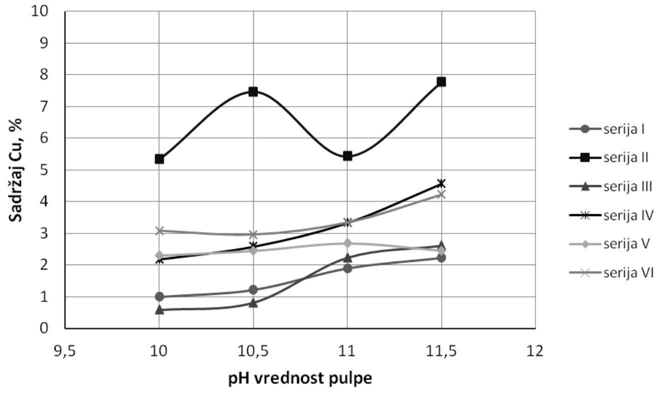

Figure 2 *Copper content by series of experiments*

It is seen from Figure 2 that the highest copper content is in the basic concentrate, obtained in the second series of experiments, or using the collector AP 5500 in the primary flotation. In addition, the combinations of collectors (series IV, V and VI) have given better results in terms of quality of copper concentrate than it is the case when collectors 3418 A and NaIPX are used individually (the I and III series of experiments, respectively). Low values of copper content in the basic concentrate, obtained in the first and third series of experiments, can be explained by large mass participation of the basic concentrate [2]. As expected, with increasing pH value of t pulp increases and the quality of basic concentrate.

Gold content in the basic concentrate by series of experiments is shown in Figure 3.

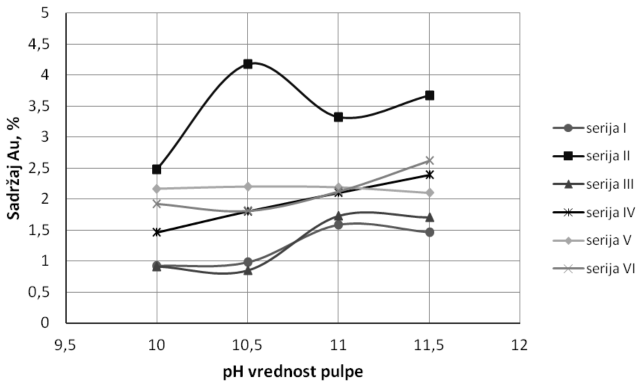

Figure 3 *Gold content by series of experiments*

Similarly as in the previous case, the highest content of gold in the basic concentrate was obtained in the second series of experiments (using the collector AP 5500), while the lowest contents of gold were achieved in the first and third series of experiments (using the collectors 3418 A and NaIPX, respectively). Combinations of all three types of collectors (series IV - VI) have given mutually the similar results. Generally, and in this case, the increase in pH value of pulp affects the increase of gold content in the basic concentrate.

Silver content by series of experiments is shown in Figure 4.

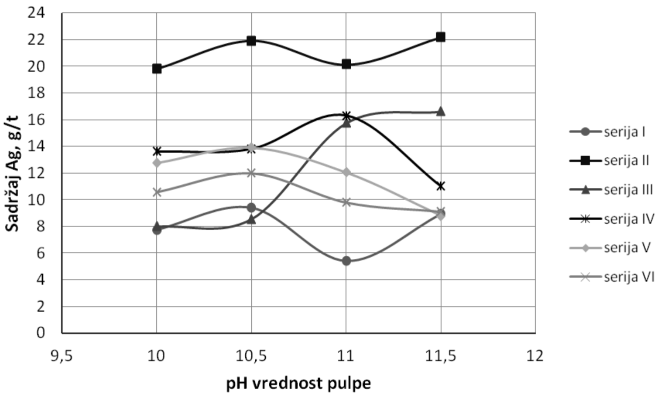

Figure 4 *Silver content by series of experiments*

Analogue to the content of Cu and Au, the individual use of collector AP 5500 (II series of experiments) has also given, in the case of the silver content in the basic concentrate, the best results, and the individual use of the collector 3418 A (I series of experiments) has given the worst results. Mutually similar results were again achieved combining the collectors. Dependence of silver content on the pH value of pulp in the primary flotation is not explicitly visible.

4 CONCLUSION

By individual use of the collector 3418 (series of experiment I) were obtained the low contents of copper, gold and silver in the basic concentrate. Slightly better results were achieved combining this collector with NaIPX and AP5500.

The use of collector AP 5500 (series of experiment II) gave conceivably the best results regarding the quality of concentrate, however, it should be noted that the recovery of copper and precious metals in this case is low [2].

Similar to the collector 3418 A, sodium isopropyl xanthate has not given a satisfactory quality of the concentrate, but in a combination with two other collectors resulted into improvement the primary flotation results, and the increase of Cu, Ag and Au content in concentrate.

In accordance with the established regime of flotation concentration of copper minerals in the plant RBM, the effect of increasing the pH value of pulp was manifested by improvement the quality of basic concentrate.

REFERENCES

[1] www.reservoirminerals.com/files/Analyst_Tour_Book_Bor_2013.pdf

[2] Vujić S., Grujić M., Salatić D., Radivojević S., Jelenković R., 2005. Copper Mine Majdanpek, Development, State, Future; Faculty of Mining and Geology, University of Belgrade, pp.167 (in Serbian)

[3] V. Milošević et al., 2011. Report - Research for Selection the Optimal Parameters of Technological Process for Obtaining the Most Favorable Utilization and Quality of Copper Concentrate from a Sample Tenka 3 - North Mining District, Archives ITNMS, Belgrade, pp. 63 (in Serbian)