A METHOD FOR SELECTIVE TECHNOLOGICAL FLOWSHEETS SYNTHESIS

Antoaneta Boteva

University of Mining and Geology "St. Ivan Rilski" 1700 Sofia Bulgaria

ABSTRACT

In process of the mineral treating it is obtain several products with very low grade for concentrate, but very grade for tailing. That middling products have to be input in some places of the flowsheet. The choice of the place is very imported for all technological results. That is the main decision in process of flowsheets construction.

INTRODUCTION

The most commonly used method for development of selective technological flowsheets for ore processing is based principally upon the chemical composition of the products, while the objective is to achieve maximum recovery of the target components at a higher possible grade for the concentrates obtained. Based upon the flotation kinetics of the principal component, either the time needed for its rougher flotation in the case of direct selective flowsheets or the time needed for collective flotation in the case of collective selective flowsheets is estimated. Further on step by step, the number and the flowsheet type for the cleaning and scavenger operations are tested. This procedure is a rather lengthy one. Its principal drawback and a source of mistakes lies in the fact that the place for middling return, in case of locked tests, is determined on the basis of the concentration of the principal component only.

Based upon technological studies performed over several years in six Bulgarian processing mills treating copper sulphide ores, it was established, that the decisive factor concerning the point of middlings return is the granulometric and mineralogical composition, rather than the concentration of the principal component. Both mining itself as well as overgrinding occurring during ore grinding and middlings and concentrates regrinding cycles could be a potential sources of slimes generation. Usually for regrinding operations the products are classified in advance, the slime classes being directed towards cleaning operations. Thus the fine ore and gangue particles which have different susceptibility to flotation report together with the normal sized particles into rougher, scavenger and cleaner flotation circuits. This contributes to overall recovery decline both for the fine and for the normal sized particles.

PRINCIPAL EXPERIMENTAL SET-UP AND COMMENTS

In the suggested method for selective flowsheets design, a principal emphasis is placed on minerals recovery from the middlings. This characteristic is linked to mineral composition, degree of mineral liberation, granulometric characteristics and the content of the different mineral types. A technological flowsheet is designed in the following sequence:

- The objective of the selection is figured out precisely. This is accomplished via punctual economic analysis: owing to the content of various components in the ore; the existing and the anticipated prices of mineral concentrates with different metal and impurities content; the market niche of the products locally and abroad; last but not least - the technological possibilities for realisation of the various options.
- 2. The parallel flotation kinetics for the whole range of components met in the ore is estimated.
- 3. The mineralogical characteristic of the different fractions of concentrates and the reasons for tailing losses is determined using up-to-date instrumentation.
- 4. Based upon the findings from p. 1-3 above, a flotation flowsheet is synthesised and is further validated on lab scale via closed cycle tests.
- 5. Based upon the results from the locked cycle tests, flowsheet alterations are envisaged if needed.

The above described procedure tested for the copper ore treated in Elatzite processing plant has suggested that for this ore the optimal flowsheet is the one illustrated at Figure 1. It has been designed taking into account the following peculiarities of the ore and requirements:



Fig. 1. Suggested technological flowsheet for Elatzy copper ores selection

- Collective copper concentrate with Cu grade 22-24 % has to be produced, at a maximum recovery of copper minerals and gold.
- Major ore components are copper, gold and molybdenum. Flotation kinetics curves obtained under lab scale are presented at Figure 2.
- The mineralogical characteristic of the separate concentrates (obtained at pH 9 – Ca(OH)₂ maintained) taken as fractions at the end of minute two, four, six, eight and fourteen (see Fig.3) is the following:
- During the first two minutes free chalcopyrite grains predominately report in the concentrate. No intergrowths are met, both between chalcopyrite-gangue and chalcopyrite-pyrite. Free molybdenum grains are met.
- From minute three to four, about 30 % of the grains recovered in the concentrate are present by free chalcopyrite, chalcozine and bornite particles. The rest particles are intergrowths of copper minerals with pyrite and gangue minerals.



Fig.2. Kinetic of the copper (1), gold (2) and molybdenum (3), recovery for Elatzy ores

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- From minute four to six the grains recovered are rich in copper bearing intergrowths. Only free pyrite grains are met as free particles.
- From minute six to ten, lean intergrowths of copper minerals and pyrite are recovered. Free molybdenum grains are met as well.
- From minute ten to fourteen, lean intergrowths are predominantly recovered.
- About 30 % of copper in intergrowths and 50 % in classes below 0.02 mm is lost with final tailings. The majority of gold is met as dispersed phase in quartz grains.

By the help of the flowsheet presented at Figure 1, a possibility is offered for the middlings to report in a particular flowsheet points, which are in line with their floatability. Table 1 presents comparative data from lab tests: following the flowsheet existing under which the mill operates and the alternative flowsheet designed according to the presented method. In order to secure the required flotation time of 14 minutes for the existing flotation line in the mill, pulp density needs to be increased from 32 % to 38-40 %.



Fig. 4. Technological flowsheet in Elatzy plant

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Table 1. Technological results by laboratory tastes											
	Technological flowsheet	Products	Yield,	Contains	Contains	Recovery	Recovery				
-			%	Cu, %	Au, g/t	Cu, %	Au, %				
	Flowsheet now	Cu c-te	1,50	28,80	7,4	86,92	89,38				
		Tailing	98,50	0,066	0,0192	13,08	14,62				
		Ore	100,00	0,497	0,13	100,00	100,00				
	Suggested flowsheet	Cu c-te	1,46	26,69	8,2	89,37	92,92				
		Tailing	98,54	0,047	0,0093	10,63	7,08				
		Ore	100,00	0,436	0,13	100,00	100,00				



Fig. 5. The suggested technological flowsheet for Chelopech ore treatment



Fig.6. Kinetics flotation of the minerals Cu, As and Au containing in Chelopech ore 1 – recovery As, 2 – recovery Cu, 3 – recovery Au.

Following the above described sequence, a flotation flowsheet aimed for processing of the ore treated in Chelopech mill is designed as well. A characteristic feature of that ore is the relatively high content of arsenic and gold. Copper minerals are presented by sulphosalts and chalcopyrite. Significant amount of pyrite is also met in the ore. Gold is evenly distributed between copper minerals and pyrite. The principal objective in this case is isolating arsenic in a product with a minimal yield and minimal gold recovery in it. The majority of arsenic associates with the sulphosalts like tetrahedrite and enargite. The sulphosalts are slightly prone to slime generation. The majority of the sulphosalts mineral grains are liberated when grinding is maintained 55 %, 0.08 mm undersize. The amount of sulphosalts intergrowths with pyrite and gangue minerals is relatively small. Sulphosalts intergrowths with chalcopyrite are absent.

Chalcopyrite grains are often covered with fine particles arising from sulphosalts overgrinding. The flowsheet shown at Figure 5 is designed on the basis of kinetics (Figure 4) and product characteristics. The advantages of this flowsheet have been confirmed on the basis of comparative tests on the background of the results obtained from the existing flowsheet.

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Fig. 7. Technological flowsheet in Chelopech plant now

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	Products	Yield,	Contains	Recovery, %	
rechnological nowsneet		%	Cu,% As, % Au, g/t	Cu As Au	
Flowsheet now	Cu c-te	8,32	18,12 2,41 28,3	90,24 67,47 77,71	
	Tailing	91,68	0,178 0,11 0,77	9,76 32,13 23,29	
	Ore	100,00	0,31 3,03 100,00	100,00 100,00 100,00	
	I Cu c-te	4,49	18,01 5,90 26,17	44,68 80,29 42,27	
Suggested flowsheet	II Cu c-te	5,02	19,16 0,207 22,83	53,14 3,16 41,22	
Suggested nowsheet	Tailing	90,49	0,043 0,06 0,507	2,18 16,55 16,51	
	Ore	100,00	1,81 0,33 2,78	100,00 100,00 100,00	

CONCLUSION

The described investigations performed at Elatzite and Chelopech flotation mills, give us the possibility the drawn up the following conclusions:

- The research method suggested for development of selective flotation flowsheets offers the possibility to reduce the amount of laboratory work needed, while placing an accent on the use of up-to-date instrumentation for quantitative mineralogical studies. The introduction of the middlings at the most optimal point inside the flowsheet guarantees reaching satisfactory technological results and leads to energy savings and more flexible unit arrangements.
- The suggested method is an universal one. It could be used for various mineral processing technological flowsheets design, encompassing gravity, magnetic, electrostatic, hydrothermal, flotation and combined methods.

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