Possibilities of Tetrahedrite Separation from Polymetallic Ore

Michal MARCIN[1)], Martin SISOL, Peter VARGA, Ivan BREZÁNI, Michal MAŤAŠOVSKÝ, Andrea ORAVCOVA

[1)] Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies, Institute of earth resources, Department of mineral processing, Park Komenského 19, 042 00, Košice, Slovak Republic; email: michal.marcin@tuke.sk

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Abstract

Using the separation methods, the tetrahedrite concentrate, which contains multiple elements, was obtained from the tetrahedrite ore. We focused mainly on copper, but also on iron and antimony. Ore also contains undesirable elements such as arsenic or mercury. The aim of this paper is an efficient separation of the utility components. Gravity separation and flotation was used. The first processing step was gravity separation on shaking table the second step was froth flotation in flotation column.

Keywords: *flotation, shaking table, recovery, tetrahedrite*

Introduction

Flotation is based on diffrent physical-chemist properties of each mineral surface. Flotation is a process of separation mineral particles by their selective attachment on fluid-liquid interface. Particles can be hydrophobic (water repulsive) or hydrophilic (water attracted) [1]. Flotation is used mostly on separation valuable minerals from rocks and fine coal from clay, sludge, slate and more coal bearing materials. Preparation process is generally crushing a grinding. After flotation can follow other metallurgical processes [1].

The three main forces acting on a particle moving through a fluid include the external force (gravitational or centrifugal force), the buoyant force (acting parallel to the external force but in the opposite direction) and the drag force (as a result of relative motion between the particle and fluid). Gravity separation involves the separation of minerals of different specific gravity by their relative movement in response to the three forces acting on the mineral particles in a viscous medium such as heavy media, water or, less commonly, air [2][3]. A marked difference in density must exist between the mineral of interest and the gangue to ensure an effective separation. An idea of separation potential can be gained from the concentration criterion [2][3], calculated using the expression [3].

The shaking table is a typical conventional gravity concentrator that has been used extensively over the years. During its operation, separation is principally effected according to the specific gravity, particle size, and particle shape of the minerals in the feed [4][5]. Detailed description of the operation of the shaking table has been presented in the literature [3][4][5]. The table has riffles where vertical stratification of mineral particles due to the shaking action takes place. The heaviest particles report to the bottom, whilst the coarsest and lightest particles migrate to the top. The lightest gangue mineral particles eventually ride over the riffles and are discharged at the lower end of the table along with the flowing film of wash water. The concentrates are then recovered at the unriffled upper section of the deck.

The crystal structure of tetrahedrite and related phases was solved and re-solved many times. The structure is commonly viewed as a complicated derivative of the sphalerite structure, and less commonly as a maximally collapsed sodalite-type framework [6]. The crystal chemical formula of this mineral group is Cu[3]6(Cu, …)[4]6(Sb,As)[3]4S[4]12S[6], with many substitutions possible. Compositions with Cu^{2+} are less stable than the composition without this species. Cu^{2+} is thus avoided by substitution of Zn, Fe, Hg, Cd, Mn, Co, Ni, or Pb into the tetrahedral sites; note that not all these metals are found in appreciable quantities in natural members of the tetrahedrite-tennantite series [7][8]. In terms of terminology, the compositions with prevailing Sb are tetrahedrite (i.e., not only the Sb end-member) and the As-dominated compositions are tennantite.

Materials and methods

Material for separation was obtained from local Slovakian deposit Roznava. Sample was mostly tetrahedrite. Main components were Cu and Fe, but also contain Si and Sb. Our focus was mainly to obtain Cu and Fe.

Sample was from mine so size reduction was necessary. Two steps of crushing and one step of milling was performed. After crushing material was screened and then proceeded to shaking table or to another step of size reduction by laboratory mill. After last step of reduction flotation tests were performed in laboratory flotation column. Sample for flotation tests was weighted and 8 kg of material was used in every flotation in total 8 tests were performed. Reagent regime was 4 $g.l^{-1}$ MIBC used as frother and 10 $g.l^{-1}$ SIPX used as collector. Flowsheet of comminution is on figure 1.

All products after gravity separation and froth flotation were weighted and set for chemical analysis.

Results

Flotation test showed that copper from tetrahedrite was successfully recovered in froth product. Copper in feed was 1523, 2 g and in concentrate 1034 g so calculated recovery

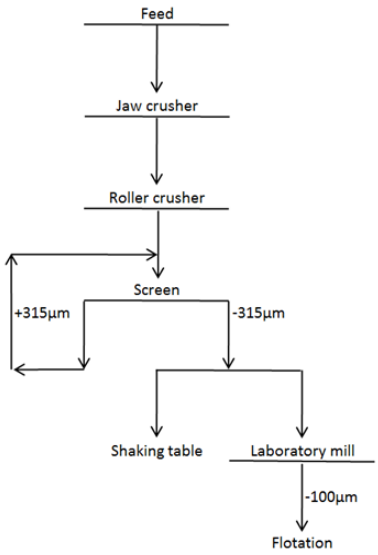

Fig. 1. Flowsheet of comminution
Rys. 1. Schemat rozdrabniania

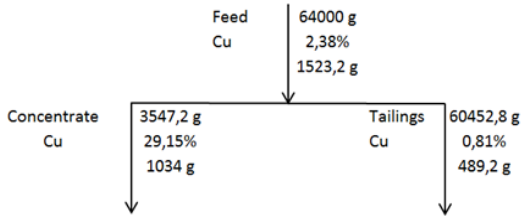

Fig. 2. Scheme of flotation tests
Rys. 2. Schemat flotacji

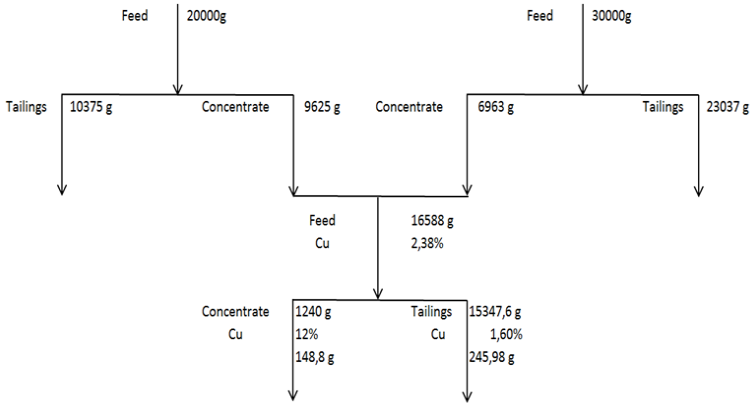

Fig. 3. Scheme of gravity separation test
Rys. 3. Schemat separacji grawitacyjnej

was 67,88%. There were no cleansing steps after first flotation, but in next experiment we decided to perform this step to increase recovery of copper. Also it is in consideration to little bit change reagent regime and increase the dosage of collector used in flotation.

Another type of tetrahedrite processing was gravity concentration on shaking table. Three tests were performed. Concentrate from this first two tests were then mixed to create new feed on shaking table and cleansing operation was followed.

On figures 2 and 3 are shown schemes and results of flotation and gravity separation tests. Recovery of copper after two steps of gravity separation was calculated 37,69%. This product can be used in further flotation test but conducted in flotation cell, because the amount of material left is not enough to fill the flotation column.

Conclusion

Froth flotation, using frother such as MIBC and collector SIPX as the only two reagents was found to be a good method

for achieving a high recovery of copper to froth product at natural pH. Such an approach could be advised for roughing or scavenging operations of the tetrahedrite ore processing using the froth flotation method.

After conducting all tests recovery of copper from flotation column is much better than from gravity separation on shaking table. Shaking table should be advised to create higher grade feed for succeeding froth flotation.

Main aim of this work was to find the most suitable method for laboratory tetrahedrite processing. After all conducted experiment, the results are very obvious. The best method for copper recovery from tetrahedrite is froth flotation.

Acknowledgments

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Możliwość separacji tetraedrytu z rud polimetalicznych

Stosując metody separacji otrzymano z tetraedrytu koncentrat który zawiera wiele pierwiastków, Autorzy skupili się głównie na miedzi, żelazie i antymonie. Ruda zawiera również niepożądane pierwiastki, takie jak arsen lub rtęć. Celem przedstawionej pracy jest efektywne oddzielenie składników użytecznych. Zastosowano separację grawitacyjną i flotację. Pierwszym etapem przetwarzania było oddzielenie grawitacyjne na stole wytrząsającym, drugim etapem była flotacja pianowa w kolumnie flotacyjnej.

Słowa kluczowe: *flotacja, stół koncentracyjny, odzysk, tetraedryt*