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Effect of desliming on the flotation of a complax copper ore from China

Yong CHEN[1,a], Yong Sheng SONG[1], Wen Juan Li[1] and Gui Ying ZHOU[1]

[1] *National Engineering Laboratory of Biohydrometallurgy, General Research Institute for Nonferrous Metals, No.2 Xinjiekouwai Street, Beijing, China*

Abstract. The complex copper oxide ore sample was taken from Deerni copper deposit, Qinghai Province of China. Batch flotation tests had been conducted to upgrade the copper concentrate by conventional amyl xanthate reagents under 73% -74 μm of the particle size; however, the unsatisfied results (Cu grade of 18.21% and recovery of 59.25%) were obtained. Also there are a large amount of slimes trapped in the concentrate and high-dosages consumption of reagents, for example, more than 2.5 kg/t sodium sulfide and 1.5 kg/t sodium silicate at only one-staged roughing. Based on the analysis of the sample, most of gangues are clay, feldspar and mica, which may easy to over-grind and deteriorate the flotation process either on reagents consumption or slurry fluidity or viscosity. A hydro-cyclone had been introduced to pre-concentrate the oxide ore by scrubbing the slime before flotation, which can result obviously in reducing the dosages of sodium sulfide from 2.5 Kg/t to 1 Kg/t, and raising the grade of Cu in the concentrate from 18.21% to 26.65% at the expense of about 1% recovery of Cu. In this paper, the effects on the recovery of Cu by the different dosages of flotation reagents with or without de-sliming were studied, with the objective of determining the different effects on the functions of flotation reagents by slime during flotation.

1 Introduction

The flotation of oxidized Cu minerals, is much more difficult than the flotation of corresponding sulfide minerals. Several factors may influence oxidized Cu minerals recovery during flotation, such assist dissemination and composition, particles size[1-3], flotation reagents, especially sodium sulfide, temperature of slurry effected on the behavior of collectors, especially fatty acid [4-5].

Sulfide compounds have long been used in oxide type base-metals mineral flotation practice for decreasing the level of metal species in solution and for modifying the surface of the mineral while still having a surface that will respond to flotation. Sodium sulfide is the most important reagents in oxidized Cu minerals flotation [6-8]. The surface characteristics of tenorite in sodium sulfide solutions have been investigated in detail by Herrera-Urbina et al. Sulfidization of the mineral surface significantly improves the flotation of tenorite with amyl xanthate as collector. The xanthate flotation of both sulfidized tenorite and malachite, however, is strongly affected by the sulfide dosage. Once the sulfide ion reports to the solution at the end of the conditioning period, mineral flotation ceases [5]. Both dispersion and depression were also found for sodium silicate [3, 6]. However, the only problem for the use of sodium silicate in oxidized Cu ore flotation is how to reduce its dosage in order to filter concentrate smoothly and fast.

Particle size has also been a subject of research for flotation of tenorite and malachite. The different sensitivities to the reagent concentration for fine (-400#) and coarse particles during phosphate ore flotation had been found by Santana et al. for carbonated and siliceous ores [9], slime has a very detrimental effecton the flotation of solids, which includes contaminating foams, raising the consumption of flotation reagents, reducing the speed of the process and causing an anarchic response in mineral separation.

Although the use of sodium sulfide and sodium silicate in copper oxide minerals flotation is well established, one of the main problems in phosphate ore in China is high-consumption of sodium sulfide, which is generally range from 5 to 8 kg/t, about 50% of total flotation agent cost [4-8], especially the mechanism between reagents and particles size and are not sufficiently understood. Singh et al. [9] indicated that "Spilt conditioning" can improve the flotation efficiency of slime (-37 micron) and coarse particles (-105+44 micron) due to hydrophobic aggregation between coarse particles and slimes from the Maton rock phosphate plant, India. Santana et al. [8] reported that the size of mineral particles plays a significant role in the sequence of events that lead to the flotation of a particle.

[a] Corresponding author: cy040311@163.com

The aim of this paper is to investigate effect on dosages of sodium sulfide and sodium silicate in flotation of copper-oxide by slime from a Deerni copper deposit ore in order to gain a better understanding of the behavior of different particle sizes in flotation performance when adding the flotation reagents.

2 Expertimental

2.1 Materials

The copper oxide ore was provided by Deerni copper deposit, Qinghai province of China, in which the main gangue were clay, feldspar and mica. Around 200 kg of representative ore samples was crushed to below 2 mm size with two-stage jaw crusher and one-stage roll crusher. The materials were then well mixed and divided into 1 kg samples for mineralogical and pre-concentration studies.

Table 1. List of the experimental conditions of flotation tests.

Experimental conditions	
Constants	
Cell type	3L XF-D
Feed ore concentration	30%(mass)
Feed size	70% -74μm
Flotation time （rougher）	10min
Impeller speed	1200rpm
Variables	
Dispersant	Sodium silicate
Sulfurizing reagent	Sodium Sulphide
Collector	Amyl xanthate
Frother	Pine camphor oil

Sodium sulphide was reagent-grade chemicals supplied by Kunming chemical reagent company. Sodium silicate was from metallurgical research centre of Kunming, which modulus was about 2. Amyl xanthate as collector was also from the same company.

2.2 Methods

2.2.1 De-sliming tests

1 kg sample was mixed with 600 ml tap water and ground to 75% -74μm in the ball mill, and then the pulp was diluted to 15% Solids and then fed to the hydro-cyclone (FX 25-PU Hydro-cyclone). The pressure was about 100kPa. The underflow from the hydro-cyclone was collected. A size analysis for the overflow from FX-25 PU by dry and wet-sieving had been conducted by a series of screens from 400 mesh to 200 mesh.

2.2.2 Bench flotation tests

Flotation tests were conducted in a 3.0L XF-D cell. In a typical ore sample flotation test, 1kg sample mixed with a certain amount of tap water was ground to 70% -74 μm for several minutes in the ball mill, then diluted to 3.0L cell XF-D which had been used to conduct roughing at 1200 rpm for a certain time.

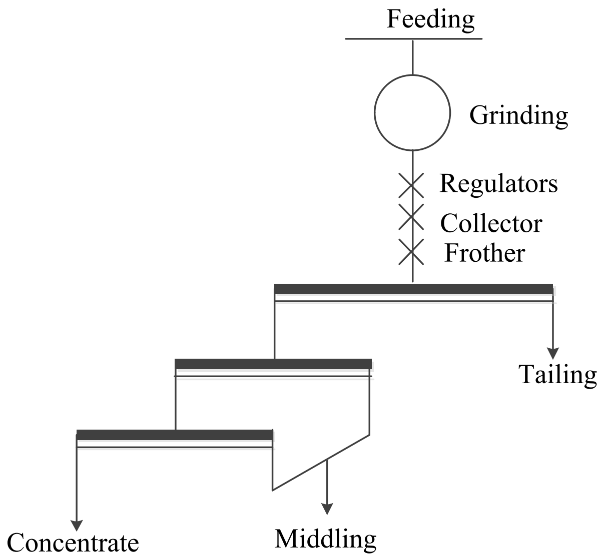

Figure 1. Flotation flowsheet

The flotation reagents had been added in the following order: depressants, collectors, before adjust the pH to a certain value by soda ash or hydrochloric acid as shown in Table 1, which presents the experimental conditions of bench flotation tests. In addition, the signs of Conc., Mid. and Tail. In the results from the flotation tests mean the concentrate, the total middlings included middling I, II and III and the total tailings involving the tailings from the flotation tests and the slime from hydro-cyclone if scrubbing was used before flotation tests.

3 Results and discussions

3.1. Size distribution

Figure 2 shows the distribution of the particles copper oxide in the different size fractions of the head-feed ore samples without grinding. As can be seen, most of copper oxide minerals distribute in the relatively coarse fractions, such as more than 80% of copper oxide minerals at the fraction of +74 μm, especially about 50% of copper oxide mineral sat the fraction of +210 μm, which indicated that it is necessary to grind the sample to ensure the reasonable liberation of value minerals before the bench flotation tests are conducted.

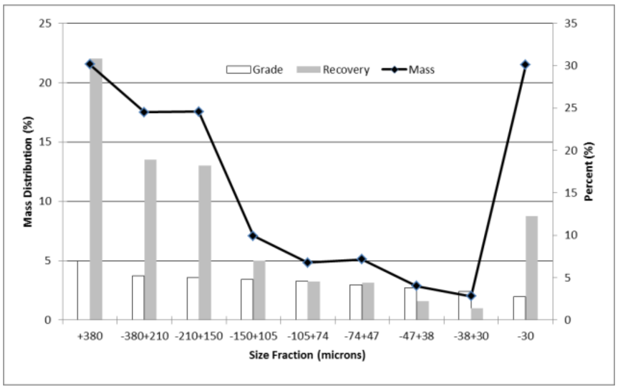

Figure 2. Size-assays, mass and Cu distributions of sample at different size fractions

Figure 3 presents the distribution of the copper oxide minerals at different size ranges at 200 mesh 73%, which indicated that a sharply increase in the mass and recovery either at the fraction of -30 μm or -74+30 μm. In the meanwhile, the low content of Cu in the fraction of -30μm may be possible to remove the slime by scrubbing effectively which can remove 30% slime from the head feed to flotation at a loss of about 13% of Cu in the slime.

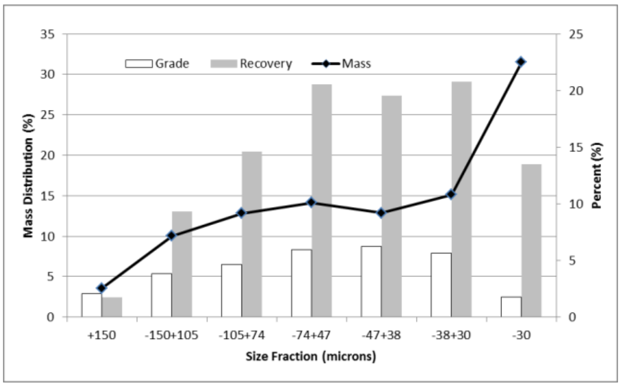

Figure 3. The distribution of the copper oxide minerals at different size ranges at 200 mesh 73%

3.2 De-sliming by hydro-cyclone

In order to remove the slime, de-sliming tests were carried out. Size analysis of the underflow and overflow from FX 25-PU Hydro-cyclone by dry and wet-sieving had been presented in figue 4. It was noted that only 28% of Cu and almost half of yields of feed distributed in the overflow. Also, -38μm size fraction is the main mass in the overflow while -105μm ～ +30μm size fraction is the main mass in the underflow. The de-sliming greatly reduces the fine mud, and create a good condition for subsequent flotation of underflow.

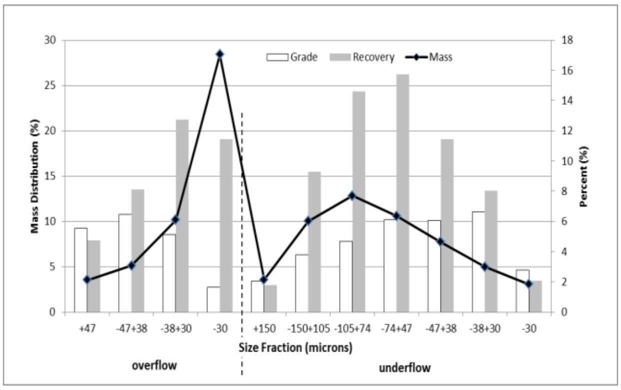

Figure 4. The size distribution of the underflow and overflow by de-sliming with FX 25-PU Hydro-cyclone.

3.3 Flotation

The flotation results without de-sliming was shown in Figure 5, which provides the grade and recovery of Cu in the concentrate, midding and tailing. As shown in Figue. 5, this illustrates the unsatisfied results (Cu grade of 18.21% and recovery of 59.25%) had been obtained. The better results (26.65% grade of Cu at 58.24% recovery) had been obtained by de-sliming with FX 25-PU Hydro-cyclone before flotation (show in Figure 6). De-sliming exhibited powerful effect on rising the grade of copper concentrate and little effect on the recovery of Cu. Therefore, it could be an efficient measure before flotation by hydro-cyclone.

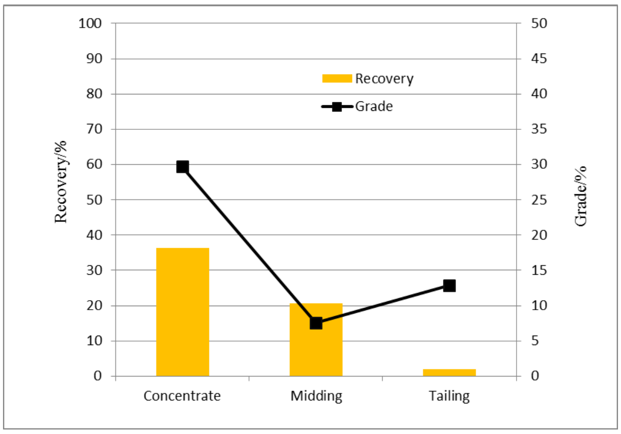

Figure 5. The flotation results without de-slimling

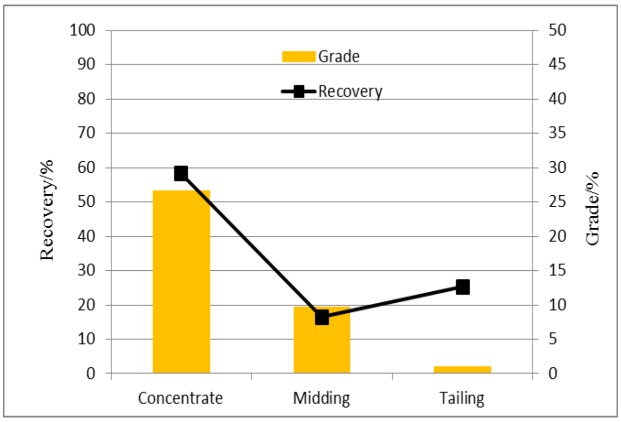

Figure 6. The flotation results of underflow by de-sliming with FX 25-PU Hydro-cyclone

3.4 Reagent consumption

The reagent consumption results with or without de-slimling before flotation was shown in figue 7. The flotation reagents consumption with de-sliming is much lower than without de-sliming, especially the amount of sodium sulphide and amyl xanthate. A hydro-cyclone had been introduced to pre-concentrate the oxide ore by scrubbing the slime before flotation reducing the dosages of sodium sulfide from 2.5 Kg/t to 1 Kg/t, which saving reagent consumption greatly and improving the beneficiation indexes.

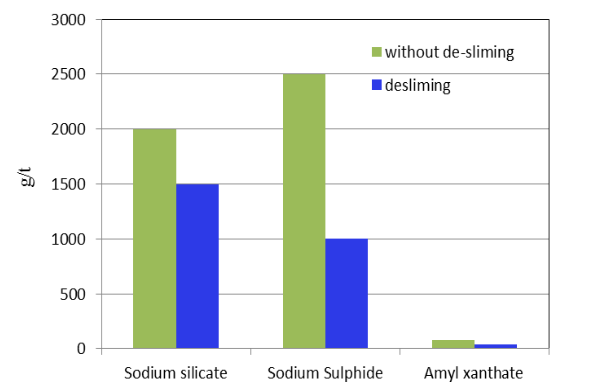

Figure 7. The reagent consumption results with or without de-slimling

4 Conclusions

(1)An increase of Cu in the concentrate from 18.21% to 26.65% at saving about 1/2th original dosages of sodium sulphide and amyl xanthate was obtained by scrubbing.

(2) The consumption of sodium sulphide may be very sensible to the amount of slime in the pulp, so may sodium silicate and collector, which all reduce the dosages after de-sliming.

Acknowledgments

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