



Cu–S flotation separation via the combination of sodium humate and lime in a low pH medium

Jianhua Chen^{a,*}, Yuqiong Li^b, Ye Chen^a

^a College of Resources and Metallurgy, Guangxi University, Nanning 530004, China

^b School of Chemistry and Chemical Engineering, Guangxi University, Nanning 530004, China

ARTICLE INFO

Article history:

Received 27 July 2010

Accepted 23 September 2010

Available online 20 October 2010

Keywords:

Froth flotation

Flotation depressants

Sulfide ores

ABSTRACT

The flotation separation of chalcopyrite and pyrite was studied in the presence of sodium humate. The results of flotation tests indicated that pyrite can be selectively depressed by sodium humate, and the activity of sodium humate was strongly affected by the pH of the pulp. At high pH values, pyrite was strongly depressed by sodium humate; however, the content of chalcopyrite was not affected. Ore flotation tests were successfully conducted in the laboratory and at the Dexing Copper Mine by applying sodium humate as a pyrite depressant. By adding 40–60 g/t of sodium humate to the pulp and adjusting the pH to 10–10.5 with CaO, a concentrate with a Cu content of 24% was obtained without reducing the Cu recovery rate. In addition, the dosage of CaO was reduced, and the recovery of Au, Ag and Mo in the copper concentrate was enhanced due to the reduced pH of the pulp. The zeta potential, adsorption of xanthate and contact angle of the mineral surface were measured, and the results from surface measurements indicated that there was a strong hydrophilic interaction between sodium humate and the surface of pyrite. Moreover, the results revealed that the interaction between sodium humate and chalcopyrite was weak. Infrared (IR) spectra of pyrite and sodium humate were obtained, and the results indicated that sodium humate was chemically adsorbed on the surface of pyrite.

© 2010 Elsevier Ltd. All rights reserved.

1. Introduction

The Dexing Copper Mine is the largest porphyritic copper mine in China, and the main sulfide minerals observed at the mine are chalcopyrite and pyrite. In addition, the ore also contains Mo, Au and Ag. In industry, chalcopyrite and pyrite are recovered, and Mo, Au and Ag are enriched in the copper concentrate. When only a primary grinding stage is applied to the pulp, the copper content of the concentrate is very low (10–12%); thus, the rougher concentrate must be subjected to a second grinding stage (regrinding) in order to increase the content of Cu. Although a copper content of 24% can be attained after two grinding stages, a large amount of lime (CaO) must be added to depress the pyrite in the separation of Cu–S circuit (5–6 kg/t CaO versus crude ore; 70–80 kg/t CaO versus Cu–S bulk concentrate), which increases the alkalinity of the pulp. As a result, the recovery of Mo, Au and Ag in the copper concentrate is reduced, and the recovery of pyrite from the circuit tailing is difficult. To improve the recovery of Mo, Au and Ag in the copper circuit and the pyrite recovery from the copper circuit tailing, the amount of CaO used in the separation of Cu–S must be reduced.

Organic depressants are diverse, readily available and cost-efficient materials, and they have attracted a considerable amount of attention. For instance, dextrin (Liu and Laskowski, 1989; Bolin and Laskowski, 1991; Drzymalaa et al., 2003) has been used in the separation of chalcopyrite and galena, and thioglycolic acid has been used as a chalcopyrite depressant in the separation of Cu–Mo bulk concentrate (Nagaraj et al., 1986; Poling and Liu, 1987). Moreover, Ansari and Pawlik (2007a,b) studied the floatability of chalcopyrite and molybdenite in the presence of lignosulfonates.

Sodium humate is the salt of humic acid and can be extracted from Leonardite. Due to its low price and excellent chemical and electrochemical properties, sodium humate has been used for a variety of different applications. For instance, sodium humate has been used as a scavenger of toxic metals in wastewater treatment, as a mud adjuster in oil drilling and as an additive in the food and fertilizer industries. Moreover, the results of the present study indicate that sodium humate can be used as a pyrite depressant in the separation of chalcopyrite and pyrite at pH values lower than usual for pyrite depression, and the amount of CaO added to the concentrate can be significantly reduced.

In this paper, the floatability of chalcopyrite and pyrite in the presence of sodium humate was studied to achieve Cu–S separation in a medium with reduced alkalinity. The zeta potential, contact angles of minerals and the adsorption of xanthate on the mineral surface were measured. In addition, an infrared (IR) study

* Corresponding author.

E-mail address: jhchen@gxu.edu.cn (J. Chen).

was conducted to investigate the interaction of sodium humate and pyrite.

2. Experimental

2.1. Materials

Chemical grade ethyl xanthate and butyl xanthate were provided by the Zhuzhou Flotation Reagents Factory in Hunan Province. Sodium humate was obtained from the Pingxiang Dewei Humic Acid Chemical Factory of Pingxiang City (Jiangxi Province), and elemental analyzes indicated that the sodium humate contained 51.30% C, 3.74% H, 2.38% N and 42.58% O. Fig. 1 illustrates the molecular structure of humic acid. As shown in the figure, sodium humate contains many functional groups, including carboxyls, phenols, amino groups, quinones and condensed aromatic rings, which play an important role in the chemical properties of sodium humate.

Samples of pyrite and chalcopyrite were obtained from the Dexing Copper Mine in Jiangxi Province, China. High purity samples were hand-picked from the mine, and a chemical analysis revealed that the chalcopyrite content of the material was 95.2% and the pyrite content was 96.3%. The pyrite was dry-ground in a porcelain ball mill and dry-screened to obtain $-0.09 + 0.06$ mm particles. With a similar method, $-0.13 + 0.09$ mm chalcopyrite particles were obtained.

Ore samples were obtained from the north and south hills of the Dexing Copper Mine, and the results of chemical analysis are shown in Table 1. According to the results obtained from the analysis of the mineralogical phase, the main sulfide minerals in the ore were chalcopyrite and pyrite, and the main gangue minerals were silicates.

2.2. Flotation tests

Flotation tests on single minerals were carried out in a Hallimond tube. Prior to the test, the sample was cleaned with super-sonic waves, and 1.0 g of the material was used in each test. The samples were conditioned with xanthate for 5 min, and sodium humate was added to the tube. The flotation time was set to 3 min in all of the single-mineral experiments.

Table 1

Elemental content in % by chemical analysis.

Species	Cu	S	Fe	Mo	As	SiO ₂	Ag ^a	Au ^a
Content	0.482	1.667	3.81	0.009	0.0068	68.74	1.20	0.274

^a Unit in g/t.

The ores were tested in a XFG Single-trough flotation machine at effective volumes of 0.25 L, 0.5 L and 1.0 L, and the flowsheet is shown in Fig. 2.

2.3. Analytical tests

The wet contact angles of the surface of pyrite and chalcopyrite were measured according to the sessile drop method, and a JY-82 goniometer-type contact angle instrument was employed. A zeta potential analyzer produced by Brookhaven Instruments Corporation was used to measure the zeta potential of the mineral surface. A dual-wavelength/double-beam recording spectrophotometer (UV-3000) was used to detect xanthate adsorption to the mineral surface at $\lambda_{\max} = 301\text{--}303$ nm. Infrared (IR) spectra of pyrite and sodium humate were obtained with a FT-IR-8400S spectrometer.

3. Results and discussion

3.1. Flotation tests on single minerals

The pH of the pulp was adjusted to 9.5 with NaOH, and the effects of sodium humate on the flotation recoveries of pyrite and chalcopyrite were determined (see Fig. 3). The results indicated that the flotation recovery of pyrite decreased gradually with an increase in the sodium humate concentration. However, as the concentration of sodium humate increased from 0 to 50 mg/L, the recovery of chalcopyrite remained relatively constant.

As shown in Fig. 4, the pH of the pulp was adjusted with NaOH or CaO in the presence of a constant concentration of sodium humate, and the recovery of chalcopyrite and pyrite was evaluated as a function of the pH. The results indicated that the pH of the pulp had a stronger effect on pyrite recovery than chalcopyrite recovery. Moreover, the depression of pyrite was enhanced when CaO was used to adjust the pH of the pulp, while the combination

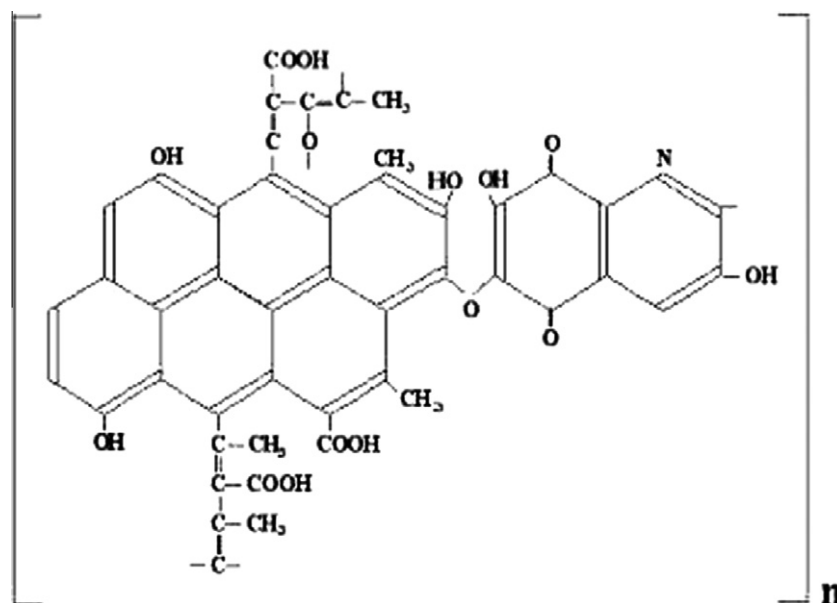


Fig. 1. Structure of the humic acid fragment.

Download English Version:

<https://daneshyari.com/en/article/234195>

Download Persian Version:

<https://daneshyari.com/article/234195>

[Daneshyari.com](https://daneshyari.com)