

Improving the recovery of fine auriferous pyrite using iso-amylxanthate and its isomeride



Dongfang Lu^{*}, Yuehua Hu, Qiang Li, Shengli Yu, Tao Jiang, Wei Sun, Yuhua Wang^{*}

School of Minerals Processing and Bioengineering, Central South University, Changsha, China

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ABSTRACT

The beneficial effects of the synergy between two reagents were realized long time ago. The purpose of using a mixture of collectors is to increase both the recovery and selectivity. In this work, sodium iso-amylxanthate (SIAX) and its isomeride (Y89), having different molecular structures, were used. The separation performance of these collectors were investigated at ratio varies of SIAX and Y89. The results showed that a better recovery of auriferous pyrite was observed with collector mixture comparing to use collector alone. There exist an optimal mass ratio between SIAX and Y89, and it is 1:2. The adsorption measurements of collector mixture and single collector were investigated at pH = 9, indicated that adsorption density of collector on auriferous pyrite surface was improved when collector mixture was used. Infrared spectral analysis suggested stretching vibration peaks from chemical adsorption were increased with using collector mixture. At an optimal mass ratio 1:2 of SIAX:Y89, an Au concentrate assaying 12.79 g/t was produced with an Au recovery of 84.24% from a feed containing only 3.44 g/t Au after one roughing stage. The advantage of this collector mixture can improve the recovery of auriferous pyrite at the same collector consumption, and this collector mixture has great potential for industrial application.

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1. Introduction

Gold is more commonly recovered together with sulfide minerals, and it is intimately associated with sulfides as fine unliberated grains (solid solutions or inclusions), or with barren and hydrophobic sulfides. The most commonly known gold bearing sulfides are the pyrite and arsenopyrite (Makanza et al., 2008).

All sulphhydryl collectors commonly are used in sulfide flotation, such as xanthates, dithiophosphates (DTPs) and dithiocarbamates (DTCs). These collectors are heteropolar and have aralkyl chain which is hydrophobic, as well as an ionized group containing sulfur, which reacts with water and is hydrophilic. The length and structure of this alkyl chain appears to have an effect on the behavior of the collector (Rao et al., 2003). Under certain redox conditions, both the xanthate and the dithiophosphate form their respective dimers, viz. dixanthogen and dithiophosphatogen, the latter less readily.

From the foregoing review of mechanisms, clearly any single collector will less than satisfactory in recovering auriferous pyrite because that fine particles have low collision efficiencies with gas

bubbles and float slowly (Bravo et al., 2005). The problem of recovering fine auriferous pyrite particles (<38 μm) continues to be a challenge for researchers working in this area (Valderrama et al., 1998; Forrest et al., 2001). Furthermore, mixtures of collectors are commonly used in flotation, and a range of performance benefits can be obtained (Lotter and Bradshaw, 2010; Chrysosoulis et al., 2004). This is a synergistic effect (Bradshaw, 1997). The synergistic enhancement of flotation performance observed has largely been attributed to improved adsorption characteristics of the collector mixture on the mineral surface as compared to those of the pure collectors. The improved adsorption characteristics would result in improved floatability by increasing the bubble-mineral attachment tenacity which would result in less mineral detachment and elutriation. The frother-collector interactions may also be increased resulting in stronger mineral-bubble attachment. Hangone et al., 2005, reported that the mixed collector system produced a more stable froth because of the increased hydrophobicity and wider range of particle sizes held in that froth.

For example, testwork reported by Glembotskii, 1958, showed that when a weaker collector is added to a stronger collector, the mixture results in a recovery gain of 2–5% relative to the single strong collector system. Glembotskii explained that the consistent better performance by the mixed collectors was due to the synergy effect generated between the two different collectors. He claimed

^{*} Corresponding authors.

E-mail address: ludongfang@csu.edu.cn (D. Lu).

that the larger the difference in structure and composition, the larger the synergy effect. Similarly, Alim et al., 2012, showed that mixtures of ethyl xanthate with diethyl dithiophosphate or ethyl dithiocarbamate resulted in large improvements in the flotation rate and recovery with pure galena in a microflotation cell. There have been numerous reports on flotation of auriferous pyrite using the mixture of the two different collector. However, a mixture collector of xanthate and its isomeride has not been extensively studied.

In this study, the flotation of fine auriferous pyrite particles (<38 μm) was studied with a collector mixture of Sodium iso-amylxanthate (SIAX) and its isomeride (Y89). The mechanisms underlying the mineral-reagent interaction were further investigated by adsorption measurements and infrared spectral analysis. The results provide a reference for effectively recovering fine auriferous pyrite before smelting.

2. Materials and methods

2.1. Pure minerals and reagents

Pure auriferous pyrite, sericite, quartz and dolomite were sourced from Xinjiang, China. X-ray powder diffraction data confirmed that the auriferous pyrite, sericite, quartz and dolomite were 97%, 95%, 98% and 96% pure, respectively. According to the results of chemical analysis, the content of Fe, S and Au was 42.37%, 45.33% and 290.64 g/t in pure auriferous pyrite, respectively. Molecular structure of auriferous pyrite is $\text{FeS}_{1.863}$. X-ray diffraction of auriferous pyrite, sericite, quartz and dolomite are shown in Fig. 1. The $-38 \mu\text{m}$ fraction was used in the flotation tests.

The sources of flotation reagents were as follows: analytical grade sodium iso-amylxanthate (SIAX) and Y89 were from Zhuzhou flotation reagents factory, Hunan, China. The molecular of col-

lectors are shown in Fig. 2. The pH was adjusted with NaOH or HCl stock solutions. Deionized water with a resistivity of more than $18 \text{ M}\Omega \times \text{cm}$ was used for all experiments.

2.2. Flotation experiment

Single mineral flotation tests were carried out in an XFG flotation machine with a 40 mL plexiglass cell, at an impeller speed of 1800 rpm. The mineral suspension was prepared by adding 3.0 g of minerals to 40 mL of distilled water. The pH of the mineral suspensions were first adjusted by adding NaOH or HCl. Once the desired reagent was added, the suspension was agitated for 3 min and the pH was measured before flotation. The flotation lasted for 4 min before the products were collected, dried, and weighed. The recovery was calculated based on the weights of the dry products obtained.

2.3. Adsorption measurements

The adsorption measurements were completed on a TU-1810 ultraviolet visible spectrophotometer (Purkinje General, Beijing, China). The curves represent the averages of five measurements, and the error bars are based on the standard deviation. Two grams of auriferous pyrite powder and 40 mL of distilled water were transferred into an Erlenmeyer flask. The particle size of auriferous pyrite powder was less than $38 \mu\text{m}$. After the reagent addition to the solution, the Erlenmeyer flask was stirred on a magnetic mixer for 1 h, allowing the adsorption process to reach equilibrium. The solution was centrifuged and filtered, and the supernatant was collected for UV spectrometry analysis. According to the residual concentration of the reagent remaining in the solution, the adsorption of the reagent on the mineral surface can be calculated as follows:

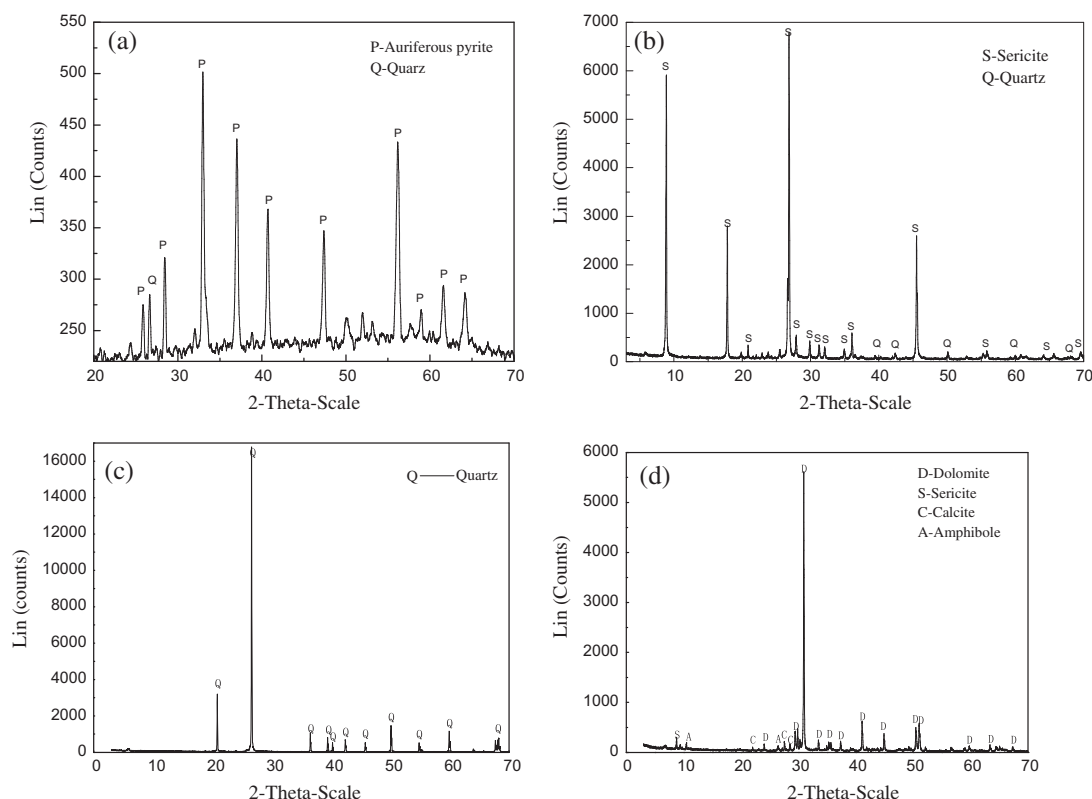


Fig. 1. X-ray diffraction of auriferous pyrite, sericite, quartz and dolomite.

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