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Influence of sodium 2,3-dihydroxypropyl dithiocarbonate on floatability of chalcopyrite and galena

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Abstract: Sodium 2,3-dihydroxypropyl dithiocarbonate (SGX), which contains —OH and —CSS— in the molecule, was used to explore selective depression of galena from chalcopyrite in the flotation tests with ammonium dibutyl dithiophosphate (DDTP), and zeta potential and adsorption measurements were performed to study the interaction between SGX and minerals. The flotation tests of single minerals show that SGX has slight activation on chalcopyrite and strong depression on galena in the whole pH range. With SGX dosage increasing, the recovery of galena decreases rapidly, while that of chalcopyrite increases slightly. At pH=6, the copper grade and recovery of concentrate are 29.52% and 82.15% respectively when mixture of two minerals is tested. Zeta potential and adsorption measurements indicate that SGX has strong adsorption on galena and slight adsorption on chalcopyrite.

Key words: sodium 2,3-dihydroxypropyl dithiocarbonate; depression; flotation; chalcopyrite; galena

1 Introduction

In the past long time, inorganic compounds were mainly used as depressants in the separation of complex sulfide ores, which made many problems in the application, such as poor selectivity, high dosage and unfriendliness to the environment. With the development of society, because of the advantages of better selectivity, structural diversity and environmental friendliness of organic compounds, many scholars mainly focused on the study of organic depressants. XIONG et al [1], and HE et al [2] indicated that sodium glycerine xanthate (SGX) depressed arsenopyrite and pyrite strongly, but had a slight depression on marmatite by butyl xanthate. Zeta potential and adsorption isotherm showed that SGX adsorbed more strongly on arsenopyrite and pyrite than marmatite.

LIU et al [3] found that ferrochrome lignin (FCLS) depressed chalcopyrite slightly, but depressed galena strongly. IR spectrum analysis indicated that FCLS adsorbed strongly on galena while the absorption on chalcopyrite was weak. DONG [4] showed that mixtures of carboxymethyl cellulose, silicate sodium and sodium sulfite could depress galena well, but depress chalcopyrite slightly. QIN et al [5] indicated that sodium pyrophosphate (SPH) separated chalcopyrite from galena in acidic condition by O-isopropyl-N-ethyl thionocarbamate. The infrared spectral analysis indicated chemical adsorption between SPH and galena. WEI [6] had synthesized a new organic depressant PPD, and found that PPD depressed galena but activated chalcopyrite, because PPD anion could react with Pb^{2+} to produce hydrophilic compound, which covered on the surface of galena and hindered the collector to adsorb on the surface of galena, and the interaction was chemisorption. BULATOVIC and WYSLOUIIL [7] reported that RB−SO_2-starch could separate chalcopyrite from galena by depressing galena. Some researchers [8−10] indicated that dextrin selectively depressed galena while chalcopyrite was floated with xanthate as the collector.

HUANG et al [11,12] found that chitosan, a linear structure of *β*-(1–4)-linked *D*-glucosamine, partially deacetylated from the *β*-(1–4)-linked N-acetyl-*D*-glucosamine, depressed chalcopyrite while galena was floated by xanthate. Chitosan−metal ions adsorption test, TOF-SIMS and X-ray photoelectron spectroscopy (XPS)

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were employed to study the interaction between chitosan and minerals, and the TOF-SIMS measurements indicated that chitosan adsorbed slightly on galena but adsorbed largely on chalcopyrite.

Because of the similar floatability of chalcopyrite and galena, the separation of two minerals is difficult. In this work, sodium 2,3-dihydroxypropyl dithiocarbonate (SGX) was studied on two minerals at different pulp pH values by ammonium dibutyl dithiophosphate (DDTP), and zeta potential and adsorption isotherms measurements were used to discuss the interaction mechanism between SGX and minerals.

2 Experimental

2.1 Materials

The mineral sample of chalcopyrite was obtained from Jiujiang, Jiangxi Province in China, and galena was obtained from Outer Mongolia. The size of sample used in flotation tests was ≤0.1 mm. Chemical composition analysis of two minerals showed that the purities of chalcopyrite and galena were 95.2% and 99.3% respectively.

2.2 Reagents

Ammonium dibutyl dithiophosphate and terpenic oil were industrial grade products from Tieling Flotation Reagents Factory, Liaoning, China. Sodium 2,3-dihydroxypropyl dithiocarbonate was synthesized in our lab. Analytical grade HCl or NaOH was used to adjust the pH value of flotation pulp.

2.3 Flotation tests

For each flotation test, 2 g of sample was taken and ultrasonically washed for 5 min to remove any possible oxides on the mineral surface. The suspension liquid was settled, and then the upper liquid layer was decanted and the remaining part was floated, after that the floated and non-floated fractions were filtered, dried and weighed for the recovery calculation. The flotation tests were carried out in a microflotation cell with a 35 mL effective volume.

2.4 Zeta potential measurement

Nano-ZS90 apparatus (Made in England) was used to measure zeta potential of minerals. First of all, the pure minerals were ground to be smaller than 5 μm in the agate mortar for the tests. Then, a small amount of mineral powder was added to a beaker with 50 mL distilled water and cleaned for 5 min with ultrasonic generator to remove the oxidation film. At last, the reagents were added to the solution, and the suspension was stirred for 3 min with a magnetic stirring apparatus.

2.5 Adsorption isotherms measurement

Adsorption isotherms measurement was photolab 6600 (Made in German). The sample was taken into the vessel and ultrasonically washed for 5 min, after that the washing solution was decanted and added 30 mL distilled water. Then, a certain dosage of reagent was taken to the vessel and ore pulp was stirred for 1.5 h. The hypothesis was that the depleted dosage of reagent had been adsorbed onto the mineral surface. At last, the mineral solution was centrifuged, and the supernatant was used to measure the residual reagent concentration [13,14].

3 Results and discussion

3.1 Flotation of pure minerals

The effects of pH on flotation of chalcopyrite by the collector DDTP (6.5 mg/L) with or without SGX (1.9 g/L) as a function of pH value are shown in Fig. 1. As seen from Fig. 1, the recovery of chalcopyrite is above 85% without SGX depressant in the whole range of pH, and increases slightly in the presence of SGX. The increment of chalcopyrite recovery gets slowly with the increase of pH.

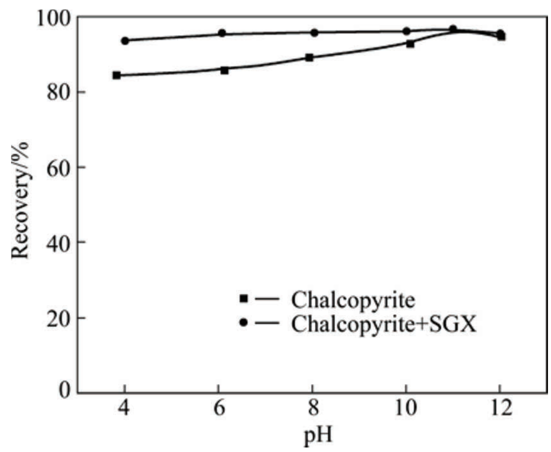

Fig. 1 Effects of pH on flotation of chalcopyrite by collector DDTP (6.5 mg/L) with or without SGX depressant (1.9 g/L)

The recovery of galena by the collector DDTP (6.5 mg/L) with or without SGX depressant (1.9 g/L) as a function of pH value is described in Fig. 2. It is shown that the recovery of galena is maintained at about 80% without SGX depressant when pH value is below 10; it is dropped to 55% at pH=11. In the presence of SGX depressant, the recovery of galena decreases slightly with pH value increasing and that is about 28% and 15% respectively when pH values are 4 and 11. According to Refs. [2,15], this is maybe attributed to the competition mechanism between DDTP and SGX on the mineral surface. Hydrophilic groups of SGX are adsorbed on the surface of galena to form a hydrophilic film, which