



The flotation separation of pyrite from pyrophyllite using oxidized guar gum as depressant



Kaile Zhao^{a,b,1}, Wu Yan^{a,*}, Xiaohui Wang^{a,1}, Bo Hui^a, Guohua Gu^{b,*}, Hui Wang^b

^a Institute of Multipurpose Utilization of Mineral Resources, Chinese Academy of Geological Sciences, Chengdu, 610041 Sichuan, China

^b School of Minerals Processing and Bio-engineering, Central South University, Changsha, 410083 Hunan, China

ARTICLE INFO

Article history:

Received 8 November 2016

Received in revised form 9 January 2017

Accepted 22 February 2017

Available online 24 February 2017

Keywords:

Pyrite

Pyrophyllite

Flotation depressant

Oxidized guar gum

ABSTRACT

The flotation separation of pyrite from pyrophyllite using oxidized guar gum (OGM) as depressant has been studied through flotation tests, adsorption and FTIR spectra measurements. Flotation tests on a single mineral and mixed binary minerals show that the reagent schedule of depressant OGM 50 mg/L, collector SIBX (sodium isobutyl xanthate) 0.2 mmol/L and frother DIDE (diethyleneglycol dimethyl ether) 7 mg/L at pH 6 could achieve selective flotation separation of pyrite from pyrophyllite (a concentrate with S grade of 48.0% and recovery of 86.9% was achieved by the mixed binary minerals flotation), which indicate that OGM has selective depression effect on pyrophyllite minerals while has little depression effect on pyrite. Adsorption and FTIR spectra measurements illustrate that OGM could absorb more strongly on pyrophyllite surface than on pyrite surface, and the interaction of OGM with the pyrophyllite surface consists of a dominant chemisorptions while the OGM cannot interfere with the FTIR spectrum of pyrite. This is the reason why OGM has excellent depression selectivity for pyrophyllite and negligible effect on pyrite flotation.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

Wufu Mining Corporation consists of two iron sulfide mines, Guangxi Zhuang Autonomous Region, China. The two mines have about 100 million T of pyrite reserves. The sulphur minerals contain averaging 16.41% S, 14.11% Fe, 27.58% Al₂O₃, and 26.65% SiO₂. The ores are mainly composed of 30.12% pyrite, 31.54% pyrophyllite, 19.15% bauxite, 9.33% kaolinite, 3.11% anatase and 0.85% graphite, which are determined by XRD and mineralogical analysis.

Pyrite flotation in Wufu has been difficult due to the presence of large amounts of pyrophyllite minerals. Pyrophyllite is a naturally occurring hydrous aluminum silicate mineral with the molecular formula of Al₂(OH)₂(Si₄O₁₀). Like talc, pyrophyllite is a non-swelling three sheet phyllosilicate, the predominant interlayer bonding forces are van der Waals. Due to this weak interlayer bonding force, the pyrophyllite surface is electrically neutral, which gives rise to natural floatability (Erdemoglu and Sarikaya, 2002; Lu, 1988; Zou, 2008). Therefore, pyrophyllite is a fast floating and easy-sliming mineral. In order to improve the flotation of the pyrite, sodium hexametaphosphate, sodium silicate, guar gum, CMC, starch, foenum-graecum and other agents are used to depress pyrophyllite (Zhao et al., 2015). However, these depressants suffer the disadvantage of limited availability, low performance and

high reagent dosages (high cost). Thus the separation of pyrite from pyrophyllite is still a big problem.

In many flotation plants, the cost of depressants can exceed the cost of any other reagent. Historically, the choice of depressants in flotation has been based on empirical testing. The trend in recent times has been to specifically design polymers for this purpose (Chen et al., 2003). The approach followed has been to tailor the functional group and molecular weight to ensure that the polymer acts appropriately by imparting the correct surface properties on the particular gangue mineral, e.g. inclusion of hydroxyl substituted groups in the polymer to impart hydrophilicity (Beattie et al., 2006). Guar gum has been widely used to depress talc in sulfide flotation (Morris et al., 2002; Shortridge et al., 2000; Wang et al., 2005). Guar gum is a natural electroneutral polysaccharide that shows many advantages over artificial materials and hydroxypropylation, carboxymethylation and oxidation are the most widely-studied modifications for guar gum (Castro et al., 2016; Chen et al., 2012; Frollini et al., 1995; Gong et al., 2011; Shortridge et al., 2000; Zou et al., 2003). In this investigation, the preparation of oxidized guar gum (guar gum was oxidized by hydrogen peroxide) was carried out, and the oxidized guar gum was developed as a depressant by the authors to depress pyrophyllite. The aim of this study is to investigate the efficiency of oxidized guar gum as a depressant in the flotation separation of pyrite from pyrophyllite. The experimental part included single and mixed model minerals flotation tests, and the adsorption mechanism of OGM on both pyrite and pyrophyllite was investigated by adsorption and FTIR spectra measurements.

* Corresponding authors.

E-mail addresses: yan507@126.com (W. Yan), guguohua@126.com (G. Gu).

¹ These authors have contributed equally on the article.

2. Experimental

2.1. Materials

The pure pyrite and pyrophyllite samples were all obtained from Wufu Mining Corporation, Guangxi Zhuang Autonomous Region, China. The minerals content and XRD results of the pure minerals are shown in Table 1 and Figs. 1 and 2, and the chemical analysis results of the pure samples are listed in Table 2. According to chemical analysis and XRD results, the purity of pyrite was 94.6% (49.88% S, 44.47% Fe) and the purity of pyrophyllite was 95.5% (Al_2O_3 31.16%, SiO_2 60.55%). The samples were dry ground (these minerals were ground in a porcelain ball mill with zirconia balls) and screened. The $(-75 + 38)$ μm fraction was used for flotation tests, and repeated ultrasounding and decantation was used to eliminate ultrafines. The -28 μm fraction was used for adsorption and FTIR spectrum measurements. The BET surface area of pyrophyllite in the size fraction -28 μm was determined at 2.13 m^2/g . The pure pyrite samples were stored in a vacuum-desiccator after prepared and washed in ultrasonic bath for 5 min to remove potential oxidation film before each use.

The depressant oxidized guar gum [OGM, MW 8000–10,000, the viscosity of solutions of 1% OGM (by weight) is 500–1000 mPa s] was supplied independently by the IMUMR Flotation Reagents Limited Company. The OGM solutions were prepared by dispersing a known weight of guar gum [the molecular formula of the guar gum is $(\text{C}_6\text{H}_5\text{O}_6)_m \cdot (\text{C}_{12}\text{H}_{10}\text{O}_9)_n$, >92% purity] in cold deionised water, the desired amounts of hydrogen peroxide (H_2O_2 , the weight ratio of hydrogen peroxide to guar gum was 5) were added to the above solutions, and then heating and dissolving them at a temperature of between 90 $^\circ\text{C}$ and 100 $^\circ\text{C}$ (which continued for a total of 120 min). The solution was made up to the required volume by adding deionised water and left to equilibrate overnight. Fresh solutions were prepared every 3 days. Other flotation reagents were sodium isobutyl xanthate (SIBX) and diethyleneglycol dimethyl ether (DIDE) as collector and frother respectively. Potassium nitrate (KNO_3) was used to vary the ionic strength of solution and hydrochloric acid (HCl) and sodium hydroxide (NaOH) were used to regulate the pulp pH. All the reagents used in the tests were of analytical grade. Deionised water was used in all tests.

2.2. Flotation procedure

The following conditioning procedure was used for all flotation tests. The flotation tests were carried out in XFG-1600 type flotation machine (Zhao et al., 2015). Pure mineral particles (3 g) were placed in a plexiglass cell (40 mL), which was then filled with distilled water. After adding the desired amount of reagents (OGM, collector and frother), the suspension was agitated for 5 min and the stable value of pH was recorded before flotation. Pulp pH was measured using a pH meter (PHS-3C). The flotation was conducted for 5 min. The products were collected, dried, and weighed. For single mineral flotation, the flotation recovery was calculated based on the dry weights of the products obtained. For mixed minerals flotation, the flotation recovery was calculated based on yield and S grade between the concentrates and tailings. Baseline flotation tests were repeated to give an indication of the error associated with the flotation recovery values for the experiments, and this is estimated to be $\pm 2\%$.

Table 1

The minerals content of the pure pyrite and pyrophyllite samples.

Samples	Minerals content (mass fraction)/%						
	Pyrite	Pyrophyllite	Chlorite	Montmorillonite	Kaolinite	Diaspore	Anatase
Pyrite	94.61	3.02	1.12	0.59	0.29	0.22	0.15
Pyrophyllite	0.51	95.52	2.85	0.27	0.42	0.21	0.22

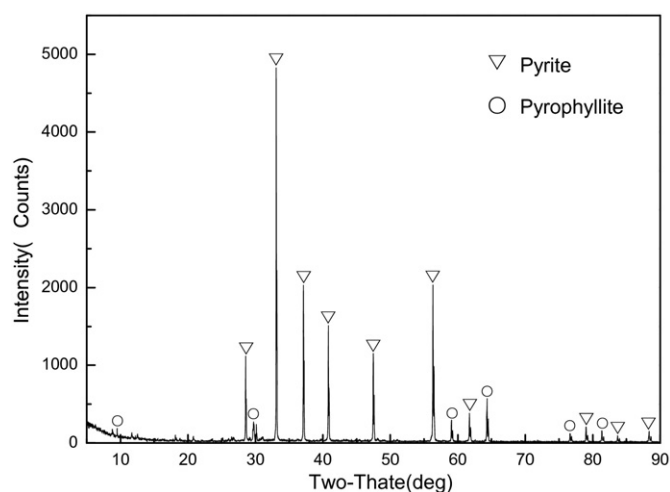


Fig. 1. XRD spectra of the pure pyrite for flotation tests.

2.3. Adsorption experiments

In the adsorption experiments, one gram of pure mineral particles were added to 100 mL distilled water in a 250 mL Erlenmeyer flasks after addition of desired concentration of OGM at pH 6. The suspension was stirred for 30 min. The sample was then centrifuged and the concentration of OGM remaining in the supernatant was measured using the TU1810 UV–Vis spectrophotometer absorbance. It was assumed that the amount of FGM depleted from solution had adsorbed onto the particular mineral phase (Zhao et al., 2015). The errors of the adsorption density were found to be within 0.2 mg/m^{-2} after at least three experiments at each condition, the average values were reported.

2.4. FT-IR spectra experiments

The following procedure was used for FTIR spectra experiments. The untreated pure mineral particles were used as a reference spectrum. One gram of pure mineral particles were added into 30 mL aqueous solution with or without 50 mg/L depressant at pH 6, and ultrasound for 5 min. Next, the solutions were magnetically stirred for 40 min and settled for another 40 min. After filtering, a vacuum drying method was used to obtain the solids. Fourier transform infrared (FT-IR) spectra of solids were recorded using a FT-IR spectrometer at room temperature (25 ± 1 $^\circ\text{C}$).

3. Results and discussion

3.1. Flotation test results

The effect of pH on the flotation recovery of pyrite and pyrophyllite using OGM/guar gum as depressant were studied by single mineral flotation tests and the results are shown in Fig. 3. The result in Fig. 3 shows that the flotation recovery of pyrite was very high ($>88\%$) in the pH range of 3–9, with increased in pH, pyrite recovery decreased due to formation of iron oxy-hydroxy species on its surface (Huynh et al., 2000). The pure pyrophyllite had a good natural floatability, and the recovery of pyrophyllite ($>90\%$) did not change across the entire pH range,

Download English Version:

<https://daneshyari.com/en/article/4769423>

Download Persian Version:

<https://daneshyari.com/article/4769423>

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